

Economic Integration and Labor Market Institutions

Worker Mobility, Earnings Risk, and Contract Structure

by

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Abstract

This paper investigates the effects of labor market integration, in the form of worker mobility, in a model with long-term labor contracts that lead to wage rigidities and unemployment. Increased mobility leads to more flexible labor market institutions in which firms can more easily vary the level of employment in response to fluctuations in demand. Economic integration is potentially Pareto-improving but, in the absence of a system of compensation, workers are harmed by greater labor mobility while the owners of firms benefit from higher profits.

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I. Introduction

Recent labor market experience in the US and Europe presents striking contrasts. While the overall level of unemployment in Europe has been somewhat higher than that of the US, the most remarkable difference between the two is that the rate of unemployment differs much more widely among EU countries than among regions within the US. Numerous analysts (e.g., Burda and Mertens (1995) or Bertola and Ichino (1995)) draw a sharp distinction between flexible “US-style” and rigid “European-style” labor market institutions, in which the former are characterized by relatively little regulatory control, high interregional and intersectoral mobility of labor, and wage flexibility, while the latter exhibit strong regulatory constraints, collective bargaining arrangements that limit the ability of firms to adjust employment and wages in the face of changing market conditions, and relatively limited intersectoral and interregional mobility of labor. These institutional differences, it is argued, explain why some European countries have suffered from persistently higher unemployment than others. In the US, rapidly-growing industries and regions can, with relative ease, attract workers from industries and regions that are experiencing job losses; by contrast, it appears that European labor market institutions prevent wage rates from adjusting downward in industries and regions experiencing weak demand for labor, causing employment levels to fall, while limited mobility of workers among sectors and regions prevents those who lose (or fail to obtain) jobs in their home countries from finding employment where economic conditions are more favorable.

A number of well-known models of labor markets, such as the “insider-outsider” model, models of unionized labor markets, implicit contract models, and job-matching models, have been proposed to explain the existence of labor market rigidities that can give rise to unemployment and to analyze the implications of alternative economic policies within specific institutional settings. In particular, with respect to Europe, the analytical and policy debate has focused on the issue of how economic policy can change labor market “institutions” in ways that might alleviate unemployment. Generally speaking, however, the literature has regarded as exogenously given what one might refer to as the fundamental or “intrinsic” determinants of labor market rigidity. One of these is the cost of adjustment in the labor market, and specifically the cost that workers incur in switching jobs. For example, the US market seems to exhibit considerable wage flexibility. This flexibility, i.e. the comparative ease with which wages can be adjusted, might be expected to give rise to large wage differentials among sectors and regions. Indeed, real wages certainly are not identical for all US workers with given skill and other attributes. But – focusing for concreteness on job switching that involves movement among spatially-distinct labor markets

– there is a high degree of mobility among regions in the US, as evidenced by persistently high rates of internal migration, so that wage differentials are eroded by migration from low- to high-wage areas. Suppose instead that internal migration in the US were more costly, as is true in Europe. In this case, if we continue to regard as exogenous those labor market institutions that determine the degree of wage flexibility, we would expect to observe large variations in wages among regions. However, one might then also expect that workers facing highly variable wages would seek to protect themselves from a much higher level of wage risk than that faced by US workers, and that labor market institutions themselves would then take a rather different form, for instance by developing various “European-style” rigidities. In turn, this would give rise to greater interregional variations in unemployment rates, as firms experiencing adverse market conditions would respond by reducing employment while workers without jobs in one region would be less able to find alternative employment elsewhere.

These considerations suggest that the labor market institutions that are believed to account for the varying experiences in US and European labor markets ¹ should be viewed, at least in part, as endogenously dependent upon underlying determinants of worker mobility, and not only upon economic policies such as labor and social regulation. Or, indeed, we might say that economic policies such as labor and social regulations, in addition to private-sector contracting and bargaining practices in labor markets, are themselves part of the institutional structure to be explained. ²

The present analysis provides a possible explanation for the observed correlation between worker mobility and labor market institutions that give rise to or help to sustain wage rigidities. In doing so, we build upon and extend the implicit contract model originated by Baily (1974), Gordon (1974), and Azariadis (1975) where wage rigidities and layoffs emerge as an equilibrium feature of labor contracts between risk-averse workers and risk-neutral employers. We interpret the implicit contract model more broadly than is usual however, thinking of the implicit contract not only as a contract between a particular firm and its workers but rather as a body of labor market institutions encompassing and supporting the contracts struck between individual firms and workers. Unlike previous analyses, we explicitly allow for workers who are laid off because of adverse local shocks to move, at a cost, to other regions in which labor market conditions are more favorable. Thus, we use the implicit-contract model to explain not just “layoffs” but “turnover”, or, expressed in slightly different terms, to explain not only the reallocation of workers from employment to leisure (or unemployment) but the reallocation of workers from one employer to another. ³

¹ See Nickell (1997) and Nickell and Layard (1999) for recent surveys of labor market institutions and their impact on unemployment.

² In this respect our approach is rather similar to that of Agell (1999, 2000).

³ Gottfries (1992) emphasizes that traditional implicit-contract models focus exclusively

By allowing for the possibility that workers from outside of a region may enter and find employment there, the analysis integrates elements from “inside-outsider” models (Lindbeck and Snower (1988)) into an implicit-contract framework.⁴ In comparison to previous literature on migration, our model insists neither on perfect wage flexibility that guarantees that labor markets always clear nor (as in the Harris-Todaro (1970) tradition) on exogenously-given wage rigidities that insure that labor markets always exhibit unemployment. Rather, it is the fundamental determinants of worker mobility, as represented in the model by some intrinsic cost of migration, that determine the structure of labor contracts and, in turn, the extent of wage rigidity and unemployment that is observed in equilibrium.

The paper is organized as follows. Section II begins by presenting the basic implicit-contract model that underlies the analysis. In Section II.A we develop a standard implicit contract model, which we refer to as the “autarky” case, where migration costs are prohibitively high so that workers cannot move among regions. Section II.B begins the analysis of worker mobility by considering how implicit contracts are determined within a single region within a system of regions. Here, it is assumed that migration costs are no longer prohibitively high so that, in the event of favorable demand shocks, it is possible for workers from other regions to immigrate or, in the event of adverse demand shocks, workers can emigrate and obtain jobs in regions with high labor demand.

Our primary interest, however, is not in the structure of equilibrium labor contracts in a single jurisdiction, but rather in the way that mobility influences labor market conditions in an entire *system* of jurisdictions. In this, we differ from Ethier (1985), who (to our knowledge) is the only other author to study migration in an economy where at least some workers are subject to implicit contracts. Whereas Ethier assumes that a single jurisdiction faces an infinitely-elastic supply of migrants at an *exogenously-fixed* wage rate, we instead suppose that the immigrants in one labor market are emigrants from another, and investigate how the equilibrium contract structures, levels of unemployment, migration, and wage rates for migrants in all markets are determined simultaneously.⁵ The major analytical contribution of the paper, the task of Section III, is to extend the implicit-contract model to investigate

on layoffs, whereas a great deal of labor-market adjust occurs through hiring; it is therefore important to accommodate both. A number of other studies have discussed the importance of turnover for wage setting and employment; see, e.g., Saint-Paul (1997) and the recent survey by Bertola (1999). (It should be noted, however, that our analysis is not designed to address issues of explicit labor market dynamics, such as duration of unemployment spells.)

⁴ Leslie (1992) in particular argues that implicit-contract and insider-outsider models should be viewed in many respects as complements rather than as substitutes.

⁵ Another critical difference between our analysis and that of Ethier is that we assume that no jurisdiction is sufficiently large to influence world prices for traded goods, whereas Ethier focuses on a single jurisdiction that is a dominant exporter of a single traded good.

wages, employment, layoffs, and migration within an imperfectly-integrated set of regional labor markets necessitates the development of a complete general-equilibrium analysis of the simultaneous determination of contract structures in many regions. We show that there are two possible types of equilibria, one, a “mixed” regime (Section III.A) in which both migration and unemployment are observed, and the other, a “full-employment” regime (Section III.B) in which all workers that are laid off in regions experiencing adverse shocks migrate to other regions and unemployment completely disappears. General-equilibrium comparative-statics analysis shows how labor market conditions such as wage rate and employment levels depend on the degree of labor mobility. As polar extreme cases, labor markets are characterized (Section III.C) by high migration and full labor-market clearing when migration costs are sufficiently low (or zero) and by wage rigidities and unemployment when migration costs are sufficiently high (or prohibitive).

Equipped with these comparative-statics results, Section IV explores the welfare implications of increased economic integration. In particular, we study the effects of reduced migration costs on the distribution of income between workers and the recipients of profit income from firms and on overall economic welfare within the system of jurisdictions. Section V summarizes the main results and discusses some policy implications of the analysis.

II. The Model

Our objective is to present a general equilibrium analysis of the effects of labor market integration in a system of regions, within each of which workers and firms negotiate long-term wage and employment contracts under conditions of uncertainty. The extent of “labor market integration” in the present framework will be parameterized by a variable c which represents the cost incurred by a worker in moving from one region to another. Throughout the paper, we will think of geographic *regions* as a basic unit of analysis. Insofar as we interpret implicit contracts to refer not only to purely private arrangements between workers and firms but also to public-sector policies such as labor-market regulations, a “region” should be considered to be a “jurisdiction”, that is, as a region within which a particular public regulatory and policy structure is implemented. However, it should be also noted that what we call “regions” could, for many purposes, equally be viewed as “sectors”. Indeed, insofar as regions specialize in particular industries – and such specialization presumably is an important reason why shocks are not perfectly correlated among regions – geographic and intersectoral mobility coincide. For example, expansion of financial services or high-tech employment and contraction of agriculture or heavy manufacturing (intersectoral labor flows) have historically been accompanied by inter-regional labor flows (e.g., rural/urban or Rust Belt/Sun Belt migration). It has been widely observed (see, e.g., Shin (1997)) that intersectoral shocks and associated reallocations of labor typically involve larger adjustment costs and play a larger role in explaining aggregate unemployment than intrasectoral shocks. When regions specialize in particular sectors, the inter-sectoral reallocation of labor will entail not only the costs associated with switching employers but the costs of switching regions. Thus, the variable c which measures labor market integration can be taken to

reflect not only the costs of relocation across space but also the costs of movements of labor among sectors.

It is convenient to begin by describing how contracts are determined by the workers and firms in a single jurisdiction in isolation, as would be the case if migration costs are prohibitively high. Once this *autarky* case is analyzed, we can then extend the analysis to incorporate the interactions between labor markets of different jurisdictions as migration costs fall.

A. *Implicit Contract Equilibria in Autarky*

Consider first the case where migration cost c is so high that no migration occurs in equilibrium, that is, migration costs are *prohibitive*. This assumption, which corresponds to the closed-economy models used in all previous literature on implicit contracts of which we are aware, means that the potential labor force in a given jurisdiction consists only of those individuals who reside there initially.⁶ Let \bar{n} , assumed for simplicity to be the same for all regions, denote the number of initial residents. As is standard in models of implicit contracts, production is assumed to be subject to stochastic shocks. Firms (or, more precisely, their owners) are assumed to be risk-neutral while workers are risk-averse. Each firm competes for workers by offering implicit long-term contracts which specify the firm's state-contingent wage and layoff policies. These implicit contracts offer workers some degree of job security and insurance against wage risk. We do not attempt to model exactly how implicit contracts are enforced, but note that firms and workers have incentives to commit themselves to fulfill such contracts if they can. Firms can commit themselves by e.g. offering high severance payments in case of lay-offs or by having built up reputation which they can lose in repeated games. Workers' remuneration may be in part conditional on the contract duration (*cf.* Feldstein (1976), Baily (1977)). As we have observed above, labor market institutions, including public- or quasi-public regulatory and organizational structures (labor laws, collective bargaining frameworks, unions, etc.) can be viewed as part of an enforcement mechanism over and above whatever purely private mechanisms are open to individual workers and firms.

To analyze the equilibrium labor contract in detail, assume for simplicity that the firms in a given region produce output under conditions of multiplicative uncertainty and that there are two possible states of the world, a "good" state which occurs with probability ρ and a "bad" state which occurs with the complementary probability. Output (or the value of output) is given by $p_i f(n_i)$ where f is a strictly increasing and concave function⁷ of the

⁶ See, e.g., Rosen (1985), Taylor (1987) for expositions of the standard implicit-contract model.

⁷ As is standard in models of interregional factor mobility, the concavity of the production function reflects the presence of immobile and fixed factors of production such as land or natural resources. In addition, depending on the time horizon of the analysis, capital could also be included among these fixed factors. (In a "long-run" interpretation of the model,

number of workers employed in state i ($f' > 0 > f''$) and where p_i is a random variable which may take on either of two values, $p_i, i = 1, 2$. Assume that $p_1 > p_2$, so that state 1 can be identified as the “good” state and state 2 as the “bad” state.⁸ It is assumed that there are many firms in each region and the random variable p_i is common to all firms within a region; under these assumptions, one may interpret $p_i f(n_i)$ as the (value of) output of all of the firms within a region, as a function of the total number of workers employed by all firms.

Partial Equilibrium Determination of Implicit Contracts. Firms compete ex ante to attract workers, offering contracts which specify the wage w_i to be paid in each state of nature and the number of workers n_i employed in each state. In particular, firms may choose to employ more workers in the good state than in the bad state, and the difference between n_1 and n_2 represents “unemployment” due to layoffs.⁹ It is assumed that all workers have an equal likelihood of layoffs in the bad state, i.e., given the contract (w_1, w_2, n_1, n_2) , each worker faces an ex ante probability $(n_1 - n_2)/n_1$ of being laid off in the bad state. The expected profit of a firm that offers a contract (w_1, w_2, n_1, n_2) is given by

$$\Pi_A = \rho(p_1 f(n_1) - w_1 n_1) + (1 - \rho)(p_2 f(n_2) - w_2 n_2). \quad (1)$$

Worker preferences are represented by a strictly increasing and concave utility-of-income function $u(\cdot)$ defined over wage income. If workers are laid off, they may engage in “home production” or leisure, and may also receive cash or in-kind benefits from the government,

capital would be viewed as a variable factor. As long as firms are able to obtain capital at an exogenously-fixed supply price – if, for instance, capital is obtained at a rate of return that is fixed on world markets – the explicit incorporation of variable capital as an additional factor of production would change none of our analysis or results.) The strict concavity of the production function means that firms earn “profits” after covering the costs of hiring labor; these “profits” should be interpreted as rents (or quasi-rents) accruing to the fixed (or quasi-fixed) factors. In particular, nothing in our model precludes free entry by firms; when entry is free and capital is variable, it is only necessary to attribute the concavity of the production technology to immobile resources like land, and to interpret “profits” as the rents earned by the owners of these resources.

⁸ One possible interpretation of the random variable p_i is that it could represent the price of a firm’s output on world markets; alternatively, the risk facing the firm may be technological in nature.

⁹ Since any state-contingent reductions in employment are contracted in advance, it can be argued that “unemployment” in this framework is not involuntary in an ex ante sense. One can view layoffs as simply “turnover” or “separations.” Within the context of the present analysis, these terms can be viewed as equivalent. Notice that in the present framework the number of separations in the bad state may be smaller than it would be in a Walrasian labor market. This “over-employment” result depends on the symmetric information assumption applied here. Hart (1981) and Grossman and Hart (1981, 1983) have shown, however, that with asymmetric information there will be more unemployment with implicit contracts than in a Walrasian labor market because laying off workers is the only way for firms to signal workers that the firm is in a bad state of the world.

receiving a level of utility $u(b)$ where b denotes cash benefits plus the cash equivalent of any in-kind benefits provided by the public sector, together with the monetized value of all non-market uses of time. Individual firms can hire as many workers as desired ex ante, provided that their contracts offer a level of expected utility that is at least as great as the expected utility that workers can obtain elsewhere, denoted by \tilde{u}_A . (The general-equilibrium determination of \tilde{u}_A is discussed further below.) Thus, the problem facing a firm in formulating an implicit contract can be written

$$(P_A) \quad \max_{\langle w_1, w_2, n_1, n_2 \rangle} \Pi_A$$

subject to

$$\rho u(w_1) + (1 - \rho) \frac{n_2}{n_1} u(w_2) + (1 - \rho) \frac{n_1 - n_2}{n_1} u(b) - \tilde{u}_A \geq 0 \quad (2)$$

Letting $\mathcal{L}_A(n_1, n_2, w_1, w_2, \lambda_A)$ represent the Lagrangian for (P_A) where λ_A is the Lagrange multiplier associated with the expected-utility constraint (2), the first-order conditions characterizing the profit-maximizing choice of wages in each period are

$$\frac{\partial \mathcal{L}_A}{\partial w_1} = -\rho n_1 + \lambda_A \rho u'(w_1) = 0 \quad (3a)$$

$$\frac{\partial \mathcal{L}_A}{\partial w_2} = -(1 - \rho) n_2 + \lambda_A (1 - \rho) \frac{n_2}{n_1} u'(w_2) = 0. \quad (3b)$$

Using these equations to eliminate λ_A ,¹⁰ it follows that

$$u'(w_1) = u'(w_2) \quad \Leftrightarrow \quad w_1 = w_2,$$

that is, *the wage rate is state-invariant under an equilibrium implicit contract*. Henceforth, this state-invariant wage is denoted by w .

The first-order conditions for the choice of employment levels in each state are

$$\frac{\partial \mathcal{L}_A}{\partial n_1} = \rho(p_1 f'(n_1) - w) + \lambda_A \left((1 - \rho) \frac{n_2}{n_1^2} u(w) - (1 - \rho) \frac{n_2}{n_1} u(b) \right) = 0 \quad (3c)$$

$$\frac{\partial \mathcal{L}_A}{\partial n_2} = (1 - \rho)(p_2 f'(n_2) - w) + \lambda_A \left((1 - \rho) \frac{1}{n_1} u(w) - (1 - \rho) \frac{1}{n_1} u(b) \right) = 0. \quad (3d)$$

Using (3a) to eliminate λ_A in (3c), we obtain

$$\rho n_1 (p_1 f'(n_1) - w) = (1 - \rho) n_2 \left(\frac{u(w) - u(b)}{u'(w)} \right) > 0. \quad (4a)$$

As the right-hand side is positive, the left-hand side can be interpreted as an insurance premium that workers pay to the firm in the good state in order to obtain insurance against income risk (see, e.g., Taylor (1987), p. 13). Furthermore, eliminating λ_A from (3d) yields

$$p_2 f'(n_2) - w = -\frac{u(w) - u(b)}{u'(w)} < 0. \quad (4b)$$

¹⁰ It is easily verified that that the expected utility constraint (2) is always binding at a solution to (P_A) so that $\lambda_A > 0$.

Thus, the marginal product of labor in the bad state is less than the wage rate. As is well-known, there are reasonable conditions under which $n_1 > n_2$, implying that firms lay off workers in the bad state.¹¹ For our purposes, the reason for considering a model with implicit contracts is that it provides a framework within which layoffs and unemployment can occur, and therefore we assume that these conditions are satisfied in the following analysis.

General Equilibrium in Autarky. The analysis thus far has examined the implicit contract that firms offer to workers given that they engage in ex ante competition for labor and must offer contracts that provide at least a specified level of expected utility, \tilde{u}_A . Individual competitive firms act as though they can hire as many workers as they wish, subject to this constraint. However, ex ante equilibrium in the labor market of an autarkic jurisdiction requires that there be no excess demand for labor, i.e., $n_1 \leq \bar{n}$. Intuitively, if \tilde{u}_A , the level of utility that firms must offer workers, is sufficiently low, wages and layoff policies will be sufficiently profitable to firms that they would wish to hire more workers than are available in the labor force, i.e., $n_1 > \bar{n}$, and in this case firms will find it advantageous to offer somewhat more attractive contracts to workers. As this competition for workers proceeds, the level of utility that workers can obtain in the labor market rises, and as \tilde{u}_A goes up, the number of workers that firms wish to hire will fall. As shown in Appendix A, comparative statics analysis confirms that $\partial n_1 / \partial \tilde{u}_A < 0$. Conversely, if \tilde{u}_A is “too high,” there will be excess supply in the labor market. Firms will be able to hire as many workers as desired while offering somewhat less attractive contracts, causing \tilde{u}_A to fall and n_1 to rise. The reservation utility level obtained by unemployed workers, $u(b)$, puts a lower bound on the value of \tilde{u}_A , however, and it is possible that $n_1 < \bar{n}$ when $\tilde{u}_A = u(b)$, in which case there is ex ante excess supply of labor in equilibrium. Throughout the analysis, we assume that this is not the case, so that $\tilde{u}_A > u(b)$ and $n_1 = \bar{n}$ in equilibrium.¹²

B. Implicit Contract Equilibria for a Single Open Jurisdiction

Now consider the case where migration costs c are sufficiently low that workers may move from one region to another. For the sake of analytical simplicity, suppose that there are many jurisdictions which initially contain identical numbers of workers \bar{n} and whose firms have identical technologies, as represented by the production function f . Output in each jurisdiction is characterized by multiplicative uncertainty of the form described above, and the random variable p_i is independently and identically distributed across all regions. With many jurisdictions, by the law of large numbers, the proportion of jurisdictions experiencing favorable technological realizations ($p_i = p_1$) is equal to ρ while the proportion

¹¹ Specifically, $n_1 > n_2$ if $w - p_2 f'(n_1) > u(w) - u(b)/u'(w)$. See Taylor (1987, p. 16), for further discussion.

¹² More generally, ex ante equilibrium in the labor market is characterized by the complementary-slackness type condition $(\tilde{u}_A - u(b))(\bar{n} - n_1) = 0$.

$(1 - \rho)$ experience an unfavorable realization p_2 . Migration occurs when firms in regions experiencing favorable technology shocks are able to attract workers who have been laid off from jobs in regions experiencing unfavorable shocks. Migrant workers are assumed to participate in a spot labor market in regions where firms are hiring additional labor, rather than entering into new long-term implicit contracts, reflecting their more transient and less-established relationships with employers.¹³ This spot market is assumed to operate under conditions of perfect competition, so that new (migrant) workers are paid according to their marginal products; assuming that migration costs are independent of the origin or destination of migrants, arbitrage in the market for migrant workers means that all will earn the same wage in equilibrium, denoted by w^* .

In the case of autarky, the marginal product of labor in favorable states of nature is equal to $p_1 f'(\bar{n})$. This places an upper bound w_{max}^* on the spot wage; if migration actually occurs, the amount of employment in jurisdictions experiencing favorable shocks will exceed \bar{n} and w^* will thus be less than w_{max}^* . It is clear, therefore, that no migration can occur if $c > p_1 f'(\bar{n}) - b$ since workers can always receive b as a minimum when laid off, and the spot wage must thus be at least equal to $b + c$ before any migration occurs.

While $c \leq p_1 f'(\bar{n}) - b = w_{max}^* - b \equiv c^*$ is a necessary condition for any migration to take place, the precise amount of migration that occurs depends on the nature of the implicit contracts that are established between workers and firms and, in particular, on the number of workers laid off by firms experiencing unfavorable shocks. In turn, however, the conditions of the implicit contract may depend on the feasibility and cost of migration; in particular, workers may willingly accept contracts with higher levels of layoffs if migration provides good job opportunities when layoffs occur. We must therefore analyze how the equilibrium implicit contract, i.e., the degree of labor market rigidity, depends on the mobility of workers.

The present subsection considers only how the equilibrium implicit contract is determined in a single jurisdiction, assuming that migration costs are not prohibitively high ($c \leq c^*$). Since the spot wage w^* is determined in competitive markets involving firms and workers from many regions, it is taken as parametrically given by the firms and workers in any one jurisdiction. The description of how the value of w^* is determined as part of the general equilibrium for an entire system of regions is postponed to Section III. As in the autarky case, firms within a single region compete in a local ex ante labor market by offering implicit contracts subject to an expected utility constraint. The formal analysis of the firm's problem with migration is very similar to that of the autarky case, except that it

¹³ One could imagine that workers who migrate to a new region gradually establish themselves on an equal footing with existing native workers and thus participate in the same types of long-term implicit contracts as existing workers. Such contracts would provide workers, including immigrants, with some protection against *future* risks; however, the present analysis focuses on migration as an ex post response to the realization of economic risks and as such it is appropriate to distinguish between the labor market conditions facing workers who do not migrate and those who do.

is necessary to take into account the fact that firms may hire migrant workers in the ex post spot market if they have favorable technological shocks and that workers who are laid off in the bad state may find migration to be a better alternative than remaining unemployed in their original jurisdiction of residence.

A firm's wage and employment policy in the presence of migration can be represented by a vector $(w_1, w_2, n_0, n_1, n_2)$ describing the wages that it pays in each state to workers engaged in an implicit contract with it, w_1 and w_2 , the number of workers in the ex ante labor market that accept the firm's offer of an implicit contract, n_0 , and the level of employment in each state, n_1 and n_2 . Due to the possibility of migration, a firm may choose $n_1 > \bar{n}$ in the ex post spot market for migrant labor. The difference between the number of workers hired initially and those employed in the bad state, $n_0 - n_2$, represents layoffs. Of course, $n_0 \leq \bar{n}$, and, as will be shown later, $n_0 = \bar{n}$ in equilibrium in most cases of interest.

A firm's expected profits when migration is possible can now be written as

$$\Pi_M = \rho(p_1 f(n_1) - w_1 n_0 - w^*(n_1 - n_0)) + (1 - \rho)(p_2 f(n_2) - w_2 n_2); \quad (5)$$

note that any workers hired in the ex post spot market for labor are paid w^* . Firms can implement a wage and employment policy $(w_1, w_2, n_0, n_1, n_2)$ only if the expected utility of the workers initially residing in the jurisdiction is at least as great as \tilde{u}_M , the utility that they can attain if they refuse to accept a firm's implicit contract in the ex ante labor market.¹⁴ The maximization problem facing a firm can thus be formulated as

$$(P_M) \quad \max_{\langle w_1, w_2, n_0, n_1, n_2 \rangle} \Pi_M$$

subject to

$$\rho u(w_1) + (1 - \rho) \frac{n_2}{n_0} u(w_2) + (1 - \rho) \frac{n_0 - n_2}{n_0} u(w^* - c) - \tilde{u}_M \geq 0, \quad (6)$$

assuming that migration is at least as attractive to laid-off workers as unemployment, i.e., $u(w^* - c) \geq u(b)$.¹⁵ Letting $\mathcal{L}_M(n_1, n_2, w_1, w_2, \lambda_M)$ represent the Lagrangian for (P_M) , the first-order conditions characterizing the profit-maximizing choice of wages in each period are

$$\frac{\partial \mathcal{L}_M}{\partial w_1} = -\rho n_0 + \lambda_M \rho u'(w_1) = 0 \quad (7a)$$

$$\frac{\partial \mathcal{L}_M}{\partial w_2} = -(1 - \rho) n_2 + \lambda_M (1 - \rho) \frac{n_2}{n_0} u'(w_2) = 0. \quad (7b)$$

¹⁴ The determination of the equilibrium value of \tilde{u}_M is discussed at the end of this section.

¹⁵ The objective of the analysis at this stage is to describe how the terms of implicit contracts are determined, assuming that migration actually occurs. This can only be the case if $u(w^* - c) \geq u(b)$.

Using these equations to eliminate λ_M , it follows that

$$u'(w_1) = u'(w_2) \quad \Leftrightarrow \quad w_1 = w_2, \quad (8)$$

that is, exactly as in the autarky case, *the wage rate is state-invariant under an equilibrium implicit contract*. Henceforth, this state-invariant wage is denoted by w .

The first-order conditions for the choice of ex ante and ex post employment levels are

$$\frac{\partial \mathcal{L}_M}{\partial n_0} = \rho(w - w^*) + (1 - \rho) \frac{n_2}{n_0} \frac{u(w) - u(w^* - c)}{u'(w)} = 0 \quad (7c)$$

$$\frac{\partial \mathcal{L}_M}{\partial n_1} = \rho(p_1 f'(n_1) - w^*) = 0 \quad (7d)$$

$$\frac{\partial \mathcal{L}_M}{\partial n_2} = (1 - \rho)(p_2 f'(n_2) - w) + (1 - \rho) \frac{u(w) - u(w^* - c)}{u'(w)} = 0, \quad (7e)$$

where (7a) is used to eliminate λ_M .

Rearranging (7c),

$$w^* - w = \frac{(1 - \rho) n_2}{\rho n_0} \frac{u(w) - u(w^* - c)}{u'(w)}. \quad (9)$$

As in the autarky case, the left-hand side can be interpreted as an insurance premium that workers pay to the firm in the good state to obtain insurance against income risk. It follows immediately from (9) that

$$w^* = w \quad \text{if } c = 0 \quad (10a)$$

$$w^* > w > w^* - c \quad \text{if } c > 0 \quad (10b)$$

Hence, *in the special case of zero migration costs, there exists only one wage rate $w^* = w$, so that workers always obtain employment at the same wage no matter whether there is a favorable or unfavorable shock in the jurisdiction where they reside*. This polar case illustrates the important point that migration can insure workers from unemployment risk and the associated risk of reduced income and welfare. In this case, there is no need for the insurance that implicit contracts can provide and, therefore, no reason for labor markets to exhibit rigidities that might give rise to unemployment. When migration costs are positive, however, workers will be better off under favorable technology shocks in their home jurisdiction, and long-term contracts will continue to serve as a partial insurance device. In the good state, as (7d) and (10b) reveal, non-migrant (“native”) workers pay an “insurance premium” to their employer in the form of the difference between their wage w and the spot wage earned by immigrant workers, which is equal to the value of the marginal product of labor in the good state, i.e., they pay a premium of

$$p_1 f'(n_1) - w = w^* - w > 0. \quad (11)$$

In the bad state, however, they receive a wage higher than the value of the marginal product; from (7e), it follows that

$$w - p_2 f'(n_2) = \frac{u(w) - u(w^* - c)}{u'(w)} > 0. \quad (12)$$

Note that the workers who are laid off in the bad state can get a higher wage abroad than they could get at home if employed. At first glance, this may seem paradoxical, since one normally associates a loss of employment with a loss of income. To avoid confusion, it must thus be emphasized that w^* is the “producer price” of migrant labor in the ex post spot market, whereas $w^* - c$ is what migrants actually receive on net. The migration cost “wedge” between the price paid by firms for workers and the net income received by workers can be divided in many ways, and the observed wage paid by firms to new workers may lie anywhere in the interval $[w^* - c, w^*]$ depending on how the costs of migration are split between workers and their employers. For example, firms that have experienced favorable technology shocks and that are hiring workers in the spot market might in practice absorb some or all of the out-of-pocket costs of relocation for workers, the costs of advertising and recruiting for new employees, and the costs of training workers for their new jobs, all of which should be interpreted as part of migration costs, c . Having covered these costs, the explicit wage paid to employees would be correspondingly reduced.¹⁶ There may remain some costs of migration – search costs, some out-of-pocket relocation costs, subjective losses from disruption of one’s affairs associated with relocation – that workers end up absorbing. The wage net of *all migration* costs $w^* - c$ will be equal to the wage actually paid to workers less that portion of migration costs absorbed by workers, and, by (10b), we know that $w^* - c < w$, that is, workers who are laid off are definitely worse off than those who are not laid off. In fact, the observed wage that firms pay to newly-hired workers will lie below the wage w received by existing workers if firms absorb a relatively high proportion of the costs of migration.¹⁷

¹⁶ Note that domestic workers cannot apply for a spot market job as the implicit contract is (assumed to be) enforceable, as discussed above.

¹⁷ It goes beyond the scope of our formal analysis to consider heterogeneity of workers. However, in practice, seniority rules will typically mean that laid-off workers are younger and less experienced than those retained by employers experiencing unfavorable shocks. If one thinks of younger workers as possessing less effective labor services than those who are more experienced, then young migrant workers who are laid off by firms facing unfavorable shocks and who are then hired by firms in other regions experiencing favorable shocks will tend to receive lower observed wages per worker than the more senior workers already employed by these firms. For this reason, as well as those mentioned above, it would be incorrect to interpret (10b) to imply that the observed wage paid to newly-hired migrant workers would exceed the wage paid to a firm’s existing work force. It may further be noted that empirical evidence (*e.g.*, Topel (1991)) indicates that job changes account for a substantial amount of lifetime earnings growth for typical workers. Ignoring the costs of job search and relocation, therefore, it is evidently true empirically that workers often obtain higher wages after separations.

The fact that workers who migrate (or remain unemployed) are worse off than those who are not laid off is the key to understanding how the equilibrium level of expected utility, \tilde{u}_M , is determined. Just as in the autarky case, clearing of the ex ante labor market requires that \tilde{u}_M adjust so that all of the workers who initially reside in a region do in fact enter into an employment relationship with a local firm. Failure to obtain a job initially means that workers will either be hired by local firms at a wage of w^* if there is a favorable realization of technology or, if there is an unfavorable realization, they will either migrate to another region and receive $w^* - c$ or remain unemployed and receive b . We assume, however, that implicit contracts dominate this alternative, so that $n_0 = \bar{n}$ at the equilibrium value of \tilde{u}_M .¹⁸

III. General Equilibrium in a System of Jurisdictions with Migration and Implicit Contracts

The analysis so far has examined how implicit contracts would be determined within a given region when it is possible for laid-off workers to migrate to other region and earn an exogenously-given spot wage of w^* . However, although w^* is taken as given by any *one* region, its equilibrium value is determined by the competition for migrant workers in the system of regions as a whole. Since the supply of workers to the spot market depends on the willingness of laid-off workers to migrate in search of other jobs, which in turn depends on the level of migration costs c , we expect that the equilibrium spot wage ultimately depends on the value of c as well. The objective of this section is to analyze how the entire general equilibrium structure of spot wages and implicit contracts for the whole system of jurisdictions depends on the migration cost parameter c .

As the analysis will make clear, there are two distinct types of equilibria that can arise. Speaking informally, when migration costs are sufficiently high, relatively few laid-off workers will, in equilibrium, choose to migrate to other jurisdictions, since the benefits of higher wages elsewhere are largely offset by the cost of moving. In these cases, some but not all of the workers laid off by firms in regions experiencing unfavorable technology shocks will leave to find jobs elsewhere; those left behind will remain unemployed and receive the reservation income b . On the other hand, if migration costs are sufficiently low, the payoff to workers from migration will be highly attractive relative to unemployment and workers will then choose not to remain unemployed. We call the latter situation a “full-employment” regime, while the former case, in which there is some migration but also some unemployment, is called a “mixed” regime. Intuitively, the mixed regime is an intermediate case between autarky (i.e., prohibitively high migration costs) and free mobility. It is of course the mixed case that is of greatest interest in the present context, since it is the mainly the existence of unemployment that motivates consideration of implicit contract models to begin with. We

¹⁸ In general, if migration costs are lower than c^* , ex ante labor market equilibrium requires that $(\tilde{u}_M - [\rho u(w^*) + (1 - \rho)u(w^* - c)])(\bar{n} - n_0) = 0$, analogously to footnote 7.

now analyze the general equilibrium of the system of jurisdiction for each of these cases.

A. General Equilibrium in the Mixed Regime

Imagine to start with that the migration cost parameter c is just equal to $c^* \equiv w_{max}^* - b$. At this value of c , w_{max}^* is in fact the equilibrium spot wage. At this wage, firms are unwilling to hire any additional workers when technology shocks are favorable, and workers are indifferent between remaining unemployed (and receiving an income of b) and migrating (and receiving an income net of migration costs of $w_{max}^* - c$), so that there is no excess demand for or supply of labor in the spot market. If the migration cost parameter c falls below c^* , workers who are laid off would definitely prefer to find employment in the spot market at a wage of w_{max}^* rather than remain unemployed, since their income would then be strictly higher ($w_{max}^* - c > b$), and thus for $c < c^*$ there would be excess supply in the spot labor market if $w^* = w_{max}^*$. There would thus be downward pressure on the spot wage as c falls and the amount of labor demanded by firms in the spot market would rise, so that there would be a strictly positive level of migration.

For any given spot wage w^* , the average demand for labor in the spot market is given by $\rho(n_1(w^*) - \bar{n})$ where $n_1(w^*)$ is determined by the condition

$$p_1 f'(n_1) = w^*. \quad (13)$$

Obviously, $\partial n_1(w^*)/\partial w^* = 1/p_1 f_1''(n_1) < 0$. The mean supply of workers to the spot market is perfectly elastic, up to the quantity $(1 - \rho)(\bar{n} - n_2)$, provided that $w^* - c = b$; for lower values of w^* , the supply of labor is zero (workers prefer unemployment to migration), and for higher values of w^* , the supply of labor is equal to $(1 - \rho)(\bar{n} - n_2)$ (migration dominates unemployment for all laid-off workers). The equilibrium value of w^* is thus

$$w^* = b + c \quad (14)$$

for any value of c and n_2 such that

$$\rho(n_1(w^*) - \bar{n}) < (1 - \rho)(\bar{n} - n_2). \quad (15)$$

These two conditions define a general equilibrium in the mixed regime. Condition (14) states that workers who are laid off will be indifferent between migrating to find new jobs and receiving their reservation income of b in their home jurisdiction. Condition (15) states that the number of workers absorbed as new hires in the spot market (the left-hand side) is less than the number laid off by firms experiencing unfavorable shocks (the right-hand side). The inequality in (15) means that there is some unemployment in equilibrium, and it is this condition which is no longer satisfied in the full-employment regime discussed in the next subsection. Note that (15) definitely holds when $c = c^*$, since then the left-hand side is zero while the right-hand side is positive. As discussed further in Appendix B, the functions in (15) are continuous in c , which means that the system must be in a mixed equilibrium for some range of values of c that are sufficiently close to c^* .

Changes in the extent of labor market integration in this system can be represented by changes in the migration cost parameter c . In general, greater economic integration will affect the entire equilibrium structure of wages and employment throughout the system of jurisdictions. General-equilibrium comparative statics analysis of the effect of changes in c shows that:

Theorem 1: For values of the migration cost parameter c such that the system reaches a mixed equilibrium, increased economic integration (i.e., a reduction in the migration cost parameter c) results in:

- (i) a decrease in the ex post spot-market wage rate w^* (i.e., $dw^*/dc > 0$);
- (ii) a decrease in the wage rate obtained under the terms of the implicit contract w (i.e., $dw/dc > 0$);
- (iii) an increase in the level of employment in the good state (i.e., $dn_1/dc < 0$);
- (iv) a decrease in the level of employment in the bad state (i.e., $dn_2/dc > 0$).

Proof: See Appendix B.

While the full proof of this theorem is given in an appendix, it is immediately apparent from (14) that $\partial w^*/\partial c = 1$, from which (i) clearly follows. Intuitively, a reduction in migration costs increases the supply of workers in the spot market, resulting in a decrease in the spot wage and an increase in employment in the good state (iii). In turn, this means that the implicit insurance premium charged by firms for protection of workers – which is the difference between the marginal product of labor in the good state and the implicit contract wage w , as shown in (9) – would fall, *cet. par.*. The firm therefore requires compensation either in the form of a lower implicit contract wage w or, alternatively, by insisting on more layoffs in the bad state. In fact, differentiating (12) shows that a change in the implicit contract wage or level of layoffs *alone* cannot be optimal, and thus, as stated in (ii) and (iv), both of these adjustments – i.e., a reduction in w and an increase in layoffs in the bad state – occur in equilibrium.¹⁹

Increased economic integration, then, has several important impacts on the structure of employment, output, and compensation in the economy. It gives rise to greater local fluctuations in both output and employment, as layoffs are increased in the bad state and there is increased hiring in the spot market when there are favorable production shocks. Implicit contracts can shelter workers from income risk resulting from production shocks,

¹⁹ Total differentiation of (12) with respect to n_2 and c reduces the left-hand side while leaving the right-hand side unchanged (recalling that $w^* - c$ is constant in the mixed regime). Similarly, an increase in w alone must also lower the left-hand side relative to the right-hand side, given that workers are risk averse.

but the level of the protection provided to workers through these contracts is diminished, in equilibrium, when the interjurisdictional mobility of workers is increased. Increased integration of labor markets thus leads firms to provide less insurance to workers than would otherwise be the case. The rise in layoffs in the bad state indicates a less rigid labor market, showing that the extent of labor market integration influences the degree of flexibility in observed labor market institutions.

B. General Equilibrium in the Full-Employment Regime

As noted, the mixed regime must occur when migration costs are sufficiently high. However, when migration costs are sufficiently low, there may be no unemployment at all. As shown in (10a), $w^* = w = w^* - c$ when $c = 0$, which means that workers who are laid off are no worse off than those who are not laid off or who are initially employed in regions that have favorable production shocks. In this case, workers who initially reside in regions experiencing unfavorable shocks and who are laid off can costlessly relocate to regions experiencing favorable shocks, earning the spot wage w^* . The implicit contract completely degenerates in this case, with firms always employing workers at a level where their state-contingent marginal product is equal to their wage; workers face no wage risk, pay no implicit insurance premium, and receive no implicit insurance benefits. Provided that the equilibrium wage with zero migration costs strictly exceeds the reservation income b , no workers who are laid off will remain unemployed. Adverse production shocks produce labor turnover in this case, but do not produce unemployment. Workers are therefore completely insured against unemployment and income risk by a fully integrated and flexible labor market. This confirms, for the extreme case where $c = 0$, the finding obtained in a full-employment market-clearing model in Wildasin (1995) that free mobility itself can provide perfect insurance against income risk.

We assume henceforth that the economy does achieve full employment when $c = 0$, which will be the case if b is sufficiently small or the equilibrium wage with zero migration costs is sufficiently high.²⁰ As discussed further in Appendix C, the equilibrium of the system varies continuously in the migration cost parameter c , and it thus follows that the economy will be in the full-employment regime for all values of c sufficiently close to 0.

²⁰ The equilibrium wage with zero migration costs satisfies

$$p_1 f'(n_1) = p_2 f'(n_2).$$

Full employment requires that

$$\rho n_1 + (1 - \rho)n_2 = \bar{n}.$$

These two conditions determine n_1 and n_2 and thus the equilibrium wage $p_1 f'(n_1) = p_2 f'(n_2)$; it is easily verified that the equilibrium wage is lower, the higher the value of \bar{n} . Thus, provided that either b is sufficiently small, \bar{n} is sufficiently small, or both, the equilibrium wage with zero migration costs must exceed b .

As in the mixed regime, a change in migration costs affects the general equilibrium constellation of wages and employment levels of the economy. In the mixed regime, condition (14) provides a rigid linkage between the equilibrium spot-market wage w^* and the migration cost parameter c . In the full-employment case, by contrast, changes in c do not necessarily give rise to unit-for-unit changes in w^* . However, stability of the general-equilibrium structure of wages and employment requires that an increase in the ex post wage rate w^* give rise to an excess supply of labor in the ex post market. This stability condition (S) is stated formally in Appendix C. Using this condition, general-equilibrium comparative-statics analysis shows that:

Theorem 2: For values of the migration cost parameter c such that the system reaches a full-employment equilibrium, and assuming that the spot-market stability condition (S) is satisfied, increased economic integration (i.e., a reduction in the migration cost parameter c) results in:

- (i) a decrease in the ex post spot-market wage rate w^* (i.e., $dw^*/dc > 0$);
- (ii) an increase in the level of employment in the good state (i.e., $dn_1/dc < 0$);
- (iii) a decrease in the level of employment in the bad state (i.e., $dn_2/dc > 0$).

Proof: See Appendix C.

This result closely parallels the findings for the mixed regime, although in this case the impact of increased integration on the implicit contract wage rate w is uncertain. Broadly speaking, the qualitative impacts of economic integration on the state-contingent levels of employment and output are the same in this case as in the mixed regime.

C. Autarky vs. Full Integration: Global Comparisons

The analysis so far has shown that there are three possible types of equilibria in the model. In autarky, migration costs are so high that migration is never observed. Implicit contracts result in layoffs that generate unemployment for some workers in regions with unfavorable production shocks. When migration costs are very low, equilibrium labor contracts also result in layoffs when there are unfavorable production shocks, but workers that are laid off migrate to other regions where they are able to find new jobs, so that there is no unemployment. In between these extremes, if migration costs are sufficiently high but not prohibitive, implicit labor contracts will give rise to layoffs in the bad state and while some of the workers who are laid off will migrate to other regions and find new jobs, others will remain in the jurisdictions in which they are laid off and will be unemployed. For present purposes, the mixed regime is of greatest interest, since we wish to explore the implications of migration in an economy with unemployment. Before turning to a more detailed analysis of the mixed regime in Section IV, however, it is useful to make some comparisons of the equilibria across regimes.

Imagine a process of economic integration in which migration costs are at first prohibitively high, falling gradually over time and finally ending in a situation of free migration where workers are perfectly mobile among jurisdictions. Comparing the starting and ending points of this process, we note that employment contracts in autarky are characterized by positive levels of unemployment in bad states. When migration costs vanish, however, there is no longer any unemployment. In regions experiencing favorable shocks, output and employment are higher than they would be under autarky, while the opposite is true for regions experiencing adverse shocks. Nevertheless, workers receive the same wage in both states, and this wage is equal to the marginal product of labor. In fact, workers face no wage or unemployment risk at all. The need for implicit contracts to insure workers against income risk is obviated and thus they completely disappear.

Starting from an equilibrium in a mixed regime, the elimination of migration costs eliminates all unemployment. Similarly, starting from an equilibrium in the full-employment regime, an increase in migration costs to prohibitively high levels brings about unemployment. It is not necessarily the case, however, that *small* reductions in migration costs necessarily cause unemployment to decrease. It is easy to see from Theorems 1 and 2 that the state-contingent employment levels n_1 and n_2 vary monotonically across regimes, with n_1 steadily rising as c falls and n_2 steadily falling. In general, however, total employment in the system as a whole, $\rho n_1 + (1 - \rho)n_2$, may rise or fall as c falls incrementally. See Figure 1 for an illustration of some of the main results obtained so far in the case where $\rho = .5$ and where we assume that there is only one interval of values of the migration cost parameter in which each regime can occur.

IV. Economic Integration, Income Distribution, and Welfare in the Mixed Regime

The analysis of Section III has focused on the positive economics of economic integration. It shows that changes in the migration cost parameter c have certain impacts on levels of employment, output, and wages. This section extends the analysis to consider how changes in migration costs affect economic welfare. We are mainly interested in the impact of economic integration and migration in an economy where there is also some unemployment, and thus we restrict attention in this section to the welfare effects of increased labor mobility in the mixed regime discussed in Section III.A.

So far, the model has assumed that there are two different groups of agents in the economy, workers and firms. While the former are risk averse and try to maximize expected utility, the latter are assumed to be risk neutral and to maximize expected profits. A natural justification for the assumption of risk-neutrality on the part of firms is that they are owned by individuals who themselves are risk neutral. Alternatively, they may be owned by risk-averse individuals who have diversified portfolios (perhaps through financial intermediaries) and who therefore can perfectly pool independent risks among firms (and regions). For the moment, let us consider workers and the owners of firms as completely distinct groups, with

the welfare of the former given by expected utility and the welfare of the latter given by expected profits.²¹

As shown above, a change in migration costs alters the entire general-equilibrium configuration of employment and wages in the economy. All of these changes affect both the expected utility of workers and the expected profits of firms. Nevertheless, it is straightforward to see how a change in c affects the welfare of each group. As shown in Theorem 1, increased economic integration (a reduction in c) causes the equilibrium number of workers laid off in the bad state to rise. In the mixed regime, laid-off workers may either be unemployed or may migrate, but in either case they receive a net income of b (recall (14)), irrespective of the value of c . Furthermore, the implicit contract wage w received by those workers who are not laid off must fall as migration costs fall. Unambiguously, therefore, the expected utility of workers must *fall* as c falls. Formally, recalling the expression for expected utility given in (6),

$$\frac{dEu}{dc} = \rho u'(w) \frac{dw}{dc} + (1 - \rho) \left[\frac{n_2}{\bar{n}} u'(w) \frac{dw}{dc} + \frac{u(w) - u(w^* - c)}{\bar{n}} \frac{dn_2}{dc} \right] > 0. \quad (16)$$

The impact of a change in c on expected profits is also easily calculated, essentially using an envelope-theorem argument. From (5), using (7d), it follows that

$$\frac{d\Pi_M}{dc} = \rho \left[-\bar{n} \frac{dw}{dc} - (n_1 - \bar{n}) \frac{dw^*}{dc} \right] + (1 - \rho) \left[(p_2 f'(n_2) - w) \frac{dn_2}{dc} - n_2 \frac{dw}{dc} \right] < 0. \quad (17)$$

The inequality in (17) follows from Theorem 1, which shows that w^* , w , and n_2 are all increasing in c , and from (12), which shows that workers are paid more than the value of their marginal products in the bad state. In words, the wage rate at which firms hire workers in the spot market in the good state is higher when migration costs are higher. The implicit contract wage rate is also higher in both states which in itself tends to raise costs for given levels of employment in each state; moreover, the number of workers employed in the bad state is higher, and the amount that these additional workers are paid exceeds the extra revenue that they produce for their employers. For all of these reasons, an increase in migration costs lowers expected profits. In summary, we have shown

Theorem 3: For values of the migration cost parameter c such that the system reaches a mixed equilibrium, increased economic integration (i.e., a reduction in the migration cost parameter c) results in

- (i) a decrease in the expected utility of workers (i.e., $dEu/dc > 0$);
- (ii) an increase in the expected profits of firms (i.e., $d\Pi_M/dc < 0$).

²¹ Recall that “profits” are interpreted as the return to fixed and quasi-fixed factors of production such as land or natural resources (see n. 4 above).

In brief, economic integration works against the interests of workers and in favor of the interests of firms and their owners. Roughly speaking, greater migration opportunities increase the supply of workers to expanding firms (those that experience favorable production shocks) and lowers the marginal product of labor in the good state. This “depreciates” the implicit insurance premium paid by workers in the good state; anticipating this, the implicit contract wage w is reduced and the level of layoffs in the bad state is increased. From the viewpoint of firms, the downward pressure on wages and the increased flexibility of state-contingent employment is beneficial. For workers, however, the reduced implicit contract wage results in a worse outcome in the good state and also a worse outcome in the bad state if they are not laid off. If they are in fact laid off, some may migrate rather than remain unemployed, but those who migrate do not enjoy any net gain from doing so as the spot wage is only sufficiently high to compensate them for migration costs. Furthermore, more workers end up being laid off when migration costs are lower. The upshot is that the increased migration that results from more integrated labor markets reduces labor market rigidities, but in a way that only helps firms and actually makes workers worse off. It is worth recalling, in this context, that increased labor mobility may or may not reduce overall unemployment. It is important to note that workers are harmed by labor market integration even if the total unemployment rate is reduced.

In a model with flexible wages and full employment (*cf.* Wildasin (1995)), workers may or may not benefit from increased labor market integration depending on the precise form of the production technology (labor demand functions in the good and the bad state) and on the degree of risk aversion of workers. By contrast, the present analysis shows that workers are unambiguously harmed by incremental increases in labor market flexibility in a world of implicit contracts and unemployment. Evidently, increased mobility worsens the terms of the implicit insurance offered by firms to workers, reducing the protection against income risk that workers obtain in a more sheltered market environment.

Since labor market integration benefits one group while harming another, it is obviously not Pareto-improving. It is natural to ask, however, how the gains and losses to different groups compare, and whether it could be possible for the gainers to compensate the losers. To address this question, it is necessary to make the gains and losses to each group comparable in some way. One natural way to do so is to assume that the value of money income is equally valuable for both groups. The welfare of the owners of firms is measured in money in any case, which thus has a marginal value of unity. For workers, one unit of money income, obtained with certainty, raises expected utility by the amount

$$Eu'(\cdot) \equiv \rho u'(w) + (1 - \rho) \left[\frac{n_2}{\bar{n}} u'(w) + \frac{(\bar{n} - n_2)}{\bar{n}} u'(w^* - c) \right]$$

which means that a worker is willing to pay an amount of money $1/Eu'(\cdot)$ in order to obtain a one-unit increase in expected utility (or must be paid this amount to compensate for a one unit reduction in expected utility). Thus, in monetary terms, the impact of a change in

c on the expected utility of workers is given by

$$\frac{1}{Eu'(\cdot)} \frac{dEu}{dc}.$$

Greater labor market integration results in a potential Pareto improvement if the gains to firms are more than sufficient to compensate workers for their losses. Formally, the gains to the firms in a jurisdiction net of the monetized value of the losses to the workers can be determined from (16) and (17):

$$\begin{aligned} \frac{d\Pi_M}{dc} + \bar{n} \frac{1}{Eu'(\cdot)} \frac{dEu}{dc} = & - \left[\rho \bar{n} \frac{dw}{dc} + (1 - \rho) \frac{u(w) - u(w^* - c)}{u'(w)} \frac{dn_2}{dc} \right] \left[\frac{Eu'(\cdot) - u'(w)}{Eu'(\cdot)} \right] \\ & - (n_1 - \bar{n}) \frac{dw^*}{dc} < 0, \end{aligned} \quad (18)$$

using (12). That is, it is possible, in principle, for the owners of firms to make compensation payments to workers that would offset the adverse effects of labor market integration and allow both groups to gain from increased mobility of workers:

Theorem 4: For values of the migration cost parameter c such that the system reaches a mixed equilibrium, increased economic integration (i.e., a reduction in the migration cost parameter c) is potentially Pareto-improving.

Of course, it is in practice difficult or impossible to devise a distortionless compensation scheme between firms and workers that would insure that increased labor mobility really results in a Pareto improvement. In practice, therefore, economic integration would benefit the owners of firms while harming workers. A judgment as to the desirability of economic integration thus necessitates an evaluation of gains and losses to different groups. A social welfare function that attaches equal value to the incomes of both groups would regard potential Pareto improvements (i.e., changes that satisfy a compensation test) as socially desirable. On this basis, improved labor market integration would be viewed as welfare-improving. Clearly this would also be true for any social welfare function that attaches a greater weight to the income accruing to the owners of firms than to the incomes of workers, whereas greater worker mobility would be socially undesirable if evaluated using a social welfare function that attaches sufficiently higher weight to the welfare of workers.

The discussion so far has treated workers and the owners of firms (or of immobile resources) as completely distinct groups. In practice, workers receive some non-wage income from capital and from their direct or indirect ownership of land, natural resources, and other fixed factors. The adverse effect of economic integration on their welfare could therefore be partially offset by gains that they experience from increases in any profits that are distributed to them. Indeed, as an extreme case, one could imagine that all profits accrue to workers who hold perfectly diversified equity portfolios, giving each worker an equal share of the profits accruing to firms in all jurisdictions. Since risks among regions are independent, each worker would receive, with certainty, a profit income of Π_M/\bar{n} in addition to its wage income. In this

case, (18) shows that the expected utility of each worker must rise as economic integration improves. In effect, perfectly functioning asset markets – which must themselves be fully integrated so that workers can diversify their ownership of firms (and fixed factors such as land or natural resources) among jurisdictions – serve as a compensation mechanism so that economic integration produces an actual Pareto improvement.

V. Conclusion

The preceding analysis has investigated the consequences of changes in the extent of labor market integration, represented in the model by a migration cost parameter c . In contrast to much previous research on labor mobility, we have not assumed that labor markets are characterized by full employment in all circumstances; in contrast to much previous research on unemployment, we have not assumed that local labor markets are completely isolated from one another. As we have seen, changes in labor mobility affect the conditions under which workers and firms enter into long-term implicit contracts, resulting in changes in the structure of wages and in the levels of employment in different states of the world. These contracts are part of the institutional structure of labor markets which may be implemented not only through purely private arrangements between firms and workers but through public policies such as labor market regulations. Thus, in exploring the dependence of equilibrium contract structures on the “technology” of labor mobility, as represented by c , our analysis can shed light on the determinants and evolution of institutional structure.

Any relatively simple and stylized model, such as that presented above, cannot possibly capture all important aspects of highly complex labor market institutions. As mentioned at the outset, there are several competing models of labor markets which do not clear instantaneously, such as the insider-outsider model, models of unionized labor markets, job-matching models, and, of course, implicit contract models. There is little consensus in the literature about which of these approaches provides the most satisfactory explanation of various labor-market phenomena, and it is certainly not our purpose to argue that the implicit contract approach is necessarily superior to its competitors in all respects. Nor, indeed, are all of these models necessarily incompatible with one another; our own analysis can be viewed as a blend that combines implicit contract theory with some aspects of insider-outside models. In any case, the model presented above does seem to be broadly consistent with important aspects of the labor market institutions and experiences of different countries; in particular, it does explain wage stickiness (“rigidities”) in regional labor markets that are, to some degree, isolated from other. It also is quite consistent with the observation that labor market flexibility need not result in a high degree of spatial wage dispersion, as regional labor demand shocks give rise to high levels of interregional labor flows rather than large fluctuations in wages.

The analysis shows that the risks faced by workers, their economic welfare, and the profits of firms all change as labor mobility increases. As migration costs diminish, the terms of implicit contracts, that is, labor market institutions, adjust so that employment

varies more across states of nature. Increased mobility leads to a more flexible labor market in which firms with high labor demand are better able to respond to market conditions by hiring additional workers, while those facing adverse conditions are more able to shed workers for whom the wage rate exceeds their marginal product. If migration costs fall sufficiently, mobility makes it possible for all workers who are laid off to move to jurisdictions with high demand for labor and unemployment – at least within our admittedly stylized model of many regions with independent labor demand shocks – completely disappears. However, if migration costs remain relatively high, some workers who are laid off will remain unemployed even though others migrate and find new jobs.

The analysis has also shown that increased integration of labor markets can harm workers, at least in cases where migration costs do not fall sufficiently to completely eliminate unemployment, that is, in cases where both migration and unemployment are observed. In fact, in the absence of some sort of compensation mechanism, workers are definitely harmed by greater labor mobility. Firms, on the other hand, benefit from labor mobility in the sense that expected profits necessarily rise as migration costs fall. The ability to hire additional workers in response to positive shocks reduces the implicit premium that the firms' existing workers pay, in favorable states of nature, under the implicit contract, leading to a change in the terms of the implicit contract in a way that ultimately reduces labor market rigidities. Workers are consequently exposed to increased risk of layoff and to a reduced implicit contract wage.

Although labor market integration may have adverse effects on workers, it also improves the efficiency of resource allocation. Our analysis has shown that it is possible, in principle, for the increased profits of firms to be used to offset the losses suffered by workers in such a way that all could benefit from increased labor mobility. To some extent, workers do share directly or indirectly in the profits of firms – not necessarily or even ordinarily the profits of the particular firms in which they are employed – through the ownership of financial assets. Banks, stock markets, and other financial institutions can provide workers with the opportunity to hold diversified portfolios in which the independent risks of region-specific shocks are effectively pooled. In the extreme, if all profit income accrues to workers through perfectly-functioning capital markets, increased economic integration would raise their non-wage income by more than enough to fully compensate them for the adverse effects on their wage income. In practice, of course, some or many workers may not in fact own much wealth, and the assets that they do own may not be fully diversified, in which case financial markets will not provide a very effective mechanism through which workers can be compensated for the adverse effects of labor market integration.

To some extent, economic integration is the result of ongoing fundamental changes in transportation, communications, and other technologies that reduce the barriers to mobility of goods and factors. It is also influenced by political events such as the breakdown of the former communist regimes in Eastern Europe. (German unification provides an example of an immediate and drastic reduction in migration costs.) Our analysis shows that these

changes can have important distributional effects. In addition to fundamental technological factors, however, the extent of economic integration, and particularly of labor market integration, also depends on a wide range of economic policies. The migration cost parameter c in our model can thus be viewed as determined, in part, by public policy decisions. For example, the Treaty of Rome, with its explicit provisions concerning the free mobility of labor without legal, fiscal, or other formal restrictions, stands as a major policy choice affecting the subsequent (and continuing) evolution of the labor market policies of individual member states of the EU. The recurring question of whether to expand the EU to include still more countries repeatedly raises afresh the question of whether the “welfare state”, including labor market protections existing workers, can be sustained in the face of the liberalization of labor mobility that new accessions entail. While we do not attempt to develop an explicit political-economy model of policies that affect the degree of market integration, our general-equilibrium welfare analysis, by identifying the gainers and losers from increased integration (i.e., its distributional effects), obviously could provide a foundation for such a model. In particular, the analysis shows that policies that enhance labor market integration could well be viewed as a threat to the welfare of workers and as a benefit to the owners of firms, two groups whose interests therefore could come into conflict in the political process. At the same time, from an *ex ante* “constitutional” perspective in which all parties step behind the “veil of ignorance”, enhanced labor market integration may well be attractive.²²

Recent papers by Agell (1999, 2000), rather consistently with the spirit of the present analysis, discuss how labor market rigidities can help to mitigate risks faced by workers, observing that many of the institutions that support these rigidities originated, historically, during episodes in which workers appear to have been exposed to substantial uninsured risks. Agell argues that trade liberalization and other trends that contribute to integration of markets for *goods and services* can expose workers to greater risks and thus might increase the demand for risk-mitigating rigidities in labor markets; by the same token, trade liberalization may be more palatable in countries with strong “welfare state” provisions. The foregoing analysis, by contrast, shows that integration of the market for *labor* can be conducive to the development of more *flexible* labor market institutions. In a classic study, Mundell (1957) shows that trade and factor mobility can be “market substitutes”. The results above, however, suggest that liberalization of factor markets and liberalization of output markets

²² A number of authors (e.g., Saint-Paul (1996a, 1996b)) have explored several aspects of the political economy of labor-market regulations, abstracting from policies that affect the degree of integration of local labor markets. In the US context, the freedom of interstate labor mobility has been enshrined in constitutional interpretations and in practice from the beginning. Thus, insofar as controls on migration are relevant determinants of the migration-cost parameter c , the labor markets of the individual states of the US have historically been characterized by lower migration costs than the countries of Europe. An explicit treatment of the political economy of policies that influence labor market integration goes beyond the scope of the present paper, but it would clearly be of value to investigate in greater detail the potential interplay between labor mobility and the political interests that shape specific aspects of labor-market institutions.

may to some extent be “policy complements”, in that the costs of risk arising from openness in output markets may be offset, to some degree, by increased openness in labor markets. Certainly, the *internal* market of the US has long been characterized by a high degree of openness in both goods and factor markets, and the Treaty of Rome similarly envisages integration in both types of markets.

International agreements such as the European Union, and other mechanisms through which policies of many jurisdictions are coordinated, affect the costs of labor mobility throughout an entire *system* of jurisdictions. From the perspective of a *single* jurisdiction, however, the effects of labor market integration may be viewed rather differently. To begin with, it should be noted that the policies of individual countries may differentially affect the costs of immigration and of emigration. Strict labor market regulations, restrictions on immigration, or other policies that limit the ability or incentives of firms to hire new workers can discourage immigration, while guest or temporary worker programs encourage firms to hire workers who come from other countries (e.g., the German *Gastarbeiter* program or the *bracero* program in the US). These policies affect the cost of *entry* into a jurisdiction. Countries may also pursue education, training, and other policies that, among other consequences, may make it easier for workers to emigrate to other locations, i.e., that affect the cost of *exit* from a jurisdiction. Fiscal policies, including both the taxation of earnings and the provision of unemployment benefits, income support, and other social benefits will also affect the incentives to enter or to leave a given country.

While our formal analysis has not distinguished between the cost of entry into a jurisdiction and the cost of exit, it clearly implies that reductions in entry costs have effects that are quite different from reductions in the cost of exit, when viewed from the perspective of any one jurisdiction. In any single jurisdiction, workers definitely benefit from the opportunity to go elsewhere in search of employment if local labor conditions are unfavorable. In equilibrium, workers can obtain more attractive long-term contracts from local employers if they have better external opportunities. These changes in the terms of long-term contracts, however, adversely affect the profits of local firms. Conversely, when it is less costly for workers to immigrate to a given jurisdiction, the welfare of the workers in that locality falls, while the profits of local firms rise. Policies that reflect the interests of workers in any one jurisdiction would thus tend to favor easy exit and difficult entry, for example in the form of strict immigration policies coupled with few or no restrictions on emigration, while policies that favor the interests of the owners of firms would work in the opposite direction.

One might suppose that public policies could be used to compensate workers for the adverse effects of integration. For instance, tax/transfer policies such as personal and corporation income taxes could capture part of the increases in profits that accrue to firms and their owners while reducing fiscal burdens on workers. Other public policies, however, might accentuate the adverse effects of integration on workers. For example, pay-as-you-go public pension programs are a major asset for many households in advanced economies. The implicit rate of return in such systems is highly positively correlated with labor mar-

ket conditions. Since labor market integration increases the risk of layoffs and (at least in some cases) reduces wages, jurisdiction-specific public pension programs (*e.g.*, national public pension programs in EU countries), far from compensating workers for the adverse effects of greater mobility, actually exacerbate these effects. Clearly, economic integration presents complex and subtle challenges for the formulation of tax, social insurance, and other public policies. The foregoing analysis has developed a general-equilibrium framework within which public policy questions concerning the effects of economic integration in the presence of unemployment could usefully be explored. Further investigation of these issues, however, lies beyond the scope of the present paper.

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Appendix A

If the equality holds in equation (2), and making use of $w_1 = w_2 = w$, condition (2) defines the state independent implicit contract wage as a function of the employment level in each state n_1 and n_2 , and the expected utility that workers obtain elsewhere:

$$w(n_1, n_2, \tilde{u}_A).$$

From total differentiation of (2) we obtain:

$$\frac{\partial w}{\partial n_1} = \frac{(1 - \rho)n_2}{n_1(\rho n_1 + (1 - \rho)n_2)} \frac{u(w) - u(b)}{u'(w)} > 0 \quad (A.1)$$

$$\frac{\partial w}{\partial n_2} = -\frac{n_1}{n_2} \frac{\partial w}{\partial n_1} < 0 \quad (A.2)$$

$$\frac{\partial w}{\partial \tilde{u}_A} = \frac{n_1}{[\rho n_1 + (1 - \rho)n_2]u'(w)} > 0. \quad (A.3)$$

The profit function (1) can then be rewritten as

$$\Pi_A = \rho p_1 f(n_1) + (1 - \rho)p_2 f(n_2) - w(n_1, n_2, \tilde{u}_A)[\rho n_1 + (1 - \rho)n_2] \quad (A.4)$$

which firms maximize with respect to n_1 and n_2 . Using (A.1) and (A.2), the first-order conditions are:

$$\frac{\partial \Pi_A}{\partial n_1} = \rho[p_1 f'(n_1) - w] - (1 - \rho)\frac{n_2}{n_1} \frac{u(w) - u(b)}{u'(w)} = 0 \quad (A.5)$$

$$\frac{\partial \Pi_A}{\partial n_2} = (1 - \rho)[p_2 f'(n_2) - w] + (1 - \rho)\frac{u(w) - u(b)}{u'(w)} = 0. \quad (A.6)$$

Using (A.1) and (A.2) again, the second (cross) derivatives are

$$\frac{\partial^2 \Pi_A}{\partial n_1^2} = \rho p_1 f''(n_1) + (1 - \rho)\frac{n_2}{n_1} \frac{[u(w) - u(b)]u''(w)}{u'(w)^2} \frac{\partial w}{\partial n_1} < 0 \quad (A.7)$$

$$\frac{\partial^2 \Pi_A}{\partial n_2^2} = (1 - \rho)p_2 f''(n_2) + (1 - \rho)\frac{n_1}{n_2} \frac{[u(w) - u(b)]u''(w)}{u'(w)^2} \frac{\partial w}{\partial n_1} < 0 \quad (A.8)$$

$$\frac{\partial^2 \Pi_A}{\partial n_1 \partial n_2} = \frac{\partial^2 \Pi_A}{\partial n_2 \partial n_1} = -(1 - \rho)\frac{[u(w) - u(b)]u''(w)}{u'(w)^2} \frac{\partial w}{\partial n_1} > 0. \quad (A.9)$$

Straightforward calculations show that the second-order conditions are satisfied, i.e.

$$\frac{\partial \Pi_A}{\partial n_i^2} < 0, \quad \left| \frac{\partial^2 \Pi_A}{\partial n_i \partial n_j} \right| > 0. \quad (A.10)$$

Finally, we have to calculate

$$\frac{\partial^2 \Pi_A}{\partial n_1 \partial \tilde{u}_A} = -\left[\rho + (1 - \rho)\frac{n_2}{n_1} \left(1 - \frac{[u(w) - u(b)]u'(w)}{u'(w)^2} \right) \right] \frac{\partial w}{\partial \tilde{u}_A} < 0 \quad (A.11)$$

and

$$\frac{\partial^2 \Pi_A}{\partial n_2 \partial \tilde{u}_A} = -\frac{[u(w) - u(b)]u''(w)}{u'(w)^2} \frac{\partial w}{\partial \tilde{u}_A} > 0. \quad (\text{A.12})$$

Using Cramer's rule, we then can calculate

$$\frac{\partial n_1}{\partial \tilde{u}_A} = \frac{-\frac{\partial^2 \Pi_A}{\partial n_1 \partial \tilde{u}_A} \frac{\partial^2 \Pi_A}{\partial n_2^2} + \frac{\partial^2 \Pi_A}{\partial n_2 \partial \tilde{u}_A} \frac{\partial^2 \Pi_A}{\partial n_1^2}}{\left| \frac{\partial^2 \Pi_A}{\partial n_i \partial n_j} \right|} < 0. \quad (\text{A.13})$$

APPENDIX B

Proof of Theorem 1:

The first-order conditions for the maximization problem P_M , (7c)–(7e), together with (14), provide four equations that determine the general-equilibrium impact of changes in the migration cost parameter c on the variables n_1, n_2, w , and w^* .

First, from (14),

$$\frac{\partial w^*}{\partial c} = 1, \quad (\text{B.1})$$

establishing part (i) of the theorem.

Second, differentiating (7d) with respect to n_1 and w^* and substituting from (B.1) yields

$$\frac{dn_1}{dc} = \frac{1}{p_1 f''(n_1)} < 0, \quad (\text{B.2})$$

which proves part (iii) of the theorem.

Using the implicit function theorem, (7e) determines the level of employment in the bad state, n_2 , as a function of the implicit contract wage w , such that

$$\frac{\partial n_2}{\partial w} = \frac{1}{p_2 f''(n_2)} \frac{(u(w) - u[w^* - c])u''(w)}{u'(w)^2} > 0. \quad (\text{B.3})$$

In turn, (7c) can be used to determine the implicit contract wage w in terms of n_2 and $w^* - c$. Using (14), differentiation of (7c) thus yields

$$dc = \left[\frac{(1-\rho)}{\rho} \frac{u(w) - u(w^* - c)}{\bar{n}u'(w)} \frac{\partial n_2}{\partial w} + 1 + \frac{(1-\rho)}{\rho} \frac{n_2}{\bar{n}} \left(1 - \frac{[u(w) - u(w^* - c)]u''(w)}{u'(w)^2} \right) \right] dw. \quad (\text{B.4})$$

Combining (B.3) and (B.4) and rearranging yields

$$\begin{aligned} \frac{dw}{dc} &= \rho \bar{n} \left(\rho \bar{n} + (1-\rho)n_2 + (1-\rho) \frac{[u(w) - u(w^* - c)]u''(w)}{u'(w)^2} \left[\frac{u(w) - u(w^* - c)}{u'(w)p_2 f''(n_2)} - n_2 \right] \right)^{-1} \\ &> 0, \end{aligned} \quad (\text{B.5})$$

which establishes part (ii) of the theorem.

Finally, the change in the employment level in the bad state is given by

$$\frac{dn_2}{dc} = \frac{\partial n_2}{\partial w} \frac{\partial w}{\partial c} > 0, \quad (B.6)$$

which proves part (iv) of the theorem.

Q.E.D.

Appendix C

Proof of Theorem 2:

The comparative statics results for the full-employment regime are similar to the mixed regime. Equations (7c) to (7e) represent the first-order conditions. However, under full employment, the equilibrium spot wage is no longer determined by condition (14); rather, full-employment requires that

$$\rho n_1 + (1 - \rho)n_2 = \bar{n}. \quad (C.1)$$

Equation (7c)–(7e) and (C.1) provide a system of four equations to determine the equilibrium values of n_1 , n_2 , w , and w^* .

To begin with, (7e) can be used to solve implicitly for n_2 as a function of w and $w^* - c$. The derivative of n_2 with respect to w is already given in (B.3); analogously,

$$\frac{\partial n_2}{\partial(w^* - c)} = \frac{1}{p_2 f''(n_2)} \frac{u'(w^* - c)}{u'(w)} < 0. \quad (C.2)$$

Next, substituting the implicit function $n_2(w, w^* - c)$ into (7c), one can solve for w as a function of (w^*, c) . Defining

$$A \equiv \rho + \frac{1 - \rho}{\bar{n}} \left(\frac{u(w) - u(w^* - c)}{u'(w)} \frac{\partial n_2}{\partial w} + n_2 \left[1 - \frac{u(w) - u(w^* - c)}{u'(w)} \frac{u''(w)}{u'(w)} \right] \right), \quad (C.3)$$

and noting that $A > 0$, implicit differentiation of (7c) yields

$$\frac{\partial w}{\partial w^*} = \frac{\rho}{A} - \frac{1 - \rho}{\bar{n}} \left(\frac{u(w) - u(w^* - c)}{u'(w)} \frac{\partial n_2}{\partial(w^* - c)} - n_2 \frac{u'(w^* - c)}{u'(w)} \right) A^{-1} > 0. \quad (C.4)$$

$$\frac{\partial w}{\partial c} = \frac{1 - \rho}{\bar{n}} \left(\frac{u(w) - u(w^* - c)}{u'(w)} \frac{\partial n_2}{\partial(w^* - c)} - n_2 \frac{u'(w^* - c)}{u'(w)} \right) A^{-1} < 0. \quad (C.5)$$

Substituting from (C.1) and using the implicit functions $n_2(w, w^* - c)$ and $w(w^*, c)$ derived from (7e) and (7c), it is now possible to write (7d) as

$$p_1 f' \left(\frac{\bar{n}}{\rho} - \frac{1 - \rho}{\rho} n_2[w(w^*, c), w^* - c] \right) = w^*. \quad (C.6)$$

General-equilibrium stability of the ex post spot market for labor requires that an increase in the spot wage w^* lead to excess supply, i.e., that

$$B \equiv 1 + p_1 f''(n_1) \frac{1 - \rho}{\rho} \left(\frac{\partial n_2}{\partial w} \frac{\partial w}{\partial w^*} + \frac{\partial n_2}{\partial(w^* - c)} \right) > 0. \quad (S)$$

Assuming that (S) holds, implicit differentiation of (C.5) yields

$$\frac{dw^*}{dc} = -p_1 f''(n_1) \frac{1-\rho}{\rho} \left(\frac{\partial n_2}{\partial w} \frac{\partial w}{\partial c} - \frac{\partial n_2}{\partial(w^*-c)} \right) B^{-1}. \quad (C.7)$$

Substituting from (B.3), (C.2), and (C.5), the bracketed expression in (C.7) can be written as

$$\begin{aligned} & \left(\frac{1}{p_2 f''(n_2)} \frac{(u(w) - u[w^* - c])u''(w)}{u'(w)^2} \right) \frac{1-\rho}{\bar{n}} \left(\frac{u(w) - u(w^* - c)}{u'(w)} \frac{\partial n_2}{\partial(w^* - c)} - n_2 \frac{u'(w^* - c)}{u'(w)} \right) A^{-1} \\ & \quad - \frac{1}{p_2 f''(n_2)} \frac{u'(w^* - c)}{u'(w)} \\ & = \frac{A^{-1}}{p_2 f''(n_2)} \frac{u'(w^* - c)}{u'(w)} \left(\frac{1-\rho}{\bar{n}} \frac{(u(w) - u[w^* - c])^2 u''(w)}{u'(w)^2} \frac{1}{p_2 f''(n_2)} - n_2 - A \right), \quad (C.8) \end{aligned}$$

where the equality in (C.8) follows after substituting again from (C.2). Finally, substituting from (B.3) into (C.3) and thence into (C.8), it follows after some rearrangement that the bracketed expression in (C.7) is positive, which establishes part (i) of Theorem 2. Part (ii) follows immediately from part (i) and (7d), and (iii) follows from (ii) and (C.1).

Q.E.D.