GEM
Generalized Exchange Macroeconomics

Chapter Three

BEYOND BASELINE WORKPLACE EQUILIBRIUM

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BEYOND BASELINE
WORKPLACE EQUILIBRIUM

This chapter continues the investigation of large-establishment workplace exchange, constructing foundations for a modern theory of wage determination and, ultimately, for stabilization-relevant, coherent macroeconomics. The central simplifying restriction of the previous chapter's baseline model, i.e., that reference-standard ($\mathbb{K}_j$) calibration remains unchanged (hereafter defined as "inactive"), is dropped. In well-defined circumstances to be derived below, employees rationally recalibrate their reference standards.

Modern macroeconomics usefully decomposes employment ($N(t)$) into stationary ($N^V(t)$) and nonstationary ($N^T(t)$) components. TVGE modeling will demonstrate that $N^V_j(t)$ is uniquely consistent with inactive $\mathbb{K}_j$, while $N^T_j(t)$ also accommodates active $\mathbb{K}_j(t)$. The nonstationary timepath of continuous-equilibrium LEV employment is sequentially partitioned into periods of inactive and active $\mathbb{K}_j(t)$ that always imply some degree of meaningful wage rigidity. Generalized exchange obviates the need for the problematic short- and long-run dichotomy used by Early and New Keynesian theorists to isolate the assumption of wage stickiness within their (consequently incoherent) SVGE model class.[1] The transition from stationary to nonstationary analysis is no longer an arbitrary, puzzling function of time.[2] Cyclical and trend job paths are now understood for what they are, i.e., analytically distinct, inherently simultaneous phenomena.

Moreover, building on the previous chapter's reconciliation of the formal economic method and meaningful wage rigidity, the generalized-exchange investigation of nonstationary labor productivity identifies a set of growth-related models, abandoned in the modern macro era, that are powerfully accommodated in TVGE modeling. Marooned analyses include Lewis's (1954, 1958) two-sector model of economic growth, Chandler's (1992, 1997) analysis of the nature and

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[1] The apex of SVGE time-separation was Samuelson's admirable Neoclassical Synthesis, introduced in the third edition (1955) of his textbook *Economics*.

[2] Like Patinkin (1956), time (t) is absent from the baseline workplace modeling in the previous chapter.

macrodynamic role of large establishments, Jensen's (2000) revival of residual-rent factor-income distribution, Olson's (1982) sweeping "distributional-coalition" growth theory, Malinvaud's (1980) profit-centric medium-term modeling with wage rigidity, and Baumol's (2002) Schumpeterian model of endogenous technological change.[3] Combined with Solow's benchmark neoclassical macrodynamics, those models provide content to the methodological mandate that acceptable theories coherently integrate business cycles and growth.

The chapter has five parts. In the first section, workplace-equilibrium theory is enriched with active $\mathbb{K}_j$. The innovation critically enables the modeling the simultaneous, intertemporal optimization of nonstationary LEV labor pricing and OJB that powerfully extends involuntary job loss from temporary layoffs to permanent downsizing. The strict association of layoffs, in the context of high-frequency stationary demand fluctuations, with inactive $\mathbb{K}_j$ is also demonstrated. The second section introduces meaningful wage rigidity into the rational distribution of firm revenue among its various claimants. Neoclassical factor-income distribution, the academy's mainstream story since Wicksell-Wicksteed despite its implausibly restrictive microfoundations, is replaced by a more general treatment that accommodates wage rent and downward rigidity, capital indivisibilities and specificities, and the existence of nonzero pure profit. More robust distribution of revenue is necessary for coherent macroeconomics to be stabilization relevant.

Third, the Lewis two-sector model is summarized and, using TVGE analytical tools, generalized to all market economies. Outside the academic mainstream, Lewis's take on poor-country economic transformations has long been the platform of choice for explaining and predicting early-phase macrodynamics. Extending its reach will hopefully encourage growth theorists to return his "organizational-dualism" model to graduate-school reading lists. The enhanced Lewis theory easily segues into Solow's neoclassical growth model, which also turns out to be readily compatible with generalized-exchange thinking.

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[3] Mainstream neoclassical growth theory developed independently from those orphan models. In the first quarter-century of the postwar period, Solow, Swan, Koopmans, Cass, and others constructed neoclassical models featuring diminishing returns (to reproducible factors) that produced steady states in which exogenous influences (notably technology and population) motivated growth. The model class excited theorists, who typically have an admirable urge to reduce reliance on exogenous factors. In the 1980s, Paul Romer, Lucas, Rebelo, Howitt, Aghion, and others began endowing macrodynamic models with increasing returns, typically rooted in human capital, seeking greater endogeneity in steady-state growth. TVGE modeling usefully emphasizes a different, albeit intuitive, class of endogenous increasing returns, the familiar scale economies rooted establishment size.

The fourth section returns to income distribution, featuring two insightful nonstationary models. Recalling Schumpeter, William Baumol constructs a model linking corporate profits and research-and-development spending, making one of the most significant classes of technological change and application endogenous. In a reprise of his appearance in Chapter 1, Alfred Chandler provides a more general, historical analysis of the reorganization of production, generating increasing returns to scale, that motivates the mid-nineteenth-century departure from the multiple-millennia stagnation of living-standards growth. The final section is a summary.

I. ACTIVE-Ҡ WORKPLACE EQUILIBRIUM

Continuous workplace equilibrium, confronting sufficient nonstationary market failure, eventually induces employee recalibration of their reference standards ($Ҡ_j$). In the dynamic analysis, wage rents are usefully decomposed into their noncyclical and cyclical components:

$$(3.1) \qquad G_j(t) = 1 - G_j(t) = 1 - W^{\acute{n}}_j(t)/W^m(t) = G^T_j(t) + G^V_j(t),$$

where W^m denotes labor-opportunity costs and $W^{\acute{n}}_j$ the jth-workplace reference wage.

In large establishments, economic rents (Π_j) claimed by owners of sunk capital (K^S_j) are a critical residual factor payment, defined as jth revenue in excess of the cost of labor hours, financial capital, and materials input:

$$(3.2a) \qquad \Pi_j(t) = P_j(t)X_j(t) - G_j(t)W^m(t)H_j(t) - \check{r}^m(t)Ҡ^r_j(t) - P^{Ш}(t)Ш_j(t) = \Pi_j^T(t) + \Pi_j^V(t) \text{ or}$$

$$(3.2b) \qquad P_j(t)X_j(t) = G_j(t)W^m(t)H_j(t) + \check{r}^m(t)Ҡ^r_j(t) + P^{Ш}(t)Ш_j(t) + \Pi_j(t)$$

where $\check{r}^m$ denotes the market price of financial capital, $Ҡ^r$ is the resale value of the establishment's capital stock, $Ш$ denotes (homogeneous) material input, and $P^{Ш}$ is its unit price.[4] Total capital $Ҡ_j$, valued at original cost, equals $Ҡ^S_j + Ҡ^r_j$; for convenience, sunk capital ($Ҡ^S_j$) is always equity financed and $Ҡ^r$ is always debt-financed. In this chapter, $\check{r}^m$ and $P^{Ш}$ are exogenous. Via G, equations 3.2 embody the MWR Channel that microfounds the crucial causation from

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[4] It is assumed, for convenience, that the capital stock is financed with asset-backed debt.

fluctuations in nominal product demand (*PX*) to same-direction movements in pure profit (*Π*). The analysis will return to pure profit later in this chapter. For now, it is sufficient to understand that meaningful wage rigidity enables *Π* existence and the powerful role it plays in rational behavior.

The residual-rent framework also enables the introduction of sunk costs, real assets, intuitive investment, interest rates, and product pricing into job-loss dynamics. In generalized-exchange modeling, stationary (Π_j^V) and nonstationary (Π_j^T) pure profits are critical transmission mechanisms through which demand disturbances influence rational firm choices that centrally include layoffs and job downsizing as well as investment, hiring, and liquidation. The residual-claims analysis is recognized as part of the Jensen (2000) class of income-distribution models.

Expected real discounted residual rents are:

$$(3.3) \qquad И_j(0) = E_{oj} \sum (1 + ŗ^e(t) + p^e(t))^{-t} \Pi_j(t),$$

where E_{oj} denotes expectations rooted in cost-effective information available to management at the beginning of the current period ($t=0$), positing objectively known probability distributions of future outcomes; $ŗ^e$ and p^e are, respectively, the expected discount and general inflation rates; and the series are summed from $t=0$ to $t=\eta$, the expected life of capital investment.[5] The residual-rent definitions imply an expected rate of return:

$$(3.4) \qquad q_j(t) = И_j(t) / Ҡ_j^S(t).$$

As noted, actual and expected residual rents are a critical capacity signal in TVGE theory, motivating a set of management production-capability decisions that includes involuntary job loss ($ώ_j$), such that $ώ_j(t) \in [0,1] = ώ_j^T + ώ_j^V$, as well as new capital investment.[6]

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[5] Expectations are continually updated over time, and the operator (*E*) has the standard properties used in statistical theory. Uncertainty, an important macro modeling input at least since Keynes, is introduced in Chapter 6.

[6] The variable $ώ_j^T$ denotes the job-loss incidence associated with the behavior of $И_j$, which is inherently nonstationary, and $ώ_j^V$ is the job-loss incidence associated with the stationary behavior of residual rents (Π_j^V).

Nonstationary Wage-Rent Dynamics: Employment Downsizing

Assumptions. The additional assumptions that facilitate tractable dynamic workplace-equilibrium modeling are:

- Job losses are allocated randomly among employees.

- The costs of creating and maintaining $\mathbb{K}_j$ are equally distributed among workers who receive wage rents.

- The homogeneous capital stock ($\mathcal{K}_j$) depreciates at a constant rate over time.

- Management is monitored at no cost by equity owners.

- The monetary authority's inflation regime is credibly stable.

The assumptions, taken together, are recognized to be uncomfortably restrictive, substantially reducing the applicability of the dynamic model. The nonintuitive restrictions, however, are not necessary for the model's conclusions, used only to shorten the presentation. They will be relaxed, strengthening the results, later in the analysis.

Employment policy. Intertemporal optimization of the establishment-specific reference wage is intuitively governed by the interaction between the firm's employment policy and workers' satisfaction with existing combination of labor rent and job prospects. Initially consider the firm's choice with respect to retaining existing employees. Management's expected discounted real residual rents relative to sunk capital motivate the nonstationary incidence of establishment-specific job destruction ($\acute{\omega}_j^T$):

(3.5) $\acute{\omega}_j^T(t) = f(q_j(t))$, such that $\acute{\omega}_j^T(t) \in [0,1]$,

$(\acute{\omega}_j^T(t) \mid q_j(t)>1)=0,\ 0<(\acute{\omega}_j^T(t) \mid 0 \leq q_j(t) \leq 1)<1$,

and $(\acute{\omega}_j^T(t) \mid q_j(t)<0)=1.$[7]

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[7] For convenience, the threshold between rational $\acute{\omega}_j^T$ inaction and action is normalized at $q_j=1$.

If $q_j(t)>1$, the establishment expects to earn discounted residual rents greater than the cost of its sunk capital. Profit-seeking management rejects reductions in production capability, implying no job loss ($\acute{\omega}_j^T(t)=0$). If $0\leq q_j(t)\leq 1$, expected discounted rents are greater than (or equal to) the establishment's liquidation value but less than (or equal to) its sunk-capital costs. The firm can justify neither investing in the facility nor closing it; production capacity tends to deteriorates with time, causing employment to erode ($0<\acute{\omega}_j^T(t)<1$). If $q_j(t)<0$, management rationally liquidates the facility ($\acute{\omega}_j^T(t)=1$).[8]

Nonstationary employment downsizing has three phases: optimal inaction; deteriorating production capability, during which capital stock depreciates and ongoing efforts to maintain positive residual rents engender cost-cutting; and establishment closure. The deteriorating-capability phase is home to interesting adjustments. Cost-cutting eventually damages labor productivity and can include reductions in capital maintenance, marketing, training, staff support, and R&D. As a result, employment policy typically demonstrates inertial direction, i.e., once an establishment enters the deteriorating-capability zone, its exit is much more likely to be closure than a return to capacity expansion. Meanwhile, the associated job downsizing feeds back to rational employee calibration of $\mathbb{K}_j$ (see below).

The analysis so far implies that macro and idiosyncratic disturbances affect employment destruction via their effect on establishment pure profit (Π). Real shocks are shown below to be associated with persistent shifts in profits and jobs. In a well-known example, when the relative price of oil jumped during the 1970s and early 1980s, labor rents increased, profits decreased sharply, and unemployment rose throughout the world. Chapter 4 elaborates on that response, explaining why its nature had changed during more recent sharp run-ups in oil prices.

Optimal worker response. Rational employees cannot be unconcerned in the face of job downsizing. The rational worker's intertemporal task is finding the sequence of endogenous $\mathbb{K}_j$ that yields the highest expected discounted consumption during his or her desired tenure at firm

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[8] Economic theorists recognize that the dynamic behavior of the two-threshold jobs-reduction policy can be analyzed as a fixed-cost stochastic control problem. That approach usefully permits intuitive treatments of sunk capital, profit expectations, and rational inaction. See Stokey (2009) and Chapter 6. Such in-depth modeling, however, is not necessary in this introductory version of generalized-exchange modeling.

j.[9] In firm j (dropping the subscript), the optimizing employee evaluates his or her expected discounted wage income ($Я_i$) resulting from maintaining the established reference wage:

$$(3.6) \qquad Я_{ni}=E_{oi}\sum(1+ŗ+p)^{-t}H^o{}_iW^n{}_i(t)(1+w^n{}_i(t))(1-\acute{\omega}_i{}^T(t)),$$

Subject to $w^n{}_i(t)=w^n{}_j(t)=r^n+p_ķ(t)$ and $\acute{\omega}_i{}^T(t)=\acute{\omega}_j{}^T(t)=\acute{\omega}_{iT}(q_j(t))$. Constant price inflation and discount rates are denoted by p and $ŗ$ respectively; H^o is the constant notional hours on the job in each period; w_n is the growth rate of the efficiency wage; r^n is the rate of trend real wage growth implied by $\mathbb{K}_n$; $p_ķ$ is the catch-up to price inflation that has already occurred (with $ķ$ measuring the fixed length of time between discrete wage adjustments); and all series are summed from $t=0$ to $t=ϰ$ (the employee's desired job tenure).[10]

The worker additionally determines the best alternative reference standards, modeled as the sequence of $\mathbb{K}_ą$ calibrations,

$$\{\underset{t=1}{\overset{ϰ}{W_ąi(t)}}\},$$

that maximize expected wage income:

$$(3.7) \qquad Я_{ąi}*=\max(E_{oi}\sum(1+ŗ)^{-t}(H^o{}_iW_ąi(t)(1+w_ąi(t))(1-\acute{\omega}_ąi{}^T(t)))),$$

subject to $w_ąi(t)=r^ą+p_ķ(t)$; $\acute{\omega}_ąj{}^T(t)=\acute{\omega}_T(q_ąj(t))$; $W^m(t)\le W_ąi(t)<W_{ni}(t)$. Maximization takes place over all available alternative reference-wage paths, and the worker rationally maintains the established $\mathbb{K}_n$ if $Я_{ni}\ge Я_ąi*-Γ^\$_ąi*$, where $Γ^\$_ą$ denotes the employee's share of the discounted total costs of recalibrating $\mathbb{K}_n$.

Dynamic persistence of the established reference wage is the critical result of the intertemporal analysis:

- If the employee (effectively using available information) expects $\acute{\omega}^T{}_j=0$, the reference wage (W^n) is rationally maintained: $Я_n=E_{oi}\sum((1+ŗ+p)^{-t}H^o{}_iW^n{}_i(t)(1+w^n{}_i(t)))>Я_ąi*$.

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[9] In the compact introductory version of generalized-exchange theory, employees are posited to strictly prefer both consumption and leisure to fair treatment by management.

[10] Chapter 6 demonstrates the consistency between the wage equation's use of catch-up to past inflation, rather than expectations of future inflation, and rational behavior.

- If the worker expects $\acute\omega^T_j > 0$, he or she still refuses to alter W^n if the discounted gain from the best available sequence of revisions is less than $\Gamma^{\S}_{ai}{}^*$, the expected cost of recalibrating $\mathbb{K}_n$: $\mathcal{A}_{ai}{}^* - \mathcal{A}_{ni} \leq \Gamma^{\S}_{ia}{}^*$. The result becomes important when the model's restrictive assumptions are relaxed.

- If $\mathcal{A}_{ai}{}^* - \mathcal{A}_{ni} - \Gamma^{\S}_{ia}{}^* > 0$, the expected incidence of firm-specific job-destruction ($\acute\omega^T_n$) has become sufficiently large to induce $\mathbb{K}_n$ recalibration, reducing the established reference wage. The employer-expected pure profit that induces that sufficient level of $\acute\omega^T_n$ is denoted by Π^*_j.

Given $q_j > 0$, the established efficiency wage is more durable (i) the larger the discounted residual rents expected by owners of capital, (ii) the greater the firm's capacity to pass on wage rents to higher product prices, (iii) the smaller the ratio of labor to total costs, making q_j less sensitive to changes in G_j, and (iv) the greater the individual worker costs of recalibrating existing $\mathbb{K}_j$.[11]

Typical of dynamic-programming/Bellman problems, using the recursive model to derive more detailed conclusions about the optimal frequency and size of reference-wage recalibrations is a space-consuming task, requiring specification of the remainder of the model and the numerical simulation of the feedback between wage rent and permanent job-loss incidence of over time. To shorten this introduction to TVGE theory, the iterative exercise, the results of which are unsurprising, will not be presented.

Reference wage durability. Rational workplace behavior in specialized, large establishments microfounds nonstationary reference-wage persistence. Dynamic nonmarket labor pricing is rooted in the feedback between employer choice with respect to establishment workforce size and employee rational substitution of consumption for perceived fair treatment. Management-labor expectations that validate inactive-$\mathbb{K}_j$ workplace equilibrium are motivated by pure-profit behavior:

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[11] Those factors are similar to the determinants of inelastic input demand, originally enumerated by Marshall to explicate the capacity of unionized workers to obtain wage rents: labor services are (nearly) "essential" to production; final product demand is "stiff and inelastic"; labor costs are a relatively small share of total production costs; and nonlabor (capital) inputs are largely establishment-specific (lacking mobility).

Reference-wage durability theorem. There exists a level of expected discounted real economic rents claimed by equity owners (Π^*_j) such that worker-expected residual rents (Π^W_j) satisfying $\Pi^W_j \geq \Pi^*_j$ restrict the downward recalibration of the established reference wage (W^n_j) to be inconsistent with rational behavior.

The TVGE macro model implies the existence of a well-defined upper limit on wage dispersion ($G(t) \leq \acute{G}(t)$) that is consistent with durable $\mathbb{K}_j$. In specialized economies, exploiting production scale, the interaction of utility-maximizing employees and profit-seeking employers implies substantial intertemporal persistence in W^n_j.[12] Workplace-equilibrium analysis identifies significant sources of residual rents ($q_j(t)>0$) that fund $\mathbb{K}_j$ durability, well into the medium term, including investor optimization under generalized risk, industry wage cartelization, endogenous product pricing, and increasing returns to scale.[13]

The most analytically significant source of pure profit is *optimal investor choice under generalized risk*. Investment in long-lived sunk capital (at $t=0$) requires investor expectations of sunk-capital rents that satisfy their required returns, i.e., $\Pi_j(0) \geq \Pi^f_j(0)$.[14] The more firm-specific is the purchased capital, the greater are the subsequent residual rents available to fund W^n_j persistence. Note that expectations of rising labor rents would be incorporated into $q_j(0)$ and, once the investment is made, are available to fund $\mathbb{K}_j$ durability. Moreover, any risk aversion by equity owners allow for some combination of (a) greater-than-expected interest rates and wage rents and (b) less than expected product pricing and real demand. Such risk aversion, if unrealized, is additionally available, after the investment is made, to fund W^n_j persistence.

Workplace-equilibrium analysis, therefore, provides a central role for the classic *hold-up problem*, in which sunk investments motivate differences between *ex ante* and *ex post* reservation prices. (See Williamson, *et al.* (1975).) In the division of rents between owners of

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[12] Even when $\mathbb{K}_j$ is rationally recalibrated in response to expected permanent job loss, optimizing behavior almost always implies that the new reference wage (W_{aj}^*) continues to embody nonmarket, albeit reduced, rents. Large-establishment labor pricing still occurs in the workplace, not the marketplace.

[13] An important source of $\mathbb{K}_j$ persistence not summarized in this section is government intervention, broadly defined to include actions that reduce industry product-demand elasticities as well as those that restrict management latitude to optimize labor costs. The analysis returns to government intervention later in the analysis.

[14] For elaboration on investor required returns (Π^f_j) in the TVGE model class, see Chapter 6.

sunk-capital stock and both labor (via wages) and government (via taxes) occurring after sunk investments have been made, equity owners rationally accept a share of the available surplus that would not have been acceptable prior to the capital purchase.[15] Note that the rational-expectations hypothesis, costlessly endowing agents with the information set of the model itself (model-consistent expectations), reinforces the role of the hold-up problem in increasing $\mathbb{K}_j$ durability.

More generally, investors' hold-up problem involves the future behavior of employees (given sufficient establishment-specific human capital), suppliers, clients, and taxing authorities and can be aggravated by macro shocks and government intervention.[16] The hold-up problem is a foundational concept in organization theory and, in macroeconomics, provides further contrast to SVGE thinking, in which generalized investment risk is sharply reduced by confining transactions to competitive markets, critically enforced by the Barro critique.

Another source of Π_j funding of $\mathbb{K}^n_j$ durability is the role of interpersonal reference standards in *industry cartelization of labor costs*, a phenomenon that Arthur Ross (an early head of the Bureau of Labor Statistics) named "orbits of coercive comparison". Given that industry product-demand elasticities are inherently lower than those constraining individual establishments, wage increases can be more easily passed on in the form of higher product prices. Lower effective elasticity provides some insulation of Π_j from higher labor costs, enhancing $\mathbb{K}^n_j$ durability.

Two other contributors to residual rent, while important in practice, violate standard textbook assumptions of market competition and constant returns to scale. First, *product-pricing power*, involving some pass-through of rising wage rents to product prices, ameliorates the effect of higher labor costs on expected profits (Π_j) and the incidence of job destruction ($\acute{\omega}^T_j$). Familiar sources of endogenous product-pricing are rooted in product-market imperfections. Most notable

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[15] Vertical integration solves a broad class of hold-up problems but not its most powerful version, i.e., the combination of establishment-specific physical and human capital. Such production specificity implies that the purchase of sunk capital inherently increases labor's capacity to extract wage rents and that the returns required by rational investors must account for their expectations of employee hold-up. Workplace-equilibrium theory, by modeling how workers organize to exploit sunk-capital investment, enhances the important hold-up literature. See, for example, Grossman and Hart (1986).

[16] Given the uncertain hold-up problem, it is not surprising that accelerator models of investment fit the data.

is monopolistic competition.[17] As originally modeled by Edward Chamberlin (1963), investment in product differentiation (and other marketing methods) endows firms with a degree of pricing power. In such circumstances, price equals marginal cost scaled up by limited product substitutability, generating a particular class of sunk capital income that can fund W^n_j durability.

Second, *increasing returns* have long been recognized to be a potent source of economic rents. In the usual story, interdependent input indivisibilities, knowledge externalities, and improvements with respect to physical and human capital and workplace organization, singly or in combination, translate investments in greater scale into greater-than-proportional increases in output.[18] The extraordinary jump in global living standards in the aftermath of the Second Industrial Revolution, featured in the first chapter, is the bright-line illustration of the transformative power of increasing returns.

Yet, despite its obviously central role in economic growth, mainstream macro theorists have shied away from using increasing returns in formal analysis. Their SVGE model class is unable to accommodate market rents that result from scale economies, stumbling badly when confronting the adding-up problem. A fundamental tenet of single-venue competitive markets is that, whatever the nature of production, inputs are paid their marginal value products, which in turn equal their marginal opportunity costs. But, with increasing returns, SVGE factor pricing fails to exhaust the total product. The understandable desire to avoid embarrassing unclaimed surpluses, which make market structures uncomfortably vulnerable to monopolization, helps motivate modern macro theorists, swallowing hard, to restrict production to be linear homogeneous.[19]

TVGE is, happily, a more powerful model class. Its endogenous, flexible distribution of sunk-capital rents, as pioneered by Michael Jensen (2000), is consistent both with optimizing

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[17] Moreover, if LEV firms are oligopolistically organized, nonstationary product pricing is a mark-up on average unit costs. (See Chapter 6.) Oligopolistic and monopolistic product pricing enhances K_j durability.

[18] Proprietary innovation also generates new products, which can increase economic rents for the firm.

[19] This is a venerable problem. Marshall, for example, concluded that increasing returns remove the limits on the growth of firm size, an outcome that is incompatible with the maintenance of competitive markets.

continuous equilibrium and income distribution that always exhausts the available product. (See below.) Moreover, rational investors, aware of the hold-up problem, will be cautious about responding to outsized profit growth by increasingly funding greater firm capacity, mitigating destabilizing market-structure effects produced by increasing-returns. As a result, the hold-up problem augments market-entry in damping down the advantages of fast-starting firms.

More generally, TVGE thinking demonstrates that large-scale production, labor specialization, employee investment in specific workplace capital ($\mathbb{K}_j$), and firm investment in sunk physical capital are intrinsically related economic phenomena. Nonmarket labor pricing is activated by workplace information asymmetries rooted in scale and input specificities, the same circumstances that produce outsized productivity gains, economic rents, and the hold-up problem.[20] Despite SVGE theorists' ongoing efforts, such intertwined phenomena cannot be understood in isolation. TVGE analysis is also compatible with the Schumpeterian class of growth theories that emphasize corporate finance in growth and innovation. In particular, workplace-equilibrium analysis provides an intuitive framework for endogenous increasing returns by modeling the funding and generation of proprietary innovations and applications to be critically dependent on the capacity of firms to appropriate returns from sunk capital investments. (See below.)

Perhaps most significantly, the analysis has identified the formal importance of the capacity to postpone job downsizing that typically results from unchanged $\mathbb{K}$. Postponement has been shown to be powerfully rooted in ubiquitous phenomena including hold-up, industry cartelization of labor costs, product-pricing power, increasing returns, and government intervention. The employee capacity, at least initially, to ignore job downsizing is largely rooted in the free-rider problem as well as unionization, the modeling of which occurs in Chapter 7.

Relaxing the assumptions. The theory's policy-relevancy can be enhanced by relaxing the restrictive model assumptions in the context of positive $\mathbb{K}_j$ recalibration costs. Once governed by more realistic assumptions, workers' sequential optimization almost always simplifies to more

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[20] $\mathbb{K}_j$ durability is also consistent with large price-cost margins that tend to be characteristic of concentrated industries. See Timothy Bresnahan's (1989) survey of the empirical industrial organization literature.

commonplace behavior, i.e., deciding whether to believe management's claims about jobs being permanently lost and how recalibrated reference standards could save them. Two related model assumptions are especially untenable.

First, assuming randomly distributed job destruction masks significant heterogeneity in the aggregation of employee preferences. Class-I employment losses are typically allocated by seniority or some other equity-based procedure for which workers know in advance the likely targets; for the more protected employees, $\dot{\omega}_{ni}(t) < \dot{\omega}_{nj}(t)$, and for the less protected workers, $\dot{\omega}_{ni}(t) > \dot{\omega}_{nj}(t)$. Heterogeneous self-interest makes achieving consensus on $\mathbb{K}_j$ revisions problematic, increasing recalibration costs ($\Gamma^*_ą$) and reinforcing W^n_j durability.

Second, free riders prevent workers from effectively distributing the costs of revising established (equity-based) workplace reference standards. Assistance from management (or a union or government) is necessary to design and implement recalibrated $\mathbb{K}_j$.[21] Management credibility, however, is inherently compromised by moral hazard, combining with free-riders to reduce workers' capacity to absorb $\mathbb{K}_j$ recalibration costs ($\Gamma^*_ą$) and strengthening the persistence of the established reference/efficiency wage.

More generally, it deserves emphasis here that large-establishment workplace information asymmetries, a structural TVGE characteristic, effectively restrict employees' use of the firm's best forecast of their job prospects. Management is perceived by workers as biased, sharply increasing the employee cost of agreeing on future jobs implications of the existing calibration of workplace reference standards, let alone investments in alternative $\mathbb{K}_j$. (Unlike macroeconomic data such as price inflation and market unemployment, the government does not issue frequent bulletins on establishment-specific job prospects.) For workers who reasonably possess local, rather than global, knowledge, hard evidence on permanent job loss is almost always necessary to give management sufficient credibility to enable the design and implementation of wage cuts that lower unit costs.

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[21] Profit-seeking firms cannot help workers recalibrate their established reference standards in order to increase W^n_j.

Relaxing assumptions of convenience along with rationally restricting the use of management's forecasts reinforces reference-wage persistence, providing an intuitive keystone for a dynamic framework that accommodates variable labor rents, rationed high-wage jobs, and chronic Walrasian disequilibrium. TVGE conclusions do not require employees to be endowed with implausibly rich information sets or implausibly powerful information-processing capabilities, providing them instead with intuitively limited information which is intuitively processed. Consequent decision-rule myopia combines with input specificities, their associated economic rents, and recalibration costs complicated by worker heterogeneities and free riders to help make worker assessment of job prospects a time-intensive process.[22] Endogenous workplace frictions, not their marketplace counterpart, play an significant role in meaningful wage rigidities. Practitioners know that $\mathbf{K}_j$ recalibrations occur in crises, often threatening establishment survival and always involving substantial, ongoing job destruction. Effective recalibrations are organized by management, a union, or government, not spontaneously by workers.

The intuitive story. The nonstationary involuntary job-loss narrative, $((\acute{\omega}_j^T(t) \mid q_j(t)<1)>0)$ and $((\Delta q_j(t) \mid \Delta G_j^T(t)>0)<0)$, is familiar to practitioners and was anticipated by Kerr *et al*.[23] Management knows that meaningful compensation rigidities, interacting with adverse shifts in product-market demand, damage an establishment's profitability and can threaten its survival. Inadequate expected trend residual rents motivate, when permitted by government, job

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[22] Workplace equilibrium easily incorporates learning dynamics. Researchers have learned that expectations frequently follow real-time learning rules that may eventually converge to forecasts ground out by the full model. See Evans and Honkapohja (1999), Evans and Honkapohja (2001), and Honkapohja (2001).

[23] The middle-century workplace labor economists conducted important case studies of job destruction. See, for example, Myers and Shultz (1951). Dunlop (1988, p.66) summarized his more general work on large-firm wage determination in periods of firms' contracting nominal revenues: "Only one set of forces are effective to *reduce* money wage levels: In some periods of depression, declines in product prices may be of such a magnitude and competition in these product markets of such a character as to compel a reduction in wages. Marginal labor costs exceed price, and the enterprise has no option but to reduce wages or go out of business. This experience is widespread and not confined to marginal enterprises. A general recognition of the reality of these price declines and competition in these product markets eases some of the conflict and pain that accompanies any reduction in wages. Unemployment itself has little if any role in influencing wage reduction behavior except in relatively small establishments…. The same perspective helps in understanding the major sectoral declines in wages and relative readjustments of the 1980s in internationally competitive industries such as basic steel and automobiles, in deregulated sectors such as airlines and trucking, and in some sectors of construction in some localities."

downsizing and, in somewhat more limited circumstances, wage givebacks.[24] Imperfect employee information in combination with free-riders is also widely understood to delay remedial $Ҡ_j$ recalibration, implying that givebacks frequently occur too late to save the facility.

Permanent job destruction and related unemployment persistence are significant policy-related problems, about which modern macro theory has provided policymakers little useful guidance. Malinvaud's (1997, p.116) assessment remains relevant: "Most Western Europe unemployment is undoubtedly a medium-term phenomenon and requires medium-term policies. Public opinion has well perceived the problem but has lost confidence in economists, precisely because they have proved unable to produce a clear common proposal on what ought to be done. Indeed, a suitable macroeconomic theory for the analysis of the medium-term unemployment phenomenon is not yet recognized to exist."

Persistent labor-market failure inherently involves meaningful wage rigidity. In the quote, Malinvaud was reviewing Phelps's *Structural Slumps* (1994), which uses efficiency-wage models to endow (albeit incompletely) his medium-term with some labor-market independence. Generalized-exchange analysis addresses the same set of problems as Phelps but with much more powerful labor-pricing capable of deriving a nonstationary timepath of wage rigidities and involuntary job loss consistent with continuous general decision-rule equilibrium.[25]

  Stationary Wage-Rent Dynamics: Layoffs

Rational layoffs. This section models, consistent with intertemporal workplace equilibrium, the second type of job-loss incidence ($\acute{\omega}^V_j$), completing some unfinished business from the previous

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[24] Later in the analysis, stabilization-relevant permanent employment loss (involuntary job downsizing) is associated with the MWR Channel interacting with adverse nonstationary demand disturbances. See Chapters 5 and 10. For more on downsizing, see Baumol, Blinder, and Wolff (2003).

[25] See Chapter 9. The financial collapse of General Motors (representing a large share of the domestic U.S. auto industry) in 2009 further demonstrates the policy usefulness of generalized-exchange modeling. The TVGE model class insightfully explicates the destruction of stakeholder interests in an important industries such as steel, airlines, and autos as a continuous-equilibrium phenomena. For elaboration, see Chapter 7.

chapter. That stationary class of employment loss is associated with layoffs, i.e., involuntary job loss expected to be temporary with or without recall rights assigned to affected workers:[26]

$$(3.8) \qquad \acute{\omega}^{V}_{j}(t) = \acute{\omega}(\Pi_{j}(t)),$$

$$\text{such that } \acute{\omega}^{V}_{j}(t) \in [0,1], (\acute{\omega}^{V}_{j}(t) \mid \Pi_{j}(t) \geq 0) = 0$$

$$\text{and } 0 < (\acute{\omega}^{V}_{j}(t) \mid \Pi_{j}(t) < 0) < 1.[27]$$

The stationary employment-reduction story is simplified by assuming that $q_j(t) > 1$. Management currently expects, over its planning horizon, the establishment to be sufficiently profitable to rule out permanent workforce downsizing. The analysis can then focus on involuntary job loss resulting from stationary downturns in jth residual rents, which in turn are rooted in adverse nominal-demand disturbances interacting with labor-pricing rigidities.[28] As described in equation 3.2, there exists some cyclical reduction in nominal demand sufficient to motivate rational temporary production cuts and worker layoffs.

Sticky wages. Instead of layoffs, why wouldn't management organize a nominal wage cut? In workplace equilibrium, large, specialized firms eschew nominal wage changes in response to stationary demand shocks, believing that the costs of such a flexible compensation policy exceed its benefits. That response contrasts with economic theorists' standard treatment of the intertwined phenomena of sticky wages and involuntary job loss, exemplified by the late Herschel Grossman's (1983, p.343) already familiar (from Chapter 1) restatement of the Barro critique: "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."

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[26] Later in the analysis, stabilization-relevant temporary job loss (i.e., involuntary layoffs) will be associated with the interaction of the MWR Channel and high-frequency stationary demand disturbances. See Chapters 5 and 10.

[27] It is analytically convenient to normalize the stationary job-loss relationship around $\Pi_j=0$.

[28] See equation 3.2 above. Keynesian aggregate demand is integrated with generalized-exchange modeling in Chapter 5. Note that assuming all involuntary job loss in recession results from temporary layoffs is, of course, not realistic. Management with unfavorable expectations of an establishment's nonstationary profits, creating a longer-term capacity problem, can rationally schedule permanent job destruction to correspond with the need to reduce production in the aftermath of an adverse stationary shock to nominal spending.

A critical characteristic of the Barro critique is that it holds for market, but not workplace, equilibriums. Theorists who restrict their attention to market exchange must ignore the sharp increase in firm costs associated with recalibrating established $\mathbb{K}_j$. Recall that the previous chapter demonstrated recalibration to be required to implement a rational wage cut. In part, the extraordinary costs result from the unexpected nature of recessions and their relatively short duration. In an environment where most employees will not be laid-off, management attempting to fine-tune labor-pricing is provided insufficient time to organize worker acceptance of the compensation change.

Moreover, as noted in Chapter Two, the establishment's internal compensation structure that is consistent with its nonconvex wage condition associates adverse-selection costs with across-the-board wage cuts in response to cyclical reductions in nominal demand. In the aftermath of such pay cuts, inherent interpersonal rent variations in static wage structures implies the most cost-efficient employees are the first to be lost to other firms, adding to the relative attractiveness of using layoffs to cut labor-costs in recession.

Most significantly, GWET implies that job loss will be allocated by a well-understood equity-based rule, almost always seniority; random job loss is not used. It follows that, to preserve Pareto optimality, a wage cut sufficient to maintain employment must be supported by low-tenure workers accepting that they face imminent layoff and agreeing to subsidize the remaining workforce to prevent reduction in their pay. In workplace equilibrium, temporary-redistribution compensation policies are inconsistent with optimization by employees and their employer, for at least three reasons. (a) The fractured wage structure, along with the arbitrary determination of its duration, engenders workplace discontent, damaging productivity.[29] (b) Longer-tenured workers are interested in career earnings and are rationally reluctant to accept, even with compensation, stationary wage flexibility.[30] (c) Temporary-redistribution wage cuts are rarely feasible.[31]

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[29] See Chapter 2.

[30] Rational 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 rents. Large-establishment employers rationally pay more than market opportunity costs because they believe their employees are inherently 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 wage rents. A significant component of

To reiterate, the fundamental restriction on fine-tuning wages in response to $\acute{\omega}_j{}^V > 0$ is management's belief that labor-price reductions must be accompanied, in order to avoid increasing unit costs, by $\mathbb{K}_j$ recalibration. Stationary demand shocks, by their nature, are unanticipated and temporary, while optimal $\mathbb{K}_j$ recalibrations are inherently time-intensive, focused on nonstationary earnings, and complicated by worker priors on their likely incidence of temporary job loss and their reservation wages. A noteworthy implication of continuous workplace-equilibrium analysis is that $\acute{\omega}_j{}^T > 0$ (not $\acute{\omega}_j{}^V > 0$) is a necessary condition for rational labor-price reductions in LEV firms. Large profit-seeking establishments respond to adverse high-frequency nominal-demand shocks with an equity-based program of layoffs, avoiding wage cuts. Management knows that labor-price reductions, absent employee acceptance, are more costly than temporary job reductions. Formal workplace modeling has made that familiar, real-world response consistent with optimizing continuous economic equilibrium.

Workers' perspective. Temporary reductions in employment are the familiar firm response to adverse nominal-demand shocks. Rational contractions in production capacity are motivated by adverse movement in profits, expected to be temporary, and the rational choice to manage unit labor costs through recessions with cuts in labor quantities rather than in labor prices. From the job losers' perspective, however, temporary employment reductions must be further separated into two classes: layoffs with and without recall.

If firm-specific human capital is sufficient to justify targeted rehiring costs, including the typically higher compensation of more experienced employees relative to new hires, the rational

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workers' $\mathbb{K}_j$ fine-tuning costs (included in Γ_a) is convincing management that, having temporarily abandoned the equity benchmark, employees are still sufficiently resolute in their attachment to W^n_j that continuing to violate the pre-recession reference standard in the subsequent cyclical rebound would spontaneously result in higher unit costs. Workers understand that accepting a wage cut (with unchanged OJB) to avoid layoffs 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.

[31] 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. (The true wage reduction in recession would likely be much larger.) No income reduction for the 70% of the workforce with more seniority implies the remaining 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 unemployment benefits as well as employment in the market-wage venue), would almost always violate reservation wages.

firm will endow laid-off workers with recall rights, i.e., first right to their previous job when production rebounds in cyclical recovery. The establishment therefore critically maintains its capacity to staff up quickly, with little loss of human capital, when nominal demand recovers.

Note that recalls make temporary employment contractions compatible with the existence of substantial firm-specific human capital and that wage rents make recalls effective. Indeed, both phases of the familiar response to adverse nominal-demand shocks (i.e., sequential layoffs and recall) are motivated by wage market-rigidities, which have been shown to be a condition of workplace equilibrium. Recall rights permit jobless workers to join firm-specific hiring queues, and the wage premium implies that most laid-off workers will accept rehiring during the subsequent recovery in nominal demand. Indeed, if laid-off workers believe their unemployment to be sufficiently short-term, they likely never join the labor-market queue; and, if they do, their reservation wages will be linked to their previous compensation.

Stationary wage-rent dynamics does not always produce layoffs 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, an adverse shock in total nominal spending generates a temporary contraction of employment for the firm while producing permanent job loss for laid-off workers.

Unlike their laid-off counterparts who are endowed with recall rights and therefore become part of a firm-specific hiring queue, workers who permanently lose their high-wage jobs must join the labor-market queue (or drop out of the labor force) and encounter the ongoing rationing of high-rent employment. Laid-off workers absent recall rights have substantially higher probability of eventually accepting a job that pays significantly less than their previous wage. Moreover, they tend to experience longer unemployment. Relatively high reservation wages are characteristic of workers who have recently experienced the permanent loss of high-wage jobs and for whom job search is needed to help them size the wage rents received in their former employment and better understand their true market opportunity costs. (For more on the nature of unemployment in a two-venue economy, see Chapter 5.)

The intuitive story. TVGE theory predicts that LEV wage cuts resulting from cyclical downturns must be rare. Indeed, the appearance of such cuts typically results from the recession being superimposed on nonstationary job destruction ($\acute\omega^{T}_{j}$). Implementing temporary labor-price reductions is too costly whenever unbundled worker behavior is interposed between the labor market and firm wage policymaking. Stationary labor flows into and out of unemployment are then motivated by large swings in forced job loss. Meanwhile, labor compensation is much more frequently cut in the small-firm venue, where effective monitoring prevents the establishment of workplace reference standards (W_k=sup $\mathbb{K}_k=W^{a}_{k}=W^{m}$); and active employee management of work-leisure choice creates large labor flows into and out unemployment that are independent of involuntary job loss.

The stationary involuntary job-loss story (($\acute\omega^{V}_{j}$(t)$\mid \Pi_j$(t)<0)>0) is broadly accepted by practitioners. LEV management knows that temporary wage cuts are rarely effective in reducing unit costs. As a result, large, profit-seeking firms instead use temporary layoffs to respond to adverse, high-frequency demand shocks. (See Chapter 6.) Workplace modeling has made that familiar response consistent with continuous general equilibrium, ratifying the intuition of Modigliani and other Early Keynesian theorists who identified wage rigidity as the most critical disconnect between real-world economic behavior and Walrasian market-centric modeling.

Taking Stock

The critical components of optimizing workplace exchange are now in place. Much has been accomplished. A continuous (decision-rule) equilibrium timepath of employment that is consistent with cyclical and trend market failure has been derived from axiomatic model primitives. Once aggregated in Chapter 5, meaningful wage rigidity induces, relative to worker preferences, insufficient good jobs and weekly hours on those jobs, causing widespread employee dissatisfaction. Chronic rationing, an inherent characteristic of generalized-exchange labor pricing and use, limits the proper use of neoclassical labor-input supply to SEV firms, substituting Workplace Exchange Relations (WER) to govern labor-input supply in the LEV sector. In the stabilization payoff, the MWR Channel uniquely translates adverse nominal

disturbances at stationary and nonstationary frequencies into involuntary job loss, generating meta-externalities that justify the discretionary management of aggregate demand. Those outcomes are familiar, consequential characteristics of modern, specialized economies. No coherent SVGE model comes close to producing a set of results so compatible with important evidence. Coherent stabilization-relevant macroeconomics is not possible absent continuous-equilibrium MWR.

In another important feature, workplace equilibrium is inherently structural, axiomatically rooted in employee preferences and firm technological constraints. Over the business cycle, rational behavior that suppresses wage recontracting is transparently independent of changes in stabilization policy. Beyond stationary demand fluctuations, rational wage recontracting occurs in well-defined circumstances. In particular, costly, asymmetric workplace information, routinized jobs, and moral hazard restrict the nonstationary environment capable of inducing reference-standard recalibration to actual job downsizing, with expectations of stabilization-policy changes playing no significant role.[32] In specialized economies, $\mathbb{K}_j$ recalibration and nominal wage givebacks necessarily respond with long lags to product-market conditions, weakening the Lucas critique of tractable macroeconometric models.

II. FACTOR INCOME AND ITS DISTRIBUTION

Factor-income distribution has fallen out of fashion among modern macro theorists. Few provide interesting roles for input shares. Indeed, given that consensus SVGE modeling is populated by a representative household that both provides labor services to and wholly owns the representative firm, the labor-capital division of establishment revenue has little consequence. Perhaps most crucially, inadequate analysis of revenue distribution arbitrarily restricts the role of pure profit in coherent mainstream modeling of business cycles and economic growth, deeply damaging its stabilization relevancy.

Marginalizing factor shares (pun intended) was not always the case. Ricardo's central economic problem was the rent-seeking contest among the owners of labor hours, capital, and land. In a

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[32] More precisely, employee expectations are rationally motivated by extrapolating permanent job loss.

more recent example, Hicks (1965, pp.145-146) assigned a key aggregate-demand role to profit macrodynamics: "As soon as we make a distinction between factor shares … the question must arise: will not the saving-income proportion be affected by income distribution? It may be affected in a 'classical' manner – that a lower rate of profit makes people less willing to save; in a Growth Equilibrium … that is by no means to be ruled out. But it is quite sufficient (as Kaldor has taught us) to induce a *direct* effect of income distribution on saving. We may call it 'a different propensity to save out of profits and out of wages'." [33]

Inspired by Jensen's (2000) residual-claim modeling as well as, more distantly, the attention paid by Ricardo and Sraffa to economic surplus, generalized exchange motivates a powerful alternative to the reductive SVGE treatment of factor-income distribution. TVGE analytics mandate close attention be paid to production in the division of firm revenue, rationally accommodating factor rents and indivisibilities, pure profit, sunk capital, increasing returns, and a more general solution to the adding-up problem.

Mainstream Problems

Wicksell (1893) and Wicksteed (1894) independently provided marginalist modeling of factor-income distribution that, combined with single-venue competitive-market exchange, famously solves the adding-up problem.[34] While their elegant model still endures in textbooks, formidable problems combine to force its rejection as an adequate description of modern economies.

First, large-scale production, broadly characteristic after the Second Industrial Revolution, damages the analytic integrity of marginal productivities for both labor hours ($\delta X_j/\delta H_j$) and capital stock ($\delta X_j/\delta \mathcal{K}_j$), depriving Wicksell-Wicksteed of its most critical microfoundations. Generalized exchange rationally imposes $H_j = E_j/\acute{Z}_j$ on labor services, while large-establishment

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[33] See also Goodwin (1967) on the interaction of factor income distribution and economic growth.

[34] A good deal of the fame resulted from the ethical overtones of the solution. From John Bates Clark (1899, pp.1-3), perhaps the most effective promulgator of neoclassical distribution theory: "It is the purpose of this work to show that the distribution of the income of society is controlled by a natural law, and that this law, if it worked without friction, would give to every agent of production the amount of wealth which that agent creates…. To each agent a distinguishable share in production, and to each a corresponding reward – such is the natural law of distribution."

BOX 3.1: ACKNOWLEDGING MALTHUS

Thomas Malthus, a contemporary of Ricardo, was another important precursor of Jensen's residual-rent theory. (See above.) He notably used his income-distribution model in a prescient analysis of periodic unemployment. Writing prior to the Second Industrial Revolution, Malthus did not anticipate unemployment persistence rooted in the wage-price rigidity that came to characterize the more specialized, large-firm bureaucratic economies that were being organized a generation or two later. Instead, Malthus rooted labor dislocation in the interaction of financial crises (associated with contracting nominal demand) and the inherent time requirements of production, the macro-problem class that later inspired Friedrich Hayek's Prices and Production (1931). Malthus recognized that his joblessness would be relatively quickly eliminated by falling wages.

From Lawrence White (2012, p.141): "Malthus was trying to explain the unemployment and depression in Britain that followed the inflationary years of the Napoleonic wars. Malthus began with an accounting identity that the value of output = the value of total factor payments = wages + rents + profits. Here 'rents' were payments to landowners, while 'profits' included both returns to the use of capital equipment and residual returns to capitalist-entrepreneurs. He worried that even if workers spend all their wages, and capitalists reinvest all their profits, landowners may not spend all their rents (which, according to classical theory, were destined to grow ever larger with rising population density). Underconsumption due to underspending of rents would result in an excess supply or 'general glut' of produced commodities. Not all output could be sold at cost-recovering prices [leading to losses and, if sufficiently severe, debt default, bankruptcy, and widespread firm dissolution]. Malthus thought it obvious that general gluts could be observed in the short-run, even if market forces eventually eliminate them….

"Keynes [1935, pp.230-4] thought that Malthus made 'powerful and unanswerable attacks on the great Ricardo,' and saluted his 'brilliant intuitions' regarding the 'insufficiency of effective demand.' But he noted in reference to the Malthus-Ricardo debate: 'For, since Malthus was unable to explain clearly (apart from an appeal to the facts of common observation) how or why effective demand could be deficient or excessive, he failed to provide an alternative construction; and Ricardo conquered England as completely as the Holy Inquisition conquered Spain.'" There is an interesting symmetry in the more recent Keynes and Keynesian inability to explain clearly (apart from appealing to common observation) how or why wages are sufficiently inflexible to support involuntary job loss. That 20th-century failure helped to pave the way for an inquisition-lite banishment of much of Early Keynesian thinking from the modern mainstream.

capital stock ($\mathcal{K}_j$) is both insufficiently divisible and excessively firm-specific to support Euler-theorem distribution. Indivisibility implies that capital cannot be incrementally withdrawn in response to reductions in output, as illustrated by the absence of small-lot capital-stock

liquidations in cyclical downturns. What is instead marginally withdrawn, with a cut in production, is some utilization of capital services (K_j) that are made available by the existing capital stock.

Capital services, distinct from capital stock, were introduced into the LEV technology space in the previous chapter.[35] Recall that potential production (X_j^P) is described by a capacity function ($X_j^P = f(K_j)$); X_j^P is increasing in physical capital K_j, providing an upper bound on output ($X_j(t) \leq X_j^P(t)$). Capital services (K_j), the measurement of which requires no knowledge of the contemporaneous interest rate, flow from the capital stock (such that $K_j^P(t) = f(K_j(t))$, $\Delta K_j^P / \Delta K_j > 0$, and $K_j(t) \leq K_j^P(t)$) and have been, for analytic convenience, posited to be used in fixed proportion to cooperative labor services (E_j).[36] Physical-capital indivisibilities/specificities in combination with optimizing workplace exchange are accommodated in the generalized-exchange specification of the large-establishment production function and consequent factor-income distribution:

$$(3.9) \qquad X_j(t) = f(E_j(t), K_j(t));$$
$$P_j(t)X_j(t) = W^n_j H_j(t) + \check{r}^m(t) K^r_j(t) + \Pi_j(t),$$

such that $E_j(t) = \acute{Z}_j(t) H_j(t)$ and $K_j(t) \leq K_j^P(t) = f(K_j(t))$, while W^n denotes the efficiency wage, $\check{r}^m$ is the market interest rate, Π is pure profit. Recall that K^r is the capital stock net of its sunk component ($K^r = K - K^S$), making the term ($\check{r}^m(t) K^r(t)$) the market opportunity cost of the firm's physical capital. Generalized-exchange modeling has established that, in large-scale production, neither labor hours nor capital services can be efficiently priced in the marketplace, breaking down the market mechanism that eliminates pure profit. Π_j is the residual claim by owners of sunk capital on revenue after deducting production-related outlays. It can be greater than, less

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[35] The dearth of capital-stock liquidation in cyclical recession provides an instructive contrast to the ubiquity of worker layoffs. The venerable indivisibility thesis, identifying broad circumstances in which $\delta X_j / \delta K_j$ does not exist, is easily accommodated in TVGE modeling. Deficient divisibility of physical capital limits its substitutability for labor services (E_j). Perfect substitution implies constant returns to scale, while indivisibilities are a wellspring for increasing returns to scale.

[36] Note that X_j^P could be alternatively defined for each available combination of the two inputs (cooperative labor hours (E_j) and firm physical capital (K_j)), described by the capacity function ($X_j^P = f(E_j, K_j)$) with X_j^P increasing in scalable combinations of E_j and K_j. In continuous WMS equilibrium, however, the optimization condition $W_j = W^n_j > W^m$ implies a horizontal labor-supply curve for LEV firms, making E_j a superfluous argument in the capacity function.

than, or equal to zero, providing critical signals for the rational management of production capacity.

BOX 3.2: NEOCLASSICAL FACTOR INCOME DISTRIBUTION

Wicksell and Wicksteed were among the great 19th-century theorists who pioneered marginal analysis, transforming how economics is done. The focus on individual optimizing exchange organized by general market equilibrium effectively crowded out the longstanding classical emphasis, accepted since Ricardo, on distributive shares. The Wicksell-Wicksteed elucidation of factor-income distribution within the SVGE framework apparently exhausted what neoclassical theorists had to say on the topic; and the simple Euler-theorem treatment endures in textbooks today. Factor inputs are paid their marginal-product values, a practice that is easily shown to exhaust total first-degree homogeneous production. The model is viewed by many as the apogee of SVGE welfare analysis, providing ethical justification for the market distribution of income. Its practical import, however, has always been limited by a set of fundamental problems.

After Walras and the marginalist revolution, mainstream macro models have been constructed within the SVGE framework. In the modern version cobbled together by New Classical, RBC and New Keynesian theorists, a representative household solves an intertemporal expected-utility maximization problem in the context of competitive markets, rational expectations, and arbitrary restrictions on the scope of optimizing exchange and the nature of technology. Pioneered by Wicksell-Wicksteed, the two-factor Euler equation (constrained to be first-degree homogeneous and subject to competitive-market pricing) has long been at the core of SVGE thinking:

$$X = f(H, Ҝ) = H(\delta X/\delta H) + Ҝ(\delta X/\delta Ҝ);$$

$$PX = PH(\delta X/\delta H) + PҜ(\delta X/\delta Ҝ) = W^m H + P_Ҝ Ҝ,$$

where $P_Ҝ$ denotes the market price of physical capital $Ҝ$. In the famous model, inputs are compensated commensurate with their marginal productivities, exhausting total revenue. The neoclassical distribution theory links the technology space and optimizing marketplace exchange and has played a central role in consensus modeling for more than a century.

It is disturbing that problems have been identified, and largely ignored, that are debilitating to the theory's capacity to describe modern economies. Four are most notable here. First, large-scale production prevents the coherent use of labor and capital marginal productivities. Second, constant returns to scale are, in many applications, a distorting, unacceptable assumption. Third, positing competitive-market labor pricing is inconsistent with the evidence. Fourth, again contrary to the evidence and distorting in application, the neoclassical model eliminates the existence of pure profit.

Second, even Wicksell acknowledged constant returns to scale to be a deeply problematic SVGE model restriction, especially with respect to growth. Increasing returns obviously exist in practice and are integral to policy-relevant macrodynamic analysis.[37] The first chapter's combination of Chandler's analysis of the Second Industrial Revolution and the sweeping millennial timepath of global living standards points to scale economies as crucial to both the extraordinary mid-19th century acceleration in economic growth and the relocation of much of that growth to new corporate forms. Scholars, aspiring to adequately elucidate the past in order to usefully advise policymakers today, must be able to explain such consequential shifts in trend living standards.

Third, the assumption of competitive-market product pricing in modern economies has been, since marginal analysis first captured mainstream thinking, frequently and thoughtfully criticized. To the degree that pricing power exists, the workhorse neoclassical model of income distribution further breaks down. (See Chapter 6.)

Fourth, the SVGE Euler-equation distribution model eliminates pure profit (Π_j). This most problematic feature of Wicksell-Wicksteed distribution has somehow morphed into an implicit tenet of mainstream thinking. It must be scrapped. In generalized exchange, Π_j is understood as surplus after all necessary production-related outlays, for each input meeting the test of profit- and utility-maximization, are deducted from firm revenues. Pure profit does not motivate the participation of any input required in the production process. In SVGE modeling with constant returns to scale, rational factor payments equilibrate marginal productivities and opportunity costs, exhausting the total product and eliminating residual claims. In TVGE modeling, enriched by workplace exchange in combination with a more intuitive treatment of the capital stock and its utilization, nonzero pure profit exists and plays a crucial macrodynamic role.[38]

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[37] In SVGE modeling, however, increasing returns to scale imply that total production is insufficient to pay all inputs the value of their marginal productivities. Production cannot exist if any necessary input is paid less than its opportunity cost, making scale economies inconsistent with market competition. In TVGE modeling, by contrast, Keynes's first, but not his second, classical postulate holds for large, specialized firms. The labor-employment decision is consistent with textbook neoclassical thinking, but the equilibrium labor price (W^n_j) implies a horizontal labor-supply curve for LEV establishments, enabling the existence of scale economies. TVGE limits on the monopolizing potential of increasing returns to scale include their intuitive confinement to a limited range of the capacity function ($X_j^P = f(K_j)$) and the omnipresent hold-up problem (H). See below.

[38] The existence of sunk capital implies the existence of pure profit. Residual rent neither disappears in the long-run nor reflects the market opportunity cost of some hidden input.

Pure profit will be shown to motivate the rational management of stationary and nonstationary productive capability. Those two classes of decision-making are critical to understanding how the timepath of employment is influenced by involuntary layoffs and job downsizing as well as capital accumulation (with its associated worker hiring) and inter-venue labor transfer. Noteworthy here, Chapter 6 assigns pure profit the most significant role in the formation of expectations ($\Pi^{\acute{}}$) required to induce firms to invest in new capital goods (ΔK).[39]

Taken together, the four production-related problems damage, beyond repair, the stabilization-relevancy of SVGE distribution theory. The issues are longstanding, having received over the years attention from a number of economic theorists. Perhaps most notably, Piero Sraffa (1926, 1960) concluded from his decomposability and increasing-returns criticisms of neoclassical theory that model coherence requires returning to the Ricardian emphasis on economic surplus, which for our purposes is functionally equivalent to pure profit. Meanwhile, Joan Robinson initiated the famous Cambridge capital controversy by demonstrating that K is ill-identified in aggregate production specifications. The prolific Robinson additionally joined Edward Chamberlin in modeling imperfect competition, which in the coherent SVGE framework problematically generates pricing power.[40] It is good news that TVGE production and factor-income modeling, anchored by nonmarket LEV labor pricing and explicitly recognizing capital indivisibilities/specificities, generates and efficiently distributes economic surpluses, replacing

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[39] The absence of Π_j, once an important concept in classical modeling, has always been one of the more troubling features of coherent, continuous-equilibrium market-centric theory. The analytic nonexistence is made particularly embarrassing by the omnipresent existence of pure profit in real-world economies, as indicated by the high incidence of adverse net-income episodes that do not trigger the voluntary separation of any factors of production from the affected firm. Marshall dealt with the practical ubiquity of Π_j by confining its analytic banishment to the theoretical long-run. His simple time-separation dodge is not available to modern SVGE theorists, who properly insist that cyclical and growth analyses be done within the same coherent model class. While the profit literature investigates income claims from organizational leadership, effective risk taking, product development, managing technical innovation, and so on, the varieties of human capital embodying those abilities have opportunity costs that must be excluded, along with any other input that is paid its opportunity cost, from Π.

[40] See Chapter 6. Sraffa, Robinson, Chamberlin, *et al.* were never incorporated into mainstream macro thinking. Textbook distribution modeling still requires first-degree homogeneous production, typically reinforced with Cobb-Douglas restrictions. The resulting constancy in returns to scale and factor shares, not to mention the incoherent treatment of capital, suppresses much that is interesting about production and diverts attention to marketplace behavior. New Keynesians, in their efforts to introduce (with one eye on the Barro critique) market-price stickiness into the mainstream model, have introduced frictions that implicitly modify the Euler results; but their modifications fall well short of a significant challenge to the deeply restrictive SVGE technological environment.

the restrictive Wicksell-Wicksteed Euler equation and accommodating, at least in part, Sraffa's and Robinson's critiques.

Recapping TVGE Income Distribution Innovations

TVGE theory broadly enriches the technology space in coherent macro thinking. Recall that, in the large-establishment venue, production capacity is determined by the firm's capital stock $(X^{P}_{j}=f(K_{j}))$, such that $f(K_{j})$ accommodates variable returns to scale. Meanwhile, actual production $(X_{j}=f(E_{j},K_{j}))$ is subject to $E_{j}=\acute{Z}_{j}H_{j}$ and $K_{j}\leq K_{j}^{P}=f(K_{j})$. Establishment revenues are distributed by a Jenson (2000) class economic-surplus model introduced above. Expected real discounted residual rents have also been defined: $\Pi_{j}(0)=E_{oj}\sum(1+\acute{r}(t)+p(t))^{-t}\Pi_{j}(t))$, where E_{oj} denotes expectations based on the information available to management at the beginning of the current period $(t=0)$; $\acute{r}$ and p are, respectively, the discount and general inflation rates; and the series are summed from $t=0$ to $t=\eta$, the expected life of the capital investment. In large establishments, pure profits (Π_{j}) are claimed by owners of sunk capital $(K^{S}_{j}=K_{j}-K^{r}_{j})$. In the practitioner-recognizable technological environment that has been assembled, the exhaustion of total product is assured by the residual nature of LEV pure profit.

Reconstructed factor-income distribution provides a platform for powerful TVGE innovations. Most critically, rational workplace behavior requires large, specialized establishments to pay efficiency wages (W^{n}_{j}), instead of worker opportunity costs (W^{m}). The resulting MWR Channel interacts with stationary and nonstationary demand shifts to induce same-direction movements in pure profit, jobs, and output. Moreover, TVGE capital pricing and use have been enriched relative to its SVGE counterpart by powerful indivisibilities and specificities.

Generalized-exchange capital investment is critically influenced by q_{j}, defined previously as the ratio of expected discounted pure profit (Π_{j}) to sunk capital (K^{S}_{j}).[41] By definition, expected capital productivity is embedded in $q_{j}(0)$. Meanwhile, the firm's financing (market-opportunity)

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[41] Technology is unchanged. Chapter 6 usefully refocuses investment decisions on expected pure profits (Π_{J}) relative to investor-required returns (Π_{J}^{i}), providing more general motivation for capital-expansion and the timepath of LEV employment.

cost of the existing capital stock is $\check{r}^m(t)\mathcal{K}^\tau_j(t)$, which also calibrates sunk capital ($\mathcal{K}^S_j=\mathcal{K}_j-\mathcal{K}^\tau_j$); and the utilization of existing capital is measured by $\Im(t)=\mathcal{K}_j(t)/\mathcal{K}^P_j(t)$. The rational input of capital services and labor hours adjusts to scheduled production, which in the TVGE model class is increasing in nominal demand ($Y_j(t)$). (For elaboration, see Chapter 6.)

The distribution model has identified two interrelated classes of market rents that motivate management's production capability and capacity decisions: *wage rents* (G_j^V,G_j^T) and *sunk capital rents* (Π_j^V,Π_j^T), both operating at high- and low-frequencies. If $\Delta P_j/\Delta G_j<1$, then $\Delta\Pi_j/\Delta G_j<0$. Imperfect labor oversight and sunk capital, both characteristic of large-scale production, generate a powerful version of the hold-up problem that was outlined in the previous section. To briefly elaborate, hold-up (H) complications influence *ex ante* and *ex post* pure profits resulting from acquisition of capital goods, with implications for investment decisions, equity versus debt financing, market valuations of equity, mergers and acquisitions, bankruptcy incidence, and more. (See Chapters 6 and 8.) Hold-up must be accommodated in policy-relevant macro, labor, and organization modeling. Increasing returns are also influential in TVGE macroeconomics, helping to explain millennial nonstationary economic growth and informing employee reference standard ($\mathbb{K}_j$) dynamics. Increasing returns and hold-up problems have been shown to fund substantial $\mathbb{K}_j$ durability.

More on capital indivisibilities. The TVGE model class can be constructed absent capital-stock indivisibilities – a substantial abridgement that has relatively little effect on its essential macrodynamic properties. Capital stock that is posited to be sufficiently divisible to support $\delta X_j/\delta\mathcal{K}_j$ and competitive market product-pricing produces considerable analytical convenience without much damage to the stabilization-relevant description of modern economies. In particular, accepting the more stylized conditions substantially simplifies the grand integration of workplace and (textbook) marketplace exchange.[42]

The only indispensable capital-modeling innovation in compact generalized-exchange theory is some degree of $\mathcal{K}$ firm-specificity. After purchase, the resale value of the investment ($\Delta\mathcal{K}_j$) drops

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[42] Throughout the remainder of the analysis, the compact TVGE model will suppress capital indivisibilities.

below its original cost. Introducing sunk capital to generalized-exchange modeling provides the necessary and proper claimant for pure profits in total-revenue distribution. In the justly famous Austrian capital theory, Menger, Böhm-Bawerk, and Mises each emphasized that capital goods used in production processes are subject to substantial specificity.

BOX 3.3: INCREASING RETURNS AND IMPERFECT COMPETITION

Modern growth theorists recognize that "the presence of increasing returns requires the introduction of imperfection competition". (Jones (2002), p.161)

Paul Romer's (1990) multi-sector modeling has helped lead the way in the formal analysis of macrodynamic pricing power:
- His "final-goods sector" is comprised of numerous perfectly competitive firms that produce homogeneous consumption goods.
- His "intermediate-goods sector" is comprised of monopolists who produce heterogeneous capital goods sold to the final-goods sector.

Monopoly power results from purchasing various patent-protected designs of capital goods from a third (research) sector.

An methodological message from Romer and other endogenous-growth theorists is that the partitioning of firms into multiple, fundamentally heterogeneous venues of exchange can confine increasing returns to scale sufficiently to enable a workable solution to the adding-up problem. In that context, it is notable that TVGE partitioning, originally constructed a decade before Romer as a synthesis of workplace and marketplace exchange in Annable (1980, 1984), is both less arbitrary and more powerful. The two-venue general-equilibrium theory accommodates the textbook treatment of scale economies, typically induced by input indivisibilities/specialization, as well as the nonrivalrous ideas that occupy Romer. In a related difference, TVGE product pricing, influenced by firm scale and labor rents, is more general than pricing power motivated by patent-protection. (See Chapter 6.) Workplace-marketplace modeling is additionally more tractable, having no critical need to kept track of multiple classes of capital.

More important than those differences, however, only TVGE modeling can rationally suppress wage recontracting. None of the alternatives in modern growth analysis accommodates policy-relevant MWR and involuntary job loss, including both stationary layoffs and nonstationary job downsizing. Generalized exchange motivates the most comprehensive macro theory, to which the economics of ideas (itself an important, albeit a relatively modest, idea) can be usefully attached.

III. NONSTATIONARY PRODUCTIVITY MACRODYNAMICS

Generalized rational exchange, with its chronic continuous-equilibrium wage rents, enhances the capacity to model nonstationary labor-productivity growth.[43] Productivity is the wellspring of rising living standards; indeed, its remarkable acceleration in the nineteenth century is the Great Fact featured in the first chapter. Despite being a longstanding focus of formal growth theory, the global trajectory of output per capita over the past two centuries is inadequately explained within the consensus SVGE framework.

In constructing a more robust model, it is particularly helpful that TVGE macrodynamics are compatible with the iconic two-sector growth process modeled more than a half century ago by Sir Arthur Lewis. Once provided workplace microfoundations, the Lewis analysis provides a formal theory that accommodates recognizable cyclical and trend behavior in employment and output.[44] The two-venue model is powerful, uniquely tracking the progression of economic activity from the subsistence productivity of primitive agriculture to the greatly improved living standards produced on a broad scale by large, specialized firms in modern economies.

Prior to introducing meaningful wage rigidities into growth modeling, consideration of measured labor productivity (X/H) in the TVGE analysis will prove useful.[45] By definition:

$$(3.10) \qquad X(t)/H(t) = (E(t)/H(t))(X(t)/E(t)) = \acute{Z}(t)(X(t)/E(t)).$$

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[43] From Woodford (2009, p.267): "… it is now accepted that one should know how to render one's growth model and one's business-cycle model consistent with one another, in principle, on those occasions when it is necessary to make such connections. Similarly, microeconomic and macroeconomic analysis are no longer considered to involve fundamentally different principles, so that it should be possible to reconcile one's views about household or firm behavior, or one's view of the functioning of individual markets, with one's model of the aggregate economy, when one needs to do so. In this respect, the methodological stance of the New Classical school and the real business cycle theorists has become mainstream."

[44] If the neoclassical growth model is the parent of modern SVGE macro theory, Lewis' two-sector growth model is the parent of generalized exchange TVGE macroeconomics.

[45] It is convenient, at this point in the analysis, to simplify the fundamental transformation equation from Chapter 2: $E_j = E^Q_j(t)$. Moreover, throughout this section, aggregation is simply assumed. The subject is considered in more depth in Chapter 5.

The workplace transformation of labor hours (H) into cooperative input (E), a fundamental economic activity set greatly complicated by the Second Industrial Revolution, implies that measured labor productivity has two distinct components:

- The *behavioral efficiency of labor* ($\acute{Z}$) is an endogenous outcome of rational LEV workplace exchange, simultaneously determined with the wage paid in the optimizing Workplace Exchange Relation (WER). The $\acute{Z}$ productivity class has been shown to be influenced by axiomatic preferences, the structure of workplace information, the nature of jobs, and $\mathbb{K}_j$ durability.[46] It is the continuous-equilibrium wellspring of meaningful wage rigidities, involuntary job loss, and powerful meta-externalities in specialized economies. In contrast to the central importance assigned to $\acute{Z}$ by practitioners, it must be insignificant in coherent SVGE macroeconomics.

- The *technical efficiency of labor (X/E)* is exogenous to LEV worker decision-rule optimization and is, instead, rooted in capital intensity, factor specialization, returns to scale, and technical change. Those determinants are familiar from the broad economic growth literature that began accumulating before Adam Smith.[47]

Lewis Two-Sector Growth Model

Lewis's two-sector growth theory (1954, 1958) quickly became the benchmark analysis of the economic transformation of subsistence economies. Awarded an early (1979) Nobel Prize, the model has a substantial lineage, having been formalized, extended, or applied by Ranis and Fei (1961, 1964), Jorgenson (1967), Harris and Todaro (1970), Stiglitz (1974, 1987, 1991), Annable (1971, 1972), Fields (1975), and many others.

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[46] Labor hoarding, a familiar cyclical phenomenon, is uniquely accommodated by the behavioral efficiency of labor, resulting from the rational adaptation of OJB to rationed available work.

[47] They were reasonably held constant in the previous chapter's modeling of stationary fluctuations of employment. Less empirically important worker-exogenous influences include pre-Hawthorne factors such as rest pauses.

From the perspective of modern macroeconomics, the Lewis model is understood as a prominent early version of economic-venue analysis.[48] It will prove useful here to formally restate his descriptive analysis. The restatement is simplified by assuming venue-specific-job and labor homogeneity.[49] While there is no explicit assumption of labor homogeneity in the famous 1954 paper, Lewis made clear, in his 1979 revisit to his model, that is what he intended. Additionally, workers cannot borrow or save. Each of the two sets of homogeneous production functions is defined for a given state of technical knowledge. Output is increasing in both worker cooperative input (E) and capital; no resources imply no production. Equilibrium is understood in the modern sense of a rest period in the space of optimizing decision rules.

Lewis venues. Lewis used two-sector technical heterogeneity to motivate separate labor-pricing processes. Rational behavior in each venue is governed by discrete decision rules, constraints, and mechanisms of exchange. His heterogeneities mirror those featured in the more general TVGE macro model class, both preventing meaningful aggregation. Gustav Ranis aptly named Lewis's restricted aggregation "organizational dualism".

Lewis's descriptive macrodynamics identify the low-productivity venue as subsistence agriculture and its high-productivity counterpart as an industrial enclave. The former is characterized by small "establishments", primitive production techniques, and the absence of input specificities, all tractably captured by positing both near-subsistence productivity ($b^\$$) and the absence of saving and capital accumulation. Low-productivity farming produces total real output $X_\c{S}$:

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[48] Reviving the Lewis model and integrating it with modern generalized-exchange macrodynamics enhances formal growth theory by extending its range backwards to its logical starting point, subsistence productivity. Implicit in that starting point, which persisted for almost the entirety of human existence, is a feedback model between finite land and population growth (rooted in a preference to reproduce powerfully supported by natural selection), famously posited by Malthus. Also notable here is Ricardo's iron law of subsistence wages, which accommodates stationary fluctuations. Of the models inspired by Lewis, Stiglitz (1971) is noteworthy in that he provides, focusing on worker health and nutrition, an early indication of the link between the Lewis dynamic venue-heterogeneity analysis and what came to be known as efficiency-wage theory See Debraj Ray (2010) for more on uneven growth as a motivating concept in development economics.

[49] More specifically, labor is posited to be homogeneous until hired and trained in the high-productivity venue, at which point the homogeneity becomes establishment-specific; and sectoral jobs do not vary in their capacity to generate nonpecuniary satisfaction.

(3.11) $X_Ş(t) = Б^Ş H_Ş(t)$,

where $Ş$ stands for the subsistence venue, $Б^Ş$ represents the average productivity of labor (posited by Lewis to be constant), $H_Ş$ denotes sector labor supply, and t is time. Product pricing ($P^Ş$) is assumed to be constant.

Lewis famously posited, in the subsistence sector, that marginal labor productivity is zero and that market institutions are poorly developed.[50] In place of the market, labor compensation and employment are determined by equity-based income-sharing arrangements:

(3.12) $W_Ş(t) = X_Ş(t)/H_Ş(t)$.

$H_Ş$ is exogenously determined by population growth in the subsistence sector. The real subsistence wage ($W_Ş$) varies only as a result of exogenous factors, such as weather and disease. The fundamental economics here, focusing on the dynamic interaction between labor productivity (reflected in living standards) and the strong preference to procreate, were provided by Thomas Malthus (1803) a century and a half prior to the Lewis model.[51]

The high-productivity venue, by contrast, exploits input specialization and scale, generating total real output $X_Ĭ$:

(3.13) $X_Ĭ(t) = Б^Ĭ(t) H_Ĭ(t)$, such that $Б^Ĭ > Б^Ş$,

where $Ĭ$ indicates the industrial venue and $Б^Ĭ$ is the sector's average labor-productivity, which Lewis also assumed to be constant, along with the product price ($P^Ĭ$) and the labor-capital ratio.[52] Reflecting Stiglitz's antecedent work on efficiency wages, it is also assumed here, although not

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[50] Lewis (1954). It is noteworthy that the International Labor Organization and the Economic Commission for Latin America and the Caribbean both define the Lewis low-productivity venue in terms of small establishment size (i.e., five or fewer workers).

[51] An well-known elaboration of the preference for large families identifies children as risky assets that provide parents' old-age security. Either the simple or more elaborate model is consistent with Lewis's analysis and results.

[52] Once activated by high-speed transportation and communications infrastructure as well as adequate total demand, LEV production demonstrates increasing returns, which can be incorporated into dynamic versions of the $Б^Ĭ$-$Б^Ş$ gap. Chandler's large-establishment dynamics, featured in Chapter 1 and below, are especially relevant here. Lewis implicitly assumes nominal demand sufficient to maintain $X_Ĭ(t) = X^P_Ĭ(t)$.

explicitly by Lewis, that labor productivity is sufficiently increasing in nutrition and health, which in turn are increasing in the real wage paid, to motivate the rational payment of constant labor rents, i.e., despite $W^{\breve{I}}>W^S$, $W^{\breve{I}}/\acute{Z}^{\breve{I}}<W^S/\acute{Z}^S$ implying that $\acute{Z}^{\breve{I}}>\acute{Z}^{m}$.[53] Wage rents motivate a rational worker preference for employment in the industrial sector. In addition, pure profits (Π), which were featured earlier in this chapter, are incorporated into growth model and assigned a critical role in Lewis macrodynamics:

$$(3.14) \qquad \Pi_{\breve{I}}(t) = P^{\breve{I}}X_{\breve{I}}(t) - W^{\breve{I}}\Pi_{\breve{I}}(t) - \breve{r}^m(t)\mathcal{K}^r_{\breve{I}}(t).$$

Dynamics.   Within his two-sector framework, Lewis constructed an intuitive macrodynamic model of saving, investment, capital accumulation, and sectoral labor transfer that explains the process of economies breaking out of subsistence.[54] Profits are posited to be the source of all saving, which is wholly invested in capital expansion:

$$(3.15) \qquad \Delta\mathcal{K}_{\breve{I}}(t)=\Pi_{\breve{I}}(t-1), \text{ and}$$
$$\Delta\mathcal{K}_{\breve{I}}(t)/\mathcal{K}_{\breve{I}}(t-1)=\Pi_{\breve{I}}(t-1)/\mathcal{K}_{\breve{I}}(t-1).^{55}$$

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[53] See Stiglitz (1991) and Leibenstein (1957). Recall that $\acute{Z}^{m}$ denotes the level of industrial-enclave labor productivity associated with the (technologically given) level of workplace supervision, such that $\acute{Z}^{\breve{I}}\geq\acute{Z}^{m}$. The health-nutrition explanation is understood to be additive to other reasons for the existence of chronic wage rents.

[54] An interesting case study of Lewis growth featuring labor transfer from subsistence agriculture to higher-productivity factory work is provided in Alfred Marshall's 1984 Bristol lectures that rebuffed Henry George's land-tax panacea. (See Stigler (1969).) Critical to Marshall's case was statistical evidence that in Britain the population share of the "lowest stratum" of the working class (engaged in subsistence agriculture) had declined by half from earlier in the 19th century. Marshall assigned the starring role in the labor-transfer process to newly developing joint-stock corporations, which he believed were nowhere as realized as in America. "Of all social institutions, the business firm was more central, enjoyed a higher status, and did more to shape the American mind and civilization than elsewhere. The company was not only the principal creator of wealth in America but also the most important agent of social change and the biggest magnet for talented individuals." (Nasar (2011), p.89) Marshall and his contemporaries less adequately understood that the transfer out of Lewis's subsistence-labor pool made workers vulnerable to employment fluctuations rooted in fluctuations in aggregate nominal demand. That fundamental problem became apparent, at least to practitioners, in the aftermath of the Second Industrial Revolution.

[55] From Lewis (1954, p. 157): "Practically all saving is done by people who receive profits or rents. Workers' savings are very small. The middle-classes save a little, but in practically every community the savings of the middle-classes out of their salaries are of little consequences for productive investment." The Lewis model implicitly assumes sufficient export demand. Its dynamic equilibrium is familiar from the Cambridge distribution and growth modeling that began in the 1930s and is most closely associated with Keynes, Kalecki, Robinson, Kaldor, and Pasinetti. Assuming that all wage income is consumed, the central Cambridge distributive equation derives a rate of profit *(Π/K)* that equals the capital growth rate (κ) divided by the propensity to save out of capital income (Π). As a result, the profit rate depends only on the expenditure decisions of the owners of capital. (Two

There is no depreciation, and the capital price is constant. It follows that the rate of growth of the homogeneous capital stock equals the rate of return on that capital stock.

The wage premium and (point-of-hire) labor homogeneity imply a horizontal labor supply for industrial establishments. Absorption of workers from subsistence farming is determined, given the constant capital-labor ratio, by the intertemporal path of the capital stock:

(3.16) $\Delta H_i(t)/H_i(t-1) = \Delta \mathcal{K}_i(t)/\mathcal{K}_i(t-1) = \kappa(t) = \Pi_i(t-1)/\mathcal{K}_i(t-1).$

The final source of dynamics in the Lewis model is total labor-force (H_T) growth, assumed to be a positive constant, $\acute{\eta}$:

(3.17) $H_T(t) = (1+\acute{\eta})H_T(t-1).$

An initial condition of Lewis's macrodynamics is that $H_i(0)/H_T(0)$ is near zero. A critical turning point will eventually be reached iff:

(3.18) $\Pi_i(t-1)/\mathcal{K}_i(t-1) > \acute{\eta}$.

The condition motivates Lewis's *turning-point hypothesis*: Once surplus workers have been eliminated in the subsistence sector, market forces and their opportunity costs assert control over all labor pricing as well as the labor-transfer mechanism. Movement to a homogeneous wage-determination process signals the economy's consolidation into a single (market) venue, governed by the law of single price. A fair assessment is that Lewis had little interest in post turning-point macrodynamics, surmising that in such circumstances his two-sector model was no longer useful. But, even at this relatively undeveloped state, the Lewis framework is more insightful, along some important dimensions, than textbook neoclassical economic growth. Lewis critically adds sectoral labor relocation as well as infrastructure and social costs to capital accumulation as necessary elements in the early growth process. His two-venue model is clearly

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noteworthy examples of that literature are Kalecki (1935) and Kaldor (1957).) Lewis macrodynamics are a special case of the Cambridge model in which all profits are saved.

superior in explaining the great European migration to the United States in the aftermath of the Second Industrial Revolution as well as, more recently, the rapid industrial growth in China.

Lewis transfer powerfully contributes to growth modeling.[56] Relocated to the world stage and motivated with reasonable assumptions over the past 150 years, moving labor from subsistence agriculture to industrial jobs produces productivity gains in line with the actual 30-fold global advance recorded in the aftermath of the Second Industrial Revolution. Lewis two-venue dynamics, informed by Alfred Chandler's new corporate forms, easily explain much of the "Great Fact" – the most profound, yet still under-appreciated, episode in all of macroeconomics.[57]

Generalizing the Lewis Model

Lewis explicitly excluded high-income, industrialized economies from his analysis, indicating (from the modern perspective of generalized-exchange modeling) insufficient ambition for his two-sector growth model. Once enriched with optimizing workplace exchange, his labor-transfer approach motivates powerful macrodynamics.

Generalized venues. TVGE tools permit a richer specification of Lewis's large-establishment, high-productivity venue:[58]

$$(3.19) \qquad X_j(t) = Б^T_j(t) \acute{Z}_j(t) H_j(t), \text{ such that}$$
$$\acute{Z}_j(t) = \acute{Z}^n_j(t), \ W_j(t) = W^n_j(t) > W^m(t).$$

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[56] Deaton (2010) interestingly identified three strands in the economic-development literature that focus on mechanisms of growth in low-income countries: (i) the link between saving and capital formation, (ii) determinants of commodity prices, and (iii) the connection between food consumption and income. A more robust list of important development/ growth mechanisms would include Lewis transfer. That mechanism is related to, but still distinct from, the related saving-capital link, a separation partly rooted in widow-cruse dynamics in which productive investment generates gains in production and income and creates its own financing.

[57] Silvia Nasar's (2011) sweeping history of macro thinking usefully focuses on the global escape from subsistence.

[58] Recall that compact WMS analysis posits labor point-of-hire homogeneity and free-market mobility of products and services. Similarly, establishments are homogenous in each of the two venues.

The variable $Б^{\text{T}}_j = X_j(t)/E_j(t)$ denotes the *j*th sector's technical efficiency of labor. Worker productivity rises over time as a result of physical and human capital accumulation as well as scale economies and technological change. Meanwhile, production in the low-productivity, effective-supervision venue is:

$$(3.20) \qquad X_k(t) = Б_k(t)H_k(t), \text{ such that}$$
$$\acute{Z}_k(t) = \acute{Z}^m_k(t), \ W_k(t) = W^m(t),$$

where $Б_k$ denotes average output per worker hour, moving in lockstep with technically-efficient labor productivity (X_k/E_k).[59] The assumption of constant capital and technology in the *k*th venue simplifies the analysis. The sector is also assumed to generate zero savings.

Rational workplace exchange extends the life of LEV wage rigidities beyond Lewis's turning point. Given rationed good jobs, labor supply to the high-productivity venue continues to be elastic. Moreover, generalizing the Lewis model significantly enriches the turning point. Once surplus workers have been eliminated in the subsistence sector, implying the introduction of more robust labor-transfer opportunity costs, robust market forces replace the "underdeveloped market institutions", asserting control over bundled labor pricing in SEV establishments.

Unbundled labor pricing simultaneously persists in LEV firms, making their compensation policies independent of contemporaneous labor-market conditions. Post turning-point economies produce a wage floor in cyclical downturns as well as chronic, time-varying labor rents. A central role is played by nominal demand, which combines with the rational MWR Channel to induce job-loss dynamics consistent with high- and low-frequency episodes of $U > U^N$. Meanwhile, trend aggregate labor-productivity and living-standard advance continues to depend on capital accumulation and labor transfer to the high-productivity venue – determinants that are largely driven by pure-profit expectations.

Harris-Todaro labor-transfer model. John Harris and Michael Todaro (1970) fit unemployment into the Lewis model. Assuming that workers need to be present in urban areas (where industrial

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[59] In the Lewis subsistence phase, $\acute{Z}^m$ is generalized to include informal group standards of acceptable OJB.

jobs are located) in order to be hired, the existence of wage rents imply that there will be more rational job-seekers than successful applicants. Initially assuming that LEV job search is mutually exclusive with holding a SEV job, a simple model captures the relation between the wage structure and the length of unemployment (ϖ) the optimizing worker would be willing to tolerate in order to obtain a specialized-venue job:

$$(3.21) \qquad \sum_{t=0}^{\varpi}(1+ɼ)^{-t}=E_o\sum_{t=0}^{\theta}(1-(1/G^T(t)))\,(1+ɼ)^{-t}.^{60}$$

The Harris-Todaro model can be solved for the continuous-equilibrium unemployment ($\hat{U}^R$) that is consistent with LEV meaningful wage rigidities and rationed jobs. In the TVGE model, $\hat{U}^R$ is increasing in wage rents: $\Delta\hat{U}^R/\Delta G^T>0$. Chapter 6 examines the implications of $\hat{U}^R$ for the natural rate of unemployment (U^N).

If workers can compete effectively for LEV jobs while being employed in the low-wage sector, queue-related unemployment can be partly disguised. Continuing to assume that labor is homogeneous with respect to innate ability, general human capital, and preferences, observed joblessness is then limited to persons who are seeking their first job, who are temporarily between jobs, or whose reservation wages are above the compensation rates paid in the market-price-taking venue.[61] (High reservation wages tend are notably characteristic of victims of job downsizing.) Frustrated preferences of low-wage workers for high-productivity jobs imply that measured unemployment is an incomplete indicator of labor-market efficiency.

Closing thoughts on the Lewis model. In TVGE modeling, the breakout from subsistence productivity to sustained growth in living-standards (the original Lewis problem) requires

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[60] E_o is an expectations operator conditional on information available at *t=0*, $ɼ$ is the discount rate, the variable wage rent consistent with workplace equilibrium is G^T, and expected job tenure in the high-wage venue ends at $\varkappa$. The inter-sectoral labor transfer model assumes that high-rent job search is mutually exclusive with holding a job in the zero-rent venue. From Katz (1986, p.235): "If efficiency wage problems are not important in some sectors, jobs may always be available there. Jobs in the efficiency wage sector will still be rationed and offer a positive utility differential. Equivalent workers are treated differently even if there are always some (typically low-quality) jobs available. Unemployment may result from workers searching and waiting for the better, rationed jobs." Also note that adding search costs and mechanisms by which firms can match job-seekers with job-vacancies transforms the rudimentary model into the modern search theory of unemployment.

[61] Economic theorists have named the replacement of voluntarily separating workers who are moving to more productive employment "churn". Most of the hiring or separation at SEV firms reflects churn rather than expansion or contraction. Lazear and Spletzer (2012), using JOLTS data, found that in the 2007-09 U.S. recession churn decreased by nearly four-fifths.

adequate transportation and communications infrastructure, an economic and political structure that supports both labor mobility and effective market incentives, and reliable, sufficient sources of demand for LEV products. Substantial differences in meeting those requirements have translated into longstanding variation among levels, as well as growth, of per capita output across countries over time, frustrating for an extended period economists' predictions of convergence. Given the difficulty of the requirements, however, substantial, persistent living-standard variation should not have been surprising.

Generalized Lewis transfer, i.e., the two-direction continuous-equilibrium flows of labor between SEV and LEV jobs that rationally mandate a variable unemployment buffer, is a critical contribution to coherent macroeconomics. It is easily demonstrated that, absent Lewis transfer, aggregate modeling of specialized economies cannot be stabilization relevant. By definition, two-venue worker flows cannot be accommodated in the mainstream SVGE model class. [62]

Solow's Neoclassical Growth Model

The basic model. In the compact TVGE analysis, simplifying restrictions confine capital investment to the large-establishment venue, which then becomes the wellspring of rising living standards. Providing the literature's basic explanation for LEV macrodynamics (after Lewis's turning point) is Solow's (1956) neoclassical growth theory.[63] His model broke the mechanical link between saving and growth and was initially made tractable by assuming that the timepaths of the labor force, technical progress, depreciation, and saving are exogenous.

The Lewis model generates nonstationary growth in labor productivity via capital accumulation (i.e., a rising capital-labor ratio ($K(t)/H(t)$)) and the transfer of workers to more productive jobs.

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[62] Despite the inhospitable macro mainstream, Lewis thinking has not completely disappeared from the modern literature. Bénassy's fine New Keynesian intermediate text (2011. p.22) briefly, but notably, outlines the "organizational duality" model at the end of its chapter on growth – unfortunately absent any mention of its lineage.

[63] See also Trevor Swan (1956).

Solow's contribution is the addition of technical change.[64] In its Harrod-neutral formulation, the Solow model is:

(3.22) $X_J(t) = f(\dot{K}_J(t), \dot{A}(t)H_J(t))$,

where $\underset{\circ}{A}$ represents technology or, more generally, the "effectiveness of labor".[65] (In their lowercase versions, the variables represent rates of change.) Assuming constant returns to scale, diminishing returns to factor proportions, and SVGE (market-clearing) pricing, the economy's dynamic path can be derived:

(3.23) $x_J(t) \cong \underset{\circ}{a}(t) - \dot{S}_K(t)\dot{k}_J(t) - S_H(t)h_J(t)$, and

(3.24) $\underset{\circ}{a}(t) \cong x_J(t) - \dot{S}_K(t)\dot{k}_J(t) - S_H(t)h_J(t)$,

where $\underset{\circ}{a}$ is the rate of change of the shift factor typically interpreted as technical change, $\dot{S}_K$ is the share of total income paid to capital, and S_H is labor's income share. Versions of the Solow model have been widely used in estimation exercises, which were themselves (for an extended period) a growth industry for macroeconomists.

The neoclassical growth theory was recognized almost immediately as an important advance in macrodynamic thinking, replacing "knife-edge" growth paths with more robust steady-state paths motivated by capital accumulation and technological change.[66] The approach showcased the longstanding "liberal" economic agenda of free markets, free trade, and sound money. Solow's 1987 Nobel-Prize citation emphasized his provision of "a framework within which modern macroeconomic theory can be structured", and his model continues to generate broad, understandable appeal as a guide to aggregate analysis.

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[64] Other interrelated sources of economic growth include factor specialization, scale economies, and organizational efficiencies (i.e., a rising $\acute{Z}(t) = \acute{E}(t)/H(t)$).

[65] Solow (2000, p.103) defined $\underset{\circ}{A}$ to include "… worker skills and attitudes toward work, managerial and administrative habits, interpersonal attitudes, social norms and institutions, and no doubt many other hard and soft characteristics of the economic and social environment."

[66] Appearing a few years prior to Solow's contribution, Lewis theory also provides a solution for the "knife-edge" growth path that characterize Harrod-Domar modeling by making saving and labor-force growth in the dynamic industrial sector endogenous (while assuming constant capital intensity and technical change).

The simple model, however, notably stumbles when asked to account for the mid-19th century growth discontinuity the first chapter's Great Fact. The central problem is its construction within the SVGE framework. Coherent single-venue modeling provides no room for the increasing returns to scale or two-venue labor transfer that combined to motivate the jump in global living-standards that began a century and a half ago. TVGE modeling, by contrast, provides the heterogeneous venues needed to accommodate increasing returns and Lewis transfer (including, but not limited to, the movement from technologically primitive farming to industrial jobs).[67]

TVGE version. A strength of the Solow framework is its remarkable versatility, enabling its relevance well beyond exchange-restricted SVGE analysis. Most critically, substituting $Ź_J$ into the core equation, more explicitly motivating the "effectiveness of labor" and the role of pure profit, makes Solow production consistent with TVGE cyclical and trend modeling:[68]

$$(3.25) \qquad X_J(t) = f(K_J(t), \mathring{A}_J(t) Ź_J(t) H_J(t)),$$
$$\text{such that } K_J(t) \leq K^P_J(t) = f(K_J(t)).$$

$\mathring{A}_j$ is understood to reflect the technical efficiency of labor (defined above), once the influence of capital-labor intensity is eliminated. The product of $\mathring{A}_j$ and $Ź_j$ measures general worker effectiveness, introducing into the Solow framework meaningful wage rigidities and their companion channel through which adverse nominal disturbances induce involuntary job and income loss.[69] The MWR channel combines with capital investment, technological change/scale economies (captured by $\mathring{A}_J$), and inter-venue labor transfer to enable intuitive, policy-relevant modeling of economic cycles and trend growth.

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[67] As noted above, the generalized-exchange model cloass also identifies hold-up aspects of rational workplace exchange that influence pure-profit expectations and rational investment, inhibiting the tendency of increasing returns to produce monopoly. It is furthermore useful to posit that, given technology, increasing returns in LEV production are confined to a limited range of establishment scale.

[68] TVGE compatibility additionally requires the substitution of K^P (maximum capital services available from the capital stock) for K and limiting the model to LEV activity.

[69] Properly generalizing labor input ($H_j(t) = E_j(t)/Ź_j(t)$) endows the iconic model with analytic range well beyond Solow's (2001,p.19) original aspirations: "… it was clear from the very beginning what I thought [the neoclassical growth model] did not apply to, namely short-run fluctuations in aggregate output and employment, what used to be called the business cycle…. In those days I thought growth theory was about the supply side of the economy, whereas the business cycle was mostly to be analyzed in terms of changes in aggregate demand."

The point is important. The TVGE version of the Solow theory explains business cycles motivated by nominal disturbances as well as nonstationary labor-productivity dynamics fed by technological advance, capital accumulation, and the transfer of labor from lower-productivity to higher-productivity employment.[70] It provides a coherent analytic framework for the middle-19th century upward shift in living standards associated with the Second Industrial Revolution, the 1930s depression, the 1970s stagflation, the extraordinary growth in central and east Asia beginning toward the end of the 20th century, and the propagation of financial crises that have characterized the early 21st century.

Putting the analytic strands together, Solow's focus on technical change provides one of the most important insights in the history of macroeconomics. Beginning in the 19th century, the broad reorganization of the global economy generated the 1% or so annual multifactor productivity growth that broke the world out of millennia of living-standard stagnation. The generalized-exchange interpretation of the neoclassical growth model reveals that the transformation also created the rational MWR Channel. Macroeconomics was henceforth tasked with making sense out of variable periods of persisting instability (producing substantial welfare loss) as well as trend growth. SVGE theorists, reflecting their inability to coherently suppress wage recontracting and derive involuntary job loss, have been understandably reluctant to accept that challenge.

Solow residual. Solow's aggregate production function, in its Cobb-Douglas simplification with a Hicks-neutral productivity term $(X_J(t)=B(t)H_J(t)^{\check{\alpha}}K_J(t)^{1-\check{\alpha}}$ such that $\check{\alpha}=S_H)$ and rewritten to feature output per labor hour, became the key formula in the large literature on growth accounting:

$$(3.26) \qquad x_J(t)-h_J(t) \cong ((1-\check{\alpha})/\check{\alpha})(\kappa_J(t)-x_J(t))+(1/\check{\alpha})b(t).$$

Multifactor productivity growth rate is b, almost always named the Solow residual. Perhaps more insightfully, Moses Abramovitz called b a "measure of our ignorance".

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[70] Derivation of MWR that includes chronic, time-varying wage rents also opens the door for aggregate demand to influence employment in the medium term. (See Chapter 5.) The generalization of exchange recalibrates the longstanding dominance of supply in macrodynamic modeling beyond the short term – a consequential outcome.

BOX 3.4: KALECKI AND SAVING-AND-INVESTMENT CAUSATION

In original Lewis and Solow growth modeling, the causation in the saving-equals-investment identity is neoclassical, posited to run from the former to the latter. An obvious complication in the simple Lewis theory is that saving is increasing in profits that are, in turn, increasing in nominal demand. It follows, for example, that breaking out of subsistence agriculture is greatly facilitated by access to robust export markets.

While participating in Keynes's Cambridge Circus, Michal Kalecki (1935) developed a model that reverses the neoclassical saving-to-investment causation.* A bare-bones summary of his "widow cruse" macrodynamics begins with a total-spending equation $(Y=C+I)$ in conditions of under-utilized capacity $(U>U^N)$. Model mechanics are rooted in a simple income-distribution model. Wage and capital incomes are separated. All of the former is assumed to be spent on consumption goods, while only a portion out of the latter is consumed:

$$Y=\ddot{Y}+\text{œ}\Pi+I, \text{ such that } \ddot{Y} \text{ is the total wage bill and } 1<\text{œ}<0;$$
$$Y=Y-\Pi(1-\text{œ})+I; \ \Pi=I/(1-\text{œ}).$$

The multiplier $(I/(1-\text{œ}))$ propagates nominal disturbances within a framework of product-price rigidity. The key result is that investment and consumption decisions determine profits, not vice-versa. (A catchy, albeit crude, version of Kalecki's conclusion is: Capitalists earn what they spend, and workers spend what they earn.) The "widow-cruse" outcome disappears at full-capacity utilization $(U=U^N)$.

Kalecki's effective-demand theory was constructed in the attempt to explain the class of market failure that periodically induces high unemployment. He employs three assumptions to construct a context for the necessary price rigidity. First, perfect competition does not exist. Second, average variable costs of production are constant up to $U=U^N$. Third, firms set product prices in relation to their average variable costs and their industry's prevailing price. His core idea is rooted in the size distribution of enterprises and is compatible with Chandler's new corporate forms mandated by the Second Industrial Revolution. Kalecki interpreted modern large firms as characterized by industrial concentration, vertical integration, product diversification and oligopolistic market coordination that combine to endow individual firms with discretionary market power with which they fix prices. (Note that the absence of meaningful wage rigidities in his analysis implies that his analysis cannot coherently generate involuntary job loss.)

In Kalecki's model, explaining the swings in unemployment is reduced to explaining movements in investment spending. Both cyclical recessions and nonstationary stagnations are the outcome of inadequate spending out of retained earnings.

*See also Nicholas Kaldor (1957) for a growth model that also reverses the neoclassical saving-investment causation, identifying the latter (and ultimately investor confidence) as the engine of economic growth and increasing returns to scale. The Kaldor model recognizes that new investment is typically needed to introduce new technology.

Fitting the simple model to U.S. data since 1874 suggests that multifactor productivity improvement accounts for roughly half of overall living-standard growth in the private economy.[71] In its coherent SVGE interpretation, the Solow residual wholly reflects technological change. That convenient explanation, however, is unconvincing from a TVGE perspective. For example, in the context of generalized exchange, growth-accounting estimates of the residual include nonstationary output-per-hour gains resulting from labor transfer from low- to high-productivity jobs. Lewis transfer is motivated by LEV capital investment and technical change. Transfer exerts a dominant influence on productivity advance in early-phase economic development and remains significant in later-stage trend growth.

Earlier in this chapter, Lewis transfer was expanded, especially in post turning-point economies, to include two-way labor flows between venues. An interesting example of rational reverse flow is the significant U.S. job downsizing that characterized the 1980s. (See Chapter 4.) Growth-accounting results are consistent with the TVGE-predicted relative contraction of LEV employment: from 1979 to 1990, output-per-hour growth decelerated to 1.6% annually (well below the 2.5% average between1948-98), with almost all the decrease attributable to the decline in multifactor-productivity gains (0.5% in the sub-period compared to its 50-year average of 1.4%). Mainstream SVGE analysis of that structural shift has problematically concentrated (as model coherence demands) on identifying some technological regress occurring in the 1980s.

Another Solow-residual artifact of coherent SVGE analysis, concerning macro stability and proving more consequential in the ongoing debate on proper macro policymaking, has been championed by RBC theorists. They used the capacity of Solow residuals to closely track stationary as well as nonstationary behavior of labor productivity to support the argument that business cycles are caused by variations in technology. If valid, that interpretation helps reestablish the classical dichotomy and fatally discredits of the discretionary management of aggregate nominal demand. However, the generalized-exchange version of Solow's growth model, outlined above, provides a much different explanation of the stationary behavior of Solow's residuals that is much more consistent with the evidence, intuition, the formal economic

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[71] For elaboration, see Solow (1957), Blanchard and Fischer (1989), pp.1-5, and Jones (2002), pp.45-50.

method, and Occam's razor. In the alternative, the continuous-equilibrium MWR channel interacts with fluctuations in nominal demand, generating business cycles that are in their details much more recognizable than those produced by periodic technological regress.

BOX 3.5: COHERENT CYCLES AND TREND

The particular offense of the Early Keynesian that resulted in their banishment from graduate-school curriculums and cutting-edge journals was their arbitrary separation of cyclical and growth analyses into inconsistent models. Woodford (2009, p.269) summarizes the central rule governing modern consensus model-building: "... it is now widely agreed that macroeconomic analysis should employ models with coherent intertemporal general equilibrium foundations. These make it possible to analyze both short-run fluctuations and long-run growth within a single consistent framework."

SVGE analytical framework. RBC theorists joined the macro fray in the 1980s. They anticipated the Woodford rule and produced, largely as a result of their rigor in restricting price-mediated exchange to the marketplace, business cycles that are unrecognizable to practitioners. Their coherent, integrated models of cycles and growth strongly reasserted the capacity to markets to efficiently capture available gains from trade, reestablishing wage recontracting and the classical dichotomy. Macro market failure was eliminated, and central-bank management of total spending was directed wholly at achieving low price inflation. (See for example Nelson and Plosser (1982).)

TVGE analytical framework. Generalized-exchange modeling produces cycles that are much more consistent with evidence generated over the past 100 years. The approach has been easily introduced (via the Workplace Exchange Relation) into Solow's iconic aggregate production function:

$$X_J(t)=f(K^P_J(t),A_J(t)\acute{Z}_J(t)H_J(t)),$$
$$\text{such that } K_J(t) \leq K^P_J(t)=f(K_J(t)), \acute{Z}_j=f(W_J,W^n_J,\acute{Z}^m_J).$$

Rational LEV firms pay meaningfully rigid wages, the nonstationary timepath of which is governed by endogenous K_J dynamics modeled earlier in this chapter. Meanwhile, rational Lewis labor transfer combines with capital investment, technical change, and population to determine the economy's trend growth. The TVGE innovations endow the broadly constructed Lewis-Solow model with Woodford's coherent intertemporal general-equilibrium foundations, permitting the analysis of both short-run fluctuations and long-run growth within a single consistent framework.

Big difference. The TVGE model class generates continuous-equilibrium involuntary job and income loss in response to adverse disturbances in nominal demand. No coherent SVGE model can accommodate, with or without fluctuating demand, forced job loss. To the extent that mainstream analysis actually conforms to Woodford's coherence rule, it must be stabilization irrelevant.

Olson's Rent-Seeking Growth Model

Unlike mainstream SVGE growth theorists, Mancur Olson (1982) assigned a starring role to chronic market supply-demand disequilibria in his sweeping reworking of nonstationary labor-productivity analysis. Olson's institutional macrodynamics are built on three propositions and describes an intuitive aging process for economies that weakens market control of resource pricing and allocation.

First, rent-seeking organizations tend to become established and flourish in stable societies, accumulating in economies undisturbed by great shocks such as invasion, revolution, or boundary changes. (From the TVGE perspective, workplace interpersonal and intertemporal reference standards are also more easily established and maintained in such environments.) Second, the distributional coalitions push prices paid out of line with market-clearing solutions, adversely affecting efficiency, productivity and total income. Third, by their nature, such coalitions tend to make decisions relatively slowly, further slowing adjustments to changed market conditions. The inefficiency drag from accumulating rents produces an Olson-convergence to slow growth in specialized economies.

Generalized-exchange modeling is consistent with a number of Olson's ideas, especially those on free riders and group behavior, deepening the rational microfoundations for his growth theory. The intra-establishment arrangements derived in the Workplace-Marketplace Synthesis are broadly consistent with his larger institutional approach. There are, of course, differences between the two theories. Olson built his model directly on a careful explication of the exclusion principle and its effect on collective action. TVGE thinking directly models, using axiomatic assumptions and a neoclassical focus on price-mediated exchange, workplace behavior and introduces free riders as an important influence on the organization of group conduct. Distributional coalitions in workplace economics have a narrower reach than in Olson's analysis.

On the plus side, the more substantial microfoundations provided by TVGE macrodynamics would allow Olson's institutional theory to avoid its slow-growth convergence problem. The rational dynamic recalibration of efficiency wages provides a channel for (long-lagged) market

correction of high wage rents and market inefficiency. Efficiency-enhancing adjustments made available by Olson are much weaker and more delayed, producing a decidedly more pessimistic prognosis that tends to be inconsistent with the available evidence.[72] The inconsistency is especially strong in countries where government intervention to subsidize the unemployed, to make product pricing more inelastic by restricting trade, and to limit the capacity of firms to hire, fire, and manage employees is relatively modest.

TVGE modeling uniquely identifies the importance of well-designed public policies to deal with rational rent-seeking. The Workplace-Marketplace Synthesis microfounds the most consequential class of such behavior in modern economies and maps its linkage to economic growth. It follows, for example, that the rigorous economic analysis of the Thatcher period in Great Britain is much better supported by TVGE, versus SVGE, thinking.

IV. MORE ON ENDOGENOUS INNOVATION

Baumol's Schumpeterian model. Technological change does double-duty in the TVGE model class. Combined with costly, asymmetric workplace information, it becomes the principal source of firms' capacity to pay chronic wage rents ($W_j^n > W^m$).[73] Meanwhile, it additionally provides the principal source for the upward trend in labor productivity and rising living standards over time. As has been noted, Joseph Schumpeter's *Theory of Economic Development* (1911) provided an early, insightful look at LEV dynamics, in which the starring role is assigned to entrepreneurs' search for ever-greater efficiency. Schumpeter argued that the productivity acceleration from the middle-nineteenth century was largely driven by big-tent innovations (new production processes, new corporate forms, new products, and new markets and sources of supply), producing his famous perennial gale of creative destruction. He also outlined the most fertile environment for effective innovation, including established property rights, free trade, moderate taxes, stable prices, and the efficient recycling of saving into credit.

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[72] For example, Olson (1988) uses his distributional coalition model to produce an overly pessimistic analysis of the U.S. economy in the aftermath of the 1970s energy price jump and productivity slowdown. As identified in TVGE modeling, the U.S. regulatory environment permitted both chronic job losses, eventually making reference labor pricing more malleable, and aggressive management practices to take advantage of that malleability as well as other market opportunities created by high and rising wage rents during the stagflation decade.

[73] For useful background analysis, see Gerschenkron (1962) and (more particularly) Chenery (1949).

A valuable modern application of the Schumpeterian thinking has been provided by William Baumol (2002). An intuitive firm-specific source of endogenous growth in nonstationary labor productivity (via enhancing the technical efficiency of workers, $\Delta(X/E)>0$) is identified in his modeling of the funding and generation of proprietary innovations/applications to be critically dependent on the capacity of firms to appropriate returns from sunk capital investments.

From Baumol (2002): "… firms cannot afford to leave innovation to chance. Rather, managements are forced by market pressures to support innovative activity systematically and substantially, and success of the efforts of any one business firm forces its rivals to step up their own efforts. The result is a ferocious arms race among the firms in the most rapidly evolving sectors of the economy, with innovation as the prime weapon." (p. ix) Note that, as Π(t) approaches zero, the firm will find it increasingly difficult to raise money in capital markets or from banks. (See also King and Levine (1993).) More generally, the systematic relation between research on profit-enhancing technological change and the resources firms are able to commit to its pursuit is a fundamental part of growth economics.

Workplace-equilibrium analysis compatibly models rational employee and employer behavior in large establishments, deriving optimizing factor-income shares that influence the capacity of management to finance research and development. Rational workers provide an important source of residual-rent dissipation (the hold-up problem) that augments the effect of market entry, strengthening the analytical capacity of modern industrial-organization theory. More generally, endogenous growth theory, explicitly modeling R&D and positing monopolistic competition, is enhanced by the WMS and its dynamic behavior of rents and associated factor pricing. Endowed with optimizing workplace equilibrium, the Lewis class of multiple-venue dynamic models provides a powerful framework for a general theory of medium-term macro behavior in specialized economies.

Chandler's historical increasing-returns model. Alfred Chandler (1977, 1997) has the most consequential, albeit underappreciated, nonstationary story to tell. Chandler's focus on the spread of large, hierarchical firms, with their associated increasing returns and Lewis transfer, beginning

in North America and Europe, provides the most plausible explanation for the extraordinary jump in global living-standards growth beginning in the mid-1800s.[74] The organization of the now ubiquitous class of enterprises was triggered by a fundamental macro disturbance: the development of railroad, steamship, telegraph and cable systems that decreased delivery times and uncertainties for large flows of goods through national and international economies. The Second Industrial Revolution describes the Schumpeterian wave of endogenous technological innovations that exploited the increased potential for high-speed, high-volume production.

The infrastructure and increasing specialization/scale of production created a fundamentally different economy from the small-establishment, overwhelmingly agrarian version that preceded it. It is, therefore, problematic that macroeconomists, who should avoid being indifferent to huge shifts in economic growth, persist in applying the bedrock economic method of optimizing, price-mediated exchange exclusively to a single venue (the marketplace) of increasingly complex economies. It is no accident that transformational activities associated with the Second Industrial Revolution occurred largely inside firms, as new organizational forms were developed to manage the challenges of large-scale, specialized production. Critically important here was the development of management methods that effectively cope with costly, asymmetric information in the workplace. (For elaboration, see Chapter 8.) New management forms identify workplace exchange as a necessary companion activity set to marketplace exchange. If economies in the aftermath of the Second Industrial Revolution are to be explained and predicted sufficiently to support macro policymaking, the workplace activity set needs to be understood, modeled, and integrated into the body of formal economic theory.

Particularly relevant to the longer-term modeling of this chapter, increasing returns motivate both the robust pure profits and rapid growth in higher-productivity jobs (given sufficient infrastructure and aggregate demand) needed to break economies out of subsistence stagnation. More generally, TVGE theory provides an analytical framework capable of integrating Chandler, Lewis, Baumol, Olson, and properly microfounded Early Keynesian thinking. The combined

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[74] Marshall notably set the stage for Chandler's analysis by defining the law of increasing returns in terms of more efficient organization that typically accompanies rising demand.

model explains much of the global history of stationary and nonstationary behavior of employment and productivity.

V. CONCLUSION

For many millennia, the persistence of near-subsistence living standards was the most significant feature of macroeconomies. The Rev. Malthus provided the core model of interacting subsistence and the urge to procreate (or, in the more subtle version, the economic advantages of children) that explains the minimal labor productivity growth in hunting, gathering, and ultimately simple agricultural economies that persisted up to the 19th century's Second Industrial Revolution. (Malthusian macrodynamics has been named the Iron Law of Subsistence Wages.) Over the past century and a half, the fundamental global shift in the means and organization of production, requiring new corporate forms and enabling huge Lewis transfer, has broken much of humanity out of the Iron-Law trap. The new corporate forms, however, became home to a substantial share of labor pricing, supplanting the marketplace. The relocation generated a formidable replacement class of macro problems that center on the emergent capacity of aggregate demand fluctuations to induce same-direction movements in employment, income, output, and profit. In particular, the real consequences of nominal disturbances became increasingly substantial with the spread of the Second Industrial Revolution, greatly influencing economic welfare.

With the proliferation of large corporations, the *raison d'être* of macroeconomic theory has become the explanation and prediction of the stationary and nonstationary behavior of total employment, output, income (level and distribution), and price inflation. The generalization of optimizing, price-mediated exchange anchored by continuous general equilibrium crucially advances that agenda by microfounding both the suppression of wage recontracting and dominance of LEV labor pricing. As demonstrated in this chapter, two-venue macrodynamics, adding the MWR Channel to the general problem set that originally motivated the study of political economy, are critically punctuated by rational $\mathbb{K}_j$ recalibrations. During the intervening periods, continuous baseline equilibrium describes optimal exchange. Once endowed with endogenous $\mathbb{K}_j$, TVGE modeling has substantially greater power than its friction-augmented

SVGE counterpart in explicating business cycles, depression, stagnation, stagflation, and the trend behavior of living standards.[75]

The MWR Channel uniquely informs what Mark Skousen (2009, p.2) has called "the mysteries of the 'money nexus', the vital connection between the micro economy and the macro economy." It critically microfounds the causal influence from nominal-demand disturbances to high- and low-frequency involuntary job loss and unemployment. That result, justifying discretionary central-bank management of total spending in pursuit of full employment, has never been coherently demonstrated outside the TVGE model class. The predictions of the MWR Channel are atypically specific and are ratified by a broad range of empirical evidence and practitioner testimony that have never been accommodated by coherent SVGE analysis. (See Chapter 10.)

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[75] From Hall (1999, p.1150): "… the most conspicuous shortcoming of the [SVGE] model is its failure to understand unemployment. The mechanism by which workers lose jobs in response to adverse shocks is a promising area to find amplification, and the slow process of reemployment is surely part of the story of persistent periods of slack."

BOX 3.6: SOME REWARDS FROM GENERALIZED-EXCHANGE MODELING

The formal modeling of a new venue of optimizing exchange probably seems like a lot of work. But the rewards from TVGE analysis are substantial, especially with respect to the improved capacity to support stabilization and growth policymaking. The multifaceted benefits make the game worth the candle.

Among the rewards from adopting the generalized-exchange approach to macroeconomics featured in TVGE modeling is the substantial enhancement of economists' ability to understand continuous-equilibrium macro market failure. Its enriched treatment of labor pricing and use motivates three broad classes of policy-relevant market breakdowns. The first, associated with adverse stationary movement in aggregate nominal demand, has already been emphasized. With respect to that problem set, Paul Krugman (1999) has been more prescient than Robert Lucas: "Even now, many economists still think of recessions as a minor issue, their study as a faintly disreputable subject; the trendy work has all been concerned with technological progress and long-run growth…. Meanwhile, in the short run the world is lurching from crisis to crisis, all of them crucially involving the problem of generating sufficient demand…. Once again, the question of how to keep demand adequate to make use of the economy's capacity has become crucial."

Second is the growth-related distortion caused by chronic wage rents with respect to the market-efficient allocation of resources. Most notable here is the rationing "good" jobs and the restriction of profits required for investment. The Thatcher revolution in U.K. economic policy, for example, cannot be understood absent effective modeling of wage rents. More recently, the collapse of the U.S. auto industry in the 2007-09 Great Recession, as well as the appropriate policy response, is uniquely informed by workplace-equilibrium analysis.

The third class of market failure, also caused by persisting wage rents, is rooted in the capacity of the MWR channel to translate adverse nonstationary nominal disturbances into job downsizing and persisting excess productive capacity. The nonstationary path of nonmarket labor pricing, described above, plays an important role in stagnation characterized by an extended period of joblessness significantly exceeding its natural rate. The noncyclical problem class informs the range of monetary interventions that promote more efficient market outcomes as well as the complex interaction between market competition and overall growth.