Unions and the Coordination Problem in an Integrated Economy

Domenico Buccella

University of Siena, Italy; University of Graz, Austria

Abstract: This work represents an extension of the model presented by Olivier Blanchard in occasion of the Lionel Robbins’ Lectures (2000) given at M.I.T. It analyzes the transnational cooperative behavior of trade unions in a two symmetric country-model with monopolistic competition firms present in the two markets under the possibility to shift production (i.e. through an increase in investments). In the case of technological shocks, firms are able to capture the advantage in wage differentials between the two countries. The country facing the shock has a loss in employment, while the other one faces a gain. But, if trade unions cooperate, in absence of transaction costs (costs to coordinate union activities), they are able to reduce the total loss of employment. If transaction costs are present, unions face a classical Prisoner’s Dilemma where the Nash equilibrium of the game is no cooperation, but this result is not Pareto-efficient.

Keywords: Technological shocks, international production, integrated economy, trade union cooperation

JEL codes: D21, F15, F21, J51

1. Introduction

In occasion of the Lionel Robbins’ Lectures (2000) given at M.I.T., Olivier Blanchard presented a model describing the impact of technological shocks on unemployment. It is a model of monopolistic competition in the products’ market and bilateral bargaining in the labor market. In the short run the number of active firms in the market is a parameter of the model and each firm faces an identical demand curve that depends on aggregate income, unitary price of the good produced by the firm and general price level. The production function of each firm has a unique variable factor, that is labor. Workers’ reservation wage in real terms depend on unemployment benefits and it is a decreasing function of the unemployment rate. The presence of monopolistic competition in the products’ market allows the formation of a rent that is shared between workers and firms through a bargaining process. The solution adopted for this bargaining problem is the Nash bargaining rule assigning asymmetric relative bargaining power to firms and workers. In the long run, the number of active firms is determined in equilibrium by the zero-profits condition given some barriers to entry level costs.

Blanchard develops his model taking in consideration only one country, analyzing the effects of a technological shock both in the short and in the long run. This work, instead,
has the purpose of extending the model in a two homogeneous countries context (Section 2) within the same currency area, limiting its analysis only in the short run. Firm’s behavior and productive choices after a technological shock will be discussed (Section 3). Successively (Section 4), a numerical example of the theory showed in the previous sections is presented and it will discuss the coordination problem on salaries policies by unions (Section 5). Some considerations (Section 6) closes.

Related strands of the literature that analyzes different aspects linked to economic integration, considering the strategic interaction between unions, are the macroeconomic models of Drifil and van der Ploeg (1993) and Danthine and Hunt (1994) and the microeconomic models of Huizinga (1993), Naylor (1998, 1999), Naylor and Santoni (1999). In particular, this class of microeconomics models take into account the strategic interaction between firms and unions, but this work wants to start analyzing the coordination problem between unions when integration occurs, discussing the eventuality of cooperative behavior between them.

2. A Two-Countries Model with Technological Shock

The basic characteristics and hypothesis of the model are for the most part similar to those used by Blanchard (2000) and described in the introduction. However, the presence of another country imposes important adjustments. Hence it is assumed:

(1) the existence of two countries (A and B) that belongs to the same currency area\(^1\);
(2) monopolistic competition in the two countries;
(3) firms could transfer production from one country to the other at zero costs\(^2\);
(4) there are \(m\) firms in the market (countries A and B) that produce a unique good\(^3\);
(5) perfect capital mobility and certainty in property rights;
(6) the two countries have an identical short run labor demand (DD);
(7) the two countries have an identical long run labor demand (LL);
(8) the two countries have an identical labor supply function (SS). Wage is a decreasing function of the unemployment rate;
(9) identical production function: \(y = F(an, k)\), where \(y\) is the aggregate production, \(n\) and \(k\) are aggregate employment and capital, and \(a\) is the technological level, growing at the constant rate \(g_a\). Firms maximize profits and use two production factors (labor and capital). Capital is assumed to be fixed in the short run.

In order to stay the closest possible to Blanchard’s model, hypothesis (6)–(9) are assumed to use functions with the same properties to whose described in his model, that is the labor demand in efficiency in the short run is equal to

\[ n = \frac{k}{a} f \left( \frac{w}{a} \right) \quad \text{with} \quad f' \left( \frac{w}{a} \right) < 0; \quad (2.1) \]

the long run labor demand for the two countries is equal to

\[ e = \pi = g \left( \frac{w}{a} \right) \quad \text{with} \quad g' \left( \frac{w}{a} \right) < 0; \quad (2.2) \]

---

\(^1\) With this hypothesis, monetary changes rate problems are not taken in consideration.

\(^2\) That is, neither transportation costs nor differences in productive factors' qualities are allowed.

\(^3\) Problems related to product differentiation are not taken in consideration.
the labor supply function is given by
\[ \frac{u}{a} = zh(u) \quad \text{with} \quad h'(u) < 0 \] (2.3)
and it is assumed that firms use a Cobb–Douglas production function.

Given the previous hypothesis, the starting point is characterized both by an equal number of employees and an equal wage in efficiency terms in the two countries.

At starting point, firms face a short term profit-maximization problem \((k)\) is kept fixed. In order to derive the analytical results, it is necessary to specify the functional form of the production function. A functional form coherent could be a production function of this type: \(F(n, k) = \left[ a(n_A + n_B)^{1-\alpha} \right]^{1/\alpha} \). Firms have an objective function of this type:
\[
\max_{n_A, n_B} p \left[ a(n_A + n_B)^{1-\alpha} k^\alpha \right] - w_A n_A - w_B n_B. 
\] (2.4)
where \(p\) is the price of the identical good in the two countries, \(w_A\) is the wage paid in country A, \(w_B\) is wage in country B, \(n_A, n_B\) are respectively the employees in country A and country B.

From the first order conditions and rearranging terms, it is obtained
\[
p \left[ a^{1-\alpha} (1-\alpha)(n_A + n_B)^{-\alpha} k^\alpha \right] = w_A. 
\] (2.5)
and
\[
p \left[ a^{1-\alpha} (1-\alpha)(n_A + n_B)^{-\alpha} k^\alpha \right] = w_B. 
\] (2.6)
From Eq. (2.5) (and analogously from Eq. (2.6)), after some algebra, it can be derived
\[
n_A = \frac{k}{\alpha} \left[ p(1-\alpha) \right]^{1/\alpha} \left( \frac{w_A}{a} \right)^{-1/\alpha} - n_B
\] (2.7)
and
\[
n_B = \frac{k}{\alpha} \left[ p(1-\alpha) \right]^{1/\alpha} \left( \frac{w_B}{a} \right)^{-1/\alpha} - n_A
\] (2.8)
that is the labor’s demand functions in the two countries given the new objective function.\(^4\) It can be observed that these labor demands are coherent with the labor demand function presented by Blanchard and that they differ for the fact that now the labor demand in one country depends on the labor demand of the other country.

Assume that a technological shock “à la Blanchard”\(^5\) occurs in country A, that is the technological efficiency level perceived by workers is equal to \(a^*\) with \(a^* > a\) (in reality, the technological progress rate in country A decrease). The situation is represented in Figure 1

\(\text{\footnotesize\(^4\)}\) These equations are written in the following way since, in equilibrium, wages are identical in country A and country B. For all the analytical derivation, see Bussola (2003).

\(\text{\footnotesize\(^5\)}\) Blanchard defines as technological shock an increase in wage greater than the technological rate of growth.
Figure 1. Labor markets in country A and country B.
Labor supply in A, due to shock, is given by
\[ \frac{w}{a^*} = z h(u), \]
where \( a^* \) is the perceived rather than actual technological level and
\[ \frac{w}{a} = z^* h(u) \quad \text{where} \quad z^* \equiv \frac{a^*}{a}. \]  \hfill (2.9)

The \( SS_A \) curve, due to shock, shifts to the left at the \( SS_A' \) level. Wages increase with respect to \((w/a)_A\), as derived from Eq. (2.9). With increased wages, the labor demand decreases and the \( DD_A \) shifts in \( DD_A' \) for two reasons as Blanchard (2000) explains: (1) given the capital stock (assumed to be fixed in the short run), firms reduce the demand of labor; (2) higher wages imply that if employment remains equal, the firms’ profit rate become less than the marginal costs of capital itself. This implies a reduced capital accumulation. The new equilibrium is now in \( E''_A \) with wages in A higher than wages in B and employment level in \( n''_A \) inferior to the initial level.

Firms, given higher wages, shrink their labor demand that will shift in \( DD'_A \) with employment at \( n''_A \) and will move production in country B. The reduction in the demand of labor in A is derived substituting the value of \( a^* \) in Eq. (2.7) instead of \( a \) in the \((k/a) \) ratio and taking in consideration that due to the effect of (2.9), \( a^* \) reflects on \((w/a)_A \) with an increase in wages level. With the value obtained from (2.7), the new labor demand in B is derived from Eq. (2.8). The \( DD_B \) curve shift to the right at \( DD'_B \) along the \( SS_B \) which it does not move because it does not depend on wages level. The new equilibrium level will be \((w/a)'_A = (w/a)'_B\), that is when wages come back to equilibrium level in both countries with employment at \( n''_A \) and \( n''_B \).

3. Implication for Firms in the Product Market

As in the Blanchard’s model, to describe firms behavior in the product market and the effects of the relative decisions to employment determination, and in order to simplify the analysis, it is assumed that \( \alpha = 0 \), that is the production function depends only from the labor factor, and that the technological level is equal to 1.

The new production function, for firm \( i \), is equal to
\[ Y_i = N_i \quad \text{where} \quad N_i = N_{iA} + N_{iB} \]  \hfill (3.1)

that is, the total number of employees in firm \( i \) is given by the summation of the employees in the two countries.

Firms act in a monopolistic competition market. Total production is given by
\[ Y = Y_A + Y_B \]  \hfill (3.2)
that is the summation of total production in A and in B. Since it was assumed that there are \( m \) identical firms, total production is given also by

\[
mY_i = Y_i, \tag{3.3}
\]

where \( Y_i \) is the production of firm \( i \) and is equal to \( Y_{iA} + Y_{iB} \), that is firm’s \( i \) production in country A plus firm’s \( i \) production in country B.

Combining Eq. (3.2) with Eq. (3.3) it can be derived

\[
Y_i = Y_{iA} + Y_{iB} = \frac{(Y_A + Y_B)}{m} \tag{3.4}
\]

Thus, each firm \( i \) faces a demand curve of this type

\[
Y_i = \frac{Y_A + Y_B}{m} D \left( \frac{P_i}{P} \right), \tag{3.5}
\]

where, with respect to the demand curve used by Blanchard (2000), \( Y_i \) is the demanded quantity of the good, \( P_i \) and \( P \) are respectively the price of firm \( i \) good and the general price level, but \( Y_A \) and \( Y_B \) represent respectively the production of the good in country A and B. It follows that:

\[
DD_{iA} = \frac{Y_A}{m} D \left( \frac{P_i}{P} \right) \tag{3.6}
\]

and

\[
DD_{iB} = \frac{Y_B}{m} D \left( \frac{P_i}{P} \right) \tag{3.7}
\]

Workers have a reservation wage in real terms given by

\[
(W/P)_r = b f(u) \quad \text{with} \quad f'(u) < 0 \tag{3.8}
\]

where the parameter \( b \) reflects factors like unemployment benefits and \( u \) is the aggregate rate of unemployment. This is a crucial point in the description of the model: it represents the link between the effects of a technological shock and the subsequent firms’ behavior in the product market. In the first part of the model, wages in the efficiency terms were presented with the following functional form \( (w/u) = zh(u) \) where \( z \) are income sources in the case of unemployment (unemployment benefits, etc., . . .) and with \( h'(u) < 0 \). In the equation describing the workers’ reservation wage, the parameter \( b \) has the same meaning of the parameter \( z \) and both are decreasing in the unemployment rate. Substantially, the equilibrium wage in efficiency terms is equal to workers’ reservation wage, that is the base wage level that labor unions present at the beginning of the bargaining process over rent sharing generated by monopolistic competition assumption. Firm \( i \) choices in term of price, wage, employment and production in A and B after a technological shock, given an unemployment rate equal to
Figure 2. Firm $i$ product demand curve.

Figure 3. Firm $i$ demand in national markets (ex-ante technological shocks).

$n_A$ and $n_B, m$ firms and an initial aggregate production equal to $Y_{iA} + Y_{iB}$, are represented in Figures 2, 3 and 4.

Figure 2 shows firm $i$ price and production’s decisions, taking in consideration the total product market demand formed by country A and B; in fact, the downward sloped curves $DD_i$ and the $MRP_i$ are respectively the product demand for firm $i$ described by Eq. (3.5) and
the firm marginal revenue. The horizontal line at level $bf(u)$ is the workers' reservation wage; employment is determined, by construction, from the equality between reservation wage and firm's marginal revenue (intersection of the line $bf(u)$ and the $MRP_i$ curve), hence at $N_i$ level.

Firm $i$'s rent is maximized choosing the relative price equal to

$$\frac{P_i}{P} = (1 + \mu)bf(u)$$

that is, applying a markup on the reservation wage. The wage paid to workers is equal to

$$\frac{W_i}{P} = (1 + \beta \mu)bf(u)$$

with part of the rents created in the product market addressed to workers through a bargaining process and determined by the parameter $\beta$. It is assumed that both workers' bargaining power and firms' markup is identical in the two countries.

With these assumptions, the ex-ante technological shock situation is absolutely identical in the two countries: equal number of employees, equal price, wages and workers' reservation wage. Continuous lines in Figure 2 represent exactly the summation of the two graphs relative to countries A and B in Figure 3 in which are represented firm's $i$ ex-ante technological shock national market and marginal productivity in the two countries, with relative real wages. The $DD_{iA}$ and $DD_{iB}$ curves describe firm's $i$ production choices respectively in country A and B.

---

6 As well known (Varian, 1992), the functional form of the marginal revenue of a firm is given by $(\partial R/\partial q) = p(q)[1 - (1/p(q))]$ where $e = (p/q)(dq/dp)$. 
Suppose now that a technological shock occurs in country A. By convention, continuous lines in graphs refer to ex-ante situation, where dotted lines refer to ex-post situation. Coherently to what described in Figure 1, that represents what happens in the labor market in the two countries, the technological shock implies a reduction in firm’s i employees in country A from \( N_{iA} \) to \( N'_{iA} \) (Figure 4, dotted lines) with a higher reservation wages and with a price level in country A equal to \( (P_i/P)^{1} \) greater than \( (P_i/P) \) in country B. However firm i sell the good at the same price in the market (given by country A and B, Figure 2) and chooses an “intermediate” price level \( (P_i/P) \) between the two price levels of A and B.

After that the price level \( (P_i/P) \) is chosen, then the firm sees its own demand function shift in A and B; that is, given the previous definitions in Eqs. (3.6) and (3.7), firm takes its production decisions in the two countries until a new reservation wage levels \( b^{*} f(\mu_{A}) \) and \( b^{*} f(\mu_{B}) \) are obtained such that the labor markets are in equilibrium at the employment levels \( N''_{iA} \) in A and \( N''_{iB} \) in B (Figure 4, dotted lines). At this point, the shock’s effects are exhausted.

The effects of the shock are: a decrease in the employment level in A from \( N_{iA} \) to \( N'_{iA} \) due to higher level wage demanded in the bargaining process. The additional reduction from \( N'_{iA} \) to \( N''_{iA} \) is due to the subsequent firm’s decision to fix its own product price and hence the decision where to produce it. The increasing employment level in B derives from this second effect. In the next section it will be presented a numerical example in which the shock’s effects, the consequences in the two countries are computed and how production choices taken by firms affect employment levels.

4. A Numerical Example

In this section are presented the results of a numerical example of the previously described model. The values used are completely arbitrary, but functional forms are coherent with those adopted in Blanchard (2000). The purpose is to make visible, with a simulation, what could be the effects of the theory discussed above.

In the numerical example are discussed three cases that refer to technological shock consequences in the labor market, taken in consideration different situations, and the subsequent firm’s decisions and behavior in national markets due to the shock. By assumption in this example the labor demand function is constructed in linear form.\(^7\)

In Case 1 of this exercise, it is described the situation where technological shock occurs only in one country (in this example, country A), while the other country is influenced by the propagation effects of the shock. The description is done in three passages (ex-ante, shock, ex-post).

In columns \( nA \) and \( nB \), relative to labor market, are reported the different employment levels in unit fractions. In columns \( DD_A \) and \( DD_B \) are reported the labor demands. In columns \( WA \) and \( WB \) in efficiency are indicated the wages in terms of efficiency values derived from Eqs. (2.7) and (2.8). The supply columns indicates the supply of labor in the two countries.\(^8\)

\(^7\) The functions used in the three cases described are identical.

\(^8\) The supply of labor is assumed to be with a fixed part and a variable arm.
Table 1. Case 1: ex-ante situation in labor market.

<table>
<thead>
<tr>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
<th>$n_B$</th>
<th>$DD_B$</th>
<th>$W_B$ in eff.</th>
<th>Supply $n_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9310</td>
<td>0.6420</td>
<td>0.6420</td>
<td>0.9321</td>
<td>0.9310</td>
<td>0.6420</td>
<td>0.6420</td>
<td>0.9321</td>
</tr>
<tr>
<td>0.9320</td>
<td>0.6419</td>
<td>0.6419</td>
<td>0.9320</td>
<td>0.9320</td>
<td>0.6419</td>
<td>0.6419</td>
<td>0.9320</td>
</tr>
<tr>
<td>0.9330</td>
<td>0.6418</td>
<td>0.6418</td>
<td>0.9319</td>
<td>0.9330</td>
<td>0.6418</td>
<td>0.6418</td>
<td>0.9319</td>
</tr>
</tbody>
</table>

Table 2. Case 1: shock of 30% in country A.

<table>
<thead>
<tr>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
<th>$n_B$</th>
<th>$DD_B$</th>
<th>$W_B$ in eff.</th>
<th>Supply $n_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8440</td>
<td>0.6496</td>
<td>0.6497</td>
<td>0.8447</td>
<td>0.9310</td>
<td>0.6420</td>
<td>0.6420</td>
<td>0.9321</td>
</tr>
<tr>
<td>0.8450</td>
<td>0.6495</td>
<td>0.6496</td>
<td>0.8446</td>
<td>0.9320</td>
<td>0.6419</td>
<td>0.6419</td>
<td>0.9320</td>
</tr>
<tr>
<td>0.8460</td>
<td>0.6495</td>
<td>0.6495</td>
<td>0.8445</td>
<td>0.9330</td>
<td>0.6418</td>
<td>0.6418</td>
<td>0.9319</td>
</tr>
</tbody>
</table>

Table 3. Case 1: extension of the shock and final situation in the labor market.

<table>
<thead>
<tr>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
<th>$n_B$</th>
<th>$DD_B$</th>
<th>$W_B$ in eff.</th>
<th>Supply $n_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8440</td>
<td>0.6489</td>
<td>0.6489</td>
<td>0.8439</td>
<td>0.9400</td>
<td>0.6489</td>
<td>0.6490</td>
<td>0.9411</td>
</tr>
<tr>
<td>0.8450</td>
<td>0.6488</td>
<td>0.6488</td>
<td>0.8438</td>
<td>0.9410</td>
<td>0.6489</td>
<td>0.6489</td>
<td>0.9410</td>
</tr>
<tr>
<td>0.8460</td>
<td>0.6487</td>
<td>0.6487</td>
<td>0.8437</td>
<td>0.9420</td>
<td>0.6488</td>
<td>0.6488</td>
<td>0.9409</td>
</tr>
</tbody>
</table>

Given these assumptions, the ex-ante situation in the two countries is identical: identical labor demand equal to $DD = 0.7239 - (0.088 \cdot N)$, identical labor supply equal to $SS = 0.52 + (w/a)^2$. This results in identical wage in efficiency terms. The ex-ante equilibrium is at the employment level 0.9320 in both countries and wage at 0.6419 (bold line in Table 1). In Table 1, Case 1, is described the ex-ante situation in A and B.

The situation of shock in country A is described in Table 2, Case 1 in which are reported the values relative to labor market in the two countries:

In A, where shock occurs, employment level decreases from 0.932 to 0.8450. Wages increases from 0.6419 to 0.6496. In B, where the shock does not occur, the situation is invariant: labor demand and wages in efficiency terms are yet computed in base to ex-ante situation in country A (as indicated in Table 2, Case 1).

In Table 3, Case 1 is described the ex-post situation with the expanded effects of the shock in B.

In order to determine the final employment levels, now in the computation of the labor demand and wages in efficiency terms are insert the effective values. Employment in A decreases to 0.8440, while employment in B increases from 0.932 to 0.941. To obtain the equilibrium in the labor market with the wage equality in A and B, the two labor

---

9 The labor demand is obtained solving a simple problem of analytical geometry: having the employment levels ex-ante and ex-post the shock and the relative wages in efficiency terms, it was applied the equation of a line passing through two points. The values of the slope (-0.088) and the intercept (0.7239) are obtained applying this formula.

10 It is a coherent functional form with the assumption regarding the labor supply that it is a decreasing function of unemployment rate. The value of 0.52 is arbitrary and represents the fixed part of the labor supply.

11 The situation of supply labor shock, assumed to be at 30%, it is obtained multiplying the equation $SS = 0.52 + (w/a)^2$ by the coefficient (1/1.3).
Table 4. Case 2: initial situation in the labor market.

<table>
<thead>
<tr>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
<th>$n_B$</th>
<th>$DD_B$</th>
<th>$W_B$ in eff.</th>
<th>Supply $n_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9310</td>
<td>0.6420</td>
<td>0.6420</td>
<td>0.9310</td>
<td>0.9310</td>
<td>0.6420</td>
<td>0.6420</td>
<td>0.9321</td>
</tr>
<tr>
<td><strong>0.9320</strong></td>
<td><strong>0.6419</strong></td>
<td><strong>0.6419</strong></td>
<td><strong>0.9320</strong></td>
<td><strong>0.9320</strong></td>
<td><strong>0.6419</strong></td>
<td><strong>0.6419</strong></td>
<td><strong>0.9320</strong></td>
</tr>
<tr>
<td>0.9330</td>
<td>0.6418</td>
<td>0.6418</td>
<td>0.9319</td>
<td>0.9330</td>
<td>0.6418</td>
<td>0.6418</td>
<td>0.9319</td>
</tr>
</tbody>
</table>

Table 5. Case 2: 30% shock in A c B and final situation.

<table>
<thead>
<tr>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
<th>$n_B$</th>
<th>$DD_B$</th>
<th>$W_B$ in eff.</th>
<th>Supply $n_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8440</td>
<td>0.6496</td>
<td>0.6497</td>
<td>0.8447</td>
<td>0.8440</td>
<td>0.6496</td>
<td>0.6497</td>
<td>0.8447</td>
</tr>
<tr>
<td><strong>0.8450</strong></td>
<td><strong>0.6495</strong></td>
<td><strong>0.6496</strong></td>
<td><strong>0.8446</strong></td>
<td><strong>0.8450</strong></td>
<td><strong>0.6495</strong></td>
<td><strong>0.6496</strong></td>
<td><strong>0.8446</strong></td>
</tr>
<tr>
<td>0.8460</td>
<td>0.6495</td>
<td>0.6495</td>
<td>0.8445</td>
<td>0.8460</td>
<td>0.6495</td>
<td>0.6495</td>
<td>0.8445</td>
</tr>
</tbody>
</table>

Demand functions shift, downward in A and upward in B\textsuperscript{12}; the labor demand in A becomes $DD_A = 0.7239 - (0.0889 \cdot N_{A})$\textsuperscript{13} while in B becomes $DD_B = 0.7239 - (0.07974 \cdot N_{B})$\textsuperscript{14}.

Comparing ex-ante and the ex-post situation in the two countries (looking at the bold lines), it can be noted that employment in A decreases from 0.932 to 0.844, reducing of the 9.8% and in B increases from 0.932 to 0.941, with a percentage increase of 0.9%. The reduction of 9.8% is due to two effects: a direct one and an indirect one. The direct one is the higher wage demanded by workers in A that generates the shock and reduces firm's i labor demand in A from 0.932 to 0.845 (9.7% reduction) due exclusively to what happens in the bargaining process; the indirect one (the additional diminution of 0.1%) is due to the fact that given the capital stock (assumed to be fixed in the short run and thus not influencing the production function), firms shrink the labor demand and higher wages imply that, whether employment does not reduce, there will be a profit rate less than the marginal cost of capital itself, with a decrease in the accumulation. The difference between the original model and this extension is given by the presence of country B, and thus firms don't suffer entirely the shock and can react moving part of their production and depressing in this way wages demands. It can be noted, however, that the employment reduction in A due to the indirect effect is more than compensated by the increase in employment level in B: this means that if in a country mistakes are made in the bargaining process on wage levels, the situation gets worst inside the country but at the same time is better off in the other country.

Case 2 of this numerical example shows the situation in which technological shock in the labor market happens simultaneously in the two countries A and B, that is, unions demand a wage increase at the same time but in a disjoint way, that is inside the own country and only for their workers. The initial situation is described in Table 4, Case 2.

In Table 5, Case 2 is described the situation of shock in the labor market, shock that happens simultaneously in the two countries.

\textsuperscript{12} Assuming linear demand functions and hence marginal revenues with a slope double with respect to the product demand, the movement of the labor demands, to maintain this characteristic, is not a translation but instead, a rotation at the intercept level.

\textsuperscript{13} The increased slope of labor demand in A means a downward rotation of the curve and thus a reduction in labor demand itself.

\textsuperscript{14} Equivalently, the decreased slope of the labor demand in B means an upward rotation and hence an increase in labor demand itself.
Table 6. Case 3: 30% shock in the unique labor market, initial and final situation.

<table>
<thead>
<tr>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
<th>$n_A$</th>
<th>$DD_A$</th>
<th>$W_A$ in eff.</th>
<th>Supply $n_A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9310</td>
<td>0.6420</td>
<td>0.6420</td>
<td>0.9322</td>
<td>0.8500</td>
<td>0.6565</td>
<td>0.6568</td>
<td>0.8519</td>
</tr>
<tr>
<td><strong>0.9320</strong></td>
<td><strong>0.6419</strong></td>
<td><strong>0.6419</strong></td>
<td><strong>0.9320</strong></td>
<td>0.8510</td>
<td>0.6565</td>
<td>0.6566</td>
<td>0.8517</td>
</tr>
<tr>
<td>0.9330</td>
<td>0.6418</td>
<td>0.6417</td>
<td>0.9318</td>
<td><strong>0.8520</strong></td>
<td>0.6564</td>
<td><strong>0.6564</strong></td>
<td><strong>0.8515</strong></td>
</tr>
</tbody>
</table>

Case 2 is different from Case 1: since the shock occurred simultaneously in A and B, no wage differential is generated between the two wages, differential that implied the formation of two different prices for the same goods in the two markets and allowed firms to make the decision if move production from one country to the other. Employment reduces in both countries from 0.932 to 0.845 with a decrease in percentage terms of 8.7%.

It is considered a third and last case. It is assumed that instead of two different labor markets, there is a unique market formed by country A and B globally taken in consideration and that a technological shock of 30% occurs in this market. The situation is described in Table 6, Case 3.\(^\text{15}\)

The situation in Case 3 is different both from Case 1 and Case 2: the shock now occurs in the labor market considered as the summation of the two countries' markets and neither in this case the wage differential, that causes different prices for the same good, is generated in the two markets (since here the market is integrated) and that allowed firms to move production from one country to the other. But notice that if unions demand jointly an increase in wages, employment now decreases from 0.932 to 0.852 with a reduction in percentage terms of 8%, that means 4% for each country.

In the next paragraph, given the results of this numerical example, it is shown how unions' cooperation and coordination in the two countries is the optimal strategy in the bargaining process with firms for the determination of wage levels so that it is possible minimize the employment loss in the labor market and it is described why, in reality, this behavior is not followed.

5. The Coordination Problem of Labor Policies

The results obtained varying the hypothesis relatively to the labor market and the behavior of trade unions elaborate in the numerical example in the previous section can be put in a non-cooperative game matrix between trade unions in country A and trade unions in country B. Each union, as described in the numerical example, has two strategies, that is either act in a separate way (non coordinated) each in its own country without take in consideration the behavior of the other union, or act in a joint way (coordinated) taking in consideration the union's behavior in the other country. Depending on the adapted strategy (C coordinated, NC non coordinated), the relative unemployment rates are different, unemployment rates that represents the game's payoffs (Table 7).

The up-right and the down-left cells refer to Case 1 of the numerical example, where the wage increase occurs only in one country while the other country is influenced by the

\[^{15}\text{The unique difference that exists in the equations of the previous cases and this last one is in the column WA in efficiency: in the previous cases it was referred to the following equation derived from 2.7 where the labor demand is equal to } (n_A + n_B) = \alpha = \left(w_A / \alpha\right)^{\alpha} / \left(1 - \alpha k / \alpha\right)^{\alpha} \text{ while now is equal to } (2n_A)^{\alpha} = \left(w_A / \alpha\right)^{\alpha} / \left(1 - \alpha k / \alpha\right)^{\alpha} \text{.}\]
Table 7. Trade union behavior and payoffs.

<table>
<thead>
<tr>
<th></th>
<th>Trade Union B</th>
<th>Trade Union B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>NC</td>
</tr>
<tr>
<td>Trade Union A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-4; -4</td>
<td>+0.9; -8.8</td>
</tr>
<tr>
<td>Trade Union A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>-8.8; +0.9</td>
<td>-8.7; -8.7</td>
</tr>
</tbody>
</table>

propagation effects of the shock. It can be thought that the trade union in the country influenced by the shock wants to act in a coordinate way with the other union demanding for an increase in wages. The results of the numerical example say that the country influenced by the shock of the other country has as a premium an increase in the employment (+0.9) while the country in which the shock occurs has a loss due to the autonomous acting (-8.8).

The down-right cell refers to Case 2, where unions demand an increase in wages each in its own countries in an autonomous way, acting separately. The result obtained in this case is an employment loss of 8.7 in each country.

The up-left cell refers to Case 3, where a unique labor market is considered and hence as if there exist unions in the two different countries acting in a coordinate way and such that to behave as an unique union that requires an increase in wages in the labor market.

The game, as it is presented, has a unique solution corresponding to the strategy (C.C): it is the unique Nash equilibrium (equilibrium in dominant strategies) and for both players the solution is also Pareto-efficient.

If the optimal strategy for unions is cooperation (assuming that unions’ objective is to minimize the employment loss), why is this strategy not followed?

As it was described in Section 2, the model does not take in consideration the eventual presence of coordination costs. It is not easy to sign binding agreements and organize activities in order to achieve some common result without considering collateral problems like cultural, traditional and customary diversities in different countries, leadership position and the pursuit of particular interests.

Referring only to monetary costs to organize the policy on labor market by unions (hence leaving out problems of other nature), and taking in consideration a context with $p$ countries, it is possible to rewrite the supply of labor equation (Eq. (2.9)) for country $i$

$$
\left( \frac{w^\text{coord}}{-a} \right)_i = \alpha^* - h(u) - \gamma \psi(p), \quad \text{with } i = 1, \ldots, p \text{ and } \psi'(p) > 0, \quad (5.1)
$$

where $\gamma \psi(p)$ are the coordination costs, increasing in the number of countries which have to organize their actions, with $\gamma$ representing a percentage of the wage in efficiency terms that it could be obtained in the labor market without coordination\(^\text{16}\) and $\psi(p)$ that could be defined as:

\(^{16}\text{Wage that is determined from Eq. (2.5) (or equivalently, (2.6)) and coincident with the marginal productivity of labor.}\)
Table 8. Trade union behavior and payoffs with coordination cost.

<table>
<thead>
<tr>
<th></th>
<th>Trade Union B</th>
<th>Trade Union B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>NC</td>
</tr>
<tr>
<td>Trade Union A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-8.25; -8.25</td>
<td>-10.9; -7.8</td>
</tr>
<tr>
<td>Trade Union A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>-7.8; -10.9</td>
<td>-8.7; -8.7</td>
</tr>
</tbody>
</table>

\[
\varphi(p) = \begin{cases} 
  0 & \text{if } p = 1, \\
  \left[ \frac{p}{2} \right] + \left( \frac{p}{p} \right) & \text{if } p \geq 2 
\end{cases}
\] (5.2)

hence without any coordination cost if the union decides to act separately\textsuperscript{17}.

Referring to the model presented, hence considering the case of only two countries \((p = 2)\) and assuming a value of \(\gamma = 0.1 \cdot (w/\alpha)\), putting the new labor supply equation in the numerical example the following results are obtained (Table 8).

In this new situation, taking in consideration the coordination costs, the solution of the game (that take the form of a classical Prisoner’s Dilemma) is given by the strategy (NC, NC) with a payoff for each country equal to -8.7 (equilibrium in dominant strategies because both for trade union A and for trade union B the payoffs relatively the strategy NC are greater to those of the strategy C whatever is the choice of the other player), but the solution is not Pareto-efficient because, as it can be seen from the matrix, it could be convenient for both unions to adopt the strategy (C, C) that minimize the employment loss in the labor market.

Nevertheless, some considerations are needed: this results are obtained assuming coordination costs equal to 10% of the wage of efficiency terms and that coordination takes place between two countries. It is possible that exist a “percentage-countries frontier” after which the payoffs of the game change in a way that the structure of the game itself change and hence the better strategy to adopt can switch. It is also possible to assume that if the game is iterated, considering a wider time horizon, with the acquisition of experience in coordination, the relative costs of coordination could decrease, the results change and hence the optimal strategy for unions. Moreover, other factors (here not modeled) can influence the decision regarding the behavior to adopt by unions.

6. Conclusions

This work analyzes the implication of a technological shock in the labor market when it is considered the existence of another country belonging to the same monetary area and the consequences in the productive choices made by a firm operating in the market represented by the two countries. In particular, it is shown that a technological shock in a country leads to an unemployment increase greater than the unemployment level predicted by the Blanchard’s model, generated only by a reduction in the labor demand by firms, due to an increase in wage demand by unions. In fact, in this case, firms move part of the residual production.

\textsuperscript{17} In the coordination cost definition, it is assumed that there are only bilateral contacts between unions and a unique collegial decision between all unions, leaving out all the others multilateral agreements. In order to have coordination, it is necessary that at least two unions are involved in the process: from here derives that if an union act alone \((p = 1)\), the coordination costs are equal to zero.
in the country not subject to shock. With the data obtained in a numerical simulation and using elements of game theory, it has been showed that if it is considered an unique labor market with zero coordination costs, the employment loss in case of technological shocks is minimized if unions act in a coordinated way, while if coordination costs are positive, at least after a certain value, the expected behavior by unions is that they act in a separated way. A definitive answer it cannot be given here, but the topic is of great interest and it needs to be studied in depth.

References


