Can Higher Wages for Foreign Workers Increase the Welfare of the Natives?

von

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Abstract

This paper analyzes the consequences of an increase in the minimum wage for foreign workers in the construction sector, being implied by the EU Posted Workers Directive. Due to the rising price of construction services, the factor demand for construction services and the capital-labor ratio in the tradeable good sector fall. The wage rate in this sector declines. Although the share of domestic workers increases with respect to both foreign workers and capital in the construction sector, the unemployment rate among domestic construction workers rises. Unemployment can change in either direction. The natives lose with respect to both aggregate income and welfare.

JEL classification: F20, J38, J61, J68
Key words: Minimum wages, temporary migration, non-traded goods
1 Introduction

In many European countries, domestic workers suspect that immigration does not only lead to a lower wage level, but also increases unemployment among the natives. Models with full employment generally show that possible losses of native workers are more than compensated by gains of domestic capital owners (Berry and Soligo (1969), Khang (1990)). However, the analysis of Brecher and Choudri (1987) confirms the nightmare of European trade unions: since natives have a higher reservation wage, every immigrant will displace one domestic worker. While the hostile attitude towards foreigners is often mirrored in a restrictive migration policy, citizens of the European Union are entitled to work wherever they want. This has led to conflicts in the construction sectors of the high-wage countries France and Germany, where temporary migrants from Portugal, Ireland and the United Kingdom, the so-called posted workers, have been employed on a large scale (Eekhoff (1996), Noll (1996), Eichhorst (1998)). At the same time, unemployment among domestic construction workers was considerable (Noll (1996), Straubhaar (1996ab)). Since the wages of the posted workers lay far below the levels of their domestic colleagues (Eekhoff (1996)), the trade unions opposed against “wage dumping”. Political pressure initiated the adoption of the Posted Workers Directive by the European Union at the end of 1996. The main content of this directive is that labor contracts between firms and workers who are sent temporarily abroad within the EU are subject to the minimum wage rulings of the host country (for details see Davies (1997)). In Germany, the parliament accepted a Posted Workers Law for workers in the construction sector in the same year. Trade unions and employers in the construction sector introduced a new low-wage group of workers in their wage contract. The corresponding wage was declared binding for all workers and firms in this sector. Since the directive will mainly be applied in the construction sector, its economic consequences are similar to the impacts of the German Posted Workers Law.

This paper analyzes the consequences of the directive in the host country. In the model, we consider an increase in the exogenous minimum wage of foreign workers. This change is not neutralized by side payments between employers and posted workers (Straubhaar (1996a), Rotte and Zimmermann (1998)). We investigate the impacts on employment of both native and posted workers, the wage rate in the non-construction part of the economy,
relative prices, the allocation of capital and the welfare of both the natives and the foreign workers.

The paper is related to the literature on the consequences of migration in the presence of unemployment in the receiving country (Rivera-Batiz (1981), Brecher and Choudri (1987), Djajić (1993), Schmidt et al. (1994), and Razin and Sadka (1995)). Given the specific structure of the problem, none of these models seems appropriate when dealing with the issues raised by the Posted Workers Directive. The analysis combines the view of a small open economy with non-traded goods (Rivera-Batiz (1982)) with the idea that migrants and natives are imperfect substitutes in production (Ethier (1985)). Moreover, it is taken into account that the good produced in the construction sector plays a double role as consumption good and production input. In a companion article (Meier (1999)), it has been shown that the increase in the wage rate of posted workers can indeed yield less unemployment and a higher welfare level of the natives. The contribution of the current paper is that allowing for mobility of domestic workers across sectors yields completely different results with respect to conditions for reducing unemployment. In addition, it removes the possibility of a rising welfare level.

A two-sector model of a small open economy is considered. Posted workers are only found in the sector that produces a good which is not traded internationally. In this sector, being interpreted as the construction sector, the wages of both domestic and foreign workers are fixed. The non-traded good is not only consumed, but also serves as an input for the tradeable good. The consequences of an increase in the posted workers' wage are analyzed.

The increase in their wage raises the unit cost of the non-traded good which implies a higher price. This yields a lower demand for construction services by the traded good sector. Moreover, the wage rate in this sector falls, and the capital-labor ratio declines. In the non-traded good sector, less foreigners will be employed. Production is restructured in favor of domestic labor, where the ratio between capital and domestic labor decreases. The lower wage rate in the traded good sector induces a relocation of domestic workers towards the construction sector, which yields an increased unemployment rate among natives in that sector.

Even if the employment of natives rises, their total income must decline since all domestic workers lose with respect to expected income. In addition, the welfare of the natives will deteriorate due to the higher price of the non-traded good. The impact on the wage bill of the posted workers is ambiguous.
2 The model

The economy consists of two sectors. The first sector produces a traded good which is the numeraire, while the second good, construction services, is not tradeable. Posted workers are only employed in the second sector. The output of the first sector, $X_1$, is produced with capital $K_1$, labor $L_1$ and construction services $X_2^1$. The production function $X_1 = X_1(K_1, L_1, X_2^1)$ is strictly increasing in each argument, strictly quasi-concave, and exhibits constant returns to scale. All pairs of factors are q-complements, i.e. all cross-partial derivatives of the production function satisfy $X_{1ij} > 0$ for $i \neq j$, $i, j \in \{K_1, L_1, X_2^1\}$. Profits in the first sector are

$$\pi_1 = X_1(K_1, L_1, X_2^1) - rK_1 - w_1L_1 - P_2X_2^1$$

where $r$, $w_1$, and $P_2$ denote the interest rate, the wage rate in the first sector, and the price of the second good, respectively. Production per worker in this sector can be written as $X_1/K_1 = f(k_1, z_1)$ with $k_1 = K_1/L_1$ and $z_1 = X_2^1/L_1$. Factors are paid their respective marginal productivities:

$$f_1(k_1, z_1) - r = 0, \quad (1)$$
$$f_2(k_1, z_1) - P_2 = 0, \quad (2)$$
$$f(k_1, z_1) - k_1f_1(k_1, z_1) - z_1f_2(k_1, z_1) - w_1 = 0, \quad (3)$$

with $f_1 := \frac{\partial f}{\partial k_1}$ and $f_2 := \frac{\partial f}{\partial z_1}$. Since $F$ is linear homogeneous and strictly quasi-concave, the function $f$ is strictly concave. In the construction sector, output $X_2$ is produced with capital $K_2$, home labor $L_2$, and foreign labor $L_F$ under constant returns to scale. The marginal productivities are positive, and the production function is strictly quasi-concave. Profits in the second sector amount to

$$\pi_2 = P_2X_2(K_2, L_2, L_F) - rK_2 - w_2L_2 - w_FL_F,$$

where $w_2$ and $w_F$ respectively denote the fixed wage rates of the domestic and foreign workers. The wage rate of foreign workers falls short of the wage rate of native workers in the construction sector, i.e. $w_2 > w_F$. While full employment in the first sector prevails, minimum wage unemployment for domestic workers occurs in the construction sector. Production per domestic
worker is given by \( \frac{X_2}{L_2} = g(k_2, z_2) \) with \( k_2 = \frac{K_2}{L_2} \) and \( z_2 = \frac{L_F}{L_2} \). Again applying the marginal productivity rule for factor prices yields

\[
P_2g_1(k_2, z_2) - r = 0, \quad (4)
\]

\[
P_2g_2(k_2, z_2) - w_F = 0, \quad (5)
\]

\[
P_2g_1(k_2, z_2) - P_2k_2g_1(k_2, z_2) - P_2z_2g_2(k_2, z_2) - w_2 = 0, \quad (6)
\]

with \( g_1 := \frac{\partial g}{\partial k_2} \) and \( g_2 := \frac{\partial g}{\partial z_2} \).

The mixed partial derivatives of the production function \( X_2 \) satisfy \( X_{2KL} \equiv \frac{\partial^2 X_2}{\partial K_2 \partial L_2} > 0 \), \( X_{2KF} \equiv \frac{\partial^2 X_2}{\partial K_2 \partial L_F} > 0 \), and \( X_{2LF} \equiv \frac{\partial^2 X_2}{\partial L_2 \partial L_F} < 0 \). Assuming foreign and domestic labor to constitute q-substitutes is certainly plausible. Moreover, given that the two types of labor are not perfect substitutes, strictly positive employment levels of both factors at different wage ratios can occur. Capital is internationally mobile and always fully employed. Every unit of capital earns the fixed world market interest rate \( r \). This implies that the natives' capital income always amounts to \( r \bar{K} \), where \( \bar{K} \) represents the stock of capital owned by natives. Households have identical homothetic preferences. This allows us to consider a representative native household maximizing its utility function \( U(C_1, C_2) \) with \( C_1 \) and \( C_2 \) denoting consumption of the first and the second good, respectively, subject to the budget constraint

\[
\pi_1 + \pi_2 + w_1 L_1 + w_2 L_2 + r \bar{K} - C_1 - P_2 C_2 = 0.
\]

Due to Euler's theorem, \( \pi_1 = \pi_2 = 0 \) holds.

Optimization leads to Marshallian consumption functions \( C_1(P_2, I) \) and \( C_2(P_2, I) \) with \( I = w_1 L_1 + w_2 L_2 + r \bar{K} \) representing the income of the natives. The foreign workers only spend their income on the tradeable good. This assumption reflects that temporary migrants usually exhibit a high savings rate. Such a behavior can be justified by preferences for consumption in their home country (Djajić and Milbourne (1988)) or just by the aim to smooth the intertemporal consumption profile (Galor and Stark (1990)). Capital owners can only repatriate their income from abroad by means of transferring units of the tradeable good. Thus, the market clearing conditions are

\[
L_2 g(k_2, z_2) - C_2(P_2, w_1 L_1 + w_2 L_2 + r \bar{K}) - L_1 z_1 = 0, \quad (7)
\]

\[
L_1 f(k_1, z_1) + r(\bar{K} - L_1 k_1 - L_2 k_2)
- C_1(P_2, w_1 L_1 + w_2 L_2 + r \bar{K}) - w_F z_2 L_2 = 0. \quad (8)
\]
Equation (7) states that the output of the non-traded good must equal the sum of consumption of this good and the factor demand of the traded good sector. The second market clearing condition (8) shows that production of the traded good plus net capital income from abroad is identical to consumption of the traded good by natives and posted workers. The equations (1)-(6) imply

\[ L_1 f(k_1, z_1) = r k_1 L_1 + w_1 L_1 + P_2 z_1 L_1, \]
\[ L_2 P_2 g(k_2, z_2) = r k_2 L_2 + w_2 L_2 + w F z_2 L_2. \]

Adding up these two equations, inserting for \( L_2 g(k_2, z_2) \) from the market clearing condition (7), and rearranging yields

\[ L_1 f(k_1, z_1) + r (K - L_1 k_1 - L_2 k_2) - w F z_2 L_2 \]
\[ - [r K + w_2 L_2 + w_1 L_1 - P_2 C_2 (P_2, w_1 L_1 + w_2 L_2 + r K)] = 0. \]

Since \( C_1(P_2, I) = I - P_2 C_2(P_2, I) \) is valid, equation (11) is equivalent to the second market clearing condition (8), which can therefore be omitted.

In contrast to the analysis in a companion paper (Meier (1999)), domestic workers are mobile within the country. As in Harris and Todaro (1970), the native workers move between sectors until the expected wages are equalized. The idea is that all jobs in the construction sector are randomly assigned to the pool of applicants in every period. In order to keep the model simple, unemployed workers do not receive social assistance payments. Hence,

\[ w_1 = w_2 \frac{L_2}{N - L_1}, \]

where \( N \) denotes the fixed number of native laborers. Note that \( 1 - \frac{L_2}{N - L_1} \) represents the unemployment rate among the natives in the construction sector. In order to create unemployment, \( w_1 < w_2 \) must hold, i.e. the construction sector exhibits a high wage level. Rearranging yields

\[ w_1 [N - L_1] - w_2 L_2 = 0. \]

The eight equations (1)-(7) and (12) determine the eight endogenous variables \( k_1, z_1, w_1, k_2, z_2, P_2, L_2, L_1 \).
3 Comparative statics

This section discusses the impacts of an increase in the foreign workers’ wage rate $w_F$. We assume that an interior solution exists which satisfies (1)-(7) and (12), and that this solution is unique.

The Jacobian of the system of equations (1)-(7) and (12) is

$$A = \begin{bmatrix}
    f_{11} & f_{12} & 0 & 0 & 0 & 0 & 0 \\
    f_{21} & f_{22} & 0 & 0 & 0 & -1 & 0 \\
    a_{31} & a_{32} & -1 & 0 & 0 & 0 & 0 \\
    0 & 0 & 0 & P_{2g_{11}} & P_{2g_{12}} & g_1 & 0 \\
    0 & 0 & 0 & P_{2g_{21}} & P_{2g_{22}} & g_2 & 0 \\
    0 & 0 & 0 & a_{64} & a_{65} & a_{66} & 0 \\
    0 & -L_1 & -C_{21}L_1 & L_2g_1 & L_2g_2 & -C_{2P} & a_{77} & -z_1 & -w_1C_{2I} \\
    0 & 0 & N - L_1 & 0 & 0 & 0 & -w_2 & -w_1
\end{bmatrix}$$

where

$$a_{31} = -k_1f_{11} - z_1f_{21},$$
$$a_{32} = -k_1f_{12} - z_1f_{22},$$
$$a_{64} = -P_2[k_2g_{11} + z_2g_{21}],$$
$$a_{65} = -P_2[k_2g_{12} + z_2g_{22}],$$
$$a_{66} = g(k_2, z_2) - k_2g_1(k_2, z_2) - z_2g_2(k_2, z_2),$$
$$a_{77} = g(k_2, z_2) - w_2C_{2I}.$$ 

Note that $f_1 = X_{1K}$, $f_{11} = X_{1KK}L_1$, $f_{12} = X_{1KL}L_1$, $f_{11}k_1 + f_{12}z_1 = X_{1KK}K_1 + X_{1KL}X_1^2 = -X_{1KL}L_1$. The last equality is implied by the rule that derivatives of a linear homogeneous function are homogeneous of degree zero. The derivatives of $g$ can be transformed in an analogous fashion.

Evaluating the determinant of the Jacobian yields

$$\Delta = [g(k_2, z_2)w_1 + w_2z_1]P_2^2 \det \begin{bmatrix}
    g_{11} & g_{12} & g_1 \\
    g_{21} & g_{22} & g_2 \\
    a_{64} & a_{65} & a_{66} \\
    P_2 & P_2 & a_{66}
\end{bmatrix} [f_{11}f_{22} - f_{21}f_{12}]$$
where
\[
\begin{vmatrix}
g_{11} & g_{12} & g_1 \\
g_{21} & g_{22} & g_2 \\
a_{64} & a_{65} & a_{66}
\end{vmatrix} = [g(k_2, z_2) - k_2 g_1 - z_2 g_2][g_{11} g_{22} - g_{21} g_{12}]
- [k_2 g_{11} + z_2 g_{21}][g_{12} g_2 - g_{22} g_1]
+ [k_2 g_{12} + z_2 g_{22}][g_{11} g_1 - g_{21} g_1]
= g(k_2, z_2)[g_{11} g_{22} - g_{21} g_{12}].
\]

Now
\[
g_{11} g_{22} - g_{12} g_{21} = L_2^2[X_{2KK} X_{2FF} - X_{2FK} X_{2KF}] > 0,
\]
\[
f_{11} f_{22} - f_{12} f_{21} = L_1^2[X_{1KK} X_{1XX} - X_{1XX} X_{1KK}] > 0
\]
hold due to the strict concavity of the functions \( f \) and \( g \). This suffices to ensure that \( \Delta > 0 \).

Proposition 1 deals with the impact of an increase in the posted workers’ wage on the price of the non-traded good and the production structure in the traded good sector.

**Proposition 1** An increase in the posted workers’ wage rate raises the price of the non-traded good, but lowers the wage rate in the traded good sector. Both the capital-labor ratio and the ratio between the input of the non-traded good and labor in this sector decrease.

**Proof:** The vector of partial derivatives of (1)-(7) with respect to \( w_F \) is
\[
b = \begin{bmatrix} 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \end{bmatrix}^T.
\]

The implicit function theorem yields the results
\[
\frac{dk_1}{dw_F} = -\frac{\Delta_{k_1 w_F}}{\Delta},
\]
\[
\frac{dz_1}{dw_F} = -\frac{\Delta_{z_1 w_F}}{\Delta},
\]
\[
\frac{dw_1}{dw_F} = -\frac{\Delta_{w_1 w_F}}{\Delta},
\]
\[
\frac{dP_2}{dw_F} = -\frac{\Delta_{P_2 w_F}}{\Delta},
\]
where $\Delta_{xwP}$ with $x \in \{k_1, z_1, w_1, P_2\}$ denotes the determinant of the matrix that arises if in matrix $A$ the column vector of partial derivatives of (1)-(7) and (12) with respect to $x$ is replaced by the vector $b$.

It turns out that

$$\Delta_{k_1wP} = -[g(k_2, z_2)w_1 + w_2z_1]f_{12}P_2 \det \begin{bmatrix} g_{11} & g_{12} \\ a_{64} & a_{65} \end{bmatrix} > 0,$$

$$\Delta_{z_1wP} = [g(k_2, z_2)w_1 + w_2z_1]f_{11}P_2 \det \begin{bmatrix} g_{11} & g_{12} \\ a_{64} & a_{65} \end{bmatrix} > 0,$$

$$\Delta_{P_2wP} = [g(k_2, z_2)w_1 + w_2z_1][f_{11}f_{22} - f_{12}f_{21}]P_2 \det \begin{bmatrix} g_{11} & g_{12} \\ a_{64} & a_{65} \end{bmatrix} < 0,$$

$$\Delta_{w_1wP} = [g(k_2, z_2)w_1 + w_2z_1][f_{11}a_{32} - f_{12}a_{31}]P_2 \det \begin{bmatrix} g_{11} & g_{12} \\ a_{64} & a_{65} \end{bmatrix} > 0,$$

since

$$f_{11}a_{32} - f_{12}a_{31} = z_1[f_{21}f_{12} - f_{11}f_{22}] < 0,$$

$$g_{11}a_{65} - g_{12}a_{64} = P_2z_2[g_{12}g_{12} - g_{11}g_{22}] < 0$$

hold due to the strict concavity of the functions $f$ and $g$. \hfill \Box

Increasing the foreign workers' wage rate yields a higher unit cost of the non-traded good which implies a higher product price. It then follows that in the traded good sector the marginal productivity of the construction input falls short of its price. Thus, the factor demand for the non-traded good will be reduced. Since all factors in the traded good sector are q-complements, the lower input of the non-traded good decreases the marginal productivities of capital and labor. Therefore, the capital-labor ratio declines, while the wage rate in this sector falls.

Proposition 2 states that the structure of production in the non-traded good sector changes in favor of domestic labor.

**Proposition 2** Increasing the wage rate of the posted workers lowers both the share of foreign workers in the non-traded good sector and their number. The ratio between capital and domestic labor in this sector decreases.

**Proof:** The implicit function theorem implies
where $\Delta_{xw_F}$ with $x \in \{k_2, z_2, L_2\}$ denotes the determinant of the matrix that arises if in matrix $A$ the column vector of partial derivatives of (1)-(7) with respect to $x$ is replaced by the vector $b$.

It turns out that

$$
\Delta_{k_2w_F} = [g(k_2, z_2)w_1 + w_2z_1][f_{11}f_{22} - f_{12}f_{21}] \det \begin{bmatrix} P_2g_{12} & g_1 \\ a_{65} & a_{66} \end{bmatrix},
$$

$$
\Delta_{z_2w_F} = -[g(k_2, z_2)w_1 + w_2z_1][f_{11}f_{22} - f_{12}f_{21}] \det \begin{bmatrix} P_2g_{11} & g_1 \\ a_{64} & a_{66} \end{bmatrix},
$$

$$
\Delta_{L_2w_F} = w_1 \det \begin{bmatrix} f_{11} & f_{12} & 0 & 0 & 0 & 0 \\ f_{21} & f_{22} & 0 & 0 & 0 & -1 \\ a_{31} & a_{32} & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{64} & a_{65} & a_{66} \\ 0 & -L_1 & -C_{21}L_1 & L_2g_1 & L_2g_2 & -C_{2P} \\
\end{bmatrix} + [N - L_1][z_1 + w_1C_{21}][f_{11}a_{32} - f_{12}a_{31}]P_2[g_{11}a_{65} - g_{12}a_{64}].
$$

Evaluating the determinants yields

$$
P_2g_{11}a_{66} - g_{1}a_{64} = P_2 \left[ g_{11}[g(k_2, z_2) - z_2g_2] + g_1z_2g_{21} \right] = P_2 \left[ g_{11}P_2 + g_1[k_{2}g_{11} + z_2g_{21}] \right] < 0,
$$

$$
P_2g_{12}a_{66} - g_{1}a_{65} = P_2 \left[ g_{12}[g(k_2, z_2) - z_2g_2] + g_1z_2g_{22} \right] = P_2 \left[ g_{12}P_2 + g_1[k_{2}g_{12} + g_{22}z_2] \right] > 0,
$$

since $g_{11} = L_2X_{2KK} < 0$, $g_{12} = L_2X_{2KF} > 0$, $g_{11}k_2 + g_{21}z_2 = -L_2X_{2KL} < 0$, and $g_{12}k_2 + g_{22}z_2 = -L_2X_{2LF} > 0$. Noting that $f_{11}f_{22} - f_{12}f_{21} > 0$, this shows that $\frac{dk_2}{dw_F} < 0$ and $\frac{dz_2}{dw_F} < 0$. 

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Furthermore,

\[
\begin{bmatrix}
    f_{11} & f_{12} & 0 & 0 & 0 & 0 \\
    f_{21} & f_{22} & 0 & 0 & 0 & -1 \\
    a_{31} & a_{32} & -1 & 0 & 0 & 0 \\
    0 & 0 & 0 & P_2 g_{11} & P_2 g_{12} & g_1 \\
    0 & 0 & 0 & a_{64} & a_{65} & a_{66} \\
    0 & -L_1 & -C_{21} L_1 & L_2 g_1 & L_2 g_2 & -C_{2P}
\end{bmatrix} = \]

\[-[f_{11} f_{22} - f_{21} f_{12}] \det \begin{bmatrix}
    P_2 g_{11} & P_2 g_{12} & g_1 \\
    a_{64} & a_{65} & a_{66} \\
    L_2 g_1 & L_2 g_2 & -C_{2P}
\end{bmatrix}
\]

\[-[f_{11} [-a_{32} C_{21} L_1 - L_1] + f_{12} a_{31} C_{21} L_1] P_2 [g_{11} a_{65} - g_{12} a_{64}] = \]

\[f_{11} f_{22} - f_{12} f_{21} \left[ -C_{2P} P_2^2 z_2 [g_{11} g_{22} - g_{12} g_{21}] \right. \]

\[ -L_2 P_2 \left[ g_1 \left[ g_{12} \frac{w_2}{P_2} + g_1 [k_2 g_{12} + z_2 g_{22}] \right. \right. \]

\[ -g_2 \left[ g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{21}] \right] \right] \]

\[ + L_1 \left[ C_{21} z_1 [f_{11} f_{22} - f_{12} f_{21}] - f_{11} \right] P_2^2 z_2 [g_{11} g_{22} - g_{12} g_{21}], \]

can be derived from

\[
\begin{bmatrix}
    P_2 g_{11} & P_2 g_{12} & g_1 \\
    a_{64} & a_{65} & a_{66} \\
    L_2 g_1 & L_2 g_2 & -C_{2P}
\end{bmatrix} = -C_{2P} P_2 [g_{11} a_{65} - g_{12} a_{64}]
\]

\[+ L_2 g_1 [P_2 g_{12} a_{66} - a_{65} g_1] \]

\[-L_2 g_2 [P_2 g_{11} a_{66} - a_{64} g_1] \]

\[= -C_{2P} P_2^2 z_2 [g_{21} g_{12} - g_{11} g_{22}] \]

\[+ L_2 P_2 \left[ g_1 \left[ g_{12} [g(k_2, z_2) - k_2 g_1 - z_2 g_2] \right. \right. \]

\[ + g_1 [k_2 g_{12} + z_2 g_{22}] \right. \]

\[ - g_2 \left[ g_{11} [g(k_2, z_2) - k_2 g_1 - z_2 g_2] \right. \]

\[ + g_1 [k_2 g_{11} + z_2 g_{21}] \right] \]

\[= -C_{2P} P_2^2 z_2 [g_{21} g_{12} - g_{11} g_{22}] \]

\[+ L_2 P_2 \left[ g_1 \left[ g_{12} \frac{w_2}{P_2} + g_1 [k_2 g_{12} + z_2 g_{22}] \right] \right] \]
-g_2 \left[ g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{21}] \right],
\frac{f_{12} a_1 C_{21} - f_{11} [a_{22} C_{21} + 1]}{C_{21} z_1 [f_{11} f_{22} - f_{12} f_{21}] - f_{11} > 0.}

Inserting the results from above yields
\begin{align*}
L_2 \Delta \Delta &= -L_2 \left( g(k_2, z_2) \right) w_1 + w_2 z_1 \left[ f_{11} f_{22} - f_{12} f_{21} \right] \\
&\cdot P_2 \left[ g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{12}] \right] \\
&+ z_2 w_1 \left[ f_{11} f_{22} - f_{12} f_{21} \right] - C_2 P_2 \frac{z_2}{P_2} \left[ g_{11} g_{22} - g_1 g_{21} \right] \\
&- L_2 P_2 \left[ g_1 \left( g_{12} \frac{w_2}{P_2} + g_1 [k_2 g_{12} + z_2 g_{12}] \right) \right] \\
&- g_2 \left[ g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{12}] \right] \\
&- w_1 L_1 \left[ C_{21} z_1 \left( f_{11} f_{22} - f_{12} f_{21} \right) - f_{11} \right] \\
&\cdot P_2 \frac{z_2}{P_2} \left[ g_{11} g_{21} - g_1 g_{22} \right] \\
&+ z_2 \left[ N - L_1 \right] \left[ z_1 + w_1 C_{21} \right] z_1 \\
&\cdot P_2 \left[ f_{11} f_{22} - f_{12} f_{21} \right] [g_{11} g_{22} - g_1 g_{21}] \\
&= \frac{g(k_2, z_2)}{g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{12}]}
\end{align*}

Note that
\begin{align*}
g(k_2, z_2) &= \frac{g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{12}]}{g_1 k_2 + \frac{w_2}{P_2}} \left[ g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{12}] \right] \\
&+ z_2 g_1 \left( \frac{w_2}{P_2} + g_1 [k_2 g_{12} + z_2 g_{22}] \right) \\
&\cdot \frac{w_2}{P_2} \left[ g_{11} \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{12}] \right] \\
&+ g_1 \frac{w_2}{P_2} \left[ k_2 g_{11} + z_2 g_{12} \right] \\
&+ g_2 k_2 \left[ k_2 g_{11} + z_2 g_{12} \right] \\
&+ g_2 \left[ k_2 g_{21} + z_2 g_{22} \right] < 0
\end{align*}
because

\[ k_2[k_2g_{11} + z_2g_{12}] + z_2[k_2g_{12} + z_2g_{22}] = -[K_2X_{2KL} + L_FX_{2FL}] = L_2X_{2LL} < 0. \]

Since \( f_{11}f_{22} - f_{12}f_{21} > 0 \), \( g_{11}g_{22} - g_{12}g_{21} > 0 \) and \( f_{11} < 0 \) hold due to the concavity of the production functions \( f \) and \( g \), while \( C_{2P} < 0 \) and \( C_{2I} > 0 \) are valid, this suffices to ensure that \( \frac{dL_F}{dw_F} < 0. \)

The foreign workers’ marginal productivity falls short of their wage rate since the latter is increasing. This reduces the demand for foreign labor. Consequently, the marginal productivity of capital decreases, while the marginal productivity of domestic labor is positively affected. Therefore, the ratios between domestic and foreign labor, and between domestic labor and capital in the non-traded good sector will increase, while employment of foreign workers will fall.

All these results are easily understood. An interesting question is in which direction the employment of domestic workers changes. It turns out that

\[
\frac{dL_1}{dw_F} = -\frac{\Delta L_{1wF}}{\Delta}, \\
\frac{dL_2}{dw_F} = -\frac{\Delta L_{2wF}}{\Delta},
\]

where

\[
\Delta L_{1wF} = -w_2 \cdot det \begin{bmatrix} f_{11} & f_{12} & 0 & 0 & 0 & 0 \\ f_{21} & f_{22} & 0 & 0 & 0 & -1 \\ a_{31} & a_{32} & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & P_2g_{11} & P_2g_{12} & g_1 \\ 0 & 0 & 0 & a_{64} & a_{65} & a_{66} \\ 0 & -L_1 & -C_{2I} & L_2g_1 & L_2g_2 & -C_{2P} \end{bmatrix} + [N - L_1][g(k_2, z_2) - w_2C_{2I}][f_{11}a_{32} - f_{12}a_{31}]P_2[g_{11}a_{65} - g_{12}a_{64}] = -w_2 [f_{11}f_{22} - f_{12}f_{21}] \begin{bmatrix} -C_{2P}P_2^2z_2[g_{11}g_{22} - g_{12}g_{21}] \\ -L_2P_2[g_1 \frac{w_2}{P_2} + g_1[k_2g_{12} + z_2g_{22}] \end{bmatrix} \]
The change in the number of employed native workers in the construction sector is ambiguous. This can be explained as follows: The changes in the factor price ratios lead to a change in factor demand in favor of domestic labor. If the output in the construction sector remains constant, this yields a higher income of the natives, which implies an increased demand for the non-traded good. The increased demand will be satisfied by raising production via a proportional increase in all inputs. The combined impact of restructuring the production and the induced demand is captured by 

\[-g_2\left[g_{11} \frac{w_2}{P_2} + g_1[k_2g_{11} + z_2g_{22}]\right]\]

\[-w_2L_1\left[C_{21}z_1[f_{11}f_{22} - f_{12}f_{21}] - f_{11}\right]P_2^2z_2[g_{11}g_{22} - g_{12}g_{21}]\]

\[+[N - L_1][g(k_2, z_2) - w_2C_{21}]z_1z_2 \cdot [f_{11}f_{22} - f_{12}f_{21}]P_2^2[g_{11}g_{22} - g_{12}g_{21}]\]

and

\[\Delta L_2 = w_1\left[f_{11}f_{22} - f_{12}f_{21}\right] - C_2P_2^2z_2[g_{11}g_{22} - g_{12}g_{21}]\]

\[-L_2P_2\left[g_{12} \frac{w_2}{P_2} + g_1[k_2g_{12} + z_2g_{22}]\right]\]

\[-g_2\left[g_{11} \frac{w_2}{P_2} + g_1[k_2g_{11} + z_2g_{22}]\right]\]

\[+w_1L_1\left[C_{21}z_1[f_{11}f_{22} - f_{12}f_{21}] - f_{11}\right]P_2^2z_2[g_{11}g_{22} - g_{12}g_{21}]\]

\[+[N - L_1][z_1 + w_1C_{21}]z_1z_2[f_{11}f_{22} - f_{12}f_{21}]P_2^2[g_{11}g_{22} - g_{12}g_{21}]\].

The change in the number of employed native workers in the construction sector is ambiguous. This can be explained as follows: The changes in the factor price ratios lead to a change in factor demand in favor of domestic labor. If the output in the construction sector remains constant, this yields a higher income of the natives, which implies an increased demand for the non-traded good. The increased demand will be satisfied by raising production via a proportional increase in all inputs. The combined impact of restructuring the production and the induced demand is captured by 

\[-w_1[f_{11}f_{22} - f_{12}f_{21}]L_2P_2\left[g_{12} \frac{w_2}{P_2} + g_1[k_2g_{12} + z_2g_{22}]\right] - g_2\left[g_{11} \frac{w_2}{P_2} + g_1[k_2g_{11} + z_2g_{22}]\right] < 0.\]

At the same time, consumption will decrease due to the higher price, implying a lower level of production of the non-traded good. This impact is represented by 

\[-w_1C_2P_2^2z_2[f_{11}f_{22} - f_{12}f_{21}][g_{11}g_{22} - g_{12}g_{21}] > 0.\]

In addition, both the lower input demand of the traded good sector, as shown by 

\[-w_1L_1f_{11}P_2^2z_2[g_{11}g_{22} - g_{12}g_{21}] > 0,\]

and the lower level of consumption by the workers in that sector, being reflected in 

\[w_1L_1z_1z_2P_2^2C_{21}[f_{11}f_{22} - f_{12}f_{21}][g_{11}g_{22} - g_{12}g_{21}] > 0,\]

reinforce the tendency of less production of the non-traded good. Last, the lower wage in the traded good sector induces a shift of domestic workers towards the construction sector. This decreases the marginal productivity of construction services and therefore lowers demand.
for the non-traded good. In addition, a higher number of unemployed in the construction sector also leads to less demand for the non-traded good. Both impacts imply a reduction of employment in the construction sector, being captured by \( [N - L_1][z_1 + w_1 C_{21}] P^2_2 [f_{11} f_{22} - f_{12} f_{21}] [g_{11} g_{22} - g_{12} g_{21}] > 0 \).

The change in employment in the traded good sector mainly mirrors the results of the changes in the construction sector. If under immobility of native workers employment in the construction sector increases, applying for a job in the construction sector becomes more attractive, and vice versa. Recalling that \( w_2 > w_1 \) must hold, the expression

\[
-w_2 * \det \begin{bmatrix}
  f_{11} & f_{12} & 0 & 0 & 0 & 0 \\
  f_{21} & f_{22} & 0 & 0 & 0 & -1 \\
  a_{31} & a_{32} & -1 & 0 & 0 & 0 \\
  0 & 0 & 0 & P_2 g_{11} & P_2 g_{12} & g_1 \\
  0 & 0 & 0 & a_{64} & a_{65} & a_{66} \\
  0 & -L_1 & -C_{21} L_1 & L_2 g_{1} & L_2 g_{2} & -C_{21} P
\end{bmatrix}
\]

shows that in the former case the flow out of the traded good sector exceeds the increase in employment in the construction sector. In contrast, the latter case is associated with an inflow of workers into the traded good sector which is higher than the reduction in employment in the second sector. Noting that \( g(k_2, z_2) - w_2 C_{21} > g(k_2, z_2) - \frac{w_2}{P_2} > 0 \) holds due to \( P_2 C_{21} + C_{11} = 1 \), the term \( [N - L_1][g(k_2, z_2) - w_2 C_{21}] z_1 z_2 [f_{11} f_{22} - f_{12} f_{21}] P^2_2 [g_{11} g_{22} - g_{12} g_{21}] > 0 \) captures that the lower wage rate in the traded good sector induces a shift of domestic workers towards the construction sector.

If \( g_{11} g_{22} - g_{12} g_{21} \) is relatively small, the impacts that arise through the increase in the price of the non-traded good and the reactions in the traded good sector will be moderate. In such a setting, employment of domestic workers in the construction sector will be raised. At the same time, the traded good sector shrinks. In contrast, if \( f_{11} f_{22} - f_{12} f_{21} \) is close to zero, the substitution effects in the production of the non-traded good will be less important. Since the lower input demand by the tradeable good sector will then constitute the dominating effect, employment of domestic construction workers will decrease. This is associated with a higher number of workers in the traded good sector.

Total employment of natives changes according to \( \frac{d[L_2 + L_1]}{dw_F} \). The sign
of this expression is the same as the sign of $Z = - [\Delta L_1 w_F + \Delta L_2 w_F]$ with

$$Z = [w_2 - w_1] [f_{11f_{22}} - f_{12f_{21}}] \left[ - C_2 P_2^2 z_2 [g_{11} g_{22} - g_{12} g_{21}] ight.$$ 

$$- L_2 P_2 \left[ g_1 \left( \frac{w_2}{P_2} + g_1 [k_2 g_{12} + z_2 g_{22}] \right) 

- g_2 \left( \frac{w_2}{P_2} + g_1 [k_2 g_{11} + z_2 g_{21}] \right) \right] 

+ [w_2 - w_1] L_1 [C_2 L_1 (f_{11f_{22}} - f_{12f_{21}}) - f_{11}] P_2^2 z_2 [g_{11} g_{22} - g_{12} g_{21}] 

- [N - L_1] [g(k_2, z_2) - w_2 C_2 + z_1 + w_1 C_{22}] z_1 z_2 

\left( f_{11f_{22}} - f_{12f_{21}} \right) P_2^2 [g_{11} g_{22} - g_{12} g_{21}].$$

It is obvious that total employment of natives will always decrease if more domestic construction workers are employed. This result is due to the shrinking traded good sector under this scenario. If, however, $f_{11f_{22}} - f_{12f_{21}}$ is close to zero, a reduction in unemployment will be achieved. The higher unemployment rate in the construction sector is then more than offset by the move of domestic workers to the traded good sector. It should be noted that the conditions for changing unemployment contrast starkly with those in Meier (1999). The divergence is due to the fact that the reduction in unemployment is reached by an increased demand for domestic construction workers in that framework.

The natives' welfare is stated in terms of a representative individual. Welfare increases if the winners are able to compensate the losers such that the indirect utility of the representative native increases. Although unemployment may be reduced, the natives will lose both in terms of income and welfare.

**Proposition 3** The increase in the posted workers' wage rate reduces both the total income of the natives and their welfare.

**Proof:** The change in income of the natives in terms of the traded good, $I = w_1 L_1 + w_2 L_2 + r \bar{K}$, is given by

$$\text{sgn} \left[ \frac{dI}{dw_F} \right] = \text{sgn} \left[ L_1 \frac{dw_1}{dw_F} + w_1 \frac{dL_1}{dF} + \frac{w_2}{dF} \frac{dL_2}{dw_F} \right].$$
Inserting the results from above yields

\[ \text{sgn} \left[ \frac{dI}{dW_F} \right] = -\text{sgn} \left[ \left[ N - L_1 \right] P_2^2 \left[ f_{11} f_{22} - f_{21} f_{12} \right] z_1 z_2 g_{11} g_{22} - g_{12} g_{21} \right. \\
\left. \cdot \left[ w_1 [g(k_2, z_2) - w_2 C_2] + w_2 [z_1 + w_1 C_2] \right] \\
+ L_1 P_2^2 [f_{11} f_{22} - f_{21} f_{12}] z_1 z_2 g_{11} g_{22} - g_{12} g_{21} \right] \\
\cdot \left[ w_1 g(k_2, z_2) + w_2 z_1 \right] \]

\[ = \text{sgn} \left[ -N P_2^2 [f_{11} f_{22} - f_{21} f_{12}] z_1 z_2 g_{11} g_{22} - g_{12} g_{21} \right] \\
\cdot \left[ w_1 g(k_2, z_2) + w_2 z_1 \right], \]

which is obviously negative.

Let \( v(P_2, I) \) denote the social indirect welfare function. The change in welfare is given by

\[ \frac{dv}{dW_F} = \frac{\partial v}{\partial P_2} \frac{dP_2}{dW_F} + \frac{\partial v}{\partial I} \frac{dI}{dW_F}. \]

Hence,

\[ \text{sgn} \left[ \frac{dv}{dW_F} \right] = \text{sgn} \left[ \frac{\partial v}{\partial P_2} \frac{dP_2}{dW_F} + \frac{\partial v}{\partial I} \frac{dI}{dW_F} \right] \]

\[ = \text{sgn} \left[ \frac{dI}{dW_F} - C_2 \frac{dP_2}{dW_F} \right] \]

according to Roy's theorem. Noting that \( \frac{dP_2}{dW_F} > 0 \) according to Proposition 1 proves the second claim.

Proposition 3 has a simple interpretation. Changes in income only occur via changes in the workers' income. As we have already seen, the wage rate in the traded good sector falls. Since expected wages are equal due to the labor market equilibrium condition (12), the unemployment rate in the construction sector must increase, implying a loss in the expected wage of a domestic construction worker. The result contrasts sharply with the analysis of a one-sector model of migration with unemployment in Brecher and Choudri (1987), where the natives will always gain if unemployment of
native workers is reduced. In the current model, the immigrants not only displace some native workers, but also contribute to lower cost of production in both sectors and a lower price level. The Posted Workers Directive hurts both the capital owners and the workers who have to face a higher price of the non-traded good. The workers experience an additional loss due to the decrease in their expected wage income. In contrast to the analysis without mobility of domestic workers (Meier (1999)), the losses cannot be compensated for by a possible reduction in unemployment.

The impact of the Posted Workers Directive on the wage bill of the posted workers is ambiguous. On the one hand, their sum of wages may even increase if those who lose employment in the host country receive an income of zero afterwards. This is a simple consequence of the well-known argument that a monopolistic trade union aiming at maximizing the wage bill of its members can set a wage above the market clearing level. On the other hand, given an existing international wage differential, the sum of wages will decrease if all posted workers have to return to their home country.

4 Conclusion

It could be shown that the production structure changes in favor of domestic labor in both sectors. However, the price of the non-traded good rises, the wage rate in the traded good sector declines, and the unemployment rate among domestic construction workers increases. As expected, less posted workers are employed.

The analysis has not offered an unambiguous answer to the question whether or not employment of native workers in either sector will increase. Moreover, it cannot be excluded that total unemployment will be reduced due to a shrinking fraction of natives applying for jobs in the construction sector. However, even a reduction of unemployment is not sufficient in order to reach a higher total income of the natives. In addition, all natives lose in terms of expected utility. The wage bill of the posted workers can either rise or fall.

The message of the paper is that it is not reasonable for a country to implement minimum wages for foreign workers in the construction sector. A possible increase in employment of domestic construction workers will be associated with a higher number of unemployed since working in the construction sector becomes more attractive. A possible reduction in unemployment
is no justification for the Posted Workers Directive since the total income of domestic workers decreases. Their relative income position deteriorates in comparison to the capital owners, who also lose in terms of real income. The political pressure for legislative action against “wage dumping” by the posted workers can be attributed to missing knowledge of the complex economic interactions.

References


