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TRADE UNIONS, UNEMPLOYMENT, ECONOMIC GROWTH, AND INCOME INEQUALITY

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In this paper, unemployment, growth, and income inequality are interdependent and endogenously determined in a unified model of a trade union. Analytically, we show that the effective labor force exhibits an intensive margin response, in the sense that in response to higher unionization the number of employed workers decreases, but each individual employed worker provides more working hours. This intensive margin response leads to the possibility of the coexistence of high unemployment and high growth. Moreover, unionization gives rise to an ambiguous effect on income inequality, whereas it has an unambiguously positive effect on the labor income share and growth rate. Our numerical study shows that the elasticity of substitution between labor and capital plays an important role in governing the steady-state consequences and affecting the impact of (de-) unionization. These results provide not only a plausible explanation of the empirical evidence, but also a reconciliation for the disparity in the empirical findings.

Keywords: Unionization, Income Inequality, Unemployment, Economic Growth

1. INTRODUCTION

Trade unions have played an important role in governing an economy's performance. The conventional point of view is that trade unions exercise their monopoly power to improve the welfare of workers by raising the wage above the competitive wage level. This excess wage increases unemployment and in turn slows economic growth. These changes give rise to a further impact on the distribution of personal income (income/wealth inequality) and factor income (labor/capital income share). Although there is no doubt as to the importance of trade unions, the

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consequences of unionization (or deunionization) are controversial. To thoroughly examine the consequences of unionization, in this paper we allow the unemployment rate, the balanced-growth rate, and income inequality to be interdependent and endogenously determined in a unified macro model.

The model is built to be consistent with three major sets of empirical evidence. First, over the past few decades, two countries – the United States and the United Kingdom – with the largest declines in unionization have also experienced the biggest increases in income inequality. This has attracted research interest in linking the two phenomena. The earlier empirical studies indicated that trade unions tend to compress wage disparity and income inequality. For example, Card (1996), Freeman (1996), Dinardo et al. (1996), and Fortin and Lemieux (1997) show that the decline in union density in the U.S. can account for about 20 percent of the rise in wage inequality during the 1980s. Likewise, the negative relationship between union density and pay inequality is also found in the United Kingdom [Machin (1997), Card et al. (2004), and Visser and Checchi (2009)], Canada [Card et al. (2004)], New Zealand [Wallerstein (1999)], and other OECD countries [Kahn (2000)]. However, more recent evidence seems to indicate the existence of an adverse effect on income inequality. Edin and Holmlund (1995), Baccaro and Locke (1998), and Schulten (2002) observe that in advanced countries trade unions no longer explicitly seek to compress the wage differentials as they did in the past, but turn to more distributionally neutral wage policies. In particular, Smeeding (2002), Gustavsson (2007), Atkinson (2008), and Bjorklund and Freeman (2010) point out that a relatively centralized collective bargaining structure has tended to increase income inequality in the past few years. The positive effect of unionization on inequality is found in both developed and developing countries [see Bertola et al. (2002), Koeniger et al. (2007), and ILO (2008) for the details].

Labor's share of national income is another distributional issue. This issue has been largely ignored by neoclassical economists owing to Kaldor's (1957) stylized fact in the sense that the factor shares of labor/capital income remain roughly unchanged over a long period. Nevertheless, recent evidence questions the robustness of the fixed distribution of factor income and shows that labor's share has been declining since the 1980s regardless of whether in the developed/European [Guscina (2006) and Arpaia and Pichelmann (2008)] or developing countries [Maarek (2012)]. Karabarbounis and Neiman (2014) further refer to a global decline in the labor share: Of the 59 countries with at least 15 years of data between 1975 and 2012, 42 exhibited downward trends in their labor shares. The new evidence has led to a resurgence of interest in this issue. Of importance, both Jayadev (2007) and the European Commission (2007) find that union density is positively correlated with the labor income share in a sample of OECD/EU countries. The decline in unionization (deunionization), together with globalization, is a crucial determinant, depressing the labor income share.

Second, although the evidence refers to an unfavorable effect of trade unionism on unemployment [see, for example, Nickell (1997) for Europe and North America], its impacts on firms' investment and hence the longer-term trend of

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growth is not so significant. According to the observations of Shister (1954) and Booth (1995, pp. 209–211), collective bargaining has relatively little impact on firms' investment decisions and an uncertain effect on firms' productivity. Although there is a widespread consensus about unionization having a negative effect on productivity and output, a number of studies have estimated positive union productivity differentials for unionized firms using industry- or firm-level data [Brown and Medoff (1978), Clark (1980), Nickell et al. (1989), and Gregg et al. (1993)]. Recently, aggregate national data have also been used to test the relationship between unionization and productivity growth and output, and their findings are still mixed. Nickell and Layard (1998) estimate a negative union effect on growth for a panel of OECD countries, whereas Asteriou and Monastiriotis (2001) find a positive growth effect in 18 OECD countries utilizing newly developed econometric methods for the estimation of dynamic panel models. The mixed empirical results motivate theoretical attempts, such as Palokangas (1996), Ramos-Parreño and Sánchez-Losada (2002), Irmen and Wigger (2003), and Chang et al. (2007), to highlight the possibly positive relationship between unionization and economic growth.[1]

Third, in the literature, growth has been examined mostly in the context of competitive labor markets that are characterized by full employment, implying that unemployment is only a business cycle phenomenon that may disappear in the long run. However, Bean (1994) and Daveri and Tabellini (2000) show that a large part of existing unemployment, particularly in Europe, is attributable to equilibrium unemployment, and economic growth often goes side by side with unemployment. There is little evidence of a robust bivariate relationship, either positive or negative, over a long time period from the 1950s to the 1980s [Bean and Pissarides (1993) and Aghion and Howitt (1994)]. Saint-Paul (1991), Aghion and Howitt (1992), Caballero (1993), and Gordon (1997) even refer to an empirical possibility of a positive unemployment-growth relationship.[2,3]

Most previous research in the literature has investigated the issue of either equilibrium unemployment or economic growth separately. In particular, there is little research that links the labor force, unionization, and income inequality. Because of these restrictions, the existing literature seemingly fails to capture the aforementioned empirical evidence in a unified model. To reconcile this empirical evidence, our model endogenizes unemployment, labor hours, growth, and income inequality, simultaneously. An economywide trade union negotiates wages for employed workers with a firm federation. The bargained wage, on one hand, governs the employed workers' labor supply (working hours) and, on the other hand, influences the equilibrium unemployment rate (or employment rate). The resulting "effective" labor force (the employment rate times working hours per worker) in turn affects the impacts of unionization on both economic growth and income inequality. With particular emphasis, in this model income inequality is caused by not only inheritance (capital endowment), but also salary earning, although the wage inequality is lower than the wealth inequality. This is important, because the recent evidence [Hendricks (2004), Francis (2009), and

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Lemieux et al. (2009)] shows that wage inequality has increased greatly over the past two decades.

Our analytical results indicate that the effective labor force exhibits an intensive margin response, in the sense that in response to an increase in the degree of unionization the number of employed workers decreases, but each individual employed worker provides more working hours. Given that the latter effect dominates, as a result of the increase in the effective labor force (aggregate labor hours), economic growth rises in response to more intensive trade unionism. This implies that high unemployment and high growth can coexist. Interestingly, our model, which sheds light on a constant-elasticity-of-substitution (CES) production technology, predicts a positive effect of unionization on the labor income share. This provides a plausible explanation for the decline in the labor income share and supports the empirical studies by Jayadev (2007) and the European Commission (2007) on OECD/EU countries. Note that as stressed by Karabarbounis and Neiman (2014), the global decline of the labor share implies that the conventional Cobb–Douglas production function with constant factor shares of income is no longer a reasonable approximation for a growing economy, even though it has been viewed as a basic workhorse in the macroeconomics literature. Instead, a CES production function enables us to endogenize the labor income share and link deunionization to it.

There is an ambiguous effect of unionization on income inequality, depending on the relative magnitudes of the direct unionization effect and the indirect labor force effect. This ambiguity reconciles the mixed empirical findings on the income inequality effect of unionization, as noted previously. In a perfectly competitive labor market, García-Peñalossa and Turnovsky (2006) point out that faster growth is related to higher employment and more unequal income. By contrast, in a unionized labor market, our analysis does not support such a monotonic relationship. In response to a higher degree of unionization, a higher balanced-growth rate not only can be associated with a lower employment rate (a higher unemployment rate), but may also have a negative correlation with income inequality, which is consistent with the well-known Kuznets (1955) hypothesis. The results are consistent with the empirical evidence provided by the OECD (2011), showing that a larger collective bargaining coverage decreases the overall employment rate, but does not give rise to a significant impact on overall income inequality.

A simple numerical analysis is also performed to ensure that our analytical results are empirically convincing. The numerical study finds that a higher elasticity of substitution between effective labor and capital is associated with higher steady-state income inequality and economic growth, but results in a lower labor income share. Besides, because the employer has the right to determine capital levels unilaterally and capital can substitute for labor more easily, the influence of the trade union on the bargained wage and employment becomes weak. It turns out that the effects of unionization on growth, income inequality, employment, and labor hours are less pronounced. However, because the firm can use capital to substitute for labor more easily, the impact of (de-) unionization on the labor income share is reinforced.[4]

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2. ANALYTICAL FRAMEWORK

Consider a unionized economy consisting of four types of agents: households, firms, a national trade union, and a government. Households derive utility from consumption and leisure. The firms produce goods by means of capital and labor service. The union cares about both wages and employment and the objective function reflects its relative preference for both. To balance its budget, the government levies a lump-sum tax in order to finance the expenditure on unemployment benefits.

2.1. Firms, the Trade Union, and Collective Bargaining

The number of firms is fixed and normalized to 1. The economywide trade union negotiates a wage-employment contract with one economywide federation, which represents these employers. To shed light on the role played by the trade union in the labor market, the product market is assumed to be perfectly competitive, for simplicity. Instead, we delicately deal with the "effective labor," which includes not only the number of employed workers, but also their working hours. Without the risk of ambiguity, time subscripts are omitted.

Firms. Firms hire physical capital k and labor l to produce a final good Y. Each firm produces output in accordance with the following CES production technology:

$$Y = A[\alpha_E(A_1E)^{-\beta} + \alpha_k(A_2k)^{-\beta}]^{-\frac{\alpha}{\beta}}, \quad 0 < \alpha < 1, \beta \geq -1, \text{ and } \alpha_E + \alpha_k = 1, \tag{1}$$

where $E = hl$ is the effective labor force, measured by the employed workers' total working hours, i.e., the number of employed workers l times the working time h. As shown in (1), an individual firm's production exhibits decreasing returns to scale in its internal capital (k) and labor (E); i.e., $0 < \alpha < 1$. However, there are positive production externalities, captured by $A_1(K)$ for effective labor (labor-augmenting externality) and $A_2(K)$ for capital (capital-augmenting externality), respectively. Both are increasing in the economywide stock of capital K; i.e., $A_1(K) = K^{\eta_1}$ and $A_2(K) = K^{\eta_2}$, where $\eta_1, \eta_2 > 0$. As a common notion, the externalities refer to the spillovers of knowledge.[5] To generate perpetual growth, we further assume that $\eta_1 = \frac{1}{\alpha}(> 0)$ and $\eta_2 = \frac{1}{\alpha} - 1(> 0)$, implying that under symmetry, $k = K$, the aggregate production function exhibits constant returns to scale in capital; i.e., $Y = AK(\alpha_E E^{-\beta} + \alpha_k)^{-\alpha/\beta}$.

We can easily learn from (1) that the elasticity of substitution between effective labor and capital is $\epsilon = -\partial(\ln \frac{E}{k})/\partial(\ln \frac{\partial Y/\partial E}{\partial Y/\partial k}) = \frac{1}{1+\beta}$. For extreme cases, if $\beta \to -1$, effective labor and capital are perfect substitutes, i.e., $\epsilon \to \infty$; by contrast, if $\beta \to \infty$, both are perfect complements, i.e., $\epsilon \to 0$. It is worthwhile noting that if $\beta \to 0$ and then $\epsilon = 1$, (1) is reduced to a Cobb–Douglas production function, $Y = \bar{A}(E^{\alpha_E} \cdot k^{\alpha_k})^{\alpha}$, where $\bar{A} = AK^{(\eta_1\alpha_E+\eta_2\alpha_k)\alpha}$. A particular emphasis is

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that in a way different from Cobb–Douglas production, the CES functional form endogenizes the distribution of income between labor and capital and allows us to explore the recent declines in labor income share.

With (1), the representative firm seeks to maximize its profit π:

$$\pi = Y - whl - rk, \tag{2}$$

where w and r are the wage rate per hour and the rental rate of capital, respectively.

Trade union. In line with Pemberton (1988), we specify that the managerial trade union's objective function has the following functional form:

$$U = [(wh - T) - b] \cdot l^{\upsilon},\ 0 < \upsilon < 1, \tag{3}$$

where wh is the average (or expected) wage compensation, T is the lump-sum tax, and b is the unemployment benefit. Relative to the wage surplus $(wh - T) - b$, the parameter υ corresponds to the elasticity of employment l with respect to the union's objective U: a lower (higher) υ implies that the union tends to be more wage-(employment-)oriented [see Mezzetti and Dinopoulos (1991) and Chang et al. (2007) for the details]. Based on a survey of union leaders in Great Britain, Clark and Oswald (1989) point out that the empirical evidence is more likely to support a wage-oriented structure of the union preference. Consistent with this evidence, we focus on the case of a wage-oriented union where $0 < \upsilon < 1$, although relaxing this assumption does not alter our main results.

Collective bargaining. In line with McDonald and Solow (1981) and Clark (1990), we assume that the union and the employer federation bargain over wages and employment through a generalized Nash bargaining solution, taking the workers' decision about hours of work h as given and subject to the firms' demand for capital. This model's setting is similar to that of Clark (1990), where the employer has the right to set capital levels unilaterally. Moreover, the union and the employer do not routinely negotiate the subject of working time, leaving this decision to the individual employed workers. By defining $\theta \in (0, 1)$ as the relative bargaining strength of the union, the bargaining problem is to maximize the following generalized Nash product:

$$\max_{w,l} \Phi = [(wh - T - b)l^{\upsilon}]^{\theta}(Y - whl - rk)^{1-\theta}, \tag{4}$$

subject to

$$k = \arg\max_{k}\ \pi,$$

where $Y = A[\alpha_E(K^{\eta_1}E)^{-\beta} + \alpha_k(K^{\eta_2}k)^{-\beta}]^{-\alpha/\beta}$, reported in (1).

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By some simple manipulations, the optimal conditions for the wages and employment are given by

$$wh - T - b = \frac{1}{\upsilon}\left\{wh - \frac{\alpha\alpha_E(K^{\eta_1}hl)^{-\beta}}{l}A\left[\alpha_E(K^{\eta_1}hl)^{-\beta} + \alpha_k(K^{\eta_2}k)^{-\beta}\right]^{-\frac{\alpha}{\beta}-1}\right\}, \tag{5}$$

$$w = \left[\frac{\alpha\alpha_E(K^{\eta_1}hl)^{-\beta}}{\alpha_E(K^{\eta_1}hl)^{-\beta} + \alpha_k(K^{\eta_2}k)^{-\beta}} + \frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}\right] \times \frac{A[\alpha_E(K^{\eta_1}hl)^{-\beta} + \alpha_k(K^{\eta_2}k)^{-\beta}]^{-\frac{\alpha}{\beta}}}{hl}, \tag{6}$$

and the firm's demand for capital is

$$r = \frac{\alpha\alpha_k(K^{\eta_2}k)^{-\beta}}{k}A[\alpha_E(K^{\eta_1}hl)^{-\beta} + \alpha_k(K^{\eta_2}k)^{-\beta}]^{-\frac{\alpha}{\beta}-1}. \tag{7}$$

As in the traditional theory of union bargaining, (5) describes the contract curve in the (w, l) space, which is the locus of points at which the union's indifference curve and the firm's isoprofit curve are tangential. Equation (6) depicts the rent division curve, indicating that the negotiated wage rate increases with the union's bargaining power θ.[6] Equation (7) is a standard $r =$ MPK condition. By substituting (5)–(7) into (2), the firm's profit is given by

$$\pi = \frac{(1-\theta)(1-\alpha)}{1-\theta+\theta\upsilon}A[\alpha_E(K^{\eta_1}hl)^{-\beta} + \alpha_k(K^{\eta_2}k)^{-\beta}]^{-\frac{\alpha}{\beta}}, \tag{8}$$

showing that the individual firm's profit is decreasing in θ and is positive as long as the employers' federation has a positive bargaining power, i.e., $0 < \theta < 1$. In the extreme case where the union's bargaining power is absolute ($\theta \to 1$), the firm's profit reduces to zero.

2.2. Households

There is a mass of one of infinitely lived agents in the economy. Households are indexed by i and are identical in all respects except for their initial endowments of capital, K_{i0}. By following García-Peñalosa and Turnovsky (2006), we define the share of individual i, K_i, in the aggregate stock of capital, K, as k_i; i.e., $k_i = K_i/K$. The relative capital k_i follows a distribution function $D(k_i)$, with mean $\sum_i k_i = 1$ and the variance is σ_k^2.

Each individual i is endowed with a unit of time that can be allocated either to labor h_i or to leisure ℓ_i, given that the employment rate l is determined by the bargaining consequence between the trade union and the firm. Let $E_i = h_i l$ and accordingly $(1 - E_i)$ is leisure. Thus, household i, taking the wage rate w and interest rate r as given, chooses consumption C_i and working time h_i to

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maximize its expected lifetime utility. This optimization problem can be expressed as follows:

$$\max_{C_i,\, h_i, K_i} \int_0^\infty \frac{[C_i(1-E_i)^\eta]^\varphi}{\varphi} e^{-\rho t} dt,\ E_i = h_i l \tag{9}$$

$$\text{s.t. } \dot{K}_i = rK_i + wh_i l + b(1-l) + \pi_i - C_i - T, \tag{10}$$

where we restrict $\varphi < 1$, $\eta > 0$, and $\eta\varphi < 1$ in order to satisfy the principle of diminishing marginal utility. Equation (10) indicates that the ith household is bound by a flow budget constraint linking capital accumulation to any difference between its income (including the capital rentals rK_i, the average labor income $lwh_i + (1-l)b$, and the dividends π_i transferred from firms' profits) and its expenditure (including consumption C_i and the lump-sum tax T). The dividends from profits are weighted by the share of the capital stock that is owned by agent $k_i{=}K_i/K$, i.e., $\pi_i = \pi k_i$.[7] Of particular note, in a unionized economy the labor market may be characterized by an "equilibrium unemployment rate." Because the population's size is normalized to one, the unemployment rate is $u = 1-l$. In line with Van der Ploeg (1987), Palokangas (1996), Eriksson (1997), and Domenech and Garcia (2008), we assume that all workers, employed and unemployed, belong to the same family. This "big family" assumption implies that, in facing a pooled resource, the "large" household has a unified preference capturing the enjoyment of all its members. Thus, $lwh_i + (1-l)b$ can be regarded as the "average" labor income of an individual household.

Let λ_i be the Lagrangian multiplier associated with agent i's budget constraint. Thus, the necessary conditions for this dynamic optimization problem are

$$C_i^{\varphi-1}(1-h_i l)^{\eta\varphi} - \lambda_i = 0, \tag{11}$$

$$l[-\eta C_i^{\varphi}(1-h_i l)^{\eta\varphi-1} + \lambda_i w] = 0, \tag{12}$$

$$\dot{\lambda}_i/\lambda_i = \rho - r, \tag{13}$$

together with the transversality condition of K_i:

$$\lim_{t\to\infty} \lambda_i K_i e^{-\rho t} = 0. \tag{14}$$

2.3. Government

The role of the government is relatively passive. We simplify the government's behavior in order to shed light on the importance of the role of the trade union. The government levies a lump-sum tax T to finance the expenditure on unemployment benefits $b(1-l)$. Thus, the government budget constraint can be expressed as

$$b(1-l) = T. \tag{15}$$

To avoid unemployment benefits being degenerated, we further specify $b = sY$, where s is the unemployment benefit–GDP ratio, in the endogenous growth model.

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3. BALANCED-GROWTH-PATH EQUILIBRIUM AND INCOME INEQUALITY

By taking the time derivative of (11) and using (13), we have

$$(\varphi - 1)\frac{\dot{C}_i}{C_i} - \eta\varphi\frac{(1 \dot{-} E_i)}{1 - E_i} = \frac{\dot{\lambda}_i}{\lambda_i} = \rho - r. \quad \textbf{(16)}$$

By taking the time derivative of (12), we further obtain

$$\varphi\frac{\dot{C}_i}{C_i} + (\eta\varphi - 1)\frac{(1 \dot{-} E_i)}{1 - E_i} = \frac{\dot{w}}{w} + \frac{\dot{\lambda}_i}{\lambda_i}. \quad \textbf{(17)}$$

These two equations indicate that each agent will be confronted with the same rate for the shadow value of capital and the wage offer, irrespective of his/her capital endowment K_{i0}. To be precise, it follows from (16) and (17) that all individuals (i or j) will choose the same growth rate for consumption and leisure and hence average consumption C and leisure $1 - E$ also grow at their respective common rate, that is,

$$\frac{\dot{C}_i}{C_i} = \frac{\dot{C}_j}{C_j} = \frac{\dot{C}}{C} \text{ and } \frac{(1 \dot{-} E_i)}{1 - E_i} = \frac{(1 \dot{-} E_j)}{1 - E_j} = \frac{(1 \dot{-} E)}{1 - E}\ \forall\, i, j. \quad \textbf{(18)}$$

Moreover, the market-clearing condition for the aggregate labor market is given by

$$\sum_i (1 - E_i) = 1 - E = 1 - hl, \quad \textbf{(19)}$$

where h and l are the average working time and the employment rate, respectively.

3.1. Balanced-Growth-Path Equilibrium

Under the symmetric equilibrium, by putting (5), (6), and (15) with $b = sY$ together, we have

$$\frac{(1-\alpha)\theta(1-\upsilon)}{(1-\theta+\theta\upsilon)} = \frac{\alpha\alpha_E(hl)^{-\beta}}{[\alpha_E(hl)^{-\beta}+\alpha_k]} - sl(2-l). \quad \textbf{(20)}$$

In addition, dividing (12) by (11) yields

$$C_i = \frac{w(1-E_i)}{\eta}. \quad \textbf{(21)}$$

Define a transformed variable $x \equiv C/K$. By summing (21) over all agents and recalling that $\sum_i C_i = C$, $\sum_i E_i = \sum_i h_i l = hl$, the aggregate consumption—capital ratio can be represented as

$$x \equiv \frac{C}{K} = \frac{w(1-hl)}{\eta K}. \quad \textbf{(22)}$$

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Equations (20) and (22) allow us to derive the instantaneous relationship of the employment rate and the average working hours as follows:

$$l = l(\underset{(+)}{x}; \underset{(-)}{\theta}, \underset{(-)}{s}) \text{ and } h = h(\underset{(-)}{x}; \underset{(+)}{\theta}, \underset{(+)}{s}). \tag{23}$$

The exact derivatives of the comparative statics are relegated to Appendix A.1. The results of (23) are straightforward. Intuitively, a higher θ induces the union to raise the bargained wage rate w by exercising its higher bargaining power. Thus, the employment rate l declines. Higher unemployment benefits (an increase in s) squeeze the wedge between the incomes of employed and unemployed, i.e., the excess wage $wh - T - b$. To compensate for the income of employed workers, the union is inclined to accept a lower bargained employment rate in exchange for a higher wage rate, thereby resulting in a lower employment rate l.

As shown in the preceding, in response to an increase in the union's bargaining power θ, the union exercises its power to raise the bargained wage rate w, resulting in a lower employment rate. On one hand, a higher bargained wage rate induces the employed workers to work more. On the other hand, a lower employment rate increases the marginal utility of leisure as they are employed, as indicated in (12). This further induces the employed workers to increase their labor supply. Because both give rise to an unambiguously positive effect on h, labor supply responds positively to the union's bargaining power θ. Similarly, unemployment benefits raise the bargained wage rate, which in turn induces the employed workers to work more (h increases).

A higher level of consumption (hence, the consumption–capital ratio x) implies a lower marginal utility of consumption, which leads households to increase their leisure. Thus, the working time h decreases with the consumption–capital ratio. Because of fewer working hours h, the union tends to bargain over a higher employment rate l for maintaining a given level of effective labor $E = hl$, in order to maximize its utility.

We now turn to the aggregates. By summing the individual budget constraints (10) and (15) and utilizing (6), (7), and (8), we have the growth rate of capital γ_K:

$$\gamma_K = \frac{\dot{K}}{K} = \frac{Y}{K} - \frac{C}{K}, \text{ with } Y = AK[\alpha_E (hl)^{-\beta} + \alpha_k]^{-\frac{\alpha}{\beta}}. \tag{24}$$

This is essentially the clearing condition for the good market or the aggregate resource constraint. Because time is bounded, $\dot{E} = (\dot{hl}) = 0$ must hold. Accordingly, based on (18) (hence, $\frac{\dot{C}}{C} = \sum_i \frac{\dot{C}_i}{C_i}(\frac{C_i}{C})$) and summing (16), we obtain the following consumption growth rate γ_C:

$$\gamma_C = \frac{\dot{C}}{C} = \frac{1}{(\varphi - 1)} \cdot \frac{\dot{\lambda}}{\lambda} = \frac{1}{(\varphi - 1)}(\rho - r), \tag{25}$$

where $r = \alpha\alpha_k A[\alpha_E (hl)^{-\beta} + \alpha_k]^{-\alpha/\beta - 1}$, derived from (7). This equation is also the economywide Keynes–Ramsey rule.

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It follows from (6) that $w = \left[\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k} + \frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}\right]\frac{AK[\alpha_E(hl)^{-\beta}+\alpha_k]^{-\alpha/\beta}}{hl}$. Given this equilibrium wage rate and (23) (i.e., $l = l(x;\theta,s)$ and $h = h(x;\theta,s)$), (22) can be expressed as $\frac{C}{K} = \frac{(1-hl)A[\alpha_E(hl)^{-\beta}+\alpha_k]^{-\alpha/\beta}}{hl\eta}[\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k} + \frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}]$. This relationship, together with the aggregate production function $Y = AK[\alpha_E(hl)^{-\beta} + \alpha_k]^{-\alpha/\beta}$, clearly indicates that the economy is characterized by a balanced growth path (BGP) equilibrium, under which (i) consumption, capital, and output all grow at a common rate $\gamma_C = \gamma_K = \tilde{\gamma}$ and (ii) the equilibrium working time $\tilde{h}$ and the equilibrium unemployment rate $\tilde{u} = (1-\tilde{l})$ are constant.

Based on this BGP equilibrium, we can easily use (22), (23), (24), and (25) to reduce the whole dynamic system to the following differential equation in terms of the transformed variable x:

$$\frac{\dot{x}}{x} = \frac{\dot{C}}{C} - \frac{\dot{K}}{K} = \left[\frac{\alpha\alpha_k}{(1-\varphi)[\alpha_E(hl)^{-\beta}+\alpha_k]} - 1\right]A[\alpha_E(hl)^{-\beta}+\alpha_k]^{-\frac{\alpha}{\beta}} + x - \frac{\rho}{(1-\varphi)}. \tag{26}$$

At the steady-state equilibrium, the economy is characterized by $\dot{x} = 0$, and x is at its stationary value, $\tilde{x}$. Linearizing (26) around the steady-state $\tilde{x}$ gives

$$\dot{x} = D(x-\tilde{x}),$$

where

$$D = x\left\{1 + \alpha\alpha_E A(hl)^{-\beta-1}[\alpha_E(hl)^{-\beta} + \alpha_k]^{-\alpha/\beta-1} \times \left[\frac{\alpha_k(\alpha+\beta)}{(1-\varphi)[\alpha_E(hl)^{-\beta}+\alpha_k]} - 1\right]\left(l\frac{\partial h}{\partial x} + h\frac{\partial l}{\partial x}\right)\right\}.$$

To ensure that the steady-state equilibrium is locally determinate, we impose a sufficient (not necessary) condition $\alpha_k(\alpha+\beta) < (1-\varphi)(\alpha_E+\alpha_k)$ such that $D > 0$ is true.

3.2. Income Distribution

To investigate the issue of income inequality, we first derive agent i's relative capital stock $k_i = K_i/K$. By substituting the government's budget constraint (15) into the individual's budget constraint (10), we have

$$\frac{\dot{K}_i}{K_i} = r_t + \frac{wh_i l}{K_i} + \frac{\pi}{K} - \frac{C_i}{K_i}. \tag{27}$$

Given that $\frac{\dot{K}}{K} = \sum(\frac{\dot{K}_i}{K_i})k_i$, we can further obtain

$$\gamma_K = \frac{\dot{K}}{K} = r_t + \frac{whl}{K} + \frac{\pi}{K} - \frac{C}{K}. \tag{28}$$

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Combining (21), (22), (27), and (28) leads to the following differential equation in terms of the relative capital stock k_i:

$$\dot{k}_i = \left[\frac{wh_i l}{K} - \frac{w(1-h_i l)}{\eta K}\right] - \left[\frac{whl}{K} - \frac{w(1-hl)}{\eta K}\right] k_i. \quad \textbf{(29)}$$

This equation refers to the evolution of the relative wealth (capital), starting from the initial endowment k_0.

As shown in García-Peñalosa and Turnovsky (2006), the only solution consistent with long-run stability and the transversality condition is that $\dot{k}_i = 0$ for all time. Based on (29), this condition is accomplished by agents selecting their working hours; i.e.,

$$h_i - h = \left[h - \frac{1}{l(1+\eta)}\right](k_i - 1), \quad \textbf{(30)}$$

where $h - \frac{1}{l(1+\eta)} < 0$ can be derived from the transversality condition $r_t > \gamma_K$.[8] Equation (30) indicates that a negative relationship exists between relative wealth and labor supply (working hours), such that the relative wealth position of agents, k_i, is unchanging over time. In other words, the more an agent's steady-state relative capital stock increases, the more leisure he/she chooses (i.e., the less labor he/she supplies). This result is consistent with the empirical evidence, such as that in Holtz-Eakin et al. (1993) and Algan et al. (2003).

Define relative income $y_i = Y_i/Y$, in which individual i's after-tax income is $Y_i = rK_i + \pi_i + wh_i l + b(1-l) - T$, whereas average economywide income is $Y = whl + rK + \pi + b(1-l) - T$. By using (2), (6), (7), and (15), we can derive the following relationship:

$$y_i - 1 = \left[\frac{(1+\eta) - w/Y}{(1+\eta)}\right](k_i - 1), \quad \textbf{(31)}$$

implying that

$$\sigma_y = \Omega\sigma_k, \quad \textbf{(32)}$$

where $\Omega = \frac{(1+\eta)-w/Y}{(1+\eta)}$, with $\frac{w}{Y} = \frac{1}{hl} \cdot \left[\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k} + \frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}\right] > 0$. Given that σ_y provides a measure of income inequality, (32) refers to two important properties of income distribution. First, the distribution of income σ_y is positively related to the initial distribution of capital σ_k, but is negatively related to the wage-to-output ratio w/Y (via Ω). This implies that in our model income inequality could be caused not only by wealth inheritance, but also by salary earning. This is consistent with the recent empirical finding of Lemieux et al. (2009), which refers to the increasing importance of wage inequality. Second, $\Omega < 1$ implies that along the BGP equilibrium, income inequality is lower than wealth inequality. This property is also consistent with the common empirical evidence, but it is rather difficult for a conventional infinitely-lived-agent model to generate such a prediction [see, for example, Carroll (2001), Hendricks (2004), and Francis (2009)]. Why does income inequality σ_y decrease with the wage–output ratio w/Y? Intuitively,

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a higher wage–output ratio implies a higher return on labor and a lower return on capital. Given that labor is more equally distributed than capital, the income gap between any two individuals falls and, consequently, income inequality σ_y decreases with the wage–output ratio. As we will see later, the union's power θ affects the wage–output ratio and in turn income inequality.

In this model, the unemployment rate $u = (1-l)$, working time h (and, hence the effective labor force hl), the consumption–capital ratio x, the balanced-growth rate γ, and income inequality σ_y are all endogenously determined. The unemployment rate, working time, and consumption–capital ratio are solved by (20), (22), and (26). Once these variables are determined, the balanced-growth rate and income inequality can be further pinned down by (24) [or (25)] and (32).

3.3. Effects of Unionization

We are ready to explore the effects of unionization θ on the steady-state unemployment rate $\tilde{u}$, equilibrium working time $\tilde{h}$, balanced-growth rate $\tilde{\gamma}$, income inequality $\tilde{\sigma}_y$, and labor income share $\tilde{S}_E = \tilde{w}\tilde{E}/\tilde{Y}$. We first establish

PROPOSITION 1 (Effects of Unionization). *In the BGP equilibrium, a higher bargaining power of the union θ increases the unemployment rate $\tilde{u}(= 1 - \tilde{l})$, the working time $\tilde{h}$, and the economic growth rate $\tilde{\gamma}$, whereas it has an ambiguous effect on income inequality $\tilde{\sigma}_y$.*

Proof. See Appendix A.2. ■

In response to a higher degree of unionization θ, the union becomes more aggressive in extracting the excess wage for its members. The rise in the bargained wage rate, on one hand, decreases the employment rate $\tilde{l}$ and hence increases the equilibrium unemployment rate $\tilde{u}$. On the other hand, faced with a higher wage rate (and a lower employment rate) households are inclined to increase their labor supply $\tilde{h}$ as they are employed, as shown in (23). The conflicting effects of unionization on the unemployment rate and the working time give rise to an interesting outcome, which leads to the following two corollaries:

COROLLARY 1 (Responses of the Effective Labor Force). *The effective labor force ($\tilde{E} = \tilde{h} \cdot \tilde{l}$) exhibits an "intensive margin response" in the sense that when trade unionism becomes more intensive, the number of employed workers $\tilde{l}$ decreases, but each individual employed worker provides more working hours $\tilde{h}$.*

Because the working-time effect dominates, our model predicts that the effective labor force (the aggregate working hours $E = hl$) increases in response to a rise in the union's bargaining power, even though the equilibrium unemployment rate increases. As shown in (7), a higher level of effective labor force increases the marginal productivity of capital and in turn increases the balanced-growth rate $\tilde{\gamma}$. This positive growth effect somewhat echoes the argument of Palokangas (1996), Ramos-Parreño and Sánchez-Losada (2002), Irmen and Wigger (2003),

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and Chang et al. (2007), although the mechanism behind the result is quite different. Palokangas (1996) shows that in a unionized labor market with skilled (only employed in the R&D sector) and unskilled workers (employed in both the production and R&D sectors), unionization speeds up growth, because union power raises the wages of unskilled relative to skilled labor, which is favorable to new designs. By developing an OLG model, Irmen and Wigger (2003) show that a trade union formed by the working young that succeeds in raising the aggregate wage bill effectively transfers resources from the dis-saving old to the saving young and, as a result, unionization leads to higher aggregate saving and per capita income growth. Ramos-Parreño and Sánchez-Losada (2002) set up a two-sector (production and educational) OLG model with altruistic agents, where growth is generated by human capital accumulation in the educational sector. They also refer to a positive growth effect of unionization, if the production sector is unionized, shifting economic resources to the educational sector and increasing human capital accumulation. Chang et al. (2007) shed light on the conflicting interests between the leadership and membership within a trade union and find that unionization can increase the balanced-growth rate, provided that the union is employment-oriented. An interesting finding is that in contradiction to their result, in the present paper unionization can favor economic growth under the case of a wage-oriented union, when we consider the effect of unionization on not only the employment rate, but also the working time of employed workers.

COROLLARY 2 (Unemployment and Growth). *In response to a higher degree of unionization, a high unemployment rate and a higher balanced-growth rate can coexist.*

Bean (1994) and Daveri and Tabellini (2000) show that a large part of the existing unemployment, particularly in Europe, is attributable to equilibrium unemployment, and economic growth often goes side by side with a higher rate of unemployment. Bean and Pissarides (1993) find that there is little evidence of a robust bivariate relationship, either positive or negative, over a long time period (1950s–1980s). Similarly, Aghion and Howitt (1994) point out that neither is there any evidence of a significant nonlinear relationship between unemployment and growth. Saint-Paul (1991), Aghion and Howitt (1992), Caballero (1993), and Gordon (1997) refer to an empirical possibility of a positive unemployment–growth relationship. By shedding light on the intensive margin response of the effective labor force, our model provides a plausible explanation for the positive correlation between unemployment and growth.

By focusing on the income-distribution effect, Proposition 2 indicates that unionization has an ambiguous impact on the degree of income inequality $\tilde{\sigma}_y$, governed by a *direct* unionization effect and an *induced* labor force effect. The direct unionization effect indicates that higher bargaining power θ allows the union to exercise its monopoly power to raise the wage–output ratio, i.e., $\partial(w/Y)/\partial\theta = \upsilon(1-\alpha)/hl(1-\theta+\theta\upsilon)^2 > 0$. As emphasized previously, a higher wage–output

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ratio implies a higher return rate on labor and a lower return rate on capital. Given that labor is more equally distributed than capital, the income gap between any two individuals falls and income inequality σ_y decreases as a response. In contrast, because unionization has a positive effect on the effective labor force, because of the diminishing marginal labor productivity, the increase in hl lowers the return on labor and raises the return on capital. Because labor is more equally distributed than capital, this then expands the income dispersion. Thus, the income-inequality effect of unionization is ambiguous, depending on the relative magnitude of the direct unionization effect and the indirect labor force effect. This ambiguity provides a reconciliation for the mixed empirical findings. As illustrated in the Introduction, whereas earlier studies [cf. Alesina and Rodrik (1994)] suggest a negative trade-off between growth and inequality, more recent empirical evidence [such as Barro (2000), Forbes (2000), and Lundberg and Squire (2003)] tends to support a positive relationship.

In a perfectly competitive labor market, García-Peñalossa and Turnovsky (2006) point out that faster growth is related to higher employment and more unequal income. However, by shedding light on a unionized labor market, our analysis does not support such a monotonic relationship. In response to a higher degree of unionization, a higher balanced-growth rate not only can be associated with a lower employment rate (Corollary 2), but also may be negatively correlated with income inequality. Of importance, the consequences of unionization can well match the empirical evidence; OECD (2011, Table 2, p. 32) shows that a wider collective bargaining coverage decreases the overall employment rate, but it does not necessarily give rise to a significant impact on overall income inequality. Moreover, the nonmonotonic relationship between growth and income inequality is consistent with the well-known Kuznets (1955) hypothesis and the recent evidence, such as in OECD (2012).

The Introduction has indicated that research interest in the distribution of income on labor is reviving, because the labor share appears to have been declining among industrial countries since the early 1980s. To investigate the relationship between the labor share and unionism, simple manipulations on (5) and (6) enable us to obtain the steady-state labor income share as follows:

$$\tilde{S}_E = \frac{\tilde{w}\tilde{E}}{\tilde{Y}} = \frac{\alpha\alpha_E(\tilde{E})^{-\beta}}{\alpha_E(\tilde{E})^{-\beta} + \alpha_k} + \frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}. \tag{33}$$

From (33), we can establish the following proposition:

PROPOSITION 2 (Relationship between Labor Share and Deunionization). *In the BGP equilibrium, there is a positive relationship between trade unionism θ and the labor income share $\tilde{S}_E$.*

Proof. See Appendix A.2. ■

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TABLE 1. Values of parameters

Preference	$\rho = 0.04$, $\varphi = -1.1$, $\eta = 1.4$
Production	$\beta = 0.429$, $\alpha = 0.874$, $\alpha_E = 0.6$, $\alpha_k = 0.4$, $A = 0.495$
Unionization	$\theta = 0.5$, $\upsilon = 0.501$
Policy	$s = 0.58$

Intuitively, a lower θ implies a relatively weak monopoly power for the trade union, which leads the equilibrium wage rate to decrease. Although the employment rate increases, the effective labor $\tilde{E}$ decreases (because of the decline in $\tilde{h}$). As a result, the labor income share falls in response. The evidence shows that, over the past two decades, the industrial countries experienced, on the one hand, declines in unionization (deunionization) and, on the other hand, slides in the labor income share. The European Commission (2007) and Jayadev (2007) further confirm that union density is positively correlated with the labor income share in a sample of OECD/EU countries. Proposition 2 provides a theoretical prediction whereby deunionization (a decrease in θ) gives rise to an unfavorable effect on the share of labor income, which confirms the recent empirical finding.

4. NUMERICAL EXAMINATION

In this section, we will numerically examine the effects of unionization on working hours, unemployment, growth, income inequality, and labor's share. On one hand, this numerical study ensures that our analytical results are empirically convincing. On the other hand and more importantly, it explores the steady-state effects of the elasticity of substitution between effective labor and capital $\epsilon = \frac{1}{1+\beta}$ and its role in terms of governing the effects of (de-)unionization. To the end, we calibrate the model to fit the underlying economy, generating realistic model predictions.

The benchmark parameter values are summarized in Table 1. On the consumption side, we set the time preference as $\rho = 0.04$ and the intertemporal elasticity of substitution in consumption as 0.48 (implying that $\varphi = -1.1$), which are commonly used in the literature, as in García-Peñalosa and Turnovsky (2006). Moreover, we assume that the working hours of employed workers are $\tilde{h} = 0.36$ of their time endowment and the consumption–capital ratio is $\tilde{x} = \tilde{C}/\tilde{K} = 0.25$ in the steady state, which are also located within the empirically plausible range in the real business cycle literature. With regard to the trade union, we choose $\theta = 1/2$, implying that the bargaining power of the trade union and the firms' federation is equal. Ideally, the strength of the trade union's bargaining power should be positively associated with the union density and/or the collective bargaining coverage (which refers to the proportion of the workforce whose pay is determined by union-firm negotiations). Nonetheless, the evidence [see, for example, OECD (2004a)] shows that these two measures exhibit different trends (particularly in the European Union area), and collective bargaining coverage is usually much higher than union density. Without loss of generality, it may be reasonable to set

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$\theta = 1/2$ as a baseline. The unemployment benefit–output ratio is set as $s = 0.58$, given the fact that in practice the replacement rates of unemployment benefit are quite varied, depending on different countries and unemployment spells.[9] In addition, the steady-state employment rate is specified as $\tilde{l} = 92\%$, implying that the equilibrium unemployment rate is $\tilde{u} = 8\%$. This specification is plausible, because during the period 2000–2012 the average unemployment rate of the 27 EU countries was around 8.8% (calculated from Eurostat).

On the production side, in line with Lingens (2003) and Chatterjee and Turnovsky (2012), we set $\alpha_E = 0.6$ and $\alpha_k = 0.4$. Moreover, we choose $\beta = 0.429$, meaning that the elasticity of substitution between effective labor and capital $\epsilon = 0.7$. This is consistent with the finding of Klump et al. (2007), who estimate that the elasticity of factor substitution is around 0.7, or precisely 0.699 for the United States during 1953–2002 and 0.669 for the European area during 1970–2003. Similarly to the specification of García-Peñalosa and Turnovsky (2006), the steady-state labor income share is set as $\tilde{S}_E = 0.66$. Accordingly, from (20) and (33), we can calculate that $\alpha = 0.874$ and $\upsilon = 0.501$. Given the two parameters and $\tilde{x} = 0.25$ specified earlier, (25), (26) with $\dot{x} = 0$, and (28) enable us to further compute that $A = 0.495$, $\eta = 1.4$, and $\tilde{\gamma} = 1.3\%$. Although the balanced-growth rate $\tilde{\gamma}$ is plausible, $\eta = 1.4$ implies that the intertemporal elasticity of labor supply is around 0.79, which conforms to the empirical survey of Chetty et al. (2011), in which the plausible range is (0.75, 4). With regard to income inequality, we follow García-Peñalosa and Turnovsky (2006) and choose $\sigma_y = 32.88\%$ (referring to the Gini coefficient in practice). Thus, we have $\Omega = 0.17$ in the steady state, implying that in conformity with the common evidence, the standard deviation of wealth $\sigma_k (= 193.41\%)$ is larger than that of income σ_y.

Under the selected and computed parameters based on the benchmark model, we then have

Result 1 (Elasticity of Factor Substitution). In the presence of a higher elasticity of substitution between effective labor and capital ϵ, the income inequality and balanced-growth rate increase, whereas the labor income share declines in the steady state. In particular, the steady-state employment rate decreases, but labor hours increase, implying that there exists a more intensive labor force margin.

As shown in Figure 1, given our parameterization, if the elasticity of substitution between labor and capital ϵ is higher, the income distribution becomes more unequal ($\tilde{\sigma}_y$ increases). The reason is that in the face of a higher ϵ, the firm is inclined to use more capital to substitute for labor, because the employer has the right to determine the capital level unilaterally, but the employment level has to be negotiated with the trade union. An increase in the firm's demand for capital raises the return rate on capital and lowers the return rate on labor. Because labor is more equally distributed than capital, this then expands the income dispersion. Meanwhile, because the returns on labor decrease and labor is replaced by capital, the labor income share $\tilde{S}_E$ declines. However, when the economy accumulates more capital (the steady-state consumption–capital ratio

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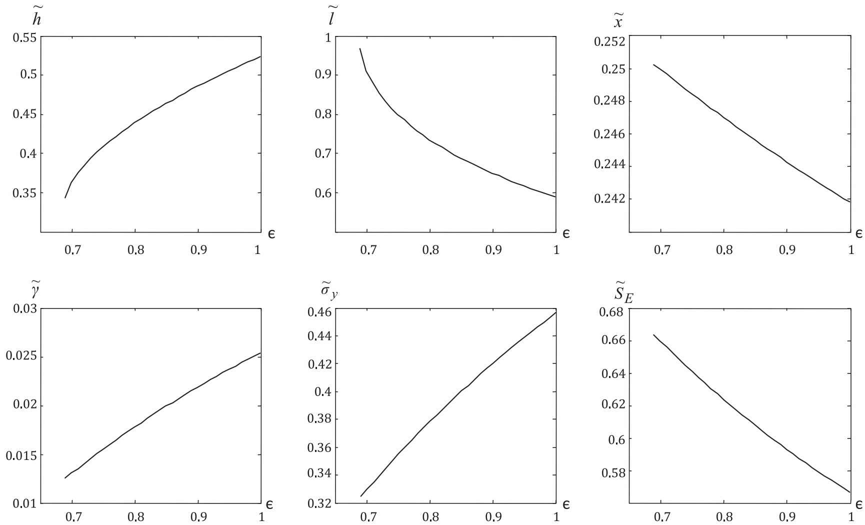

FIGURE 1. Effects of the elasticity of substitution.

$\tilde{x}$ decreases), the balanced-growth rate $\tilde{\gamma}$ increases in response. Once labor is replaced by capital more easily, the optimizing firms tend to decrease the number of workers (the employment rate $\tilde{l}$), but use these employed workers more intensively (increase the working time $\tilde{h}$). Therefore, there exists a more intensive labor force margin in response to a higher elasticity of factor substitution.

Figure 2 shows that the analytical results of the comparative statics on unionization are confirmed numerically: a higher bargaining power of the union θ increases

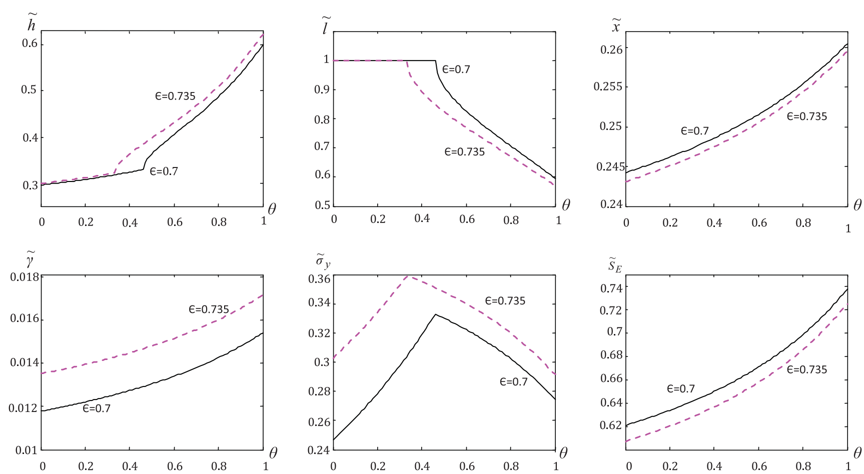

FIGURE 2. Effects of unionization under various elasticity of factor substitutions ϵ.

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TABLE 2. Effects of an increase in unionization θ by 5%

	Long-run changes (%)				
Elasticity ϵ	$\Delta\tilde{h}$	$\Delta\tilde{l}$	$\Delta\tilde{\gamma}$	$\Delta\tilde{\sigma}_y$	$\Delta\tilde{S}_E$
0.69	5.29	−4.76	0.8	−0.59	0.39
0.7	3.19	−2.83	0.77	−0.58	0.41
0.735	2.06	−1.74	0.68	−0.55	0.42

the steady-state labor hours $\tilde{h}$, unemployment rate $\tilde{u}(= 1 - \tilde{l})$, labor share $\tilde{S}_E$, and growth rate $\tilde{\gamma}$, and it has an ambiguous effect on income inequality $\tilde{\sigma}_y$ (exhibiting an inverted-U relationship). Of particular interest, we find that the macroeconomic effects of unionization are crucially related to the elasticity of factor substitution ϵ. The finding is summarized as follows.

Result 2 (Effects of Unionization under Various Elasticities of Substitution). Under a higher (resp. lower) elasticity of substitution between effective labor and capital, the steady-state effects of unionization on growth, income inequality, employment, and working hours are attenuated (resp. amplified), whereas the labor share effect becomes more (resp. less) pronounced.

The intuition for Result 2 is straightforward. Given that capital can substitute for labor more easily (the elasticity of substitution is raised by 5% from the benchmark value of 0.7 to 0.735) and that the employer has the right to determine capital levels unilaterally, it turns out that the influence of the trade union on the bargaining consequences (bargained wage and employment) becomes attenuated. Thus, the effects of a rise in the degree of unionization on both employment and working hours are weakened as well. As indicated in Table 2, in response to an increase in θ by 5% (from 0.5 to 0.525), the employment rate decreases by 1.74% (2.83%) and the working time increases by 2.06% (3.19%) in the case with a higher $\epsilon = 0.735$ (a lower $\epsilon = 0.7$ in the benchmark). Once the labor force effect becomes smaller, the impacts of unionization on growth and income inequality also become less pronounced. To be specific, the balanced-growth rate increases by 0.68% (0.77%) and the standard deviation of income σ_y decreases by 0.55% (0.58%) in the case with a higher $\epsilon = 0.735$ (a lower $\epsilon = 0.7$). In addition, our numerical study predicts that because the firm can use capital to substitute for labor more easily, in response to a higher bargaining power of the trade union, the increase in the labor income share becomes more significant ($\tilde{S}_E$ increases by 0.41% in the case with a lower $\epsilon = 0.7$, whereas it increases by 0.42% in the case with a higher $\epsilon = 0.735$).[10] This gives rise to an implication: because of the fact of deunionization, the decline in the labor income share will be more pronounced in the countries with a higher elasticity of substitution between labor and capital.

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5. CONCLUDING REMARKS

In this paper we have developed a trade union model in which unemployment, growth, and income inequality are interdependent and endogenously determined. Analytically, it has been shown that the effective labor force exhibits an intensive margin response: in response to an increase in the degree of unionization, the number of employed workers decreases, but each individual employed worker provides more working hours. This intensive margin response leads to the possibility of the coexistence of high unemployment and high growth. In addition, unionization gives rise to an ambiguous effect on income inequality, depending on the relative magnitude of the direct unionization effect and indirect labor force effect. This ambiguity has enabled us to reconcile the disparity in the empirical findings.

A simple numerical analysis has been conducted to ensure that our analytical results are empirically convincing. We have found that a higher elasticity of substitution between labor and capital is associated with higher steady-state income inequality and economic growth, but results in a lower labor income share. Moreover, the economy exhibits a more intensive labor force margin. We have also shown that because capital can substitute for labor more easily and the employer has the right to determine capital levels unilaterally, the influence of the trade union on the bargained wage and employment becomes attenuated. Therefore, the effects of unionization on growth, income inequality, employment, and working hours are less pronounced, if the elasticity of substitution is higher. Nevertheless, because the firm can use capital to substitute for labor more easily, the impact of (de-)unionization on the labor income share is reinforced. This result predicts that because of deunionization, the decline in the labor income share will be more pronounced in those countries with a higher elasticity of substitution between labor and capital.

NOTES

1. See Section 3.3 for detailed discussions.
2. Caballero (1993) indicates a positive unemployment–growth relationship in both the United Kingdom and the United States between 1966 and 1989.
3. Analytically, Corneo and Marquardt (2000) point to a nonmonotonic relationship between unemployment and growth in response to a change in public pensions. Ono (2010) further indicates that public pensions produce no trade-off between unemployment and growth in a lump-sum pension system where both the employed and the unemployed receive pensions.
4. The CES production function and the related numerical analysis were suggested by an anonymous referee, whose insightful points of view have led to a much improved paper, for which we are very grateful.
5. This specification is similar to that of Barro and Sala-i-Martin (2004, Chap. 2, p. 82).
6. See Booth (1995) for the details.
7. The weight k_i can be thought simply of as the household's shareholding divided by the stock market value of the firm.
8. The transversality condition $\lim_{t\to\infty} \lambda K e^{-\rho t} = 0$ indicates that the equilibrium rate of return on capital must exceed the equilibrium growth rate; i.e., $r > \gamma_K$. From (28), this implies that the condition $\frac{whl}{K} + \frac{\pi}{K} - \frac{C}{K} < 0$ holds true. Equivalently, $h - \frac{1}{l(1+\eta)} < 0$ is valid.

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9. According to the survey conducted by the OECD Employment Outlook (2007), on average the unemployment benefit–income ratio is around 50% for 1-year unemployed workers and the corresponding ratio is around 45% for 2-year unemployed workers. From the Benefits and Wages, OECD Indicators (2004b), the unemployment benefit replacement rate by family for the average production worker (including family and housing benefits) is around 67%.

10. As shown in Figure 2, $\tilde{\sigma}_y$ is at its highest when the union's power θ is around 0.47, which is very close to the benchmark value $\theta = 0.5$. Thus, an increase in θ from the benchmark value has an unambiguously negative effect on income inequality, given that the unionization–income inequality relationship exhibits an inverted-U shape.

REFERENCES

Aghion, Philippe and Peter Howitt (1992) A model of growth through creative destruction. *Econometrica* 60, 323–351.

Aghion, Philippe and Peter Howitt (1994) Growth and unemployment. *Review of Economic Studies* 61, 477–494.

Alesina, Alberto and Dani Rodrik (1994) Distributive politics and economic growth. *Quarterly Journal of Economics* 109, 465–490.

Algan, Yann, Arnaud Cheron, Jean-Olivier Hairault, and Francois Langot (2003) Wealth effect on labor market transitions. *Review of Economic Dynamics* 6, 156–178.

Arpaia, Alfonso and Karl Pichelmann (2008) Dimensions of Inequality in the EU. OeNB (Oesterreichische National Bank) workshop paper 16.

Asteriou, Dimitrios and Vassilis Monastiriotis (2001) Trade Unionism and Growth: A Panel Data Study. Henley Business School, Reading.

Atkinson, Anthony B. (2008) *The Changing Distribution of Earnings in OECD Countries.* Oxford, UK: Oxford University Press.

Baccaro, Lucio and Richard M. Locke (1998) End of solidarity? The decline of egalitarian wage policies in Italy and Sweden. *European Journal of Industrial Relations* 4, 283–308.

Barro, Robert J. (2000) Inequality and growth in a panel of countries. *Journal of Economic Growth* 5, 5–32.

Barro, Robert J. and Xavier I. Sala-i-Martin (2004) *Economic Growth*. Cambridge, MA: MIT Press.

Bean, Charles R. (1994) European unemployment: A survey. *Journal of Economic Literature* 32, 573–619.

Bean, Charles R. and Christopher Pissarides (1993) Unemployment, consumption and growth. *European Economic Review* 37, 837–859.

Bertola, Giuseppe, Francine D. Blau, and Lawrence M. Kahn (2002) Comparative analysis of labor market outcomes: Lessons for the US from international long-run evidence. In Alan B. Krueger and Rober Solow (eds.), *The Roaring Nineties: Can Full Employment be Sustained*? pp. 159–218. New York: Russell Sage and Century Foundations Press.

Bjorklund, Anders and Richard B. Freeman (2010) Searching for optimal inequality/incentives. In Richard B. Freeman, Birgitta Swedenborg, and Robert Topel (eds.), *Reforming the Welfare State: Recovery and Beyond in Sweden,* pp. 25–56. National Bureau of Economic Research. Chicago: University of Chicago Press.

Booth, Alison L. (1995) *The Economics of the Trade Union.* Cambridge, UK: Cambridge University Press.

Brown, Charles and James Medoff (1978) Trade unions in the production process. *Journal of Political Economy* 86, 355–378.

Caballero, Ricardo J. (1993) Comment on Bean and Pissarides. *European Economic Review* 37, 855–859.

Card, David (1996) The effect of unions on the structure of wages: A longitudinal analysis. *Econometrica* 64, 957–979.

https://doi.org/10.1017/S1365100514000443 Published online by Cambridge University Press

Card, David, Thomas Lemieux, and W. Craig Riddell (2004) Unions and wage inequality. *Journal of Labor Research* 25, 519–562.
Carroll, Christopher D. (2001) A theory of the consumption function, with and without liquidity constraints. *Journal of Economic Perspectives* 15, 23–45.
Chang, Juin-Jen, Ming-Fu Shaw, and Ching-Chong Lai (2007) A "managerial" trade union and economic growth. *European Economic Review* 51, 365–384.
Chatterjee, Santanu and Stephen J. Turnovsky (2012) Infrastructure and inequality. *European Economic Review* 56, 1730–1745.
Chetty, Raj, Adam Guren, Day Manoli, and Andrea Weber (2011) Are micro and macro labor supply elasticities consistent? A review of evidence on the intensive and extensive margins. *American Economic Review: Papers and Proceedings* 101, 471–475.
Clark, Kim B. (1980) The impact of unionisation on productivity: A case study. *Industrial and Labour Relations Review* 33, 451–469.
Clark, Andrew (1990) Efficient bargains and the McDonald–Solow conjecture. *Journal of Labor Economics* 8, 502–528.
Clark, Andrew and Andrew J. Oswald (1989) An Empirical Study of Union Preferences. Center for Labour Economics discussion paper 352.
Corneo, Giacomo and Marko Marquardt (2000) Public pensions, unemployment insurance and growth. *Journal of Public Economics* 75, 293–311.
Daveri, Francesco and Guido Tabellini (2000) Unemployment, growth and taxation in industrial countries. *Economic Policy* 30, 47–104.
DiNardo, John, Nicole M. Fortin, and Thomas Lemieux (1996) Labor market institutions and the distribution of wages, 1973–1992: A semiparametric approach. *Econometrica* 65, 1001–1044.
Domenech, Rafael and Jose R. Garcia (2008) Unemployment, taxation and public expenditure in OECD economies. *European Journal of Political Economy* 24, 202–217.
Edin, Per-Anders and Bertil Holmlund (1995) The Swedish wage structure: The rise and fall of solidarity wage policy? In Richard Freeman and Lawrence Katz (eds.), *Differences and Changes in Wage Structures,* pp. 307–344. Chicago: University of Chicago Press.
Eriksson, Clas (1997) Is there a trade-off between employment and growth? *Oxford Economic Papers* 49, 77–88.
European Commission (2007) The labour income share in the European union. In *Employment in Europe 2007*, pp. 237–272. Luxembourg: Office for Official Publications of the European Communities.
Forbes, Kristin J. (2000) A reassessment of the relationship between inequality and growth. *American Economic Review* 90, 869–887.
Fortin, Nicole M. and Thomas Lemieux (1997) Institutional changes and rising wage inequality: Is there a linkage? *Journal of Economic Perspectives* 11, 75–96.
Francis, Johanna L. (2009) Wealth and the capitalist spirit. *Journal of Macroeconomics* 31, 394–408.
Freeman, Richard B. (1996) Labor market institutions and earnings inequality. *New England Economic Review* May/June, 157–168.
García-Peñalosa, Cecilia and Stephen J. Turnovsky (2006) Growth and income inequality: A canonical model. *Economic Theory* 28, 25–49.
Gordon, Robert J. (1997) The time-varying NAIRU and its implications for economic policy. *Journal of Economic Perspectives* 11, 11–32.
Gregg, Paul, Stephen Machin, and David Metcalf (1993) Signals and cycles: Productivity growth and changes in union status in British companies, 1984–1989. *Economic Journal* 103, 894–907.
Guscina, Anastasia (2006) Effects of Globalization on Labor's Share in National Income. IMF working paper 06/294.
Gustavsson, Magnus (2007) The 1990s rise in Swedish earnings inequality-Persistent or transitory? *Applied Economics* 39, 25–30.
Hendricks, Lutz (2004) Accounting for Patterns of Wealth Inequality. CESIfo (Center for Financial Studies), Iowa State University, working paper.

https://doi.org/10.1017/S1365100514000443 Published online by Cambridge University Press

Holtz-Eakin, Douglas, David Joulfaian, and Harvey S. Rosen (1993) The Carnegie conjecture: Some empirical evidence. *Quarterly Journal of Economics* 108, 413–435.

International Labour Office (ILO) (2008) Labour institutions and inequality. In *World of Work Report 2008*, pp. 71–114. Geneva: International Labour Office.

Irmen, Andreas and Berthold U. Wigger (2003) Trade union objectives and economic growth. *Finanz-Archiv/Public Finance Analysis* 59, 49–67.

Jayadev, Arjun (2007) Capital account openness and the labor share of income. *Cambridge Journal of Economics* 31, 423–443.

Kahn, Lawrence M. (2000) Wage inequality, collective bargaining, and relative employment from 1985 to 1994: Evidence from fifteen OECD countries. *Review of Economics and Statistics* 82, 564–579.

Kaldor, Nicholas (1957) A model of economic growth. *Economic Journal* 67, 591–624.

Karabarbounis, Loukas and Brent Neiman (2014) The global decline of the labor share. *Quarterly Journal of Economics* 129, 61–103.

Klump, Rainer, Peter McAdam, and Alpo Willman (2007) The long-term SucCESs of the neoclassical growth model. *Oxford Review of Economic Policy* 23, 94–114.

Koeniger, Winfried, Marco Leonardi, and Luca Nunziata (2007) Labor market institutions and wage inequality. *Industrial and Labor Relations Review* 60, 340–356.

Kuznets, Simon (1955) Economic growth and income inequality. *American Economic Review* 45, 1–28.

Lemieux, Thomas, W. Bentley MacLeod, and Daniel Parent (2009) Performance pay and wage inequality. *Quarterly Journal of Economics* 124, 1–49.

Lingens, Jorg (2003) The impact of a unionised labour market in a Schumpeterian growth model. *Labour Economics* 10, 91–104.

Lundberg, Mattias and Lyn Squire (2003) The simultaneous evolution of growth and inequality. *Economic Journal* 113, 326–344.

Maarek, Paul (2012) Labor Share, Informal Sector and Development. MPRA paper 38756.

Machin, Stephen (1997) The decline of labour market institutions and the rise in wage inequality in Britain. *European Economic Review* 41, 647–657.

McDonald, Ian M. and Robert M. Solow (1981) Wage bargaining and employment. *American Economic Review* 71, 896–908.

Mezzetti, Claudio and Elias Dinopoulos (1991) Domestic unionization and import competition. *Journal of International Economics* 31, 79–100.

Nickell, Stephen (1997) Unemployment and labor market rigidities: Europe versus North America. *Journal of Economic Perspectives* 11, 55–74.

Nickell, Stephen and Richard Layard (1998) Labour Market Institutions and Economic Performance. LSE: CEP discussion paper 407.

Nickell, Stephen J., Sushil Wadhwani, and Martin Wall (1989) Unions and Productivity Growth in Britain, 1974–86: Evidence from Company Accounts Data. LSE: CLE working paper 1149.

OECD (2004a) Wage-setting institutions and outcomes. In *Employment Outlook* 2004, pp. 127–181.

OECD (2004b) Benefits and wages: OECD indicators. In *Directorate for Employment, Labour and Social Affairs*. Available at http://www.oecd.org/els/benefitsandwagesoecdindicators.htm.

OECD (2007) *Employment Outlook* 2007.

OECD (2011) An overview of growing income inequalities in OECD countries: Main findings. In *Divided We Stand: Why Inequality Keeps Rising*, pp. 21–45. Paris: OECD Publishing. Available at http://dx.doi.org/10.1787/9789264119536-en.

OECD (2012) Reducing income inequality while boosting economic growth: Can it be done? In *Economic Policy Reforms 2012: Going for Growth*, pp. 181–202.

Ono, Tetsuo (2010) Growth and unemployment in an OLG economy with public pensions. *Journal of Population Economics* 23, 737–767.

Palokangas, Tapio (1996) Endogenous growth and collective bargaining. *Journal of Economic Dynamics and Control* 20, 925–944.

Pemberton, James (1988) A "managerial" model of the trade union. *Economic Journal* 98, 755–771.

https://doi.org/10.1017/S1365100514000443 Published online by Cambridge University Press

Ramos-Parreño, J. Maria and Fernando Sánchez-Losada (2002) The role of unions in an endogenous growth model with human capital. *Journal of Macroeconomics* 24, 171–192.
Saint-Paul, Gilles (1991) Productivity Growth and Unemployment in OECD Countries. Paris: DELTA working paper 91-09.
Schulten, Thorsten (2002) A European solidaristic wage policy? *European Journal of Industrial Relations* 8, 173–196.
Shister, Joseph (1954) Trade-unionism, collective bargaining, and economic growth. *American Economic Review* 44, 214–227.
Smeeding, Timothy M. (2002) Globalisation, inequality and the rich countries of the G-20: Evidence from the Luxembourg income study. In David Gruen, Terry O'Brien, and Jeremy Lawson (eds.), *Globalization, Living Standards and Inequality: Recent Progress and Continuing Challenges*, pp. 179–206. Sydney: Reserve Bank of Australia.
Van der Ploeg, F. (1987) Trade unions, investment and employment: A non-cooperative approach. *European Economic Review* 31, 1465–1492.
Visser, Jelle and Daniele Checchi (2009) Inequality and the labor market: Unions. In Wiemer Salverda, Brian Nolan, and Timothy M. Smeeding (eds.), *The Oxford Handbook of Economic Inequality*, pp. 230–256. Oxford, UK: Oxford University Press.
Wallerstein, Michael (1999) Wage-setting institutions and pay inequality in advanced industrial societies. *Journal of Political Science* 43, 649–680.

APPENDIX

A.1. DERIVATIVES OF EQUATION (23)

From (22) and (20), we can obtain

$$\frac{\partial l}{\partial x} \equiv l_x = \frac{-\alpha\beta\alpha_E\alpha_k(hl)^{-\beta-1}l}{x\Gamma[\alpha_E(hl)^{-\beta}+\alpha_k]^2} > 0,$$

$$\frac{\partial l}{\partial \theta} \equiv l_\theta = \frac{(1-\alpha)l}{\Gamma(1-\theta+\theta\upsilon)^2}\left\{\frac{\upsilon\alpha\beta\alpha_E\alpha_k(hl)^{-\beta-1}}{[\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k}+\frac{\theta\upsilon(1\text{-}\alpha)}{1-\theta+\theta\upsilon}][\alpha_E(hl)^{-\beta}+\alpha_k]^2} - (1-\upsilon)\Psi\right\} < 0,$$

$$\frac{\partial l}{\partial s} \equiv l_s = -\frac{l(2-l)}{2s(1-l)} < 0,$$

$$\frac{\partial h}{\partial x} \equiv h_x = \frac{1}{x\Gamma}\left\{\frac{\alpha\beta\alpha_E\alpha_k(hl)^{-\beta-1}}{[\alpha_E(hl)^{-\beta}+\alpha_k]^2}h + 2s(1-l)\right\} < 0,$$

$$\frac{\partial h}{\partial \theta} \equiv h_\theta = \frac{(1-\alpha)}{\Gamma(1-\theta+\theta\upsilon)^2}\left[(1-\upsilon)h\Psi - \frac{\upsilon\left\{\frac{\alpha\beta\alpha_E\alpha_k(hl)^{-\beta-1}}{[\alpha_E(hl)^{-\beta}+\alpha_k]^2}h + 2s(1-l)\right\}}{\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k}+\frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}}\right] > 0,$$

$$\frac{\partial h}{\partial s} \equiv h_s = \frac{(2-l)h}{2s(1-l)} > 0,$$

where

$$\Psi = \frac{1}{hl}\left[\frac{-1}{1-hl}+\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k}\right] - \frac{\frac{\alpha\beta\alpha_E\alpha_k(hl)^{-\beta-1}}{[\alpha_E(hl)^{-\beta}+\alpha_k]^2}}{\frac{\alpha\alpha_E(hl)^{-\beta}}{\alpha_E(hl)^{-\beta}+\alpha_k}+\frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}} < 0 \text{ and } \Gamma = 2sl(1-l)\Psi < 0.$$

■

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A.2. PROOF OF PROPOSITION 1

It follows from Appendix A.1 that unionization θ has an unambiguously positive effect on the effective labor force; i.e.,

$$\frac{\partial(\tilde{h}\tilde{l})}{\partial\theta} = \frac{-2s\upsilon\tilde{l}\tilde{x}(1-\alpha)(1-\tilde{l})}{D\Gamma(1-\theta+\theta\upsilon)^2[\frac{\alpha\alpha_E(\tilde{h}\tilde{l})^{-\beta}}{\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k} + \frac{\theta\upsilon(1-\alpha)}{1-\theta+\theta\upsilon}]} > 0.$$

Given that and the definition of $\tilde{u} = 1 - \tilde{l}$, (23), (25), (26) with $\dot{x} = 0$, and (32) allow us to derive

$$\frac{\partial\tilde{\gamma}}{\partial\theta} = \frac{\alpha\alpha_E\alpha_k(\alpha+\beta)(\tilde{h}\tilde{l})^{-\beta-1}}{1-\varphi} A[\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k]^{-\frac{\alpha}{\beta}-2} \cdot \frac{\partial(\tilde{h}\tilde{l})}{\partial\theta} > 0,$$

$$\frac{\partial\tilde{h}}{\partial\theta} = \frac{\tilde{x}}{D}\Bigg(h_\theta - \tilde{h}\Theta\alpha\alpha_E A(\tilde{h}\tilde{l})^{-\beta-1}[\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k]^{-\frac{\alpha}{\beta}-1}$$
$$\times\left\{\frac{\alpha_k(\alpha+\beta)}{(1-\varphi)[\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k]} - 1\right\}\Bigg) > 0,$$
$$\frac{\partial\tilde{u}}{\partial\theta} = -\tilde{l}_\theta = -\frac{\tilde{x}}{D}\Bigg(l_\theta + \tilde{l}\Theta\alpha\alpha_E A(\tilde{h}\tilde{l})^{-\beta-1}[\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k]^{-\frac{\alpha}{\beta}-1}$$
$$\times\left\{\frac{\alpha_k(\alpha+\beta)}{(1-\varphi)[\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k]} - 1\right\}\Bigg) > 0,$$
$$\frac{\partial\tilde{\sigma}_y}{\partial\theta} = \frac{1}{\tilde{h}\tilde{l}(1+\eta)}\left(\left\{\frac{w}{Y} + \frac{\alpha\beta\alpha_E\alpha_k(\tilde{h}\tilde{l})^{-\beta-1}}{[\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k]^2}\right\}\frac{\partial(\tilde{h}\tilde{l})}{\partial\theta} - \frac{\upsilon(1-\alpha)}{(1-\theta+\theta\upsilon)^2}\right)\sigma_k \gtreqless 0.$$

where $\Theta \equiv l_\theta h_z - l_z h_\theta = \frac{-2s\tilde{l}(1-\alpha)(1-\tilde{l})(1-\upsilon)\Psi}{\Gamma^2\tilde{x}(1-\theta+\theta\upsilon)^2} > 0$. Finally, from (33), we can obtain

$$\frac{\partial\tilde{S}_E}{\partial\theta} = \frac{\tilde{x}\upsilon(1-\alpha)\left\{\Psi\left(\frac{D}{\tilde{x}}-1\right) + \frac{1}{\tilde{h}\tilde{l}}\left[\frac{-1}{1-\tilde{h}\tilde{l}} + \frac{\alpha\alpha_E(\tilde{h}\tilde{l})^{-\beta}}{\alpha_E(\tilde{h}\tilde{l})^{-\beta}+\alpha_k}\right]\right\}}{D\Psi(1-\theta+\theta\upsilon)^2} > 0.$$

Note that given the stability condition, $(\frac{D}{\tilde{x}} - 1) > 0$ holds true. ■

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