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“Empirical Specifications for a General Equilibrium Analysis of Labor Market Policies and Adjustments”, by Andréa Maechler and David W.Roland-Host, produced as part of research programme on Sustainable Development: Environment, Resource Use, Technology and Trade, May 1995

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RÉSUMÉ

L'analyse économique orthodoxe des interactions entre l'offre, la demande et l'emploi, fondée sur des économies fermées, devient obsolète à mesure que progresse la globalisation. La croissance considérable de l'emploi observée dans certaines régions du monde est tirée par la demande extérieure ; mais dans d'autres régions, la satisfaction de la demande par l'importation est perçue comme une menace pour l'emploi. Afin de mieux comprendre, et si possible d'anticiper, les changements structurels du marché du travail induits par le commerce international, il convient d'introduire les principaux acquis de la théorie du marché du travail dans un modèle empirique d'équilibre général qui permettrait de circonscrire ces interactions particulièrement complexes. Cette étude vise à faire le point des travaux récents les plus novateurs portant sur le marché du travail, puis d'en extraire les apports les plus intéressants pour les exprimer en formules économétriques faciles à utiliser. Cette étude propose ainsi une typologie des nouvelles théories du marché du travail et quelques orientations de recherche empirique sur l'ajustement de l'emploi et des salaires.

SUMMARY

Economic globalization is increasingly challenging traditional, closed-economy intuition about linkages between demand, supply, and employment. In some parts of the world, substantial employment growth is arising from external demand while, in other areas, there is growing concern that domestic demand is being diverted to external sources of supply and employment. To better understand and predict how employment patterns will evolve with expanding international trade, the best of labor market theory must be brought into an empirical general equilibrium framework which can capture these complex interactions. The purpose of the present study is to review the innovative recent literature on labor markets and distill essential elements which can be implemented in a practical manner. The result is a taxonomy of new labor market theories and an agenda for new empirical research on wage and employment adjustment.

PREFACE

This Technical Paper, part of the Development Centre's research programme on "Sustainable Development: Environment, Resource Use, Technology, and Trade," synthesizes an overview of the new literature on labor markets with a series of practical examples to implement these new theories for empirical research on wage and employment adjustment.

Employment is an issue of paramount importance to both Member and non-Member countries of the OECD. Among the former, there is concern about sustainable domestic growth rates and a sense that expanding international economic opportunities may not yield significant job and wage gains at home. Among the latter, there is excitement about the pace and promise of globalization, but considerable uncertainty about how to develop their human resources to meet new trade and growth opportunities. Whatever the evolution of international and domestic markets for goods and services, however, better policies to secure job and wage growth must be based on detailed understanding of the workings of labor markets. We are fortunate to live in a period where academic research on this subject has been unusually imaginative and prolific, and this paper attempts to distill this large and growing literature for practitioners who want to study labor markets empirically.

The methods and results surveyed here indicate how great is the challenge of understanding the wage and employment effects of policies and market adjustments. The authors show, for example, how social protection measures like minimum wages can be regressive, how the same policy applied to different sectors or occupational groups can have very different direct and indirect effects, how the same distortions can hinder efficiency in one case and promote it in another, and how behavioral information unlikely to be available to the average policy maker can undermine or even reverse intended outcomes. Given these variegated results, in relatively simple applications, generalization to more detailed interactions or across countries is even more tenuous. Thus policy makers cannot reasonably rely only on simple theoretical intuition or rules of thumb. While theoretical work like that reviewed here can and has produced important insights, the authors argue persuasively that only detailed, case by case, empirical work will elucidate the workings of real labor markets and policy interventions.

With more theoretical and practical research of the kind reviewed and proposed here, it is hoped that economists in both Member and non-Member countries can provide stronger support for policy makers. In a world of increasing economic complexity and interdependence, the success of both domestic and external policies depends more than ever on the quality and availability of reliable economic research.

Jean Bonvin
President,
OECD Development Centre
April, 1995

I. INTRODUCTION

In an era of globalization, linkages between international trade and labor markets are receiving intensified scrutiny. Many OECD countries are preoccupied with the implications of expanded trade for employment growth, employment diversion (referred to in Europe as *delocalisation*), and real wages. At the same time, more and more developing countries are concerned about how best to facilitate human resource development for trade-driven economic expansion. With increasing capital mobility and technology diffusion, the quantity and quality of domestic labor is an ever more important determinant of comparative advantage. Structure and conduct in domestic labor markets can be just as important as labor endowments, however. As expanding trade has imbued commodity markets with greater competitiveness and flexibility, trade-induced domestic growth is placing new adaptive pressures on labor markets. Increasingly, labor market rigidities are being viewed as impediments to more effective participation in the global economy, as well as to more sustainable growth of output, employment, and average living standards.¹

At least as important as the level and composition of employment are real wage trends and policies that influence these directly and indirectly. While government and labor groups are understandably reluctant to abandon the social priorities which underlie many labor market interventions, the efficiency costs these confer upon their economies are often significant and usually not well understood. Despite a vast body of labor market research emerging in the last two decades, only a small part focuses on trade or empirical estimates of efficiency effects. The main objective of this paper is to review and synthesize the new labor market theories, embedding them in an empirical general equilibrium framework so that they can be used to answer policy concerns about employment and wage effects which arise from both external and domestic influences.

Rather than exhaustively testing competing labor market specifications and evaluating real cases, our present purpose is expository. In the following sections, we provide a rational menu of generic labor market specifications, with relatively parsimonious numerical examples of how each can be implemented in a single prototype calibrated general equilibrium (CGE) model. The CGE model is a real one, based on a complete dataset for Mexico, but its application in this paper is more methodological than empirical. From the basic tool kit presented here, it is hoped that other practitioners will join us to enlarge the very incomplete basis of empirical evidence on how international trade and domestic labor markets interact.

1. The *OECD Jobs Study* (1994) provides a comprehensive historical overview of such trends. See also the OECD's annual *Employment Outlook*.

Each section covers different genera of labor market theory with the same three-part structure: conceptual motivation, literature survey, and numerical example. No attempt has been made to cover every contending theory, contributor, or alternative specification. The sample here is intended to represent the main streams of this rapidly growing research area, cite their leading contributors, and offer simple entry points for more detailed empirical research.

II. WAGE RIGIDITIES

Wage rigidities are one of the most pervasive distortions in labor markets. These arise from essentially two sources: 1) government interventions which seek to secure basic living standards or, in rarer cases, to limit wage growth; 2) distortions against competitive wage adjustment which arise from market power held by workers, employers, or both. In this section, we consider general examples of both cases, where wage rigidities are exogenous or endogenous to the labor market.

Exogenous Wage Rigidity

A broad spectrum of government policies exist in different countries to legislate minimum wage levels directly or support reservation wages via social insurance programs. Although these policies use economic instruments and have pervasive economic effects, they are rarely implemented with economic efficiency criteria in mind. In this section, we conduct a variety of simulation experiments to see how minimum wage policies can affect the adjustment process ensuing from trade liberalization.

The first major contribution to the analysis of minimum wage is presented in Stigler (1946). He demonstrates that the imposition of a minimum wage above the equilibrium wage reduces employment. An alternative version recognizes that minimum wage regulations may apply only to a covered sector, with an uncovered sector in which workers displaced by the higher minimum wage could find jobs. This approach can be extended further to allow for job queuing at the minimum wage, either by those earning the lower wage in the uncovered sector, or by those dropping out of the labor force². Holzer, Katz and Krueger (1991) demonstrate that jobs paying around the minimum wage have a greater number of applicants than other jobs, suggesting the presence of significant rents.³ Edwards and Edwards (1990) provide an excellent analytical survey of a number of international trade models with wage rigidities. For further discussions on the theory underlying the economic impact of minimum wage policy, see Riveros (1990) and Fiszbein (1992). Econometric evidence on minimum wage policies includes Brown, Curtis, Kohen (1982), Riveros and Paredes (1988), and Lopez and Riveros (1988). Using a time-series approach, Santiago (1989) estimates labor market effects of higher effective minimum wage levels.

In this set of simulations, we shall examine four alternative types of minimum wage policy. Each represents different target groups or different social insurance objectives, and together they cover the main policy alternatives and generic types of distortionary effects. The prototype general equilibrium model is described, and its structural equations set forth, in the appendix. All notation used in the following discussions is based on the conventions of the prototype.

² See Mincer (1976) for a standard model of queuing.

³ See also Hamermesh (1993)(p.182-191) for a stylized version of labor market effects of minimum wages and a brief survey of relevant empirical work.

Minimum Wage by Occupation

In this case, the government attempts to guarantee a nominal hourly minimum to one or more specific labor categories. We assume fixed labor supplies throughout, and in the event that the minimum wage is binding, unemployment will be created in the target occupational groups. We assume that these workers respond by entering the informal labor market and finding jobs there, putting downward pressure on the informal wage. The wage equation for a given target occupational group (l) is modified from the prototype to take the form

$$w_l \geq \bar{w}_l \quad (1)$$

where w_l and \bar{w}_l represent, respectively, the average and minimum wage to the target occupational group.

Some observations about this specification are in order. Firstly, note that we assume the minimum applies to occupational average wages rather than to individual wages of workers. Distributional effects within occupations are ignored. Secondly, inter-sectoral wage differentials are also ignored, so the incidence of the minimum wage policy will be distorted, i.e. sectors with low wage premia may still pay below the target minimum on average. Third, note that the inequality above makes the prototype model under-determined. To eliminate the extra degree of freedom, we add an orthogonality condition

$$(w_l - \bar{w}_l)(L_l^S - L_l^D) = 0 \quad (2)$$

where L_l^S and L_l^D represent, respectively, the labor supply and demand of the given target occupational group.

Finally, we modify the labor supply equation for the informal occupational group (N) to allow for spillover of unemployed workers in the minimum wage target group, i.e.

$$L_N^S = \bar{L}_N^S + (L_l^S - L_l^D) \quad (3)$$

Minimum Real Wage by Occupation

Although most minimum wage policies are enunciated in terms of nominal hourly rates, some have escalation clauses to reflect the social objectives of real purchasing power maintenance. In the case of an occupational target group, such a policy can be simply specified as

$$w_l \geq \bar{w}_l P_l \quad (4)$$

where P_l represents an endogenous price index. This might be an aggregate GDP deflator or an index more focused on the needs of a target group, such as a consumption-weighted purchaser price index. In any case this simple modification may increase or decrease the distortionary effects of the wage

minimum, depending upon whether deflationary or inflationary pressures dominate a given adjustment process.

Minimum Wage by Sector

In some instances, minimum wage policies are targeted at workers in specific occupations and sectors. This more focused approach may be designed to correct severe inter-sectoral differentials or could be the result of sector-specific political forces. In this case, the wage determination equation for a given target occupational (l) and sectoral (i) group takes the form

$$\omega_{ii}w_l \geq \bar{w}_{li} \quad (5)$$

where the average occupational wage, w_l , is tied to the sectoral wage premium, ω_{ii} , and where \bar{w}_{li} represents the target occupational and sectoral minimum wage. The other modifications above are unchanged.

Minimum Real Wage by Sector

A final variation concerns real wage maintenance in a specific sector. This kind of policy is especially common in public sector employment, where wages are normally legislated in any case and often indexed. Here the wage constraint takes the form

$$\omega_{ii}w_l \geq \bar{w}_l P_l \quad (6)$$

Simulation Experiments

We now compare the results of the reference simulation with those obtained under a variety of minimum wage specifications. The first experiment is the reference case used throughout this exercise, a trade liberalization scenario entailing abolition of Mexican tariffs and NTBs on all imports.⁴ Five alternative experiments then follow, including a minimum fixed at the observed wage for unskilled workers, a real (GDP deflated) minimum for the same group, sectoral minimum wages for export-intensive (Energy) and import-intensive (Durables) sectors, respectively, and a minimum real wage for service sector workers.

The reference experiment is typical of CGE trade liberalization scenarios, with modest aggregate GDP growth arising from sectoral productivity gains in this fixed employment setting (Table 1). Removing import protection, other things equal, will induce real exchange rate and domestic price depreciation, exerting downward pressure on real wages in most occupational groups. When

⁴ See Reinert, Roland-Holst, and Shiells (1995), for a more detailed discussion of such liberalization experiments.

labor markets are competitive, as in Experiment 1, unskilled workers take most of the brunt of this.

Assuming instead that unskilled wages are protected by official minimum wage policy, nominally in Experiment 2 and in real terms in Experiment 3, changes the results significantly. The results in the two differ only in the magnitude of the adjustment necessary to offset unskilled wage rigidity, but are otherwise identical in qualitative terms. Because of the factor market rigidity, the real exchange rate must depreciate even further to align domestic and international resource costs.⁵ Consumer prices also fall further, this time because of the significant wage repression in the residual, informal labor market which receives a significant influx of newly unemployed unskilled formal workers. This result clearly illustrates the regressive nature of minimum wage policies which has been emphasized by many authors.⁶ In per capita terms, however, the fixed nominal wage policy is less wage repressive than the reference, while the fixed real wage policy is more so.

Finally, one might at first be startled by the increase in aggregate efficiency under distortionary policies. Recall, however, that this is a second-best situation, where we have assumed inter-sectoral labor productivity differences and calibrated these into a fixed wage distribution.⁷ This means that reallocating labor can raise aggregate productivity per unit of resource cost, and especially so if the labor is induced to migrate from higher to lower wage categories. Under the assumption that sectoral wage differences correspond to labor productivity differences, re-allocating workers from low to high wage (productivity) sectors increases real GDP. This effect is amplified when workers also cross over to informal employment. Like economies of scale, then, labor market distortions appear to have the potential to amplify efficiency gains, but of course subject to other economic and social costs which may not be incorporated in this model.

Sectoral fixed wages have smaller absolute and distributional effects, except for the large and relatively low wage service sector. Efficiency effects vary with the skill and productivity composition of the target sectors. Real exchange rate depreciation is smaller when the distortion is on the income (export) side (Energy) of the trade balance than on the expenditure (import) side (Durables), but highest when the distortion is in the large, relatively nontradeable service sector (reverse Dutch Disease).

⁵ This point is omitted by Edwards and Edwards (1990) in their otherwise detailed treatment of this subject.

⁶ Compare, e.g. Devarajan, Ghanem, and Thierfelder (1994).

⁷ This kind of labor market distortion, where sector-specific wage differences correspond to productivity differences, has been observed by a number of authors. See e.g. Krueger and Summers (1987, 1988).

Table 1. **Minimum Wage Scenarios**
(percentage changes)

<i>Experiment</i>							
<i>Selected Aggregates</i>	1	2	3	4	5	6	
Real GDP	.8	3.0	2.3	.9	1.2	3.7	
Real Exchange Rate	-5.7	-7.8	-7.2	-5.9	-6.8	-7.6	
Consumer Price Index	-9.3	-9.8	-9.9	-9.4	-9.8	-8.5	
<i>Real Wages</i>							
Unskilled	-10.2	9.8	.0	-9.8	-11.0	-16.6	
Skilled	-3.6	-10.1	-9.2	-3.2	-1.2	-11.6	
Informal	-.5	-38.9	-33.5	-.1	3.4	.7	
Val. Added Wgt. Ave.	-5.5	-8.3	-10.6	-5.1	-4.0	-11.0	
Employment Wgt. Ave.	-7.0	-4.9	-9.8	-6.7	-6.3	-11.5	
<i>Premia for Sectoral Real Wage Maintenance</i>			<i>Energy</i>			<i>Durables</i>	<i>Services</i>
Unskilled	.0	.0	.0	23.7	26.3	23.2	
Skilled	.0	.0	.0	14.4	12.4	15.6	

- Experiment 1: Mexican tariff and NTB abolition with competitive labor markets.
- Experiment 2: Experiment 1 with a nominal minimum wage for unskilled labor.
- Experiment 3: Experiment 1 with a real minimum wage for unskilled labor.
- Experiment 4: Experiment 1 with minimum nominal wages for formal workers in Energy.
- Experiment 5: Experiment 1 with minimum nominal wages for formal workers in Durables.
- Experiment 6: Experiment 1 with minimum real wages for formal workers in Services.

Table 2 gives an overview of sectoral results associated with the reference and minimum wage experiments. As is typical, sectoral adjustment to liberalization and with respect to different labor market policies are more dramatic than aggregate results. In all cases, however, they follow intuitively from the economic structure, pattern of prior protection, and occupational composition of sectoral employment (see Table 6 in the appendix).

Table 2. **Sectoral Changes Resulting from Trade Liberalization**
(percentages)

<i>Output</i>							
<i>Output</i>	<i>Exp 1</i>	<i>Exp 2</i>	<i>Exp 3</i>	<i>Exp 4</i>	<i>Exp 5</i>	<i>Exp 6</i>	
1	Agriculture	-9	-12	-11	-8	-7	-7
2	Energy	9	5	6	3	11	11
3	NonDurables	-2	-4	-4	-2	-1	-1
4	Durables	6	9	7	6	0	8
5	Services	2	4	3	2	2	1
	Weighted Ave.	1	1	1	1	0	1
<i>Exports</i>							
1	Agriculture	50	30	35	51	57	56
2	Energy	18	11	13	9	21	21
3	NonDurables	48	38	41	49	54	52
4	Durables	50	57	53	51	38	55
5	Services	32	44	43	32	35	22
	Weighted Ave.	40	44	43	40	39	39
<i>Demand for Dom. Goods</i>							
1	Agriculture	-11	-14	-13	-11	-10	-10
2	Energy	-4	-5	-4	-5	-5	-3
3	NonDurables	-6	-7	-7	-6	-5	-5
4	Durables	-10	-8	-9	-10	-13	-9
5	Services	0	1	1	0	0	-1
	Weighted Ave.	-4	-3	-3	-4	-4	-3
<i>Imports</i>							
1	Agriculture	138	156	151	137	132	134
2	Energy	217	232	228	239	205	215
3	NonDurables	52	58	56	52	48	51
4	Durables	27	28	29	27	28	26
5	Services	-24	-29	-29	-24	-26	-19
	Weighted Ave.	38	42	41	38	37	37

The uniformity of weighted average adjustments across experiments is striking but logical, being the result of the macroeconomic components of the model such as fixed aggregate factor supplies and constant external policy. Individual sectoral differences are significant across experiments, however, indicating that important differences in relative competitiveness can emerge under different labor market specifications.

Endogenous Wage Rigidity

Simple Rent Sharing

By definition, wage rigidities arise when wages do not move fast enough to reflect the changing value of labor productivity. One of the simplest cases of this arises when firm-level excess profits exist and labor takes a share of these in addition to its competitive wages. This rent sharing partially de-couples wages from the first order relationship characteristic of neoclassical labor markets. Before looking at more complex bargaining models, we extend the prototype model with a simple rent sharing rule to see how it may compromise economic efficiency.

The idea that the behavior of labor markets could be represented satisfactorily by standard competitive models was first criticized by Schlichter (1950). He argued that competitive models failed to account for the empirically tested significant wage differentials among observationally homogeneous types of workers. Recent empirical work supports these results (see Dickens and Katz 1987, Krueger and Summers 1987 and 1988, Katz and Summers 1989, Christofides and Oswald 1989 and 1992, and Abowd, Kramarz and Margolis 1994). Several authors advanced the hypothesis that rent-sharing behavior can significantly affect the wage determination process⁸. For a discussion on the implications of industry rents, refer to the excellent work by Katz and Summers (1989) who present an insightful literature review and relevant empirical evidence on the subject.⁹ While Blanchflower and Oswald (1989 and 1992) present empirical evidence on the negative relationship between workers' earnings and local unemployment level, Blanchflower, Oswald, Sanfey (1992) find that the real wage is an increasing function of employers' past profitability¹⁰. Christofides and Oswald (1989 and 1992) support both of these results, which are consistent with rent-sharing theory¹¹.

Assume that, in a given sector, a given occupational group has bargaining power for rent sharing which can be represented by a simple index β_{ii} whose value lies between zero and unity. In this case, a premium ω_{ii} above the competitive wage w_l will accrue to these workers, given by rent sharing rule

$$\omega_{ii} = 1 + \frac{\beta_{ii}}{1 - \beta_{ii}} \frac{r}{w_l L_{ii}^D} \quad (7)$$

where r represents firm operating rents.¹² As a practical matter in this implementation, we calibrated the parameter β_{ii} and rents r equal the total wage premium and labor value added in the sector under consideration.

⁸ The observed wedge between the marginal productivities of factors in different uses is a type of market imperfection which is likely to cause certain factors to earn rents. In the present context of rent-sharing, the idea is that workers are able to capture a large part of the rents earned by firms.

⁹ Their empirical results find that a large portion of monopoly rents earned by product markets may be captured by workers rather than shareholders.

¹⁰ The argument is that workers benefit of higher wages when the firm or industry is booming. Local unemployment, however, tends to weaken workers' bargaining power, producing a negative relationship between wages and unemployment.

¹¹ A standard competitive framework would expect factor prices to be equalized across sectors and firms to hire factors of production up to the point where their marginal productivity equals their cost. Consequently, wages should be affected by labor supply forces rather than by unemployment and the profitability of a firm or industry should not prevent employers from paying exactly the "competitive" wage.

¹² Compare to Blanchflower, Oswald, and Sanfey (1992) for details.

Wage Bargaining

A more elaborate view of endogenous wage determination recognizes the existence of labor unions as explicit bargaining agents. When labor is organized to negotiate the terms of employment, wages may be above and employment below their competitive levels. In this and the next subsection, two cases are considered. Here, we look at the case where unions bargain over wages only and firms choose the level of employment to maximize profits. Next, we shall examine joint wage-employment contracts.

Unions can be viewed as instruments used by employees to extract rents from firms. There exist two broad categories of wage bargaining models, namely the *monopoly union model* and the *efficient bargaining model*¹³. Essentially, there is a tradeoff between wages and employment. The monopoly union model is a special case where the firm has no bargaining power in wage setting and the union has no power in employment. The wage is set unilaterally by the union. However, bargaining over the wage alone will generally not permit an efficient outcome¹⁴. For a simplified presentation of standard wage bargaining models, see Blanchard and Fischer (1989)¹⁵. Extensive surveys of work on the economic theory of union behavior are found in Oswald (1985) and Farber (1986). Penclavel (1985) reviews microeconomic research on union models and extends them to the macroeconomic level¹⁶. Excellent empirical work for Britain is presented in Layard and Nickell (1986). Blanchflower, Oswald and Garrett (1990) estimate the relative importance of inside power enjoyed by unionized workers in the wage determination process¹⁷.

Extending the prototype model to incorporate labor negotiation requires a specification of the union's objective function. Assume that union members are homogeneous with individual utility represented by $U(\omega_i w_i)$ and that their group utility can be represented by

$$V(\omega_i w_i, L_i^D) = \left(\frac{L_i^D}{L_i^0} \right) U(\omega_i w_i) + \left(1 - \frac{L_i^D}{L_i^0} \right) U(w_i) \quad (8)$$

where we assume that employment in the base situation, L_i^0 , represents maximum union membership.¹⁸ Thus the welfare of the union is a convex combination of utilities for those who remain in the sector, earning the

¹³ This latter category of models is also referred to as the *right-to-manage* model.

¹⁴ See Farber (1986) for a formal discussion. Generally, most of the existing applied work assumes that unions bargain over wages and employers select the employment level.

¹⁵ See Blanchard and Fischer, Chapter 9, p. 438-546.

¹⁶ See also Calmfors (1985) for discussion on trade union behavior and its macroeconomic implication.

¹⁷ The "inside power" hypothesis is also discussed in Solow (1985) and Lindbeck and Snower (1986,1987) in the context of efficiency wages.

¹⁸ A number of authors (e.g. de Melo and Tarr (1990)) use a single utility function for the union, but this is more difficult to motivate from principles of demand theory. See Oswald (1987) for more on this point.

negotiated wage, and those who find employment elsewhere, assumed to earn the average wage. Note now that

$$V(\omega_i w_l, L_i^D) - V(w_l, L_i^D) = \frac{L_i^D}{L_i^0} [U(\omega_i w_l) - U(w_l)] \quad (9)$$

so that, in a wage-only contract, the net gain for the members who remain employed is independent of the utility of unemployed members. The bargaining problem facing the union is then given by the Lagrangian

$$\text{Max}_{\omega} L_i^D [U(\omega w_l) - U(w_l)] + \lambda [L_i^0 - L_i^D] \quad (10)$$

whose interior (i.e. $\lambda = 0$) solution is obtained by solving the following expression

$$\frac{U_{\omega}(\omega w_l)}{\sigma} = \frac{U(\omega w_l) - U(w_l)}{\omega} \quad (11)$$

where σ denotes endogenous wage elasticity of labor demand in the prototype CES specification of production. Intuitively, this expression represents an equivalence of ratios for marginal (subjective and technical) substitution rates and values. Using the Extended Linear Expenditure System in the prototype model, this specification can be implemented without difficulty.

Efficient Contracts

Most anecdotal evidence indicates that unions bargain over wages and firms generally have discretion about employment levels.¹⁹ Despite this, however, wage-only bargaining can produce outcomes which are not on the firm-union, wage-employment contract curve and are therefore inefficient. To remedy this, we extend the prototype below to incorporate simultaneous bargaining over both wages and employment levels.

Under efficient bargaining models, firms and unions share equal bargaining powers in wage and employment setting. In their seminal paper, McDonald and Solow (1981) argue that a contract is efficient, when it lies at a point of tangency between an indifference curve and an isoprofit locus, that is at a point on the contract curve. Which point is chosen on the contract curve will depend on the relative bargaining power of the firm and of the union. If the union is relatively weak, the outcome may be close to the competitive equilibrium; if the union is relatively powerful, it may be close to the firm's zero profit point²⁰. In terms of efficient contracts, the bargaining outcomes are most likely going to lie off the demand curve. This occurs because at the bargained wage level, employers would prefer to cheat by reducing the level of employment. Abowd and Lemieux (1993) estimate a simple model of efficient wage-setting. Espinosa and Rhee (1989) extend standard bargaining models to allow for repeated

¹⁹ See Oswald (1987) for discussion.

²⁰ See also Penclavel (1985), Oswald (1985) and Farber (1986) for further discussion.

bargaining.²¹ Empirical evidence supporting efficient bargaining models include MaCurdy and Penclavel (1986), Brown and Medoff (1986), and Brown and Ashenfelter (1986)²².

The basic implementation for wage-employment bargaining relies on a Nash solution to the following joint optimization problem:

$$\text{Max}_{\omega, L} L \{U(\omega w_l) - U(w_l)\} \{F_i(L; \dots) - \omega w_l L - C_i(\dots)\} + \lambda \{L_{li}^0 - L\} \quad (12)$$

where F_i and C_i denote the production and (non-labor) cost functions in sector i , respectively. Omitting second-order cost effects, the solutions to this problem can be approximated with the following two expressions

$$\omega = \frac{\alpha_E}{2w_l} \left[\frac{F}{L} + F_L \right] \quad (13)$$

$$F_L L_\omega - \omega w_l = -\beta_E \left(\frac{U(\omega w_l) - U(w_l)}{U_\omega(\omega w_l)} \right) \quad (14)$$

where α_E and β_E are calibrated parameters. These two equations are easily interpreted. The first represents a rent sharing rule like that in equation (7) above. It states that the wage premium equals an arithmetic mean of the average and marginal products of labor.²³ The second expression is the equation representing the locus of efficient wage-employment bargains, the firm-union contract curve. The right-hand side represents the firm's iso-profit loci, the left-hand side the union's indifference curve.²⁴

The results of three endogenous wage experiments are presented in Table 3 below, accompanied by the reference simulation. Since each of these experiments is confined to a single occupational group (skilled labor) and sector (durables), aggregate differences are negligible.

21 The authors show that when choosing the level of employment, firms may often give up short-term profits (i.e. cheating on the level of employment) for better contracts in the future.

22 For different point of views, see Layard and Nickell (1990) who show that employment may not be always higher under efficient bargaining than under monopoly union models, and Alogoskoufis and Manning (1991) who reject both the monopoly union model and the efficient bargaining model in favor of a generalized model of inefficient bargaining for wages and employment.

23 More on rent sharing can be found in Abowd and Lemieux (1993).

24 For more details, see MacDonald and Solow (1984) and Oswald (1987).

Table 3. **Endogenous Wage Rigidity Experiments**
(percentage changes)

<i>Selected Aggregates</i>	<i>Experiment</i>			
	<i>1</i>	<i>7</i>	<i>8</i>	<i>9</i>
Real GDP	.8	.7	.8	.8
Real Exchange Rate	-5.7	-5.5	-5.8	-5.5
Consumer Price Index	-9.3	-9.1	-9.3	-9.2
<i>Real Wages</i>				
Unskilled	-10.2	-11.2	-9.9	-11.5
Skilled	-3.6	-1.6	-4.1	-2.9
Informal	-5	-7	-4	-1.0
Val. Added Wgt. Ave.	-5.5	-5.1	-5.6	-5.8
Employment Wgt. Ave.	-7.0	-7.6	-6.8	-8.0
<i>Sectoral Wage Premium and Employment</i>				
WP.Skilled.Durables	.0	-10.9	3.6	1.6
LD.Unskilled.Durables	29.5	18.1	32.7	19.8
LD.Skilled.Durables	-16.1	18.2	-25.3	1.7
LD.Informal.Durables	-30.8	-40.3	-28.0	-39.1
LD.Durables	7.7	9.2	7.3	9.0
Output.Durables	5.8	6.9	5.5	6.8

Experiment 7: Experiment 1 with rent sharing by skilled labor in Durables.

Experiment 8: Experiment 1 with wage bargaining by skilled labor in Durables.

Experiment 9: Experiment 1 with wage and employment bargaining in Durables.

Wage and employment results are affected in significant and revealing ways, however. In the rent sharing scenario (Experiment 7), skilled labor takes a significant wage cut ($-10.9 - 1.6 = -12.5$ per cent), thereby reversing a 16.1 per cent employment loss to a 18.2 per cent gain. This permits output and total employment expansion in the durables sector, but still comes at the expense of unskilled and informal workers. The latter suffer less than under minimum wage policies, however, in part because we assume no crossover from skilled to informal labor markets.

Then the same group bargains over wages only, their sectoral gain in wage premium (3.6 per percent) is only just offset by a 4.1 per cent decline for skilled workers across the economy, implying they achieve significant own-wage protection. This comes at a price in terms of job security, however, when 25.3 per cent of skilled workers in this sector are laid off.²⁵ As has been observed in some long term union bargaining situations, labor shedding induced by wage escalation contributes to the economywide wage losses, ultimately

²⁵ The laid off workers join the rest of the skilled labor pool and, on average, experience greater wage losses than their former co-workers. This, and the minimum wage effect on informal workers, illustrates two important effects of wage distortions, own-regressive (within occupational group) and cross-regressive (spilt over to another occupational group) wage linkages. These are among the most complex and interesting aspects of incidence which can be analyzed with labor-oriented CGE models, but detailed analysis extends beyond the scope of the present exposition.

undermining the original group's bargaining power. Despite this mixed result, however, skilled workers better their lot vis-à-vis the reference case in terms of the target variable, wages.

When both wages and employment are negotiated, skilled workers gain job increases of 1.7 per cent and wage premia in durables rise slightly. As a group, skilled workers in Durables still see slight ($1.6 - 2.9 = -1.3$ per cent) wage depreciation, resulting mainly from firm substitution with unskilled workers. All in all, however, it appears that combined wage and employment bargaining yields significant improvement in the latter (1.7 against -16.1 per cent) without too much sacrifice in the former (-1.3 against -3.6 per cent), particularly with respect to the reference case.

III. EFFICIENCY WAGE MODELS

Incentive Wages and Fair Wages

Traditional neoclassical production theory views wages as determined by prices and labor productivity, which in turn is determined by exogenously given technologies and economic conditions outside the worker-employer contract. In reality, compensation has complex incentive properties, and there are causal links running not just from productivity to wages, but from wages to productivity. In modern labor market theory, such issues come under the rubrics of efficiency wages and fair wages. These theories recognize that a worker's productivity depends not only on human endowments, but on the perceived reward for effort. This section derives a basic specification where worker effort depends upon wages, and we give indications about how such behavior might qualify the conclusions drawn from the prototype model.

At first, the efficiency wage hypothesis was formulated by Leibenstein (1957) to highlight linkages among wages, nutrition, and health in less-developed countries. Then, Solow (1979) transferred the efficiency wage concept to developed economies with a model in which increased wages improve morale and thus directly affect productivity through an increase in worker effort. Akerlof (1984) develops a "gift exchange" model in which firms can raise effort by offering a "gift" of higher wages in return for higher individual effort. Another school of thought emphasizes sociological evidence supporting the view that workers' effort level may significantly depend on the perceived fairness of their wage²⁶. Excellent surveys of works on efficiency wage theories are presented in Katz (1986) and Blanchard and Fischer (1989)²⁷. Efficiency wage models have been advanced as providing a coherent explanation for empirically observed "noncompetitive" wage differentials across firms and workers with similar productive characteristics²⁸. Bulow and Summers (1986) introduce a model of dual labor markets based on employers' need to motivate workers. Gibbons and Katz (1992) present evidence that wage differentials reflect unmeasured differences in workers' productive abilities²⁹.

²⁶ See Akerlof and Yellen (1990) who introduce the "fair-wage-effort" hypothesis and explore its implication. For an alternative specification of the effort function, see Wadhvani and Wall (1991).

²⁷ See Yellen (1984), and Murphy and Topel (1990) for additional survey on the theory and evidence of efficiency wages.

²⁸ Recent empirical studies indicate that large and substantial wage differentials remain even after controlling for observed worker and job characteristics. See, for example, Dickens and Katz (1986), Krueger and Summers (1988), Katz and Summers (1989), Blanchflower and Oswald (1992), and Abowd, Kramarz and Margolis (1994). The theory of equalizing differences in the labor market reflects an alternative explanation for the existence of true wage differentials across industries. For a comprehensive review of the theory of compensating differentials, see Rosen (1986).

²⁹ A number of empirical studies suggest the existence of wage differentials, focusing on specific aspects. See Bishop (1987) for employee's performance, Brown and Medoff (1989) for plant size, and Groshen (1991) for establishment type.

Assume that worker effort can be represented by a twice continuously differentiable increasing function of the wage premium, denoted by $e(\omega)$ and satisfying $0 \leq e(\omega) \leq 1$. This function will then enter the firm production function multiplicatively, e.g. $F(L)$ is replaced by $F(e(\omega)L)$ to represent effective labor input. For firms facing a market wage then, the optimal employment level is that where the marginal product of an additional worker equals the wage, taking account of effort as determined exogenously by wage levels.

To implement this specification, we choose a general functional form

$$e(\omega_i w_l) = \frac{\omega_i w_l}{\omega_i w_l + \alpha_w e^{-\beta_w \omega_i w_l}} \quad (15)$$

where the parameters α_w and β_w are calibrated to exogenously specified base effort levels and wage elasticity of effort, σ_{ew} , satisfying

$$\sigma_{ew} = \frac{\partial e}{\partial w} \frac{w}{e} = \alpha_w e^{-\beta_w w} \frac{1 + \beta_w w}{w + \alpha_w e^{-\beta_w w}} \quad (16)$$

where, for the sake of brevity, $w = \omega_i w_l$.

Principal-Agent Relations (Shirking and Monitoring)

A significant component of labor productivity is thought to be governed by pecuniary incentives and worker supervisory mechanisms. Wage premia might be offered to bias recruitment in favor of higher productivity workers and motivate workers already on the job. Monitoring may be a complement to or substitute for this, a means of overcoming moral hazard and seeing to it that workers perform as expected. Both these approaches entail costs which exceed those which would be incurred by a firm with perfect information which could perfectly discriminate in the labor market, but the degree to which these second-best approaches compromise efficiency is an empirical question.

When shirking detection is uncertain, the firm attempts to pay wages in excess of market clearing to induce workers not to shirk³⁰. Then, if a worker is caught shirking and is fired, he will pay a penalty. Considering the threat of firing a worker as a method of discipline is not novel. The works of Calvo (1979) and Shapiro and Stiglitz (1984) have highlighted the moral hazard problem underlying the employer and wage-earner relationship³¹. However, the equilibrium unemployment rate must be sufficiently large that it pays workers to work rather than to take the risk of being caught shirking. Shapiro and Stiglitz

³⁰ Models of this type have been analyzed by Bulow and Summers (1986), Calvo (1985), Eaton and White (1983) and Shapiro and Stiglitz (1984).

³¹ In this type of models, unemployment is involuntary, in the sense that workers without jobs would be happy to work at the market-clearing wage, but cannot credibly signal not to shirk at this wage. For further discussion on this issue, see also Nalebuff, Rodriguez and Stiglitz (1993), and Akerlof and Katz (1987, 1989).

(1984) develop a model introducing a “non-shirking constraint”.³² For a formal discussion on the reasons why firms monitor their workers, see Dickens, Katz, Lang and Summers (1990). For empirical evidence on the substantial resources devoted to monitoring workers, see Dickens, Katz and Lang (1986). Empirical evidence that efficiency wages are paid to elicit effort includes Raff and Summer’s (1987) examination of Henry Ford’s five-dollar day, Bulow and Summer’s (1986) analysis of the impact of sectoral wage declines on employment and Cappelli and Chauvin’s (1991) finding of a negative relationship between wage premia and dismissal rates.

In this section, the prototype model is extended to incorporate a simple shirking and monitoring specification, giving an indication of how principal-agent relations might affect empirical conclusions from general equilibrium models. Consider a given sector (i) and labor occupational category (l), and assume that workers in this sector have an exogenously defined quit rate (q) and, if they shirk, a probability (f) of being fired. In a steady state, it can be shown that the wage premium necessary to make workers just indifferent between shirking and not doing so is given by

$$\omega_{li} = 1 + \alpha_s \frac{L_l^S}{L_l^S - L_l^D} \frac{q}{f} \quad (17)$$

where L_l^S and L_l^D denote total labor supply and labor demand for occupational group l , respectively.³³ The parameter α_s is calibrated from base data on sectoral wage differentials and f may be exogenous or endogenous, depending upon whether the firm uses monitoring in an effort to influence worker productivity. In a relatively simple case, such a firm would choose monitoring resources M to impose firing risk $f(M)$ on shirking workers. Assume, as is common in this literature, that $f(M)$ is twice continuously differentiable and $f_M > 0$ and $f_{MM} < 0$ in the relevant range. Then the firm will use monitoring inputs just until their marginal cost, c_M , equals the marginal benefit they occasion in terms of reduced wage premia, i.e.

$$c_M = - \frac{\partial \omega_{li} w_l L_l^D}{\partial M} = \frac{f_M}{f} (\omega_{li} - 1) w_l L_l^D \quad (18)$$

In other words, the marginal cost of the last unit of monitoring inputs should equal the percentage change in monitoring effectiveness, times the premium component of the wage bill.

To implement this specification, we assume that workers in another occupational category (k) are monitors, and unit monitoring costs equal their

³² It has been argued that upfront performance bonds could provide incentives for adequate employee productivity. Bulow and Summers (1986), Dickens, Katz, Lang and Summers (1987), and Shapiro and Stiglitz (1984) provide detailed discussions of why firms may be limited in requiring workers to exhibit performance bonds, pay fines or charge entrance fees.

³³ See e.g. Bulow and Summers (1986) for a discussion of no shirking constraints.

wage (i.e. $c_M = w_k$). We then choose a generalized logistic function to represent how the monotone and bounded ($0 < f < 1$) risk of firing depends upon the level of monitoring. Thus $f(M)$ takes the general form

$$f(M) = \frac{M}{M + \alpha_M e^{-\beta_M M}} \quad (19)$$

where the parameters α_M and β_M are calibrated from an exogenously specified number of supervisory workers M and elasticity of firing risk with respect to monitoring inputs, $\sigma_{f,M}$.

Table 4 presents the results of four experiments, which are compared to the reference case as usual. Again, activity is largely confined to sector and occupational groups and aggregate effects are relatively small.

Table 4. Incentive Wage and Monitoring Experiments
(percentage changes)

<i>Selected Aggregates</i>	<i>Experiment</i>				
	<i>1</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>
Real GDP	.8	.3	.6	1.1	.8
Real Exchange Rate	-5.7	-6.7	-5.8	-6.5	-5.6
Consumer Price Index	-9.3	-10.1	-9.4	-9.7	-9.2
<i>Real Wages</i>					
Unskilled	-10.2	-10.2	-9.6	-12.0	-10.0
Skilled	-3.6	10.5	-1.1	1.2	-4.0
Informal	-.5	10.5	1.5	3.1	-.7
Val. Added Wgt. Ave.	-5.5	2.5	-3.8	-3.4	-5.6
Employment Wgt. Ave.	-7.0	-3.0	-5.9	-6.8	-7.0
<i>Sectoral Wage Premium and Employment</i>					
WP.Unskilled.Durables	.0	.0	.0	27.6	-2.2
LD.Unskilled.Durables	29.5	-53.2	19.2	-17.8	34.0
LD.Skilled.Durables	-16.1	105.0	4.8	33.4	-20.4
LD.Informal.Durables	-30.8	104.2	-10.1	19.5	-34.8
LD.Durables	7.7	-7.2	4.7	1.1	8.4
Output.Durables	5.8	-5.4	3.7	1.0	6.3
Effort.Unskilled.Durables	.0	-45.7	-9.0	.0	.0
Firing Risk	.0	.0	.0	.0	3.4
Monitors	.0	.0	.0	.0	9.1

Experiment 10: Experiment 1 with basic effort function, elasticity = 2.0.

Experiment 11: Experiment 1 with basic effort function, elasticity = 0.5.

Experiment 12: Experiment 1 with constant effort, endogenous wage premium.

Experiment 13: Experiment 1 with monitoring.

Experiments 10 and 11 use two simple specifications of the effort function to evaluate efficiency or incentive wage effects for unskilled workers in durables, one with a wage elasticity of effort of 2.0 and the other with $\sigma_{ew} = 0.5$. In these

simulations, declining incentive wages generally lead to falling effort (depending in magnitude on the relevant elasticity), falling efficiency, and a competitive disadvantage for the sector of employment. Where effort falls faster than wages (Experiment 10), durables employers substitute away from unskilled labor. If the wage elasticity of effort is less than unity, an employment shift in favor of this group occurs.

Experiment 12 poses the question: What wage premium in durables would be necessary to maintain constant effort in the face of declining economy-wide unskilled wages, and what would be its ultimate effect on the rest of the adjustment process? The answer in this case is 27.6 per cent, driving many unskilled workers (17.8 per cent) out of durables employment, but keeping sectoral output relatively constant. Thus a significant own-regressive effect emerges, where firms are induced by the incentive problem to choose a new occupational mix, including fewer unskilled worker who receive higher wages to maintain their effort levels, but shedding a significant number of them to face unemployment or sharply lower wages in new jobs. Vis-à-vis the reference case, unskilled employment in durables reverses a 29.5 per cent gain to a -17.8 per cent lay off, while skilled workers switch from -16.1 per cent laid off to 33.4 per cent more employed.

A final simulation implements our simple monitoring specification, with the result that both durables employment and output can exceed reference levels by employing more monitors. Under trade liberalization, the opportunity cost of supervisory (skilled) workers or monitors falls, making it economic to have (9.1 per cent) more of them, thereby raising the firing risk for unskilled shirkers 3.4 per cent (from 80 per cent in the base) and lowering the sector's unskilled, constant effort, wage premium by 2.2 per cent.

IV. TRANSACTION COSTS

The prototype model assumes that the process of job creation and destruction is costly for workers and firms, but in general both parties may incur significant expenses from labor market participation. Workers may engage in costly search activities and purchase goods and services designed to increase their search effectiveness. For firms, labor market transactions costs fall into four broad categories: 1) recruitment; 2) training; 3) severance; 4) costs arising from labor relations. Although some of these costs might affect a worker's ultimate productivity, they must be factored into firm profits in addition to basic wage compensation.³⁴ For this reason, transactions costs drive a wedge between labor productivity in the firm's production function and the hiring/firing decision, with a commensurably detrimental effect on efficiency.

The role of labor turnover costs in the efficiency wage mechanism is analyzed in Salop (1979) and Stiglitz (1985). Turnover costs is costly to firms in terms of search for new workers, lost production during vacancies, and a loss of specific training. If firms must bear part of the costs of turnover and if quit rates are a decreasing function of wages paid, firms will attempt to pay above market clearing wages in order to reduce costly labor turnover costs³⁵. However, the same wage may not clear simultaneously the market for new hires and the market for trained workers³⁶. There is almost no available data on the size or breakdown of labor market transaction costs. While few surveys have attempted to analyze the costs of firing and hiring, even fewer studies have tried to infer the accounting costs of turnover within particular firms. Taken together, the diversity of the reported estimates illustrate the difficulty of clearly identifying and measuring these costs.³⁷ Given these constraints, turnover models predict high wages where hiring and training costs are substantial. Empirical studies indicate that industry wage premiums reduce voluntary turnover (Brown and Medoff 1978, Dickens and Katz 1987, Krueger and Summers 1986 and 1988).³⁸ These

³⁴ Training costs can in some cases be amortized into the wage.

³⁵ In most types of efficiency wage models, firms' willingness to pay higher relative wages lead to involuntary unemployment equilibrium, mainly because the wage is unable to clear the labor market when it must simultaneously allocate labor and provide adequate incentives. See Krueger and Summers (1988) for discussion.

³⁶ The dual role of wages causes a type of market failure which induces a non-unique market-clearing wage equilibrium for workers with different quit functions (Salop 1979). Following this line of thought, Stiglitz (1985) provides a rationale for wage distributions within an industry for similar workers.

³⁷ Penclavel (1972) presents a general discussion on training and labor turnover in US manufacturing industries and Hamermesh (1993) reports available data on this issue.

³⁸ Krueger and Summers (1988) find a positive and statistically significant effect of industry wage premiums on job tenure, and a negative but statistically insignificant effect on quit rates. Moreover, Brown and Medoff (1978) estimate a mean elasticity of quits with respect to the wage premium of about -0.3. Dickens and Katz (1987) find qualitatively the same results for nonunion workers. See also Freeman (1980) and Leonard and Jacobson (1990).

results provide additional evidence that wage premiums may not reflect compensating differences.³⁹

Because of their symmetry and complexity, transactions costs can lead to a broad array of distortions on both sides of labor markets, including underemployment or over-employment, wage premia or wage discounts, excessive worker retention and employment stability or excessive layoffs and employment volatility. Higher costs and more limited information both confer strategic disadvantage on those who possess them. Ultimately, qualitative results will depend upon relative recruitment/severance cost and information quality for firms and workers, while magnitudes can only be assessed empirically.

To illustrate the role of labor market transactions costs, we extend the prototype model with a simple specification for both workers and firms. For workers, it is assumed that employment is associated with a cost equal to a fixed proportion of their entry wage representing turnover costs.⁴⁰ For firms, we assume that both recruitment and severance are associated with a cost in fixed proportion to wages. In a competitive labor market, one might expect these costs to be passed through equilibrium wages, while in a bargaining or rent-sharing environment they might be shifted from strategically stronger to weaker agents.

Transaction costs can be incorporated into all the endogenous wage determination models discussed in the previous section, but for illustrative purposes we only evaluate them in the competitive labor market setting. To do this, the labor demand and supply equations for the prototype must be amended to include the parameters δ_h and δ_f , denoting coefficients for transaction costs for employment (from the worker perspective), hiring, and firing (both from the firm perspective), represented as unit costs discounted over the expected term of employment.⁴¹ It is also a simple matter to incorporate search costs from the worker perspective, but this omitted in the interest of brevity. The results of these experiments are given in Table 5 below and discussed in that section.

³⁹ See also Gavin (1986) and Lazear (1990) for a discussion and econometric results concerning severance pay.

⁴⁰ For convenience only, we assume the payment is made to the government. In general, this turnover cost would appear as worker demand for goods and services associated with employment. We assume there is no direct worker cost associated with a lay-off.

⁴¹ This discounting is necessary in a comparative static framework, where there is only on wage bill during the term of labor market clearing.

V. SELECTION MODELS

A large component of modern labor market theory focuses attention upon the process of employee selection by firms. In a simplified neoclassical setting, firms and workers are each homogeneous populations with perfect information, making costless contracts in a frictionless labor market. In reality, of course, both employers and candidates are very diverse and considerable uncertainty governs their interactions. These practical limitations will undermine the efficiency of the labor market and can lead to behavior which has complex incentive properties. In this section, we consider a representative example which indicates how the standard neoclassical model and information set must be expanded to account for these phenomena.

Imperfect information by firms about the quality of workers provides a selection rationale for efficiency wage payments. If workers are heterogeneous in ability and if ability and reservation wages are positively correlated, firms that offer higher wages will attract higher-quality job applicants. The simplest reason for the dependence of productivity on wages is adverse selection (Stiglitz 1987, Weiss 1980 and Greenwald 1986). With a continuum of worker types, steepening the wage profile will be a profitable strategy for selecting a subset of types⁴². Some rents will exist because it is not worthwhile to achieve perfect sorting. Nalebuff, Rodriguez and Stiglitz (1993) present a model with asymmetric information in which wages serve as an effective screening device. For an excellent overview of the theory of contracts, see Hart and Holmström (1987). See also Nalebuff and Stiglitz (1983) for a presentation on the role of compensation in economies with imperfect information⁴³. Weiss (1980) and Malcomson (1981) apply the efficiency wage concept in the context of a pool of heterogeneous workers, where firms can only roughly estimate the quality of each applicant.

To illustrate how different assumptions about the underlying labor market selection process can affect empirical simulation results, consider two alternative explanations of inter-sectoral wage differentials. In both cases, we assume that the wage differences reflect equilibrium differences in sectoral labor productivity. The first scenario is used in the prototype and is standard in most CGE models. Here one assumes that productivity differences are specific to the firm, and workers who enter a sector “inherit” that sector’s productivity and wage premium. Thus workers moving from high low productivity sectors experience a corresponding drop in their individual productivity. At the other extreme, we assume that labor productivity is specific to workers, and the existing wage distribution reflects equilibrium differences in recruitment which place more productive workers in higher wage sectors. In this case, workers take their productivity levels with them when they change jobs. As usual, the truth probably lies somewhere between these two extremes, but their implications for the adjustment process are very different.

⁴² See Stiglitz (1985) for the implications of imperfect information on the equilibrium wage distribution.

⁴³ The implications of imperfect information in competitive markets is discussed in the seminal paper of Rothschild and Stiglitz (1976).

To implement the second scenario in the prototype model is a simple matter. We need only to convert the base sectoral employment levels from worker units to efficiency units. This is accomplished by simply rescaling employment in each sector and occupation by the observed wage differential, then setting the latter to unity. The results are presented and discussed in the next section.

VI. LABOR MARKET SEARCH AND MATCHING

The prototype neoclassical model represents an extreme simplification of the process by which workers seek employment and firms seek recruits. The true underlying dynamics of labor market search and matching are of course very complex, and an extensive theoretical and econometric literature has developed to elucidate it. Most of this work simplifies this task considerably, representing the underlying process by a functional form which, while parsimonious in most cases, has enough structure to capture the essential behavioral features of search and matching.⁴⁴ We incorporate one such functional form in the prototype to give an indication about how its general properties are affected and as an example of how more empirical work might be done in this area.

It is the large literature on the Unemployment-Vacancy (*UV*) curve which has fueled new interest in the analysis of structural change in the labor market.⁴⁵ Search theory has emerged from the idea that trade in the labor market is an economic activity which yields crucial implications for unemployment⁴⁶. Mortensen (1986) presents a useful survey of the literature on job search⁴⁷. Stochastic job matching functions were first developed by Jovanovic (1979)⁴⁸. Standard references in the matching literature include Diamond (1981, 1982a, 1982b), Mortensen (1982b), and Pissarides (1985b, 1987, 1990). For an insightful discussion on the methodology and empirical evidence of search and matching models, see Eckstein and Wolpin (1990) and Stern (1990).⁴⁹ In these models, the labor market is characterized by unemployed workers searching for jobs and firms recruiting workers to fill their vacancies. The potential trading partners are brought together pairwise by a given stochastic matching technology and the probability of matching a worker-firm pair depends on the number of active searching workers and recruiting firms. A number of authors have examined the (in)efficiency of search equilibria⁵⁰. Pissarides (1984) presents a model with endogenous demand for

⁴⁴ At the microeconomic level, the work of Pissarides (1981, 1985b, 1986, 1987) is representative, while the work of Blanchard and Diamond (1990) on the Beveridge Curve shows how search and matching is approached from a macroeconomic perspective.

⁴⁵ Early studies on vacancy-unemployment interactions were motivated by the desire to find a way of measuring the excess labor demand discussed in Phillips curve studies. For recent empirical work on the *UV* curve, see Jackman, Layard and Pissarides (1989) for Britain, and Blanchard and Diamond (1989) for the United States.

⁴⁶ Lucas and Prescott (1974) present a theoretical paper in which the theory of job search is used to develop an equilibrium theory of employment.

⁴⁷ See also Layard, Layard and Pissarides (1991) for various theoretical extensions and empirical evidence on job search theory.

⁴⁸ In the context of matching-bargaining models, Howitt's (1985) model of transaction should also be noted. Empirical studies on the probability of leaving include Lancaster (1979), Nickell (1979), Yoon (1981), Flinn and Heckman (1982), Narendranathan and Nickell (1985) and McKenna (1987).

⁴⁹ See also Pissarides and Wadsworth's evidence (1994) of on-the-job search for Britain.

⁵⁰ Mortensen (1982b) argues that agents' search and recruitment expenditures are generally inefficient because no agent internalizes the value of his increased search activity to other searchers. See also Diamond (1982a) and Pissarides (1984, 1985b and 1987).

labor, later extended to include a dynamic dimension (1985a, 1987, 1990). Mortensen (1982a) and Howitt and McAfee (1987) introduce models with variable search intensities.⁵¹ Jackman, Layard and Pissarides (1989) present empirical evidence on variable intensities and Pissarides (1986) provides a search model with interesting econometric results for Britain.

Assume as in the prototype that notional labor demand is given by the number of vacant jobs v , number employed is given by L , and number of employable workers equals T . In a neoclassical labor market, efficiency would prevail and these notional levels would be realized at some equilibrium wage rate. Assume instead that labor market pairing of prospective workers ($u = T-L$) with vacant jobs (v) is inefficient and can be modeled by a generalized function or matching technology of the form

$$m(v, u, w) = v \left(1 + \alpha_m e^{-(\beta_u v + \beta_v u + \beta_w w)} \right)^{-1} \quad (20)$$

where the $\beta_i > 0$ are elasticities of effective job creation with respect to each explanatory variable and α is a calibrated scale parameter. This multi-nomial logistic function is a generalized version of a variety of specifications discussed and estimated in the literature on this subject.⁵²

Since the matching function is asymptotic to the number of vacancies, the labor market will never clear completely, and thus underemployment plus a wage premium are likely to emerge among the efficiency costs of imperfect matching. The matching function is calibrated to an assumed 10 per cent and two hypothetical different elasticity regimes.

Table 5 presents the results of illustrative experiments with transactions costs, labor market selection, and a search/matching specification. The direct adjustments ensuing under transactions costs are completely intuitive, with hiring costs (Experiment 14) increasing unskilled unemployment and reducing wages and firing costs reducing lay offs and wage declines. A 10 per cent hiring premium depresses new employment by almost an equal amount ($29.5 - 19.0 = 10.5$ per cent), but firing costs cannot be compared directly since this requires a reference case with lay offs.

Also significant, and much less obvious, are the spillover effects on other occupational groups. Even though the latter labor markets have been assumed to be competitive, they move with the unskilled group in ways which would be difficult to predict from simple rules of thumb. Of particular interest is Experiment 15, where, despite that fact that firing costs are not incurred directly, their presence induces a distortion which reduces wage and employment losses for the other groups.

Experiment 16 represents the simple but illuminating labor market selection experiment. Assuming that labor productivity is embodied in those workers employed in the base equilibrium, removing trade distortions confers no

51 Extending Hosios' work (1990), Pissarides (1990) considers variable intensities as input-augmenting technical progress.

52 See e.g. Hosios (1990) for more discussion.

efficiency gains in the presence of resource constraints. This is because worker reallocation cannot raise average efficiency levels. The assumption that base wages and employment reflect worker-specific differences in productivity has very different implications for structural adjustments within the economy, however. The reference simulation indicates that the 1990 Mexican system of prior import protection may have been relatively “worker friendly” in the sense that all three occupation groups’ real wages decline as a result of liberalization. When productivity is embodied in those workers, however, they benefit from removing distortions, since they can allocate their skills more “efficiently” (in terms of factor rewards) when distortions are removed. Since we now assume that any sector can pay premium wages to premium workers, and durables had relatively superior average wages in the base case, they expand less than other sectors which are, for example, more export competitive and can bid away high quality workers.

The final two simulations indicate how more general labor market inefficiencies, captured by a generic matching function, can effect adjustment to trade liberalization. Among a three-dimensional continuum of cases, we chose only five regimes for the three elasticity values in expression (20) above. The first two correspond to uniformly flexible and inflexible cases, i.e. all three β 's = 5.0 and 0.2, respectively. In between these hypothetical extremes, we consider three cases, one where each β equals 5.0 while the other two equal 0.2, thereby imputing most of the new matching to each of the three constituent influences, vacancies, unemployment, and wages. While the results do differ at the sectoral and occupational level, it is difficult to generalize from these experiments. Apparently, greater sensitivity of the matching function to vacancies (Experiments 17 and 19) leads to more job creation for unskilled workers, in part because the declining wage permits firms to recruit more. This does not imply, however, that wage sensitivity (Experiment 21) leads to the smallest unskilled wage decline. While the qualitative results are comparable in all cases, and the three intermediate elasticity specifications yield intermediate outcomes, more intensive investigation of this specification is obviously needed. In particular, some detailed econometric work could do much to narrow the acceptable range of functional forms and parameter values.

Table 5

**Transactions Cost, Selection, and Search/Matching Experiments
(percentage changes)**

<i>Experiment</i>									
<i>Selected Aggregates</i>	1	14	15	16	17	18	19	20	21
Real GDP	.8	.6	.8	.0	1.0	.7	1.0	.7	.7
Real Exchange Rate	-5.7	-5.9	-5.6	-5.6	-5.6	-5.7	-5.7	-5.7	-5.6
Consumer Price Index	-9.3	-9.5	-9.2	-9.3	-9.2	-9.3	-9.2	-9.3	-9.3
Real Wages									
Unskilled	-10.2	-11.7	-9.9	4.3	-14.3	-9.8	-13.0	-9.9	-11.5
Skilled	-3.6	-4.5	-3.0	5.3	-6.0	-3.4	-5.0	-3.4	-4.5
Informal	-.5	-1.4	-.2	6.2	-2.5	-.4	-1.6	-.4	-1.4
Val. Added Wgt. Ave.	-5.5	-6.6	-5.1	5.1	-8.5	-5.3	-7.4	-5.3	-6.6
Employment Wgt. Ave.	-7.0	-8.3	-6.7	4.9	-10.5	-6.8	-9.3	-6.8	-8.2
Sectoral Wage Premium and Employment									
LD.Unskilled.Durables	29.5	19.0	30.0	7.0	35.8	28.1	34.4	28.2	29.9
LD.Skilled.Durables	-16.1	-18.4	-10.3	1.4	-20.9	-14.1	-20.1	-14.3	-15.2
LD.Informal.Durables	-30.8	-32.9	-30.6	-3.6	-36.4	-28.7	-35.5	-28.8	-29.9
LD.Durables	7.7	8.2	7.6	3.9	8.5	7.5	8.3	7.5	7.7
Output.Durables	5.8	6.1	5.8	3.8	6.1	5.7	6.1	5.7	5.7

Experiment 14: Experiment 1 with unskilled *ad valorem* Hiring cost of 10 per cent.

Experiment 15: Experiment 1 with unskilled *ad valorem* Firing cost of 10 per cent.

Experiment 16: Experiment 1 with selection via labor-embodied productivity.

Experiment 17: Experiment 1 with matching function in unskilled labor, $\beta=\{5,5,5\}$.

Experiment 18: Experiment 1 with matching function in unskilled labor, $\beta=\{.2,.2,.2\}$.

Experiment 19: Experiment 1 with matching function in unskilled labor, $\beta=\{5,.2,.2\}$.

Experiment 20: Experiment 1 with matching function in unskilled labor, $\beta=\{.2,5,.2\}$.

Experiment 21: Experiment 1 with matching function in unskilled labor, $\beta=\{.2,.2,5\}$.

VII. CONCLUSIONS AND EXTENSIONS

This paper offers a practical taxonomy of more recent labor market theories, combined with a menu of specifications to implement them in empirical simulation modeling. After reviewing an extensive theoretical literature and providing guidelines for using these ideas empirically, the task ahead is very clear. Even the focused and parsimonious examples used above show how challenging it can be to understand trade and employment linkages, particularly when taking account of labor market imperfections. The universe of discourse is an essentially general equilibrium one, where second-best properties are endemic. Thus policy makers cannot reasonably rely only on simple theoretical intuition or rules of thumb.

We have seen how social protection measures, like minimum wages, can be regressive, how the same policy applied to different sectors or occupational groups can have very different direct and indirect effects, how the same distortions can hinder efficiency in one case and promote it in another, and how behavioral information unlikely to be unavailable to the average policy maker can undermine or even reverse intended outcomes. Given these variegated results in a relatively aggregated single country application, generalization to more detailed interactions or across countries would be even more tenuous. While theoretical work can and has produced important insights, only detailed, case by case, empirical work will elucidate the workings of real labor market structures, conduct, and policy interventions.

APPENDIX - Specification of the Prototype Mexican CGE Model

For all the experiments reported above, a single Mexican CGE model was used. Although the labor market specifications differ between experiments, all are based upon the same set of equations for other economic structure and conduct, as well as the same underlying database. This section provides a more complete description of the model, but it must be emphasized at the outset that our objective in using it is pedagogical and is not intended to represent empirical analysis of the Mexican economy *per se*. None of our conclusions or inferences should be construed as applying to this country in isolation.

The Mexican model is a one-country calibrated general equilibrium (CGE) model, typical in most respects except for the treatment of labor markets. While Mexican trade is disaggregated between the US, Canada, and other trading partners, these other economic zones are exogenous to the model itself. The second essential dimension of the model is the commodity (or sectoral) breakdown of economic activities. This version incorporates only 5 sectors which are aggregated from 50 sectors in the basic dataset for the model, a 1990 social accounting matrix. The purpose of the commodity decomposition is to capture the essential features of Mexican structural adjustment in terms of domestic output, demand, factor use, and trade flows. To elucidate the structure of the base year economy, Table 6 below provides some share calculations from the SAM on a sectoral basis.

A third dimension of the model is factor and household disaggregation, since this is essential to analyze labor market dynamics and trace the incidence of trade and other policies. The current version details three labor categories and one representative household. These groups represent the main segments of the Mexican labor market and the principal household groups in terms of factor ownership and policy focus.

Production

As with many applied general equilibrium models, the Mexican model decomposes the production structure into a series of nested decisions allowing for a wide range of substitution possibilities between the various inputs. Figure 1 provides a graphical depiction of the nested production structure.

The top level of the production structure decomposes the production decision between aggregate inputs and an aggregate bundle composed of capital and labor value added. While there is the possibility for allowing some substitution between intermediate inputs and value added, for the purposes of this paper, it is assumed that the substitution elasticity is zero, or in other words the value added is always mixed in fixed proportions with intermediate inputs. It is also assumed that all the intermediate inputs are consumed in fixed proportion amongst themselves, though it is possible to substitute between domestic and imported intermediate goods.

The next level of the production structure decomposes the value added bundle into aggregate labor demand, on the one hand, and a capital on the other. Labor demand is disaggregated into three occupational categories as

shown in the figure. Producers are assumed to choose the optimal mix of labor groups based on relative wages and the available production technology.

Consumption

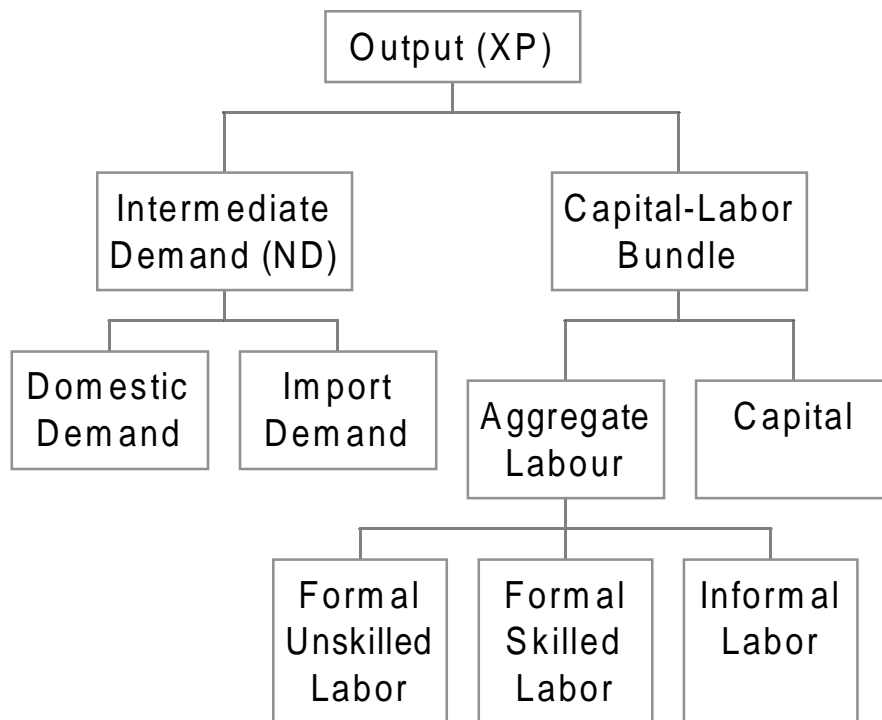
For each household, there is a single representative consumer who allocates disposable income across the various commodities. The model uses an extension of the familiar Stone-Geary consumer demand system, known as the extended linear expenditure system (ELES). The ELES has several distinct advantages over other demand systems. It allows for commodity-specific income elasticities which can either be econometrically estimated or derived from literature searches, it is easy to calibrate and implement, and it integrates the household saving decision in the consumer optimization process. In the ELES system, consumption is represented as the sum of two components, a subsistence minimum, and a share of supernumerary income, which is the residual disposable income after subtracting expenditures on the subsistence minimum. Household direct taxation is a fixed proportion of income.

Table 6
Sectoral Economic Structure of Mexico, 1990
(percentages)

<i>Sector</i>	<i>Output</i>	<i>Demand</i>	<i>Exports</i>	<i>Imports</i>	<i>Value Added Shares</i>			
					<i>Unskilled</i>	<i>Skilled</i>	<i>Informal</i>	<i>Capital</i>
1 Agriculture	7.27	7.61	3.18	6.10	12.90	5.04	.31	9.88
2 Energy	1.07	.48	8.06	.14	1.70	1.45	.22	1.72
3 NonDurables	25.86	26.47	18.64	31.54	24.44	12.75	8.04	18.68
4 Durables	15.49	14.03	32.81	54.86	14.45	7.19	4.97	9.20
5 Services	50.31	51.41	37.31	7.36	46.51	73.57	86.46	60.52
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Figure 1

Production Structure



Other Final Demand

There are three other domestic final demand accounts: government expenditures, investment expenditures, and changes in inventory. Aggregate real government expenditure is assumed to be fixed, while aggregate real investment expenditure will depend upon the closure rule. The decomposition into demand for commodities is assumed to use fixed shares in both cases.

Trade

The model uses an extension of the familiar Armington hypothesis to implement trade equations. The principle behind the Armington assumption is that goods are differentiated according to region of origin. In practice this means that each agent specifies demand for a specific *aggregate* good (derived from maximizing utility for example). This good is a constant elasticity of substitution (CES) aggregate of imports and domestic products in each sector. At this stage of the demand system, agents decompose demand for the aggregate good into its domestic and (aggregate) import components based on relative prices and (calibrated) penetration shares.

Export supply is treated symmetrically to import demand, i.e. domestic producers are assumed to differentiate between domestic and export markets. A rise in export prices (relative to domestic prices), induces producers to shift

production resources towards export markets. The model implements a constant elasticity of transformation (CET) curve to capture this assumption.

Equilibrium

Production is modeled with a constant-returns-to-scale technology, which guarantees that supply equals domestic plus external (export) demand for domestic output. Factor prices, wages and capital returns, are generally determined by equilibrium conditions. In both markets there are a wide range of possibilities. We assume that aggregate capital is fixed in supply and mobile between sectors. We assume that labor of a specific skill is perfectly mobile across sectors, which implies a single economy-wide average wage rate for each skill, assuming labor markets are competitive. A number of authors have demonstrated, however, that significant and persistent wage differentials exist across sectors for the same occupational groups.⁵³ To account for this, we calibrate a distribution of inter-sectoral wage differentials which are held constant during the simulations. Explaining the determination of these differentials is one of the main tasks of this chapter.

Closure

There are three key macro closure rules. The first concerns the government revenue-expenditure balance. For the purposes of the simulations, we assume real government saving is fixed in each region. The instrument used to achieve the balance is the household tax schedule which will shift either right or left to guarantee the budget balance holds.⁵⁴

The second closure rule concerns the saving-investment balance. Domestic investment is determined by the stock of domestic private and public saving, plus net foreign saving (which is exogenous).

The third and final closure rule governs the external account, where we assume that the trade balance is equal to the level of foreign saving. If foreign saving were fixed, all adjustment would necessarily be mediated by the real exchange rate, since increased import demands which follow from trade liberalization must be financed by increased exports. At rigid terms-of-trade, exports can only expand by attracting resources whose relative prices have declined due to structural adjustment in other sectors. These include tradables which are being displaced by new imports and nontradeables, whose price declines both contribute to falling domestic resource costs or real exchange rate depreciation. When foreign saving is endogenous, as in the present model, net flows of foreign investment will also exert an influence on external adjustment, possibly even driving up the real exchange rate and offsetting the export competitiveness which would otherwise result from trade liberalization.

53 See e.g. Katz and Summers (1989).

54 This is equivalent to lump sum taxation or rebates.

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