

**AGRICULTURAL UNSKILLED LABOR MOBILITY:
DOES IT MATTER?**

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Keywords: Labor mobility, Agriculture, Turkey-EU Integration

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Abstract:

Labor mobility is an important issue in quantitative economic analyses due to its possible implications for the sectoral reallocation of factors of production, output response, prices, and wages. This paper investigates the issue of agricultural unskilled labor mobility from both modeling and empirical perspectives. After discussing the issue from a theoretical perspective, I look into the empirical implications of treating agricultural unskilled labor less than mobile in the context of Turkey-EU agricultural integration. The results indicate that degree of mobility of the agricultural unskilled labor matters. It has certain implications on sectoral reallocations, and accordingly factor returns. The higher the degree of unskilled labor mobility between farm and nonfarm sectors, the higher the output response, and the lower the real earnings of unskilled labor in agriculture.

(*) I would like to thank Professor Tom Hertel for his valuable help in modeling agricultural unskilled labor mobility. All remaining errors are mine.

I. INTRODUCTION

Labor mobility is an important issue in quantitative economic analyses due to its possible implications for the sectoral reallocation of factors of production, output response, prices, and wages. Hertel (1989) highlights the importance of agricultural technology and factor mobility in determining the impact of changing support policies. Under normal circumstances, the more mobile is the labor between sectors, the higher the supply response we would expect to trade policy reforms. Impact on returns to sector-specific factors is also a key issue in the context of labor mobility.

In the ideal world of neoclassical frictionless markets, labor is perfectly mobile between sectors and responds instantaneously to wage differentials. However, in the real world we usually observe various kinds of frictions between markets, which adversely affect the mobility of the factors. In particular, perfect mobility assumption becomes more questionable when it comes the mobility of the relatively less skilled agricultural labor between farm and non-farm sectors.

Many empirical studies are skeptical about the labor mobility between agricultural and non-agricultural sectors, and question if labor market clearing is realized between these markets. Even though Barkley (1990) shows that migration from agriculture responds to relative wage differentials between sectors, he argues that the labor migration to higher wages does not take place immediately due to the uncertainty of getting a job in the other sector. Similarly, Patterson (1998) argues that for economists American fruit and vegetable growers' notion of a shortage of agricultural labor implies an excess demand at the prevailing wage. This situation would normally cause agricultural wages to go up, inducing a labor inflow from other sectors until the shortage disappears. However, this equilibration of wages, hence market-clearing process does not appear to be occurring statically, as would be suggested by the neoclassical economic theory.

Alston and Hatton (1991) interpret differences between wages in agriculture and manufacturing in the early 1900s as evidence of a permanent disequilibrium, or nonintegration, between farm and nonfarm sectors. Hatton and Williamson (1991a) cite that "unskilled fulltime nominal urban wages are about 41% higher than farm wages in the contemporary Third World" (Squire, 1981, p.102), and "they were about 51% higher among late 19th-century industrializers" (Clark, 1957, pp.526-531). The wage gap was even higher in England in the 1830s, about 73%, and about 50% in the United States in the mid-1890s (Williamson, 1987).

However, Hatton and Williamson found that this 50% nominal gap collapses to 9-13% urban-agricultural real wage gap after correcting for differences in the cost of living, personal

(human capital) characteristics, perquisites¹ received by farm laborers, and urban unemployment. They conclude that their findings imply for the transfer of labor out of agriculture that the measured gaps are smaller than often believed, suggesting that labor mobility was not perfect, but complete market segmentation was not the case, either. Similarly, in another paper (1991b) on America from 1890 to WWII Hatton and Williamson found that unemployment and wage differentials played the roles predicted by Todaro, but migration was not sufficiently elastic to equilibrate the returns to rural and urban unemployment. Thus, they concluded, “the labor markets linking farm to city did not work perfectly, but they worked well enough to keep the wage gap within relative narrow bounds” (Hatton and Williamson; 1991a, p.406).

In light of the above discussion, agricultural unskilled labor mobility can be considered important for developing countries in search of regional economic integration. Given the fact that the economy in these countries rely more heavily on agriculture, regional integration with a group of countries in the form of customs union or free trade area might have important implications for these countries, depending on the degree of mobility of agricultural labor. In this context, this paper is an attempt to model agricultural unskilled labor mobility and investigate its empirical implications in a multi-sector general equilibrium framework. The rest of the paper is organized as follows.

Section II discusses modeling agricultural unskilled labor mobility. Section III presents the results obtained from applying this model to a regional integration project, i.e. Customs Union between Turkey and the EU. Conclusions follow.

II. MODELING AGRICULTURAL UNSKILLED LABOR MOBILITY

In order to address the issue of agricultural unskilled labor mobility, this study extends the standard Global Trade Analysis Project (GTAP) modeling framework developed by Hertel (1997)². First the issue of factor mobility will be reviewed in a general context as tackled by the standard model. And then details of the extension on how to model unskilled labor mobility will follow.

Partial equilibrium supply response to a change in output price, in a neoclassical applied general equilibrium model with constant returns to scale, is determined mainly by two factors: technology and factor mobility. Interaction between these two factors would also affect supply

¹ Payments or profits received in addition to regular wages or salaries.

² GTAP is a project dedicated to the development and support of a global research network, data base, and modeling framework for conducting quantitative analysis of international trade, environment and resource issues in an economy wide framework. For the standard GTAP Model, see Hertel (1997).

response. When all inputs are perfectly mobile and input prices are exogenously determined³, then supply is perfectly elastic at the output price determined by the unit costs, implying a horizontal supply curve. Only the factor endowment constraints will reduce supply response in this case. However, once one of the inputs is treated *less-than perfectly mobile* then technology comes into play as another factor affecting supply response. Sectoral supply response becomes a function of the industry's ability to substitute away from the fixed factor of production.

For the simple case of a single, specific factor, the supply response (i.e. partial equilibrium supply elasticity) can be derived as follows (Hertel, 2000). Let us start with derivation of the zero profit condition. Starting from the production function

$$Q = f(Q_1, \dots, Q_N) \quad (1)$$

where Q denotes output, and $Q_1, \dots, Q_N$ denote all inputs used in the production process.

Totally differentiating equation (1) yields:

$$dQ = (\partial f / \partial Q_1) dQ_1 + \dots + (\partial f / \partial Q_N) dQ_N \text{ or, letting } \partial f / \partial Q_i = f_i \text{ (} i = 1, \dots, N \text{) we have} \quad (2)$$

$$dQ = \sum_i f_i dQ_i \quad (3)$$

Cost minimizing firms will equate the marginal value product⁴ of each input with its cost (i.e. price of input, p_i):

$$p_i = p f_i \text{ or } f_i = p_i / p \quad (4)$$

Substituting (4) in (3) for f_i we get:

$$dQ = \sum_i (p_i / p) dQ_i \quad (5)$$

Multiplying the terms in the summation by (Q_i / Q_i) and dividing the whole equation by Q gives:

$$(dQ / Q) = \sum_i (p_i Q_i / p Q) dQ_i / Q_i \quad (6)$$

Multiplying through by 100% to convert the quantity changes to percentages and noting that the sum in parentheses on the right-hand side is simply a cost share, we have:

$$q = \sum_i \theta_i q_i \quad (7)$$

Therefore, for the cost-minimizing firm, percentage change in output is simply a cost-share-weighted sum of the input changes. This relationship can be utilized in deriving the zero

³ This is a common partial equilibrium assumption.

⁴ Marginal Value Product of input i = Marginal Physical Product of i (f_i) $\times$ price of output (p)

profit expression as follows. Competitive entry and exit in an industry will eventually drive the industry to zero profit equilibrium where total revenue equals total cost:

$$PQ = \sum_i P_i Q_i \quad (8)$$

Totally differentiating (8) yields:

$$(Q dP + P dQ) = \sum_i (Q_i dP_i + P_i dQ_i) \quad (9)$$

Dividing through by PQ gives:

$$(dP/P + dQ/Q) = \sum_i (Q_i dP_i + P_i dQ_i)/PQ \quad (10)$$

Multiplying the right-hand side terms by (Q_i/Q_i) and (P_i/P_i) , respectively, using the definition of “cost share,” and multiplying through by 100% yields:

$$p + q = \sum_i \theta_i (p_i + q_i) \quad (11)$$

Making use of (7) we can simplify (11) to obtain the desired zero profit condition:

$$p = \sum_i \theta_i p_i \quad (\text{zero profit condition}) \quad (12)$$

Next step is to derive the labor supply equation in percentage change form linking output price and wages. For simplicity, suppose labor input is immobile across sectors, which implies that there are as many different types of labor as there are sectors in the model. This, in turn, implies that there are as many wage rates as there are labor types. We can write the resulting equilibrium system as three sets of equations (13) - (16). The first set of equations represents the derived demand conditions (i and j are inputs, σ_{ij} is elasticity of substitution between inputs i and j):

$$q_i = \sum_j \theta_j \sigma_{ij} p_j + q \quad (\text{derived demand}) \quad (13)$$

The second set of equations refer to the input supplies for the fixed factor, L (unskilled labor), and the perfectly mobile inputs whose supply are assumed to be perfectly elastic, hence prices are fixed:

$$q_L = 0 \text{ and} \quad (\text{factor supply condition for fixed input } L) \quad (14)$$

$$p_j = 0 \quad (\text{factor supply conditions, for input } j \text{ other than } L) \quad (15)$$

Lastly, recall the zero profit condition (equation 12) derived above: $p = \sum_j \theta_j p_j$.

Substituting (14) and (15) into (13) for $i = L$, we have:

$$q_L = \theta_L \sigma_{LL} p_L + q = 0 \quad (\text{equilibrium in the immobile factor market}) \quad (16)$$

Equation (16) implies that the only way to expand output, q , while remaining in factor market equilibrium, is to save on the scarce factor, L . This is induced by a rise in factor price (wage rate), p_L , which in turn causes firms to substitute other inputs for L , according to the available technology determined by the elasticity of substitution.

From (12) and (15) we have:

$$p = \theta_L p_L \text{ or } p_L = \theta_L^{-1} p \quad (\text{magnification effect}) \quad (17)$$

Since all other input prices are fixed, in partial equilibrium, the only adjustment that can occur on the cost side is in the wage rate, p_L . The magnitude of this adjustment will be greater, the smaller the share of L in total costs.

Substituting (17) into (16) and rearranging gives the supply response in terms of output price:

$$q = -\theta_L \sigma_{LL} (\theta_L^{-1} p) = -\sigma_{LL} p \quad (\text{supply response}) \quad (18)$$

Therefore, the partial equilibrium supply elasticity in this case is given by:

$$\eta_s = q / p = -\sigma_{LL} \quad (\text{supply elasticity}) \quad (19)$$

where σ_{LL} is the own elasticity of substitution for input L . In other words, the sectoral supply response is simply determined by the industry's ability to substitute away from the fixed factor. If $\sigma_{LL} = 0$, then price changes will not be able to induce any supply response. Furthermore, when output prices rise all the benefit will be transmitted to the return to sector-specific factor⁵. If the share of this factor in total costs is small, then the magnification effect can be substantial⁶.

⁵ By the formula linking input price with the output price p : $p_L = \theta_L^{-1} p$, where θ is the cost share of input L . In the case of single input $\theta_L = 1$, hence $p_L = p$, which means percentage change in output price will be equal to percentage change in input price.

⁶ For example if the cost share is 33%, the increase in input return will be three times the increase in commodity price. i.e. $p_L = (1/.33) p = 3.03 p$

The case of less-than perfect factor mobility is modeled in the standard GTAP model by introducing “sluggish endowment commodities.” These factors are distributed across uses according to a Constant Elasticity of Transformation (CET) function. Of particular interest here is the conditional own-price elasticity of supply, which is given by:

$$v_{LL}^j = \Omega_L^j(1 - \Omega_L^{j-1})\sigma_E = (\Omega_L^j - 1)\sigma_E \quad (20)$$

where $\sigma_E < 0$ is the elasticity of transformation of, say, labor endowments across uses in the CET function, and Ω_L^j is the share of the total labor endowment employed in sector j .⁷ The parameter v_{LL}^j describes the sensitivity of labor supply to sector j in response to a change in the wage rate in sector j , i.e. p_L^j . To get this in terms of the change in output price, we use equation (17), which links percentage change in output price with the price of labor input. This labor supply equation replaces (14) in the previous case, which yields the following partial equilibrium supply elasticity for sector j :

$$\eta_s^j = -\sigma_{LL}^j + [(\Omega_L^j - 1) / \theta_L^j] \sigma_E \quad (21)$$

The above equation decomposes the partial equilibrium commodity supply response of sector j into two components: technology ($-\sigma_{LL}^j$) and the remainder $[(\Omega_L^j - 1) / \theta_L^j]\sigma_E$, which is attributable to factor mobility.

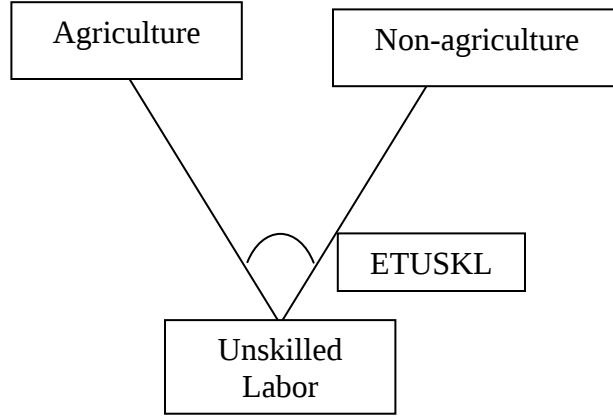
Having overviewed the issue of factor mobility in general, we can now turn to treatment of agricultural unskilled labor mobility. The standard GTAP model has been modified in the following way to address the issue of agricultural unskilled labor mobility. The key point here is that unskilled labor is assumed to be perfectly mobile within agriculture (and nonagriculture), but imperfectly mobile between these two sectors⁸. According to this specification there are effectively two sectors for unskilled labor as depicted by Figure 1 below: agriculture being comprised of all primary agricultural sectors, and non-agriculture including all sectors other than agriculture i.e. processed food, industrial, and services sectors. The distribution of unskilled labor between agricultural and nonagricultural sectors is determined by the wage differential between the two sectors and elasticity of transformation (ETUSKL). In particular, ETUSKL is the

⁷ Note from the above equation that if sector j uses all the labor available in the economy, then $v_{LL}^j = 0$ and we are effectively back in the previous case.

⁸ For sluggish factors (i.e. land and natural resources) there is no distinction between agriculture and nonagriculture for they are assumed to be imperfectly mobile between all sectors.

analytical instrument to represent the imperfect character of unskilled labor mobility between farm and nonfarm sectors pointed out by the empirical studies mentioned in the introduction.

Figure 1. Unskilled Labor Mobility Between Agriculture and Non-agriculture



In order to handle this task in the model, first price and quantity variables for agricultural and non-agricultural unskilled labor are defined.

$qousklagr(r)$ = supply of unskilled labor to agricultural sectors, in region r ,

$qousklnagr(r)$ = supply of unskilled labor to nonagricultural sectors, in r ,

$pmuskl(r)$ = composite price of unskilled labor, in r ,

$pmusklagr(r)$ = market price of unskilled labor used by agricultural sectors, in r ,

$pmusklagr(r)$ = market price of unskilled labor used by nonagricultural sectors, in r .

Second, elasticity of transformation parameter, $ETUSKL$, is introduced.

$ETUSKL(r)$ = elasticity of transformation for unskilled labor. i.e. how easy or hard to transform agricultural unskilled labor into nonagricultural unskilled labor. It is, by definition, non-positive.

In other words, we expect a decline in agricultural unskilled labor supply when there is an increase in the price of unskilled labor in non-agriculture.

Third, all sectors are merged into two broad sectors (agriculture and non-agriculture) in terms of unskilled labor usage.

$VOMAGUL(i,r)$ = value of i (agricultural unskilled labor) in region r
 = $\sum(j, AGR_COMM, VFM(i,j,r))$ and

$VOMNAGUL(i,r)$ = value of i (non-agricultural unskilled labor) in region r
 = $\sum(j, NAGR_COMM, VFM(i,j,r))$

where

AGR_COMM = {primary agricultural sectors},

NAGR_COMM = {nonagricultural sectors},

VFM(i,j,r) = value of firms' purchases of factor i in sector j in region r.

Fourth, shares of agricultural and non-agricultural unskilled labor in total payments to unskilled labor by firms (i.e. *revenue shares* of unskilled labor in farm and nonfarm sectors, respectively) is computed by dividing the value of agricultural and non-agricultural unskilled labor by aggregate payments to unskilled labor in the economy.

$$\begin{aligned} \text{REVSHRAGR}(i,r) &= \frac{\text{sum}(j, \text{AGR_COMM}, \text{VFM}(i,j,r))}{\text{sum}(k, \text{PROD_COMM}, \text{VFM}(i,k,r))} \text{ for agriculture, and} \\ \text{REVSHRNAGR}(i,r) &= \frac{\text{sum}(j, \text{NAGR_COMM}, \text{VFM}(i,j,r))}{\text{sum}(k, \text{PROD_COMM}, \text{VFM}(i,k,r))} \text{ for nonagriculture.} \end{aligned}$$

Market clearing conditions follow, which require equality of Supply and Demand for unskilled labor in each market. Starting from the level equations, supply of agricultural unskilled labor equals sum of the demand for unskilled labor in individual agricultural sectors:

$$L_A = \sum_j L_A^j \quad (\text{equilibrium condition in levels form}) \quad (22)$$

Differentiating (22) gives

$$dL_A = \sum_j dL_A^j \quad (23)$$

Dividing through by L_A yields

$$dL_A / L_A = \sum_j (dL_A^j / L_A). \quad (24)$$

Multiplying right hand side by (L_A^j / L_A) , using the definition of cost share, and rearranging gives

$$l_A = \sum_j \theta^j l_A^j \quad (\text{equilibrium condition in percentage form}) \quad (25)$$

where lower case l means percentage change. Same procedure applies to nonagricultural unskilled labor, which yields $l_{NA} = \sum_j \theta^j l_{NA}^j$. In GTAP notation this can be expressed as:

$$\begin{aligned} \text{VOMAGUL}(i,r) * \text{qousklagr}(r) &= \text{sum}(j, \text{AGR_COMM}, \text{VFM}(i,j,r) * \text{qfe}(i,j,r)), \\ \text{VOMNAGUL}(i,r) * \text{qousklnagr}(r) &= \text{sum}(j, \text{NAGR_COMM}, \text{VFM}(i,j,r) * \text{qfe}(i,j,r)). \end{aligned}$$

Domestic and firm demand prices are linked in the following equations through taxes on unskilled labor input i employed in sector j in region r , which capture the effect of taxation of firms' usage of unskilled labor. In level form, tax on input i in sector j in region r is given by value of firms' purchases at agent's prices over market prices:

$$\begin{aligned} \text{TF}(i,j,r) &= \text{VFA}(i,j,r) / \text{VFM}(i,j,r) \\ &= \text{PFE}(i,j,r) \text{QFE}(i,j,r) / \text{PM}(i,j,r) \text{QFE}(i,j,r) \\ &= \text{PFE}(i,j,r) / \text{PM}(i,j,r) \end{aligned} \tag{26}$$

where $\text{PFE}(i,j,r)$ and $\text{QFE}(i,j,r)$ represent price paid and quantity demanded by firms for endowment commodity i in sector j in region r , respectively. PM denotes market price.

Given the fact that there is a single price for unskilled labor across agricultural sectors, in differential form equation (26) converts to

$$\text{tf}(i,j,r) = \text{pfe}(i,j,r) - \text{pm}(r), \text{ or } \text{pfe}(i,j,r) = \text{tf}(i,j,r) + \text{pm}(r). \tag{27}$$

Same thing applies to nonagriculture, too. Hence price paid by firms for agricultural and nonagricultural unskilled labor are given by:

$$\text{pfe}(i,j,r) = \text{tf}(i,j,r) + \text{pmusklagr}(r); \tag{28}$$

$$\text{pfe}(i,j,r) = \text{tf}(i,j,r) + \text{pmusklnagr}(r); \tag{29}$$

Price of composite unskilled labor is calculated as the revenue share-weighted average of agricultural and non-agricultural unskilled labors.

$$\begin{aligned} \text{pmuskl}(r) &= \text{REVSHRAGR}(i,r) * \text{pmusklagr}(r) \\ &\quad + \text{REVSHRNAGR}(i,r) * \text{pmusklnagr}(r). \end{aligned} \tag{30}$$

The distribution of unskilled labor between agricultural and non-agricultural sectors are determined by elasticity of transformation of agricultural unskilled labor (ETUSKL) multiplied

by the wage differential. Starting from the definition of elasticity of substitution (L = Unskilled Labor, a = agriculture):⁹

$$\sigma_{ETUSKL} = \frac{(Q_L^a / Q_L)}{(P_L^a / P_L)} < 0 \Rightarrow (Q_L^a / Q_L) = \sigma_{ETUSKL} (P_L^a / P_L). \quad (31)$$

In percent change form this converts to

$$q_L^a - q_L = \sigma_{ETUSKL} (p_L^a - p_L) \text{ or } q_L^a = q_L + \sigma_{ETUSKL} (p_L^a - p_L). \quad (32)$$

III. EMPIRICAL IMPLICATIONS

The issue of imperfect agricultural unskilled labor mobility is a relevant issue in the case of Turkey-EU customs union due to its possible implications on output changes and sectoral reallocations given the relatively high share of agriculture in the Turkish economy and unskilled labor-intensive character of the agriculture. As depicted by Table 1 below, cost shares of unskilled and skilled labor are 35% and 2% in grains and oilseeds, 20% and 1% in livestock, 40% and 2% in vegetables and fruits, 42% and 2% in other crops and forestry-fishing sectors, respectively.

Table 1. Cost shares of primary factors in agricultural sectors, Turkey

	<i>GOS</i>	<i>LVS</i>	<i>VAF</i>	<i>OCR</i>
Land	0.22	0.13	0.25	0.27
Unskilled Labor	0.35	0.20	0.40	0.42
Skilled Labor	0.02	0.01	0.02	0.02
Capital	0.07	0.04	0.07	0.08

Source: The GTAP 4 data base, Yeldan and Köse (1996).

In this section implications of unskilled labor mobility is investigated by applying the model to agricultural integration between Turkey and the EU. Data calibration, experimental design and the results follow.

1. Data Calibration

The calibration of ETUSKL is an empirical question, which involves revenue shares and estimations of own price elasticity of unskilled labor supply. This can be done by using the link between own price elasticity of unskilled labor supply and elasticity of transformation parameter.

⁹ Same procedure applies to nonagriculture.

Recall that the conditional own-price elasticity of supply for input L is given by equation (20), replacing σ_E with σ_{ETUSKL} :

$$v_{LL}^j = \Omega_L^j(1 - \Omega_L^{j-1})\sigma_{ETUSKL} = (\Omega_L^j - 1)\sigma_{ETUSKL} \quad (20)$$

where $\sigma_{ETUSKL} < 0$ is the elasticity of transformation of unskilled labor across uses in the CET function, and Ω_L^j is the revenue share of the unskilled labor employed in sector j (i.e. share of unskilled labor employed in primary agricultural sectors with respect to total payments to unskilled labor). The parameter v_{LL}^j describes the sensitivity of labor supply to sector j in response to a change in the labor wage rate in sector j. Note from the above equation that if sector j uses all the unskilled labor available in the economy, then $v_{LL}^j = 0$, which implies perfectly immobile labor supply.

There are two possibilities to calibrate elasticity of transformation parameter, $ETUSKL$. Either we can calibrate it with the help of revenue shares from individual region's IO flow data. This approach implies fixed labor supply elasticities (v_{LL}^j) across regions. Alternatively, we can calibrate $ETUSKL$ for a given labor supply elasticity for a sample region, hold it fixed across regions and let the implied unskilled labor supply elasticities vary. The second approach, which we chose, seems more plausible since it allows labor supply elasticity to vary across regions, which is a reasonable assumption given the differences in factor intensities and economic infrastructure across regions.

With regard to the value of labor supply elasticity, the ideal case would be to get estimations of agricultural unskilled labor supply elasticity for each individual region, which is not readily available for most regions. In the absence of local estimation for individual regions, then, we looked for an estimation based on relatively more reliable data. A recent estimation of agricultural unskilled labor supply elasticity is provided by Perloff (1991) for the US economy.

Perloff (1991) discussed in his paper the impact of wage differentials on choosing to work in agriculture. Based on a model of industry choice and wage determination, and using 1988 US data, he estimates that the response of average agricultural unskilled labor to a 1% increase in the relative wage in agriculture is 3.37%. In another study Rosenbloom (1991) discussed the occupational differences in labor market integration for the US in the 1890s and estimated unskilled labor supply elasticity as 2.23. Even though the latter estimation is related to labor supply elasticity between urban jobs rather than between agriculture and nonagriculture, nevertheless it gives an idea about the range in which labor supply elasticity can fluctuate.

The revenue share of agricultural unskilled labor is calculated for each region from the GTAP 4 data base and the implied ETUSKL value for the US is calculated using the above link between labor supply elasticity and the revenue shares. Holding it fixed, the implied labor supply elasticities are also calculated in Table 2, which reports payments to agricultural unskilled labor, revenue shares and the implied supply elasticities for all regions.

Table 2. ETUSKL and Unskilled Labor Supply Elasticities

	<i>Agricultural USKL</i>	<i>Total USKL</i>	<i>Revenue share</i>	<i>Implied USKL supply elasticity</i>	<i>ETUSKL</i>
TUR	13265	57979	0.229	2.638	-3.421
EU	129330	3145092	0.041	3.280	-3.421
ROW	413825	6127334	0.068	3.190	-3.421
USA*	37520	2514868	0.015	3.370	-3.421

* USA is put for reference purposes. Source: The GTAP 4 data base and own calculations.

2. Experimental Design

The 1995 Customs Union agreement between Turkey and the EU has been effective since 1996 and it was projected to be completed by 2001. The agreement excluded agricultural sectors, but kept the door open for future agricultural integration (Article 22, *Customs Union With EU*, 1995). One of the possibilities before the Turkish Government in search of deciding the future of agricultural policies, therefore, is to evaluate the possible costs and benefits of integrating Turkey's agriculture with that of the EU. Acar (2000) investigates the implications of agricultural integration in many respects, i.e. welfare, sectoral reallocations, factor markets, cost on the EU budget, revenue replacement, etc. Experimental design and the data draw heavily on this study.

The original IO data for Turkey is taken from The Input-Output Structure of the Turkish Economy 1990 published by State Institute of Statistics of Turkey (1994). It is modified in accordance with the additional data provided by Yeldan and Köse (1996). This IO table is incorporated into the GTAP 4 data base in order to separate out Turkey for quantitative analysis, as explained in Acar (1998). Agricultural sectors and labor categories are disaggregated by following a series of procedures explained in detail in Peterson (1998), Liu and McDougall (1998), and Liu et al. (1998). The following table shows the sectoral aggregation, which includes 12 sectors: 5 primary agricultural, 4 processed food, and 3 industrial sectors.

Table 3. Commodity Aggregation

#	Code	Sector
1	GOS	Grains and oilseeds
2	LVS	Livestock
3	VAF	Vegetables and fruits
4	OCR	Other crops
5	FAF	Forestry and fishing
6	MTP	Meat products
7	DAP	Dairy products
8	BTP	Beverages and tobacco products
9	OFP	Other food products
10	TEX	Textiles
11	WAP	Wearing apparels
12	OIS	Other Industrial Sectors

There are two experiments designed to explore the empirical implications of agricultural unskilled labor mobility: Experiment 1 (E1), and Experiment 2 (E2). The former is a counterfactual scenario to answer the question “what if Turkish agriculture had been included in the Customs Union agreement from the beginning?” The latter is a projection for the future and looks into the implications of agricultural integration after the year 2001 once the industrial integration is completed. Essentially, in both experiments all trade barriers between the two regions, i.e. import tariffs and export subsidies, are removed, and Turkey adapts the common external tariffs of the EU against other regions.

The first experiment applies this harmonization to all sectors in the beginning, while the second experiment applies it in two stages. In the first stage harmonization is applied only to industrial sectors as proposed by the 1995 CU agreement. In the second stage agricultural sectors are integrated by removing the trade distortions and extending the common agricultural tariffs to include primary agricultural sectors. What is important for the focus of this study is to see if different mobility assumptions would make a visible difference in terms of output response and reallocation of resources.

3. Results

The relevance of the imperfect mobility of unskilled labor between sectors has been emphasized previously. When factors are assumed to be infinitely elastic, i.e. perfectly mobile between alternative uses, then supply response would be higher compared to imperfect factor mobility case. In this section how the results are affected by different treatments of labor with regard to intersectoral mobility are going to be highlighted. First, an example is chosen to highlight the impact on sectoral output response when unskilled labor is treated imperfectly mobile between sectors. Table 3 gives the output response in E1 under perfect and imperfect factor mobility assumptions.

The first column gives the output response when unskilled labor is treated imperfectly mobile between all sectors, agriculture and non-agriculture alike. The second column does the same thing for perfectly mobile unskilled labor. As indicated by figures in Table 3, when factors are freely mobile between sectors, supply response is remarkably higher in most sectors relative to imperfect mobility case. This is more visible especially in meat products (MTP), textiles (TEX), and wearing apparels (WAP). For instance, estimated output growth in WAP in the case of perfect factor mobility is 168% as opposed to 87% in the imperfect mobility case, 81 percent points higher in the former case. Similarly, MTP expands by 27.3% in perfect mobility case compared to 12.4% of imperfect mobility case.

Table 3. Impact of unskilled labor mobility on output response, Turkey, E1

	Imperfect mobility	Perfect mobility
GOS	4.5	5.6
LVS	2.5	4.3
VAF	2.6	2.8
OCR	6.5	9.8
FAF	-2.3	-5.0
MTP	12.4	27.3
DAP	4.3	1.6
BTP	-6.5	-1.3
OFP	4.3	-7.7
TEX	11.7	55.8
WAP	86.8	168.0
OIS	-9.9	-8.1

Source: simulation results

Economically it does not seem to be a puzzle to explain these results: when trade distortions are removed, foreign demand as well as domestic demand will respond positively to increasing export prices and falling input costs via reduced import prices. Derived demand for factors will go up in expanding sectors. If factors are freely mobile between sectors, it will be

easier to pull additional factors from other sectors. The easier to get these additional factors, the higher would be the supply response. Percentage increases are more visible in MTP, TEX, and WAP sectors because protection is heavier in these sectors, and the last two sectors have a considerable share in Turkey's foreign trade with the EU.

The above results indicate that it matters to treat unskilled labor between all sectors. What about treating unskilled labor imperfectly between two broader categories: agriculture and non-agriculture? In this context, let's go one step further and look at the response of output under different assumptions of unskilled labor mobility between agriculture and non-agriculture.

Recall that ETUSKL and unskilled labor supply elasticity are linked through the revenue share of unskilled labor in a given economy (equation 20). The following table shows different values of elasticity of transformation of unskilled labor and the corresponding unskilled labor supply elasticities.

Table 4. ETUSKL and Corresponding Labor Supply Elasticities

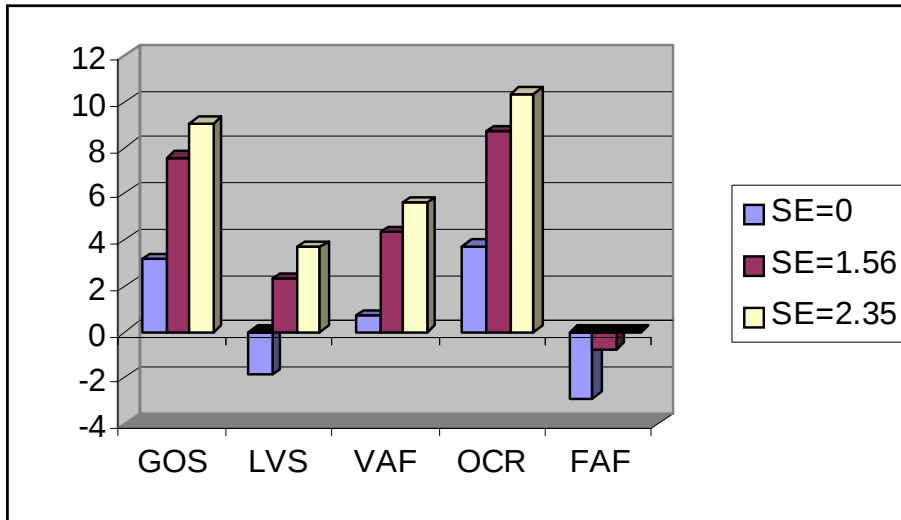
		ETUSKL = 0.0	ETUSKL = - 2.030	ETUSKL = - 3.045
	Revenue share of USKL	Unskilled Labor supply elasticity	Unskilled Labor supply elasticity	Unskilled Labor supply elasticity
TUR	0.229	0.000	1.566	2.348
EU	0.041	0.000	1.947	2.920
ROW	0.068	0.000	1.893	2.839
USA	0.015	0.000	2.000	3.000

Source: The GTAP 4 data base and own calculations

Notice that when elasticity of transformation is assumed to be zero, the implied unskilled labor supply elasticity will also be zero, i.e. there is no way of using agricultural unskilled labor as non-agricultural unskilled labor. This means unskilled labor is perfectly immobile between farm and nonfarm sectors. The second and third columns correspond to implied labor supply elasticities for Turkey, EU and Rest of the World when labor supply elasticity of the US is assumed to be 2.0 and 3.0 respectively.

In light of the above, the Figure 2 below shows the output response in primary agricultural sectors—grains and oil seeds, livestock, vegetables and fruits, other crops, and forestry and fishing of Turkey in experiment 1 (E1) under different mobility assumptions mentioned above. The first, second and third columns in the figure represent output response for each sector when unskilled labor supply elasticity is assumed to be zero (perfectly immobile), 1.56 and 2.35, which correspond to elasticity of transformation of unskilled labor (ETUSKL) = 0.0, -2.030 and -3.045 respectively.

Figure 2. Output response under different mobility assumptions, %, Turkey, E1



As the figure shows, output response is minimum when labor supply elasticity is zero, i.e. unskilled labor is fixed. Output response gets higher as we relax this assumption and allow unskilled labor mobility between agriculture and nonagriculture. For example, GOS sector expands only by about 3% when unskilled labor is not mobile, while it expands more than 7% and about 9% when labor supply elasticity is assumed to be 1.56 and 2.35, respectively. The rate of expansion jumps up when we switch from perfect immobility to a moderate level of mobility. Same trend applies more or less to other primary agricultural sectors as well. The implication of this finding on factor returns, however, is in the opposite direction, as revealed by Table 5 below, which shows the impact of agricultural integration in E2 scenario on real factor prices in Turkey under different mobility assumptions.

Table 5. Real Factor Returns, % change, E2

	USKL supply elasticity (Turkey)		
	0.0	1.56	2.35
	real factor earnings		
Land	35.2	48.2	53.1
Agricultural Unskilled Labor	32.3	8.35	0.81
Nonagricultural Unskilled Labor	0.81	3.81	4.76
Skilled Labor	1.78	3.35	3.84
Capital	0.63	2.1	2.56

Source: Simulation results

The role of agricultural unskilled labor mobility on real factor returns is clearly reflected in the above table. Recall that in E2 scenario, agricultural sectors are included in the Customs

Union once the industrial integration is completed. As a result of removing all the barriers for agricultural sectors and output subsidies are harmonized with the EU, most of the agricultural sectors tend to expand as also reflected by Figure 2. Accordingly we expect real factor returns to be positive and higher returns for those factors intensively used in agricultural sectors. This is confirmed by the figures in Table 5. A closer look at those figures can tell more on the impact of unskilled labor mobility between farm and non-farm sectors.

As indicated by Table 5, real returns on agricultural unskilled labor are the highest (32.3%) when no intersectoral factor mobility is allowed, nearly as high as return on land (35.2%), which is also sector specific. As we allow unskilled labor mobility, that means we are moving away from sector-specific nature of unskilled labor. This results in loosening the strong link between factor returns and output price, which dampens the real return on unskilled labor, hence reducing the gap between return on farm and nonfarm unskilled labor. For instance, real earnings gap on agricultural and non-agricultural unskilled labor is quite high (32.3-0.81=31.49%) when factor mobility is not allowed. It falls sharply to 4.54% (8.35-3.81) when labor supply elasticity is taken to be 1.56. When factor mobility is taken to even higher levels, agricultural unskilled labor loses its sector specific nature almost completely; hence non-agricultural unskilled labor earns more than agricultural labor (4.76 vs. 0.81 respectively under labor supply elasticity of 2.35).

Real return on land is the highest relative to all other factors of production in all cases. This is because land is always used as a sector-specific factor employed only in the primary agricultural sectors. As labor supply elasticity goes up from zero, while farm unskilled labor earnings get reduced, return on land increases even further. This, once again, follows from the strong relationship between the price of sector-specific factor and the price of output in that sector and the level of support. As unskilled labor mobility is allowed, land becomes the only sector specific factor, and hence getting the highest return as agricultural sectors expand. The following table highlights further what happens to prices and quantities of unskilled labor in the case of agricultural integration.

Table 6. Changes in price and quantity of Unskilled Labor, %, E2

	TUR	EU	ROW
Agricultural unskilled labor supply	7.39	-0.36	0
Nonagricultural unskilled labor supply	-2.13	0.02	0
Price of agricultural unskilled labor	10.59	-0.52	0.07
Price of nonagr. unskilled labor	7.63	-0.41	0.07
Average price of unskilled labor	8.31	-0.42	0.07

Source: Simulation results

When agriculture is included in the integration, most agricultural sectors expand as mentioned earlier, which calls for more primary factor usage to accommodate increased demand. Since primary agricultural sectors are unskilled labor intensive, agricultural unskilled labor supply goes up by 7.39% while nonagricultural unskilled labor supply goes down by 2.13% in Turkey. Accordingly, prices of agricultural unskilled labor increases faster (10.59%) than that of skilled labor (7.63%).

Finally we would like to take a look at the impact of labor mobility on exports of Turkey to the EU in the case of agricultural integration. The following table shows estimated changes in export volume in million dollar terms under three different unskilled labor supply elasticity (SE) assumptions in primary agricultural and food processing sectors.

Table 7. Impact on export volume (Turkey to the EU, \$m, 1995 prices, E2)

	SE=0.0	SE=1.56	SE=2.35
GOS	17.1	19.9	20.9
LVS	42.6	50.6	53.2
VAF	223.8	419.2	480.7
OCR	135.0	150.8	155.6
FAF	-13.6	-10.0	-8.8
MTP	13.5	13.9	14.1
DAP	1.83	1.84	1.84
BTP	5.6	6.1	6.2
OFP	309.7	327.1	332.3

Source: Simulation results

As far as the impact of unskilled labor mobility on exports is concerned, similar trend is observed as output and factor returns. That is, as we allow higher degrees of mobility, response of exports also gets higher. For example \$223 million worth of export volume change in vegetables and fruits (VAF) sector in 1995 prices¹⁰ in the case of perfect immobility goes up to \$419.2 million and \$480.7 million, respectively, when unskilled labor elasticity is assumed to be 1.56 and 2.35 respectively. Similarly, other crops (OCR) sector starts with an export volume change of \$135 million in strict immobility and climbs to \$150.8 and \$155.6 million as unskilled labor is allowed to move between farm and nonfarm at various degrees. This trend applies to all primary agricultural and food processing sectors, except for forestry and fishing (FAF) sector, which seems to have no chance for increasing exports.

¹⁰ Dollar value of quantity changes at initial 1995 prices.

IV. CONCLUSION

Labor mobility is an important issue in quantitative economic analyses due to its possible implications for the sectoral reallocation of factors of production, output response, prices, and wages. This paper investigates the issue of agricultural unskilled labor mobility from both modeling and empirical perspectives. After discussing the issue from a theoretical perspective, I look into the empirical implications of treating agricultural unskilled labor less than perfectly mobile in the context of Turkey-EU agricultural integration.

The results indicate that degree of mobility of the agricultural unskilled labor matters. It has certain implications on sectoral reallocations, and accordingly factor returns. The higher the degree of unskilled labor mobility between farm and nonfarm sectors, the higher the output response, and the lower the real earnings of unskilled labor in agriculture. Export volumes also go up as unskilled labor is allowed to move between farm and nonfarm sectors.

One little remark for future research follows. Given the finding that different assumptions on labor supply elasticity lead to different results as far as the impact of a regional economic integration project on sectoral reallocations, factor earnings and export volumes are concerned, it would be a good area to look into the magnitude of unskilled labor supply elasticity for the particular region(s) in question. More refined estimation of labor supply elasticity will make the results of quantitative economic analyses more plausible.

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