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ABSTRACT

Mainstream macro theorists construct their models on 19th-century theories of labor pricing. A great deal of modern wage determination, especially that practiced in large, bureaucratic corporations, is constrained in ways that did not emerge until the 20th century. Consequently, the labor-price narrative of the great 19th-century marginalists, especially their description of labor supply, does not come close to capturing wage administration as practiced by large firms today. (Even worse, absent difficult modeling of bargaining power, the contract indeterminacy of Edgeworth that provides analytic roots for Nash bargaining does not explain much of anything.) Playing by the consensus rules of macro modeling, i.e., acceptable theories must be grounded in optimizing price-mediated exchange organized by continuous general equilibrium, this paper reconstructs textbook wage analysis to accommodate the vast changes in the production landscape over the past 100-plus years. The game is worth the candle. Once enriched with modern wage theory, macroeconomics can be both coherent and stabilization relevant – a combination that has been out of the reach of mainstream thinking since the Second Industrial Revolution.

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The 2007-09 Great Recession generated more than six million involuntarily lost jobs (ILJ), accounting for more than three-quarters of the overall increase in unemployment. That outcome is deeply problematic for mainstream macro theorists. Broad market failure featuring ILJ is beyond the reach of the coherent market-centric general equilibrium (DSGE) model class around which contemporary stabilization analysis has converged.[1]

[1] From Woodford (2009, p.268): "there has been considerable convergence of opinion among macroeconomists over the past 10 or 15 years…. The cessation of methodological struggle within macroeconomics is due largely to the development of a new synthesis by Marvin Goodfriend and Robert G. King, called 'the New Neoclassical Synthesis,' that incorporates important elements of each of the apparently irreconcilable traditions of macroeconomic thought." The foremost element of the new synthesis is New Keynesian acceptance of the necessity of dynamic stochastic general-market-equilibrium (DSGE) microfoundations in macro modeling, while New Classical/RBC theorists accept the use of DSGE-consistent market frictions. Again from Woodford (p.270): "What is important is having general-equilibrium models in the broad sense of requiring that all equations of the model be derived from

Many, frequently labor-related, deficiencies of consensus macro theory are rooted in a single difficulty. Modern theorists rely on the elegant 19th-century marginalist model of wage determination and, as a result, have never derived the existence of meaningful wage rigidity (defined below). Coherent modeling has always lacked a rational channel through which adverse nominal disturbances induce involuntary job and income loss. For those who believe that such a channel is part of the practical core of macroeconomics, and most economists do, the absence of robust labor-pricing rigidity is the fundamental obstacle to the stabilization-policy usefulness of mainstream thinking.[2]

This paper argues that the policy limitations of modern macroeconomics are *not*, as many critics assert, rooted in theorist use of the formal method of optimizing price-mediated exchange organized by continuous general decision-rule equilibrium. The core problem instead results from the singular analytic focus on market exchange. Once rational transactions are intuitively generalized from the marketplace to the workplace, coherent macroeconomics easily accommodates the causal link from total-spending disturbances to forced job separation, providing much superior correspondence to the available evidence.

Demonstrating the nonexistence of involuntary job loss in the New Neoclassical Synthesis (NNS) is the undemanding task of the first section. In the second, the rudimentary state of generalized-exchange modeling in macro research is reviewed. The third section provides the main analysis, deriving from axiomatic model primitives the class of meaningful wage rigidity that informs the first stabilization-relevant theory of wage determination in more than 100 years.

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mutually consistent foundations, and that the specified behavior of each make sense given the environment created by the behavior of the others." See also, from a policymaker perspective, Kocherlakota (2009) and Trichet (2010).

[2] The problem ranks among the most important, and most durable, in macroeconomics. Ohanian's (2010, p.45) assessment of mainstream macro thinking when used to model the 2007-09 recession is illustrative: "…we do not understand the channels through which financial distress reduced labor input… [A] research program focusing more broadly on understanding the shocks and the details of the channels through which they drive fluctuations will be a major component of business cycle research in coming years." It is easily demonstrated that adequate answers to Ohanian's questions cannot rely wholly on product-price stickiness. Consistent with the intuition of many great theorists, downward wage inflexibility is a necessary condition of stabilization-relevant coherent macro theory.

Next, layoffs are analyzed as a continuous-equilibrium phenomenon. The various pieces are pulled together and the theory summarized in the fifth part, which is followed by a conclusion.

TABLE 1. INVOLUNTARY JOB-LOSS BEHAVIOR IN U.S. RECESSIONS

	Peak-to-Trough Change in:		
	Unemployment Rate	Job-Losers Incidence	Job Losers (000)
1969-70	+2.4 points	+8.2 points	+1,230
1973-75	+3.8 points	+16.0 points	+2,599
1980	+1.5 points	+7.4 points	+1,315
1981-82	+3.6 points	+11.2 points	+3,433
1990-91	+1.3 points	+6.8 points	+1,373
2001	+1.2 points	+6.0 points	+1,423
2007-09	+4.8 points	+13.1 points	+5,807

Notes: Current-population survey, Bureau of Labor Statistics; job-loser data are seasonally adjusted and available only from 1967; job-loser incidence is the ratio of job losers to total unemployed. In the 2007-09 recession, involuntary job loss accounted for more than three-quarters of the overall increase in unemployment.

I. TWO THEOREMS

What follows is constructed on two ILJ-related macro theorems, the first of which is:

> In order to be stabilization-policy relevant, coherent macro theory must accommodate involuntary job loss.

The theorem is a formal statement of policymaker preferences that are so broadly accepted as to require no further proof. Monetary and fiscal authorities understand that forced job loss exists and, given the characteristic absence of alternative employment paying comparable wages (see below), creates significant income loss.[3] ILJ is the socioeconomic problem most central to

[3] Throughout this paper, dismissal for cause and relocation costs are ignored. The evidence strongly indicates that being fired for shirking is a negligible cause of job loss. Moreover, firings cannot, by definition, be a source of layoffs. Other evidence supports policymaker priors by demonstrating that involuntary job loss (without recall rights) produces lower lifetime earnings, subsequent employment instability, and broad welfare damage in affected households.

business-cycle pathology. Policymakers also know that employment and income loss restricts spending in other markets, compounding the adverse effects of layoffs. Pulling the pieces together, stabilization authorities properly reject the exclusion of involuntary job loss from models used to support their decisionmaking.

The second fundamental macro proposition is named the *Two-Venue Theorem*:

> The coexistence of dynamic general equilibrium, demonstrating analytic coherence, and downward wage inflexibility, sufficient to support involuntary job loss, implies the existence of a dominant nonmarket equilibrium governing labor pricing.

Venues of economic exchange are defined by heterogeneity in optimizing decision rules, constraints, and mechanisms of exchange that imposes boundaries to meaningful aggregation. (See Section III.) The Two-Venue Theorem will be derived from axiomatic model primitives later in the analysis. For now, it is probably best understood as a coherent implication of Robert Barro's well-known wage-recontracting critique.[4]

Wage recontracting. In single-venue (market) general equilibrium (DSGE), opportunity costs govern wage recontracting, which plays an important role in exhausting available gains from trade and avoiding "dollar bills left on the sidewalk".[5] There are two relevant DSGE scenarios:

- The employee is being paid his or her market opportunity cost, and the employer imposes a wage cut. The rational worker quits, moving to the alternative employment paying the (now higher) market rate. Involuntary job loss does not exist.
- The employee is receiving a wage rent (for example, as the result of an adverse aggregate demand shock), and the employer offers a choice between accepting a wage cut or losing the job. Rational workers who remain in the labor force must accept any wage reduction not greater than the rent being received. Involuntary job loss still does not exist.

[4] See, for example, Barro (1979).

[5] Barro, quoted in Snowdon and Vane (2005, p.231). Mainstream macro thinking posits a single (marketplace) venue and is rooted, within that venue, in optimizing price-mediated exchange organized by intertemporal general equilibrium. In this paper, the market-centric DSGE model class and the New Neoclassical Synthesis (NNS) are used synonymously.

The coherent DSGE message is that rational employees must consent, in lieu of losing their jobs, to any wage reduction that does not violate their perception of market opportunity costs. The message makes sense. Any other choice results in sidewalks cluttered with dollar bills. As a result, ILJ coexistence with continuous decision-rule equilibrium requires two interrelated changes from textbook labor pricing. First, some employees must be rationally receiving wage rents. Second, their employers must be rationally precluded from offering a wage cut in place of job loss.[6] Forced job separation implies the existence of a robust class of wage rigidity, tasked to produce both chronic labor rents and downward cyclical inflexibility and is hereafter named "meaningful". Meaningful wage rigidity (MWR) is a sufficiently nuanced nonmarket concept that free-parameter guessing, especially when focused on labor-market imperfections, cannot come close to the actual phenomenon.[7]

That admonition helps set the stage for the contemporary message. MWR existence has not been, nor can it be, established by the endogenous frictions being variously identified by the New Keynesian branch of the consensus New Neoclassical Synthesis (NNS). In the single-venue DSGE framework, recontracting always provides employee choice to remain on the job (at reduced compensation) or voluntarily leave the firm. The choice occurs simultaneously with the firm's wage reduction and, combined with employer profit-seeking, eliminates involuntary job loss.[8] The most interesting New-Keynesian DSGE-consistent frictions have induced contractions in total employment by creating a wedge between the marginal labor product and the marginal value of worker time. The labor wedge, however, does not alter the role of opportunity costs in, or the timing of, employer-employee recontracting and is inherently limited to motivating voluntary joblessness.

The New-Keynesian research agenda, to the extent it has focused on microfounding high-frequency employment fluctuations that are consistent with the evidence, has not been successful. No one has figured out how to rationally suppress Barro's recontracting, providing room for

[6] Albert Rees (1951), one of the best labor economists of his generation, anticipated modern wage theory in his early argument that labor-price rigidities must result from employer unwillingness to cut money wages.

[7] The point is illustrated by Christiano *et al.* (2005) and Chari *et al.* (2009).

[8] See, for example, Hall (2005).

involuntary layoffs.[9] As a result, arbitrary and misleading free parameters remain unhappily omnipresent in New Keynesian empirical models.

Missing venue. The intuitive location for the Two-Venue Theorem's nonmarket class of labor-pricing equilibrium has always been the large, specialized workplace.[10] Managers in bureaucratic establishments are broadly understood, albeit outside university macroeconomics departments, to pay close attention to nonmarket factors in their wage policymaking. Employers learned early in the past century that, in circumstances of imperfect supervision and contracting, labor pricing embodies information that affects workplace, distinct from marketplace, incentives.

On-site workplace knowledge accumulated since Frederick Taylor's (1911) time-and-motion studies and the famous 1927-32 Hawthorne experiments indicates that the policy usefulness of macro models microfounded by dynamic stochastic general equilibrium is badly truncated by restricting labor-related price-mediated exchange to the marketplace. More generally, the effectiveness of modern macro theorists has been damaged by a collective hubris that labor pricing and use can be adequately modeled while being largely innocent of the huge literature on workplace behavior. That innocence, however, has not been universal. In the late 1970s, efficiency-wage theorists pioneered the introduction of workplace exchange into formal macro-economics. The original literature, generating substantial interest at the time and providing analytical roots for this paper, is briefly summarized in the next section.

[9] Modern research has failed to challenge Barro's (1989, p.14) basic argument: "As a theoretical matter, it has long been known that direct costs of adjustment could explain some stickiness in prices. However, the basic misgiving about menu [or recontracting] costs is that the direct costs of adjusting prices are typically trivial relative to the losses from choosing inappropriate quantities." Similarly Herschel Grossman's (1983, p.343) conclusion that single-venue general equilibrium and meaningful wage rigidity are inherently inconsistent remains intact: "If the predetermined wage implies a level of employment that is less than the quantity supplied, the provision of additional employment at some lower wage will produce a Pareto improvement." Indeed, most New Keynesians have long accepted recontracting as one of the "rules of the game". From Robert Gordon (1990, p.1137): "No new-Keynesian wants to build a model with agents that Barro could criticize as failing 'to realize perceived gains from trade'." Finally, from Blanchard and Fischer (1989, pp.373-374): "… nominal rigidities can only go so far. To take an example, if fluctuations in demand lead to unemployment and if being unemployed is much worse than being employed, it is hard to see why individual workers do not take a cut in their wages to gain employment."

[10] Carefully organized workplaces are ubiquitously observable throughout the world and, therefore, are missing only in the limited sense of having been arbitrarily excluded from mainstream macro modeling. Working largely in the middle 20th century, prominent American and British labor economists pioneered the study, from the perspective of neoclassical economic theory, of rational workplace exchange. This paper critically draws from that literature. See Clark Kerr (1988, 1994) for summaries of the powerful literary economic analyses of large workplaces.

II. MEAGER LITERATURE ON WORKPLACE-EXCHANGE MODELING

More than three decades ago, Solow (1979) and Annable (1977, 1980), working independently, introduced price-mediated workplace exchange into formal macroeconomics.[11] In particular, we identified critical axiomatic employee preferences and derived employer optimization conditions in the circumstances of costly, asymmetric workplace information and consequent feedback between worker on-the-job behavior (OJB) and management labor pricing. The admitted goal was to microfound Keynesian wage market-stickiness.

The original EWT, focusing on optimizing workplace exchange, is illustrated in Figure 1. The firm minimizes unit costs by paying the nominal labor price ($W=W^n$) consistent with both the dominant radius vector and its labor-market constraint ($W\geq W^m$).[12] The geometry indicates that worker OJB, represented by the locus of labor productivity and the wage paid, is at the core of efficiency-wage thinking. The good news for economists hoping to explain actual employment instability is that the Workplace Exchange Relation (WER), once constrained by labor market opportunity costs (W^m), suppresses employer latitude to offer employees wage cuts in lieu of losing their jobs. The bad news is that, contrary to the aspirations of early efficiency-wage theorists, such WERs have always been assumed, never derived from model primitives. Experi-ence has taught that free parameters provide shaky foundations for policy-relevant modeling.

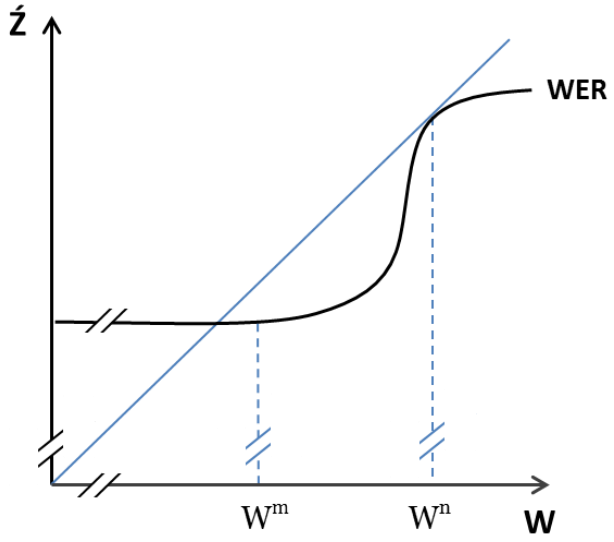
Workplace-centric EWT never fulfilled its early promise because research agendas followed the lead of Solow and Annable and focused on the relatively easy problem of employer optimization, setting aside the more challenging issue of employees' rational response to workplace incentives. The point deserves emphasis. In the literature, labor pricing demonstrating downward market inflexibility (W^n) has never been formally derived.[13] Efficiency-wage

[11] Solow and Annable modeled morale-centric EWT, with the objective of eventually deriving downward rigid nominal wages consistent with optimizing, continuous equilibrium. This paper completes that original EWT research program, satisfying the authors' early objective. As will be shown, the original EWT was constructed on the labor-management literature, especially the fundamental practitioner findings that employees do not prefer to shirk but do strongly prefer fair treatment by their employers. Many subsequent EWT variants reverted to shirking to motivate worker OJB (e.g., Shapiro and Stiglitz (1984)) or abandoned the formal economic method (e.g., Akerlof (1982)). None was ever successful in formally deriving downward wage inflexibility; most did not even try. It is noteworthy that the best known of the subsequent variations (the Shapiro-Stiglitz shirking theory) produces wages that are downward flexible (falling as market unemployment rises), cannot generate involuntary job loss (producing instead discharge for cause), and provides an inadequate channel through which nominal disturbances induce real effects. Shapiro-Stiglitz and other variants in the big-tent EWT differ from the original morale-centric version of efficiency wages; they are fundamentally distinct model classes, designed to answer different questions.

[12] In the diagram, which Annable (1980) introduced into formal macro theory, W^m denotes market opportunity cost, i.e., the expected best alternative wage upon separation from firm j; W^n is the nominal efficiency wage; $\acute{Z}$ represents worker productivity; the implicit intersection of the $\acute{Z}$ axis and the workplace-exchange relation (WER) occurs at $\acute{Z}^m$, the on-the-job cooperative behavior associated with cost-effective workplace monitoring (assumed for convenience to be technologically given). Throughout the paper, firms' capital stocks are held constant. See Section III. It will become clear that the characteristic shape of the original WER, however analytically convenient, reveals a relatively poor understanding of rational employee OJB.

theorists, as a result, failed in the goal of microfounding the class of wage stickiness that played the keystone role in Early-Keynesian thinking.

FIGURE 1. EARLY GEOMETRY OF EFFICIENCY-WAGE OPTIMIZATION



The failure to microfound meaningful wage rigidity is made especially frustrating by the abundant evidence that supports the class of WERs illustrated in Figure 1. Employers have long believed that dissatisfied workers, given the latitude, adversely alter their behavior on the job. An early Yankelovich poll of business leaders asked the question: Does job dissatisfaction lead to high turnover, tardiness, loafing on the job, poor workmanship, and indifference to customers and clients? Of the 563 respondents, 94 percent thought that such an association does exist.[14]

In a more targeted survey conducted in the early 1990s, a period that includes the 1990-91 recession, Bewley (1999a) interviewed 104 business leaders, asking them why worker morale matters to them. The incidence of their responses is particularly noteworthy:

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[13] In Solow (1979, 1980, 1990), Annable (1977, 1980, 1984, 1988), Akerlof (1982, 1984, 2002, 2007), Yellen (1984), Shapiro and Stiglitz (1984), Malcomson (1984), Bulow and Summers (1986), Weiss (1990), Akerlof and Kranton (2005), and everybody else, *the existence of labor pricing capable of suppressing wage recontracting always depends on free parameters.* Please do not ignore that fact; it is important. Given that free parameters are not particularly interesting and that formal modeling of employee behavior looked laborious at best, macroeconomists' attention to the workplace-centric class of labor pricing waned. For important antecedent work on workplace exchange outside the EWT literature, see Okun (1981).

[14] Katzell and Yankelovich (1975), p.114.

Reason	Percentage of Businesses Citing the Reason
Low worker productivity	89%
Poor customer service	14
Turnover	13
Recruiting	7
Absenteeism	4
Unionism	3

From Bewley (1999b, p.1): "Employers were reluctant to cut pay because they believed doing so would hurt employee morale, leading to lower productivity and current or future difficulties with hiring and retention. It was thought that these effects would in the end cost more than the savings from lower pay." When asked about labor-pricing practices, including wage cuts, many employers describe (once translated into EWT terminology) the active management of a nonconvex workplace exchange relation that is at the heart of original efficiency-wage theory.

In a third example, Campbell and Kamlani (1997) surveyed 184 compensation executives from large firms, asking how much workplace productivity would decrease if wages were cut by 10 percent. The mean response was 20 percent. Nearly 7 out of 10 believed that the principal reason for the harmful effect was damaged worker loyalty. [15]

[15] Blinder and Choi (1990) reported similar survey results. Also notable are international examples of this class of research. Agell and Lundborg (1995) examined management views of workplace conduct in response to adverse departures from established reference wages in a survey of 170 manufacturers in Sweden. Most firms responded that fairness and worker morale are of overriding importance in wage policymaking; eighty percent believed that at least half of their jobs would have to be clearly at risk for employees to accept wage cuts with no adverse effects on productivity on the job. Kaufman (1984) interviewed 26 nonunionized firms in Britain and similarly reported that the related issues of fairness and worker morale were the most cited reasons for not cutting wages. Romer (2001, p.460) summarized the survey-based results: "The surveys consistently suggest that workers' morale and perceptions of whether they are being treated appropriately are critical to their productivity. The surveys also suggest that workers have strong views about what actions by the firm are appropriate, and that as a result their sense of satisfaction is precarious." Away from the survey approach, Holzer and Montgomery (1990, p.4) investigated data from the Employment Opportunity Pilot Project (covering more than 3,400 firms between 1980 and 1982) and, with respect to nominal labor pricing, concluded: "Wage adjustments in response to demand shifts appear to be quite asymmetric, with significant adjustment in response to positive shifts but little in response to negative shifts." Data drawn from German Social Security accounts, analyzed by Beissenger and Knoppik (2001), also reveal substantial downward nominal wage rigidity. Analyses by Altonji and Devereux (1999) and Lebow *et al.* (1999) additionally found consistent sharp asymmetries around zero wage change. Nominal wages in modern economies are sticky downward, not upward. Altonji and Devereaux also econometrically tested their data (from the Panel Study of Income Dynamics), estimating that notional wages must decline by at least 20% for a nominal wage cut to occur. Studies by Kahn (1997) and Card and Hyslop (1997) each used panel data to find that cross-sectional

The evidence indicates that, to be adequate to the task of explaining labor pricing in an environment of costly, asymmetric intra-firm information, economic theory must explicitly model workplace exchange and, therefore, employee optimization on the job. Furthermore, in order to microfound meaningful wage rigidity, OJB modeling must motivate the WER class illustrated in Figure 1. In the absence of that incremental progress, efficiency-wage modeling persisted in relying on free parameters to generate interesting results and became, itself, uninteresting.

The remainder of this paper presents a compact workplace-equilibrium model that completes original efficiency-wage research project. Once combined with the 19th century labor-market modeling of the innovators of marginal analysis including Marshall, Clark, Wicksell, and Wicksteed, workplace analysis microfounds the first modern theory of wage determination. Salient features of intra-firm modeling include defining employee on-the-job behavior and specifying of worker utility, two-venue workplace exchange, the rational intertemporal tradeoff between permanent job loss and labor rents, factor-income distribution in the presence of rents, and venue aggregation.[16]

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distributions of worker pay changes are asymmetric around zero. Fortin (1996) examined Canadian collective-bargaining results and found the same sharp spike at zero nominal wage change, reflecting a reluctance to cut compensation rates. In a detailed survey of the micro evidence, Kramarz (2001) found general support for downward wage rigidity. Specifically, he reported that the available data show that "… firms prefer to cut employment rather than cut wages in a downturn." Nonconvex WERs have long been recognized by hands-on labor economists. Kerr *et al.* wrote about nonunion workers penalizing their employers for cutting wages by withholding cooperative effort or even sabotaging production. From Kerr (1994, p.85): "We all knew of such actions." See also Mathewson (1931), Reynolds (1951), and Lester (1951).

[16] This compact paper is confined, both to conserve space and to emphasize its incremental relationship with the existing EWT literature, to baseline establishment-specific workplace equilibrium, which is defined to be consistent with unchanged wage reference standards. (See below.) Section IV demonstrates that stationary involuntary job loss (layoffs) is always consistent with unchanged reference standards. Contemporary investigation of optimizing workplace exchange has usefully extended the compact analysis, notably a comprehensive study that models (i) the rational intertemporal tradeoff between job loss and established wage reference standards, microfounding the standards' substantial nonstationary persistence, and (ii) proper venue aggregation. (See Annable (2013).) Modern intrafirm analysis has generalized dynamic general equilibrium to the workplace venue and can be readily integrated into the highly developed, market-centric mainstream New Neoclassical Synthesis.

III. BASELINE WORKPLACE-EQUILIBRIUM THEORY

Labor input. Workplace modeling begins with some definitions.[17] Labor cooperative services are denoted by E_j, which is restricted to be in 1-1 technical correspondence with production (X_j). The firm's measure of worker OJB is $\acute{Z}_j$, an operator that links the standardized labor input to hours paid for (H_j):

$$(1) \qquad \acute{Z}_j = \acute{E}_j / H_j,$$

where *j* denotes the work establishment.

The baseline relationship between employee behavior ($\acute{Z}$) and the hourly wage (W) is the locus of rational workplace exchange (WER). It is viewed from the aggregating perspective of management but motivated by employee optimization on the job. The rational firm must sufficiently identify its WER to enable payment of its unit-cost minimizing labor price (the *efficiency wage*):

$$(2) \qquad W^n_j = \max_w (\acute{Z}_j / W_j).$$

A necessary condition for the rational payment of a wage greater than workers' opportunity cost is lower unit labor costs, implying that optimal wage rent ($W_j > W^m$) exists iff: [18]

$$(3) \qquad \acute{Z}_j / W_j > \acute{Z}^m_j / W^m.$$

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[17] The introductory, compact version of workplace-equilibrium theory posits that labor is homogeneous until hired and trained, at which point the homogeneity becomes firm-specific; that workers cannot borrow or save; that employees and employers are risk-neutral. Firms maximize expected profits; workers maximize expected utility rooted in stable, axiomatic preferences; and both form expectations rationally. Firms operate in product and factor markets with no barriers to competition. Technology is fixed, with useful heterogeneity introduced via a bimodal division. One homogeneous class of establishments is characterized by large scale and input specificities generating workplace information costs and asymmetries that induce imperfect monitoring. The other homogeneous class demonstrates small scale and cost-effective labor supervision. Relevant production functions are posited to generate maximum real output (X) for each available combination inputs. Output is increasing in both cooperative labor input (E) and physical capital ($K^{\#}$), subject to diminishing returns; production technology accommodates increasing returns to scale; no resources imply no production. Other restrictions on the technology space are the exclusion of prices from the domain of inputs and $0 \in \boldsymbol{X}_j$ (the firm can be idle).

[18] Recall that $\acute{Z}^m$ is the on-the-job behavior associated with cost-effective workplace monitoring (assumed for convenience to be technologically given), and W^m denotes market opportunity cost, i.e., the discounted expected best alternative wage upon separation from firm *j*.

The WER class (over the range of feasible labor pricing, $W_j \geq W^m$) that is consistent with the rational payment of nonmarket wage incentives is *unbundled* ($\acute{Z}_j/\acute{Z}^m{}_j > W_j/W^m$), while WERs mandating payment of market-opportunity costs are *bundled* ($W_j/W^m \geq \acute{Z}_j/\acute{Z}^m{}_j$).

Worker utility. The von Neumann-Morgenstern expected-utility framework easily adapts to reflect employees' desire for fair treatment by management, which over the past century has been established as an axiomatic labor preference:[19]

$$(4) \qquad E_{oi} \Sigma\, \gamma^t\, U_i(C_i(t), L_i(t), W_j(t)/W^{\acute{n}}{}_j(t)), \text{ such that } (\Delta U_i/\Delta(W_j/W^{\acute{n}}{}_j) \mid W_j \leq W^{\acute{n}}{}_j) > 0.$$

The innovation here is the definition and role of $W^{\acute{n}}$ (the *reference wage*). Three classes of reference standards calibrate homogeneous employees' preference for equity: W^a (the best alternative wage), W^b (the interpersonal reference standard), and W^c (the intertemporal standard).[20] There exists a set of labor prices $\mathbf{K}_j=\{W^a, W^b, W^c\}$ for which workers' preference for fair treatment is satisfied by the set's least upper bound: $W^{\acute{n}}{}_j = \sup \mathbf{K}_j$. Instantaneous utility is strictly increasing in $W_j/W^{\acute{n}}{}_j$ up to unity and unchanged thereafter.

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[19] In the function, C represents consumption ($\Delta U_i/\Delta C_i > 0$); L is leisure ($\Delta U_i/\Delta L_i > 0$); E_o denotes the expectation of future values of the function's arguments based on the information available at the beginning of the current period ($t=0$); γ is the subjective discount factor; Δ is the change operator; and the series are summed from $t=0$ to $t=\chi$, the employee's desired tenure at the firm. The function is temporally separable; and, to assure its existence, preference relations motivating the arguments are posited to be complete, transitive, and continuous. Other restrictions with respect to instantaneous utility are $\Delta L_i/\Delta H_i < 0$, $(\Delta U_i/\Delta(W_j/W^{\acute{n}}{}_j) \mid W_j > W^{\acute{n}}{}_j) = 0$. It is convenient, as well as comforting to most economists, to assume that employees strictly prefer both consumption and leisure to fair treatment by management.

[20] For elaboration, see Annable (2013). The preference for wage equity calibrated by reference standards is so broadly accepted by practitioners that it requires no derivation. The long-standing literature here notably includes Patchen; Goodman; Major and Testa; Heneman, Schwab, Standal, and Peterson; Dornstein; Messe and Watts; Ambrose and Kukik; Gartrell; Ross and McMillen; Hills; Livernash; Merton and Rossi; and Lipset and Trow. For economists, John Dunlop (1957) is still most informative on reference wages. His *wage contour* denotes the end result of external comparisons. A wage contour is a relatively stable group of establishments that are linked via similar product markets, similar labor sources, or common labor-market organization. By virtue of those linkages, the contours inform key jobs with labor-pricing characteristics to which employees become accustomed. Similarly, he defined *job clusters* as a stable group of job classifications or work assignments within an establishment that are linked by technology, the administrative organization of the production process, or social custom. The relationships within a cluster develop around key jobs and their pay. Those key rates provide the reference standards that peg all job rates within the job cluster. Arthur Ross (1968, p.227) was more succinct: "[Employees] always want more. There are two circumstances under which the pressure is likely to be imperative. One is a strain upon established standards of living brought about by inflation in the price level [represented this paper by W^c]…. The other is an individual's comparison with the wages, or wage increases, of other groups of workers [represented by W^b]." In describing the latter reference standard, Ross coined the colorful term, "orbits of coercive comparison". Dunlop and Ross were both part of a school of 20th-century labor economists, cited above, who modeled (from the perspective of neoclassical economic theory) large, specialized workplace behavior. Again, see Kerr (1988, 1994).

The calibration of $\mathbf{K}_j$ can accommodate the payment of nonmarket wages ($W^{ń}_j \geq W^a = W^m$).[21] Rational wage rents (derived below) constrain labor optimization. Rent-receiving jobs are rationed; employment by a rent-paying establishment implies being pushed off one's market labor-supply schedule, suppressing work-leisure choice and making control of the workweek a management prerogative. For an employee receiving rents, hours on the job are exogenously determined (L^o), limiting the instantaneous pursuit of self-interest to adjusting his or her OJB:

$$(5) \qquad \max_{Ź} U_i(C_{ij}, L^o_{ij}, W_j/W^{ń}_j).$$

Durable $\mathbf{K}_j$ implies an unchanged reference standard and, given the assumption of zero saving, exogenous consumption (C^o) unless the firm alters hours or reduces worker rents by cutting W_j from $W^{ń}_j$. Worker dissatisfaction with the perceived inequitable wage change would then be reinforced by his/her preference for more consumption. Constrained by firm profit-seeking, employees maximize instantaneous utility at $W_j/W^{ń}_j=1$.

Heterogeneous jobs. Generally define the outcome (O) from and perceived input (I) to a job as follows:

$$(6) \qquad O = O^W + O^N \text{ and } I = I^E + I^f,$$

where O^W denotes the pecuniary outcome from the job, O^N represents nonpecuniary outcome, I^E stands for cooperative effort of the employee holding the job, and I^f is his or her job-related fixed characteristics. One of Adam Smith's well-known injunctions is that wage determination cannot

[21] The calibration of $\mathbf{K}_j$ (and, therefore, $W^{ń}_j$) is *durable* for a period t to $t+ķ$ ($ķ>0$) if unchanged reference standards ($\mathbf{K}_j(t)=\mathbf{K}^{ń}_j$) remain, during that period, consistent with rational behavior. Simultaneous employer-employee rest periods in the space of intra-firm decision rules, if consistent with durable $\mathbf{K}_j$, are named *baseline workplace equilibrium*. As noted earlier, Section IV will justify $\mathbf{K}_j$ durability in the limited circumstances of garden-variety business cycles. Given high-frequency stationary demand disturbances, the economy remains in baseline workplace equilibrium. Moreover, the workplace-equilibrium literature has elsewhere generalized $\mathbf{K}_j$ durability by demonstrating, in the context of nonstationary economic dynamics (with its potential for permanent job destruction), that a set of plausible factors (notably including the well-known hold-up problem, increasing returns, industry-demand elasticities activated by spontaneously cartelized labor pricing, and firm product-pricing power) strongly imply that $\mathbf{K}_j$ can reasonably remain unchanged well into the medium term. See Annable (2013).

be independent of the nature of employment. The first modern wage theory uses a bimodal separation to introduce useful job heterogeneity. Employees retain point-of-hire homogeneity.

Class-I jobs are defined to impose two significant restrictions on the rational workplace exchange of inputs for outcomes:

- Nonpecuniary outcomes are an inherently minor component of total employee outcomes. In Class-I workplace exchange, $\dot{O}^{N}_{j}/\dot{O}_{j}$ is relatively small.
- Personnel policymaking that confronts significant workplace information costs and asymmetries is more informed by worker fixed inputs, particularly seniority, than by imperfect measurements of on-the-job behavior. In Class-I work-place exchange, $\dot{I}^{f}_{j}/\dot{I}_{j}$ is relatively large.[22]

The formal definition of *Class-I* jobs is:

$$\dot{O}^{N}_{j}/\dot{O}_{j} < \dot{I}^{f}_{j}/\dot{I}_{j}. \tag{7}$$

The remainder of the employed workforce holds *Class-II* jobs, defined by fundamental order axioms as:

$$\dot{O}^{N}/\dot{O} \geq \dot{I}^{f}/\dot{I}. \tag{8}$$

This second job class significantly (but not exclusively) includes employment that yields substantial personal satisfaction from the performance of the work tasks themselves.

The bimodal employment separation is easily recognizable in modern specialized economies. Class-I jobs tend to be routinized, shaped by large-scale, high-volume production technology and operating in workplaces characterized by costly, asymmetric information. Such undemanding employment is "unpleasant mainly because it fails to stimulate the worker yet prevents him from

[22] Class-I employees also prefer that management, in constructing incentives, emphasize their fixed inputs relative to imperfect measures of their OJB. The assignment of high significance to $\dot{I}^{f}_{j}$ relative to $\dot{I}_{j}$ makes workplace exchange less arbitrary and, therefore, less likely to generate discontent. It should additionally be noted that, although fixed inputs such as education are restricted by the assumption of point-of-hire worker homogeneity, their inclusion as part of variable human capital would little alter the analysis.

seeking stimulation elsewhere." (Scitovsky (1977, p.92)) Adam Smith drew early attention to the progressive simplification of work tasks, concluding that the routinization of jobs is, for employees, a source of substantial boredom. Moreover, large bureaucratic establishments make no secret of their general practice of rewarding employees in routinized jobs more on the basis of their fixed characteristics, such as seniority, than on inherently flawed measures of their performance on the job.[23] In particular, the evidence demonstrates the typical policy of awarding wage increases, eligibility for desirable job transfers, and ranking in a layoff queue on the basis of employee seniority.

Meanwhile, Class-II jobs tend to be more of a hodgepodge, variously reflecting employment characteristics that include substantial satisfaction from the work itself (pushing up $\dot{O}^N/\dot{O}$), cost-effective OJB supervision (pushing down $\dot{I}^f_{ij}/\dot{I}_{ij}$), and low value that some workers place on their fixed inputs (pushing down $\dot{I}^f_k/\dot{I}_k$). For example, economists employed at research-oriented universities hold Class-II jobs. Their personal experiences, focused on work satisfaction, idiosyncratic matching in job search, and evaluations based on transparent (publication) performance, poorly illuminate the circumstances and behavior of Class-I workers.

Deriving unbundled WERs. Some comparative statics are useful at this point. From a position of workplace equilibrium, disturb the employee with a reduction from his/her reference wage. If the homogeneous worker's job inputs are not altered, he/she is now in disequilibrium with respect to workplace exchange:

$$(9) \qquad (\Delta\dot{O}_j+\dot{O}_j)/\dot{I}_j < \dot{O}_j/\dot{I}_j,$$

where $\Delta\dot{O}$ represents the negative departure from the preferred job outcome (caused by the wage reduction). If market-opportunity costs are violated ($W_j<W^a$), the rational employee quits, moving to the better position. If only established interpersonal or intertemporal reference standards are contravened, the employee rationally keeps the job but is dissatisfied.

[23] The Industrial Relations Research Association has examined this issue in some depth. In a summary of the relevant IRRA studies, Kleiner *et al.* (1987, p.108) concluded: "Using data collected within firms, they all reached similar conclusions – that pay level is weakly or not significantly correlated with performance rating and is more strongly related to seniority and education." Indeed, wage-setting procedures in large firms resemble a system of entitlements, with their emphasis on across-the-board increases, catch-up to consumer price inflation, and seniority-based hierarchies used in job changing and layoffs..

Consistent with the evidence cited above, limited monitoring in large, specialized establishments provides dissatisfied employees the latitude to alter his or her input to the job:

$$(10) \qquad (\Delta \dot{O}_j + \dot{O}_j)/(\Delta \dot{I}_j + \dot{I}_j) \sim \dot{O}_j/\dot{I}_j.$$

The worker cannot decrease fixed inputs to the job, implying that the input of cooperative labor services is adversely affected. Given that the outcome change is a reduction from the reference wage, preference relation (10) can be restated:

$$\Delta W^{\acute{n}}_j/\Delta(\acute{Z}^{\acute{n}}_j H_j) \sim \dot{O}_j/\dot{I}_j;$$

$$(11) \qquad (\Delta(\acute{Z}^{\acute{n}}_j H_j)/(\acute{Z}^{\acute{n}}_j H_j))/(\Delta W^{\acute{n}}_j/W^{\acute{n}}_j) \sim (W^{\acute{n}}_j/O_j)/((\acute{Z}^{\acute{n}}_j H_j)/I_j).$$

For employees in Class-I jobs, workplace equilibrium reflects unbundled OJB:

$$(12) \qquad (\Delta \acute{Z}^{\acute{n}}_j/\acute{Z}^{\acute{n}}_j)/(\Delta W^{\acute{n}}_j/W^{\acute{n}}_i) > 1.$$

As illustrated in Figure 2, rational workplace exchange generates unbundled OJB for all feasible reductions from the reference wage ($W^{\acute{m}} \leq W_j < W^{\acute{n}}_j$).[24] The $\acute{Z}_j$ contraction is reasonably assumed to decelerate relative to labor-price cuts as the input of employee cooperative services approaches the minimum associated with cost-effective workplace monitoring ($\acute{Z}^{\acute{m}}_j$). A critical baseline implication of unbundled workplace exchange is the endogenous downward rigidity of nominal labor pricing.

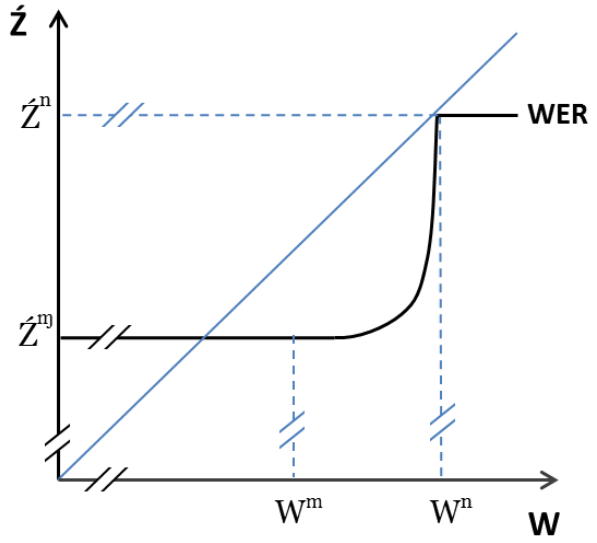
The Figure also illustrates a significant asymmetry produced by unbundled $\acute{Z}_j$. All disturbances begin from a position of equilibrium ($W_j = W^{\acute{n}}_j$, $\acute{Z}_j = \acute{Z}^{\acute{n}}_j$). The model, informed by employee preferences, implies that a positive compensation shock (i.e., the wage paid increasing from $W^{\acute{n}}_j$) has no effect on $\acute{Z}_j$.[25] Meanwhile, W_j reductions from $W^{\acute{n}}_j$ cause worker dissatisfaction. Employees

[24] Expression (12) is easily shown to reflect unbundled WER, as defined in expression (3): $\Delta \acute{Z}^{\acute{n}}_j = \acute{Z}^{\acute{m}}_j - \acute{Z}^{\acute{n}}_j$; $\Delta W^{\acute{n}}_j = W^{\acute{m}}_j - W^{\acute{n}}_j$; $(\Delta \acute{Z}^{\acute{n}}_j/\acute{Z}^{\acute{n}}_j)/(\Delta W^{\acute{n}}_j/W^{\acute{n}}_j) > 1$ implies $((\acute{Z}^{\acute{m}}_j/\acute{Z}^{\acute{n}}_j) - 1)/((W^{\acute{m}}_j/W^{\acute{n}}_j) - 1) > 1$, which implies $\acute{Z}^{\acute{n}}_j/W^{\acute{n}}_j > \acute{Z}^{\acute{m}}_j/W^{\acute{m}}_j$.

[25] Workplace equilibrium, consistent with optimizing employer-employee behavior, neither requires nor accommodates gift-exchange. Management cannot increase productivity by simply increasing labor's price from the reference wage ($W^{\acute{n}}$). In both the Workplace-Marketplace Synthesis and the real world, significant productivity response is limited to wage *reductions* from the established referent rate.

restore workplace equilibrium by altering their on-the-job cooperative conduct ($\Delta \acute{Z}_j<0$). Asymmetric labor behavior in the neighborhood of the reference wage combines with firm profit-seeking to establish workplace equilibrium stability at $W_j=W^{\acute{n}}_j$, $\acute{Z}_j=\acute{Z}^{\acute{n}}_j$, validating the earlier use of comparative statics.

FIGURE 2. MODERN GEOMETRY OF WORKPLACE WAGE OPTIMIZATION



Furthermore, conditions have been identified for which the reference wage ($W^{\acute{n}}_j$) equals the efficiency wage (W^n_j), such that $W^{\acute{n}}_j=W^n_j \geq W^m$: large, specialized work establishments, subject to costly, asymmetric workplace information, that offer Class-I jobs. The grouping is named, for convenience, the large-establishment venue (LEV); remaining firms are assigned to the small-establishment venue (SEV).) The LEV *efficiency* wage is used by management to minimize unit labor costs, while the *reference* wage is rooted in interpersonal, intertemporal, and best-alternative-job reference standards used by workers to assess their satisfaction with the firm's compensation policies and their own workplace conduct. Neither wage concept is well defined absent the other; in combination, they microfound the nonconvex-WER Holy Grail of original efficiency-wage theory, producing meaningful wage rigidities.

Two-venue WERs. Axiomatic worker preferences have combined with axiomatic technological constraints to enable the derivation of unbundled workplace exchange from the simultaneously

optimizing interaction of employers and employees in large establishments offering Class-I jobs. Implied workplace exchange relations for large- and small-establishment venues are:

(13a) $\acute{Z}_j=f(W_j,W^n_j,\acute{Z}^{\eta}_j)$ such that if $W_j\in[W^n_j,W^m]$, then $(\Delta\acute{Z}^n_j/\acute{Z}^n_j)/(\Delta W^n_j/W^n_j)>1$;[26]

(13b) $\acute{Z}_k=\acute{Z}^{\eta}_k$, implying that if $\Delta W_k= W_k-W^m>0$, then $(\Delta\acute{Z}_k/\acute{Z}^{\eta}_k)/(\Delta W_k/W^m)<1$.

In the LEV, unbundled WERs sufficiently restrict the simultaneous optimization of wages and OJB to produce baseline workplace equilibrium at $W_j=W^n_j=\sup \mathbb{K}_j\geq W^m$ and $\acute{Z}_j=\acute{Z}^n_j$. Those rest points in the space of workplace decision rules hold until $\mathbb{K}_j$ is rationally recalibrated. (Section IV demonstrates $\mathbb{K}_j$ durability in response to involuntary job loss over the business cycle.) LEV labor pricing generates meaningful wage rigidities and involuntary job loss, responding to adverse nominal disturbances, that are consistent with continuous optimizing equilibrium.

Meanwhile, the small-establishment venue (effectively monitoring workplace behavior) optimizes worker behavior at $\acute{Z}_k=\acute{Z}^{\eta}_k$ and labor pricing at $W_k=W^m$, the conditions of workplace equilibrium whenever OJB is bundled. Profit-seeking small firms pay the market wage. Workers, preferring equitable treatment but lacking exploitable intrafirm information imperfections, cannot establish interpersonal and intertemporal reference standards, truncating $\mathbb{K}_k$ ($\mathbb{K}_k=\{W^a\}$, $\sup \mathbb{K}_k=W^a=W^m$). In such circumstances, employee attention shifts to optimizing his/her work-leisure choice and the on-going search for "good" (rent-paying) employment. SEV job tenure is, as a result, much more sporadic than tenure in the fundamentally different *J*th venue.

Large- and small-establishment venues produce heterogeneous equilibria rooted in profoundly disparate decision rules, constraints, and exchange mechanisms, completing the baseline modern wage theory, deepening Early and New Keynesian modeling, and greatly enhancing the stabilization relevancy of the New Neoclassical Synthesis. In order to provide a placeholder in the evolution of the mainstream macro thinking, the enriched modeling is named the Workplace-Marketplace Synthesis. The WMS powerfully combines optimizing exchange in workplace and marketplace venues in an analytic framework that demonstrates continuous equilibrium. The

[26] Recall that, if $W_j>W^n_j$, $(\Delta\acute{Z}_j/\acute{Z}^n_j)/(\Delta W_j/W^n_j)=0$. See Card *et al*. (2010) for recent empirical work supporting that specification. Throughout the remainder of this paper, large establishments are assumed to offer only class-I jobs.

two-venue analysis recalls Kerr's (1954) path-breaking analysis of balkanized labor markets and notably microfounds a more powerful version of John Hicks's (1974) fix- and flex-price macro model.[27] The two-venue macro model, moreover, closely corresponds to available evidence on the breakdown of the law of single wage. From Mortensen (2003, p.2): "… evidence suggests that different employers do pay similar workers differently. For example, the empirical literature on wage determination finds a positive association between wages paid and firm size."

Putting the pieces together. The first modern theory of wages generalizes the reach of optimizing, price-mediated exchange from the marketplace to the workplace, resulting in two venues of heterogeneous decision rules, constraints, and exchange mechanisms.[28] Simultaneous employer-employee rest periods in the space of workplace decision rules, subject to costly, asymmetric intrafirm information and Class-I jobs, are consistent with the rational suppression of wage recontracting, solving the policy conundrum implicit in the first and second ILJ theorems above. Dominant LEV labor pricing and consequent job rationing critically constrain SEV (marketplace) decision-rule optimization, permitting continuous-equilibrium interaction of inconsistent wages. Powerful stabilization-relevant macroeconomics results, substantially strengthening New Keynesian analysis and easily accommodated by the mainstream New Neoclassical Synthesis.

IV. MODELING LAYOFFS

The incidence of involuntary job loss in the workplace venue is denoted by $\acute{\omega}_j$, such that $\acute{\omega}_j(t) \in [0,1]$. The variable is usefully decomposed into its nonstationary and stationary compon-

[27] Hicks provide interesting literature roots for workplace-equilibrium theory. Private correspondence establishes that the great theorist was familiar with the workplace analysis of Kerr, Dunlop, *et al*., who (as noted above) closely analyzed employer-employee intra-establishment behavior. As a result, Hicks informally motivated his fix-price sector with rational *workplace* behavior. From Hicks (1974, p.66): "Employers were reluctant to raise wages, simply because of labour scarcity; for to offer higher wages to particular grades of labour that had become scarce would upset established differentials. They were reluctant to cut wages, simply because of unemployment; for if they did so they would alienate those whom they continued to employ. The 'stickiness' is not a matter of money illusion; it is a matter of continuity."

[28] The generalization of exchange also provides a robust port of entry into formal macro theory for institutional collective-bargaining models. (See Annable (2013.) It may be usefully emphasized here that the workplace class of optimizing exchange is no less recognizable in actual economic arrangements than its marketplace counterpart. Employee-employer feedback (captured in the model by nonconvex WERs) is the principal reason for the existence of large-firm human-resource departments and their ubiquitous equity-based policies.

ents, $\acute{\omega}_j(t)=\acute{\omega}_j^T(t)+\acute{\omega}_j^V(t)$. This section investigates $\acute{\omega}^V_j$, the class of job loss that reflects layoffs, i.e., forced job reductions anticipated by the firm to be temporary with or without recall rights assigned to affected employees:

$$(14) \qquad \acute{\omega}^V_j(t)=f(\Pi_j^V(t)),$$

such that $(\acute{\omega}^V_j(t) \mid \Pi_j^V(t)\geq 0)=0$, $0<(\acute{\omega}^V_j(t) \mid \Pi_j^V(t)<0)\leq 1$.[29] Π_j^V denotes cyclical variation in profit. Given sufficiently adverse stationary nominal demand disturbances, downward rigidity in the money wage implies temporary financial losses, production cuts, and worker layoffs.[30]

Employers' perspective. Instead of layoffs, why wouldn't management arrange a nominal wage cut? The modern theory of labor pricing has demonstrated that large, specialized firms rationally eschew wage reductions (from the established reference rate) in response to stationary demand shocks. The costs of such wage cuts exceed their benefits. (Recall the evidence cited above.)

Large employers have learned that wage reductions, if they are to lower unit costs, must be accompanied by employee voluntary recalibration of established reference standards ($\mathbf{K}^{\acute{n}}_j$). Theorists who restrict their attention to market exchange ignore the sharp increases in firm and worker costs associated with high-frequency $\mathbf{K}^{\acute{n}}_j$ recalibration. In part, fine-tuning costs result from the uncertain timing of recessions and their typically short duration. In an environment where most employees will not be laid-off, management wishing to fine-tune labor-pricing is provided insufficient time to organize workforce acceptance of the compensation change.

Moreover, in order to preserve Pareto optimality, a wage cut sufficient to maintain employment requires that workers facing layoff subsidize the remaining employees to prevent reductions in veteran pay. In workplace equilibrium, such redistribution is inconsistent with optimization by employees and their employer for three interrelated reasons. First, the fractured wage structure engenders workplace discontent, damaging productivity. That result was derived in the previous

[29] In the compact workplace-equilibrium model, it is analytically convenient to normalize the threshold between rational $\acute{\omega}_j^V$ inaction and action by the firm at $\Pi_j=0$.

[30] Throughout the normal range of relevant industry price-demand elasticities, downward-rigid nominal wages make production cuts preferable to price cuts in response to adverse money-demand disturbances. (See Annable (2013).)

section and, as indicated by the survey evidence, is well understood by LEV employers to be an effective barrier to temporary wage cuts. Second, workers not at risk of layoff are interested in career earnings and are rationally reluctant to accept, even with compensation, stationary downward wage flexibility.[31] Third, temporary wage cuts, absent redistribution, almost always violate the opportunity costs of employees at risk of layoff, making such cuts infeasible.[32]

To reiterate, the fundamental restriction on fine-tuning labor pricing in response to $\acute{\omega}_j^V>0$ is management's belief that nominal wage cuts must be accompanied, in order to avoid adverse effects on unit costs, by voluntary worker $\mathbb{K}^{\acute{n}}_j$ recalibration. Stationary demand shocks, by their nature, are unanticipated and temporary, while optimal $\mathbb{K}^{\acute{n}}_j$ recalibrations are inherently time-intensive, focused on the nonstationary timepath of earnings, and complicated by moral hazard as well as worker priors on both their likely incidence of job loss and their reservation wages. An important implication of workplace-equilibrium analysis is that $\acute{\omega}_j^T>0$ (not $\acute{\omega}_j^V>0$) is a necessary condition for rational nominal wage cuts in large, specialized establishments.

In response to adverse high-frequency nominal-demand disturbances, profit-seeking firms eschew wage recontracting and, instead, pursue carefully designed programs of layoffs. The first

[31] Rational personnel policy allocates temporary job loss via some equity-based mechanism, typically seniority. Employees (especially those who expect to retain their jobs through the recession) must weigh any short-term income gains going to those who avoid being laid-off against the damage done to reference-standard effectiveness in enforcing the payment of labor rents. Large-establishment employers pay more than market opportunity costs because they believe their employees are deeply committed to established reference standards independent of conditions in the labor market. Reference-standard flexibility in recession would challenge that belief, making employers more skeptical about the efficacy of paying equity-based wage rents. A significant component of workers' $\mathbb{K}^{\acute{n}}_j$ fine-tuning costs is convincing management that, having temporarily abandoned the equity-based benchmark, employees are still sufficiently resolute in their attachment to $W^{\acute{n}}_j$ that continuing to violate the pre-recession reference standard in the subsequent cyclical rebound would spontaneously result in higher unit costs. Accepting a wage cut (with unchanged OJB) to avoid layoffs for some colleagues carries the risk that the lower rate will not be temporary. In relying on their employer to design and implement the wage reduction, the workers' free-rider problem is replaced by moral hazard that makes the true intentions of management nontransparent.

[32] A numerical example illustrates the feasibility issue. Posit that a 20% overall wage cut is needed to prevent a 30% jobs cut in the *j*th establishment. No wage reduction for 70% of the workforce implies that at-risk employees must accept a two-thirds reduction in pay. Such a draconian cut, given that leisure is a positive good and alternative income sources exist (usually including jobless benefits and employment in the small-establishment venue), would almost always violate reservation wages. Layoffs are the only Pareto-efficient solution.

modern theory of wage determination uniquely makes that familiar, real-world response consistent with optimizing exchange organized by continuous economic equilibrium.[33]

Employees' perspective. From the job losers' point of view, the firm's temporary job reductions can be further usefully separated into two classes: layoffs with and without recall. If firm-specific human capital is sufficient to justify the costs of targeted rehiring, including the typically higher compensation of more experienced employees relative to new hires, management will rationally endow laid-off workers with recall rights, i.e., first claim to their previous job when hiring resumes.

The firm, as a result, is able to staff up quickly, with little loss of human capital, when nominal demand recovers. Laid-off workers are additionally able to join relatively short, highly efficient rehiring queues. The sequential layoff and recall responses to adverse nominal disturbances are rooted in meaningful wage rigidity, which has been shown to be characteristic of large, specialized workplaces.

Stationary employment fluctuations are not always associated with recall. If specific human capital is insufficient to justify recall costs, including the higher compensation of more experienced employees relative to entry-level workers, the rational firm will choose to staff up in cyclical recovery with new hires. In this variation, a sufficiently adverse spending disturbance generates a temporary reduction of employment for the firm while producing permanent job loss for laid-off employees.

Unlike their counterparts who are endowed with recall rights and therefore join a rehiring queue, workers who permanently lose their high-wage jobs must engage in labor-market search and price discovery (or drop out of the labor force), encountering the chronic rationing of rent-receiving employment. Laid-off workers lacking recall rights are much more likely to eventually accept a job that pays significantly less than their previous wage. As a result, they tend to

[33] Meanwhile, labor prices are more frequently cut in the small-firm venue, where effective monitoring prevents the establishment of nonmarket workplace reference standards (W_k=sup $\mathbf{K}_k$=W^a_k=W^m). In the SEV, wages are subject to recontracting; and job loss is confined to voluntary quits.

experience longer spells of unemployment. Relatively high reservation wages are characteristic of workers who have experienced the permanent loss of a LEV job. For that class of workers, job search is needed to properly size the nonmarket wage premiums formerly received, helping them to better understand their true market opportunity costs. Downward calibration of reservation wages is an understandably painful process that greatly interests policymakers. It cannot be adequately explicated absent meaningful wage rigidity.[34]

V. THE MODERN THEORY OF WAGES

Technological size-heterogeneity of firms has been a fundamental fact of market economies since the Second Industrial Revolution. The generalized-exchange model derived in this paper accommodates the profound transformation of the production landscape via the bifurcation of labor pricing, one branch located in the marketplace and the other in the workplace. The result is the first coherent, stabilization-relevant theory of wages in a more than a century.

For SEV firms, seeking to hire sufficient labor and contain voluntary quits while exercising cost-effective employee oversight, mainstream market-centric (DSGE) analysis continues to suffice. Employer profit-seeking and employee utility-maximization combine to produce familiar equality among the nominal wage paid, the value of labor's marginal product (Keynes's First Classical Postulate, governing demand), and labor's marginal disutility of work (Keynes's Second Classical Postulate, governing supply): $W_k=VMPL_k=MRS_k=W^m$. Firms and workers can do no better than being market-price takers.

Profit-seeking LEV management not surprisingly confronts greater complexity, largely because employee oversight is now restricted by costly, inherently asymmetric information. Labor input (E_j) that always demonstrates a 1:1 correspondence with production cannot be measured or priced in the labor market. The firm must construct its own labor-pricing apparatus. Moreover, in the evolution of best-practices compensation systems, management relatively quickly recognized

[34] For example, the ubiquitous Diamond-Mortensen-Pissarides (DMP) search/matching/bargaining model class is enriched, enhancing its policy-relevancy, once integrated with the modern two-venue wage theory. Black-box Nash bargaining is replaced with well-motivated wage determination, and labor-market flows are fed by involuntary, as well as voluntary, job separations.

that a strong worker preference for equitable treatment, suppressed in rational marketplace exchange, substantially influences on-the-job behavior and must, as a result, be carefully dealt with in rational workplace exchange. In the circumstances of large, specialized establishments offering routinized jobs, employer profit-seeking and employee utility-maximization combine to produce equality among the nominal wage paid, the value of labor's marginal product (retaining Keynes's First Classical Postulate), and the workers' reference wage ($W^{\acute{n}}_j$), which provides the unit-cost-minimizing discontinuity in the Workplace Exchange Relation derived above: $W_j = W^n_j = \max(\acute{Z}_j/W_j) = W^{\acute{n}}_j = \sup \mathbf{K}_j = {}_j > W^m$. Keynes's First and Second Classical Postulates have been eliminated, replaced by the workplace optimization of cooperative labor productivity ($\acute{E}_j/H_j$), a process that is recognizable to practitioners. (Recall the evidence cited in Section II.)

The process is also recognized to be unfamiliar to economists, suggesting the value of some further elaboration on the paper's LEV innovations. The key is that the profit-seeking management of labor input is separable into two parts. The first, and most critical, step is the firm's sufficient identification of its WER to enable payment of the labor price consistent with unit-cost minimizing employee behavior: $W_j = W^n_j = \max(\acute{Z}_j/W_j)$ and $\acute{Z}_j = \acute{Z}^n_j = (\acute{E}_j/H_j)^n$. The need for hands-on WER management is why large, specialized firms always have large human-resource departments while their SEV counterparts do not.[35] Section III's derivation of the robust nonconvex WER class illustrated in Figure 2 microfounds the equality of the employer's optimizing efficiency wage (W^n_j) and employees' optimizing reference wage ($W^{\acute{n}}_j$): $W_j = W^{\acute{n}}_j = \sup \mathbf{K}_j = W^n_j = \max(\acute{Z}_j/W_j) > W^m$. The primary task of rational LEV labor pricing is to manage worker OJB, requiring close attention to employee reference standards.

The second LEV task is to assure the adequate size of the firm's workforce. In the two-venue model, satisfying that objective is not difficult. Given $W_j = W^n_j = W^{\acute{n}}_j$, the relevant supply of labor can be measured by worker hours (H_j), which are restricted by the wage condition to be in 1:1 correspondence to production. Chronic wage rent combines with the large size of total SEV employment to produce an infinitely elastic market supply schedule at W^n_j.

[35] Hopefully, mainstream macro theorists will stop making the embarrassing assumption that the task of HR departments is labor recruitment. Practitioners know that recruitment is a small part of HR activity, which is instead focused on informing and maintaining the firm's labor-pricing apparatus as well as its elaborate, quasi-judicial system of equity-based workplace rules and incentives

Moreover, given that optimized $\acute{Z}^{n}_{j}$ does not imply a determinate level of hours, the firm's demand must be rooted elsewhere. In generalized exchange modeling, LEV management identifies its production schedule (with particular levels of labor hours, capital services, and material input) as a function of its expected product demand. That process, once again, is recognizable to practitioners. A pleasing feature of the reformulated LEV labor demand relative to the familiar neoclassical narrative is its consistency with the overall reorientation of coherent macroeconomics induced by generalized-exchange modeling. Classical causation is replaced by Keynesian (reversed) causation that runs from nominal demand to employment/output.[36] With acceptance of the generalization of rational price-mediated exchange to the workplace, Say's Law is scrapped along with Keynes's Classical Postulates. The era of coherent, stabilization-relevant macro theory can begin.

V. CONCLUSION

The market-centric general-equilibrium model that dominates modern macro thinking today is an elegant, coherent description of rational price-mediated exchange that produces efficient resource pricing and allocation. Like many beautiful theories, however, it is a way-station, carrying seeds of its own demise (as a general theory) that hint at even deeper, more universal models to come. For example, Newton's explanation of gravity, a prototypically beautiful theory, requires instant communication over arbitrarily large distances. General relativity fixed that problem, while profoundly deepening our understanding of the physical universe. Relativity's own false premise, i.e., that momentum and position can be simultaneously known, turned out to be especially damaging in the study of fundamental particles, opening the door to quantum mechanics and an even more complete blueprint of how things actually work.

Moving down several rungs from the lofty standard of theoretical physics, an important tip-off with respect to the productive development of stabilization-relevant macroeconomics was provided by Keynes's shrewd, albeit arbitrary, rejection (in *The General Theory*) of the

[36] For elaboration, see Annable (2013).

neoclassical equality between the wage paid and marginal disutility of work. Considering Keynes's intuition in the context of the global spread of large corporations, the symmetric, cost-effective workplace information necessary in the derivation of the Second Classical Postulate is clearly an untenable assumption. Add to the mix the cumulating, now overwhelming, evidence of workers' axiomatic preference for fair treatment by management; and there is room for a powerful revolution in the consensus treatment of rational worker supply.

The reworking of labor supply in the information-constrained circumstances of large, specialized establishments has become the keystone of a coherent, stabilization-relevant theory of wage determination. It is the next substantial step on a macroanalytic continuum that features Keynes as well as his New-Classical antagonists. Lucas (2001, p.18, emphasis his) has described his famous *JPE* (1969b) article with Leonard Rapping, which effectively fired the first shot in the anti-Keynesian reformation by reorienting the study of employment fluctuations away from income- to substitution-effects, as "writing down a labor supply curve and taking it seriously!"

The first modern theory of wages in more than a century is constructed on the generalization of exchange from the marketplace to the workplace, augmenting neoclassical labor supply that is still applicable to SEV firms with a nonconvex class of Workplace Exchange Relations produced by LEV establishments.[37] For highly specialized firms, cooperative labor input demonstrating 1:1 correspondence with production has been derived as a continuous-equilibrium phenomenon from axiomatic model primitives. As illustrated in Figure 2, it is the most serious advance in writing down labor-supply functions since the Second Industrial Revolution. The essential WER is best understood as a heretofore unappreciated fundamental law of modern macroeconomics, uniquely enabling coherent macro theory to accommodate meaningful wage rigidity and be stabilization relevant. Once a large share of workers have been rationally pushed off their neoclassical labor-supply schedule, rigorous aggregate modeling can answer important, previously unanswerable questions and explain significant, previously inexplicable evidence.

[37] SEV firms also have WERs, but their specification (a horizontal line anchored by cost-effective employee supervision ($\acute{Z}^{m}_{k}$)) makes workplace exchange uninteresting. More interesting, worker interaction between the two venues has been modeled, originally for low-income economies, by Harris and Todaro (1970). Overall, the melding of the two venues into a single coherent macro model is a productive exercise, uncovering powerful macro laws and explaining a broad range of evidence that must be ignored in the more limited single-venue analysis.

This paper began by citing the perilous 2007-09 Great Recession. For mainstream macro theorists, the contraction quickly became a wellspring of inexplicable evidence and unanswerable questions. The financial crisis was notably accompanied by the largest reduction of aggregate nominal demand since the 1930s depression, and the spending collapse, interacting with meaningful wage rigidity, produced more than six million involuntarily lost jobs that, in turn, accounted for more than three-quarters of the overall increase in unemployment. The need to understand extreme real-world instability, and ameliorate the huge welfare loss it engenders, powerfully affirms the importance of the century's first modern theory of wages.

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