Migration and Foreign Trade: Further Results

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Abstract

We use the production-theory approach to immigration in an open-economy setting to investigate the role of nonresident workers in Swiss production decisions. Unlike earlier work in this area, exports are explicitely taken into account. Indeed, a statistical test for global separability bewtween inputs and outputs reveals that exports and goods intended for domestic use cannot be aggregated. Empirical results show that immigration tends to shift the output mix away from exports. Moreover, nonresident labour services are found to be an Allen-Uzawa complement for imports, and a Hicksian substitute for domestic labour. Immigraiton therefore tends to favour capital owners.

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1 Introduction

In a recent paper (Kohli, 1999), we investigated the role of guestworkers in Swiss aggregate production over the postwar period. Unlike earlier studies using the production-theory approach to immigration pioneered by Grossman (1982), we did so in an open-economy setting, explicitely taken into account imports as an input to the technology. Indeed, it is well known that the bulk of imports is in raw materials and intermediate goods, and that even most so-called "finished" imported products are not ready to meet final demand: they must still go through a number of domestic changes (e.g. unloading, transportation, insurance, repackaging, retailing), so that a substantial proportion of their final price tag is generally accounted for by domestic value added. That is, imports flow through the production sector, where they are combined with domestic capital, resident labour, and nonresident labour.

As noted in our earlier paper, our results were dependent on the assumption that all outputs could be aggregated into a single composite good, which could be either aborbed at home, or exported to the rest of the world. This led to an asymmetry in the model, not only because it meant that far greater scrutiny was devoted to inputs than to outputs, but also because if one is to argue that imports require further processing before they are ready to meet final demand, then the same must be true for exports which are an input to the foreign technology. Exports are therefore conceptually different from goods intended for domestic sales.[1] The purpose of this note is to formally investigate the question of the aggregation of domestic sales and exports in the presence of migrant workers. It will also make it possible to shed some light on the link between migration and both sides of foreign trade, an issue which has been extensively debated in the theoretical trade literature, but which has failed to yield any firm conclusions.[2]

[1] One would typically expect that exports contain less domestic value added than similar products intended for domestic use, if for no other reason that the latter are likely to go through additional domestic distribution channels.

[2] See Ethier (1997) for a recent review. According to some authors (e.g. Mundell 1957), external trade can be viewed as a substitute for international factor movements, while for others (e.g. Markusen, 1983) it acts rather as a complement.

2 Description of the Technology and Global Separability

Our starting point is the aggregate production function, such as in Kohli (1999):[3]

$$y = f(\mathbf{x}), \tag{1}$$

where y is the quantity of gross output, $\mathbf{x} \equiv [x_j]$ $(j \in M, N, L, K)$ is the vector of input quantities. The labels stand for imports (M), nonresident labour (N), resident labour (L), and capital (K). We assume that the production possibilities set T is a convex cone, in which case $f(\mathbf{x})$ is nondecreasing, quasi-concave, and linearly homogeneous with respect to the components of $\mathbf{x}$.

In order to be able to handle situations where the number of outputs is greater than one, it is convenient to use a joint revenue function which can be viewed as a generalization of the production function expressed in nominal terms:[4]

$$\begin{aligned} R(p_S, p_X; x_M, x_N, x_L, x_K) \equiv & \max_{\mathbf{y}} \{ p_S y_S + p_X y_X : \\ & (y_S, y_X, x_M, x_N, x_L, x_K) \in T \}, \end{aligned} \tag{2}$$

where $\mathbf{y} \equiv [y_S \, y_X]'$ and the p_i's denote output prices; $R(\cdot)$ is well defined for positive prices and nonnegative inputs; it is linearly homogeneous, nondecreasing, and convex in prices, as well as linearly homogeneous, nondecreasing, and concave in input quantities (Diewert, 1974).

The representation of the technology by a joint revenue function makes it easy to derive the profit maximizing supply of outputs and inverse demands for inputs:

$$y_i = \frac{\partial R(\cdot)}{\partial p_i} \equiv y_i(p_S, p_X; x_M, x_N, x_L, x_K), \tag{3}$$

$$w_j = \frac{\partial R(\cdot)}{\partial x_j} \equiv w_j(p_S, p_X; x_M, x_N, x_L, x_K), \tag{4}$$

$$\tag{5}$$

for $i = S, X$ and $j = M, N, L, K$ and where w_j denotes the price of input j.

[3] Alternatively, we could describe the technology by the dual cost function, but for what follows, the primal representation is more convenient.

[4] Note that production function (2) itself can be viewed as a single-output revenue function if it is multiplied it by the price of aggregate output (p): $R(p, \mathbf{x}) \equiv pf(\mathbf{x})$.

The substitution possibilities allowed for by the technology can be summarized by a set of elasticities of transformation, substitution, and intensity (σ_{mn}) which can be obtained as follows:

$$\sigma_{mn} = \frac{R_{mn} R}{R_m R_n}, \tag{6}$$

where $R_m \equiv \partial R(\cdot)/\partial z_m$ and $R_{mn} \equiv \partial^2 R(\cdot)/(\partial z_m z_n)$ where z_m and z_n denote the elements of $\mathbf{p}$ and/or $\mathbf{x}$. It is a simple matter then to derive the price and quantity elasticities of the output supply and inverse input demand functions; see Kohli (1991, pp. 37–39).

The description of the technology by the joint revenue function makes it possible to investigate the question of the aggregation of output. In order for domestic sales and exports to be consistently aggregated, the technology must be globally separable between inputs and outputs. A necessary and sufficient conditition for this to be possible is:[5]

$$\sigma_{Sj} = \sigma_{Xj}, \quad j = M, N, L, K. \tag{7}$$

For empirical implementation, we select the Translog functional form:

$$\begin{aligned} \ln R \;=\; & \alpha_0 + \sum \alpha_i \ln p_i + \sum \beta_j \ln x_j + \frac{1}{2} \sum \sum \gamma_{ih} \ln p_i \ln p_h + \\ & \frac{1}{2} \sum \sum \phi_{jk} \ln x_j \ln x_k + \sum \sum \delta_{ij} \ln p_i \ln x_j, \\ & i, h = S, X;\ j, k = M, N, L, K, \end{aligned} \tag{8}$$

where $\sum \alpha_i = 1$, $\sum \beta_j = 1$, $\gamma_{ih} = \gamma_{hi}$, $\phi_{jk} = \phi_{kj}$, $\sum \gamma_{ih} = 0$, $\sum \phi_{jk} = 0$, $\sum_i \delta_{ij} = 0$, and $\sum_j \delta_{ij} = 0$. The derived revenue maximizing output supply and inverse input demand functions can then best be expressed in share form:

$$s_i = \alpha_i + \sum \gamma_{ih} \ln p_h + \sum \delta_{ij} \ln x_j, \quad i = X, S \tag{9}$$

$$s_j = \beta_j + \sum \delta_{hj} \ln p_h + \sum \phi_{jk} \ln x_k, \quad j = M, N, L, K \tag{10}$$

where $s_i \equiv p_i y_i / R$ and $s_j \equiv w_j x_j / R$ are the revenue shares of output component i and of input j, respectively.

It can easily be seen that a necessary and sufficient condition for (7) to hold is:[6]

$$\delta_{Sj} = \delta_{Xj} = 0, \quad j = M, N, L, K. \tag{11}$$

[5] See Berndt and Christensen (1973), and Kohli (1991), pp. 48–49.

[6] See Kohli (1991), p. 186.

Given the adding-up properties of the δ_{ij}'s, condition (11) amounts to three restrictions on the parameters. It can easily be seen global separability implies that the aggregate technology can be described, on one hand, by a Translog production function — see (2) above —, and on the other hand, by a Translog transformation function aggregating domestic sales and exports.

3 Empirical Results

The model of equations (9)–(10) is estimated using the same data as in Kohli (1999).[7] In order to allow for technological change and shifts over time in the technology, we follow the same procedure as in Kohli (1999); that is, a fourth-degree polynomial in time is included. The estimation method is the same as well; see Berndt, Hall, Hall, and Hausman (1974).[8] Although all monotonicity conditions were satisfied at the outset, the initial estimates violated the required curvature conditions for some of the observations. Yet curvature conditions are an important part of the theoretical framework, and they must be satisfied for the estimates to be economically meaningful.[9] Convexity in prices and concavity in quantities were therefore imposed (in 1986 and in 1950, respectively), using the technique of Wiley, Schmidt, and Bramble (1973) applied to the reparameterization originally suggested by Lau (1978).[10] The resulting estimates satisfy all regularity conditions for all observations.[11]

A likelihood ratio test is used to verify the validity of restrictions (11). It shows that these restrictions are very decisively rejected by the data: the test statistic is 20.17, for a critical χ^2-value of 11.34 at the 99% confidence level with three degrees of freedom. We therefore can conclude that the elasticities of substitution between inputs depend on relative output prices, and that the elasticities of transformation between outputs depend on relative input quantities. This also suggests that

[7] The data are for Switzerland, and they are annual for the period 1950–1986. The division between exports and domestic sales follows the national accounts. Additional details, and the series themselves, are available from the author upon request.

[8] Since the revenue shares add up to unity, two equations (one from the output side and one from the input side) must be omitted for estimation purposes, but the results do not depend on which equations are left out.

[9] A little noted fact about Grossman's (1982) widely cited study is that her results are derived from a Translog production function which is not well behaved since it fails to be concave.

[10] See Kohli (1991), pp. 111–113.

[11] Parameter estimates and standard errors are available from the author upon request.

nonresident workers may have a differential effect on the production of exports and goods intended for domestic use.

We report in Table 1 1986 estimates of the price and quantity elasticities consistent with the GNP-function setting.[12] That is, these elasticities are defined for variable domestic sales, exports, imports, and nonresident labour services, and for fixed endowments of domestic labour and capital; see Kohli (1999). Asymptotic standard errors are shown in parentheses.

It is apparent that many of these elasticities are estimated with a fairly high level of precision, with t-values in excess of two (in absolute value) in half the cases. Of considerable interest are the own price elasticities of the demand for imports (it lies between -0.50 and -0.75 for much of the sample period) and of the demand for nonresident labour (it is quite steady, at about -1.20). It thus appears that the demand for foreign labour services is quite elastic, more so than the demand for imports. The own price elasticities of the supply of exports and domestic sales are both found to be rather small.

In the northwest corner of the table, one finds the (own- and cross-) price elasticities of the supply of outputs (domestic sales and exports) and of the demand for variable inputs (imports and nonresident labour services); these are defined for given domestic factor endowments. In the southeast corner of the table, one finds the quantity elasticities of the inverse demands for the domestic primary factors, defined for given output and variable input prices. The elasticities in the northeast corner — often dubbed Rybczynski elasticities — describe the effect of a change in domestic factor endowments on the output mix and on the demand for variable inputs. Those in the southwest corner, finally, show the effect of a change in output or variable input prices on domestic factor rental prices — the so-called Stolper-Samuelson elasticities.

Looking first at the demand for imports (line 3), one sees that it is quite sensitive to price changes. An increase in the price of domestic sales stimulates the demand for imports, whereas an increase in the nonresident wage rate discourages it. This indicates that imports and foreign labour services are complements in the Allen-Uzawa sense. Naturally, the demand for imports is also a decreasing function of its own price, as dictated by the convexity of the production possibilities set. The corresponding point estimates are rather large in absolute value, but the

[12] Similar tables for 1950 and 1970 are available from the author upon request.

standard errors are rather large too, although all three effects are statistically significant. The demand for imports is also very senstitive to changes in the endowment of capital. Qualitatively the same results hold for the demand for foreign labour services, although, their statistical significance is reduced, except for the role of the capital stock. The supply of exports is largely driven by the endowment of capital, and to a lesser extent by the population of native workers. A drop in the nonresident wage rate would have no impact on the supply of exports, but it would heavily favour the output of goods and services intended for domestic use. It would also lead to a significant increase in the return to capital, but hurt domestic workers. An improvement in the terms of trade (an increase in the price of exports or a fall in the price of imports) would overwhelmingly benefit capital owners.

As pointed out in Kohli (1999), annual permits, seasonal permits, and trans-border permits are not issued freely in Switzerland, and it is therefore of interest to also consider the polar case of immigration quotas, i.e. to treat nonresident labour services as a fixed, rather than as a variable, input. The resulting elasticity estimates can easily be derived from the figures in Table 1 (see Kohli, 1999), and they are shown in Table 2. It is noteworthy that 32 out of 36 of these effects have a t-value in excess of two in absolute value. We observe that a ten-percent increase in the nonresident workforce would reduce the income of resident workers, by approximately 0.4 percent. This shows that resident and nonresident workers are Hicksian substitutes for each other. The guestworker wage rate would fall by about 2.8 percent. The beneficiaries would be capital owners whose return would increase by about 1.4 percent. The demand for imports would rise by about 2.8 percent, again suggesting a complementarity relationship, but the supply of exports would hardly change: the increased use of nonresident labour would mostly favour the production of goods and services intended for domestic use. Thus, increased immigration tends to alter the income distribution in favour of capital at the expense of labour, and it tends to have a negative impact on the trade balance. It is also apparent from the estimates in Table 2 that an increase in the price of imports hurts both domestic factors of production, not least capital; it penalizes migrant workers as well due to the complementarity relationship between the two foreign inputs. An increase in the price of exports favours both domestic factors of production, with a magnifying impact on the rental price of capital; nonresident workers would essentially be unaffected.

Many of the results reported here are very similar to those obtained in our earlier study.[13] Our latest estimates are more detailed, however, and they reveal asymmetries in the role of nonresident workers — and of both domestic factors — in Swiss production patterns which could not have been detected before. Thus, whereas we had earlier on established that a fall in the wage rate of migrant workers would have a positive effect on the supply of output, one could not have known that this effect concerns almost exclusively the output of goods intended for domestic use, rather than exports. The result that an increase in relative capital intensity heavily shifts the output mix towards exports could not have been deduced either. The fact that the restrictions implied by global separability are severely rejected by the data means that the more recent estimates must be viewed as more reliable.

4 Conclusions

Our empirical results indicate that it is inappropriate to model the contribution of migrant workers to Swiss production possibilities with the help of a simple, one-output production function. All four inputs have a differentiated effect on output supplies. Thus, nonresident workers appear to contribute mostly to the production of goods and services intended for domestic sales. This is true to a lesser extent for native workers, while the opposite holds for capital. The nonresident labour service bias towards the production of nontraded goods may have to do with the fact that many migrant workers are relatively unskilled and employed in the service industry. Nonresident labour services tend to be a complement for imports, in the sense that an increase in import prices will reduce the demand for foreign labour services, or depress their rental price if their supply is fixed. Or, expressed differently, an increase in the number of nonresident workers would tend to be accompanied by an increase in the demand for imports. It would only have an insignificant impact on the supply of exports, and thus a negative effect on the trade balance. Not surprisingly, an increase in immigration is found to hurt first and foremost earlier immigrants. It would also tend to harm domestic workers and to benefit capital owners, but these effects are numerically small, even if

[13] See Kohli (1999), especially Tables 7 and 8.

statistically significant.

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Table 1: GNP-Function Setting
1986 Price and Quantity Elasticities
(standard errors in parentheses)

Endogenous variables	Exogenous variables					
	p_S	p_X	w_M	w_N	x_L	x_K
y_S	2.252	0.234	-2.192	-0.565	0.435	0.565
	(1.146)	(0.220)	(0.784)	(0.294)	(0.139)	(0.139)
y_X	0.490	0.160	-0.634	-0.015	0.322	0.678
	(0.461)	(0.113)	(0.356)	(0.145)	(0.060)	(0.060)
x_M	4.452	0.615	-4.238	-0.830	0.087	0.913
	(1.549)	(0.344)	(1.117)	(0.389)	(0.197)	(0.197)
x_N	10.283	0.133	-7.436	-2.980	-1.309	2.309
	(5.813)	(1.253)	(3.861)	(1.524)	(0.752)	(0.752)
w_L	0.704	0.249	-0.070	0.116	-0.074	0.074
	(0.224)	(0.046)	(0.155)	(0.058)	(0.038)	(0.038)
w_K	1.806	1.036	-1.437	-0.406	0.147	-0.147
	(0.419)	(0.096)	(0.315)	(0.099)	(0.078)	(0.078)

Table 2: Immigration Quotas
1986 Price and Quantity Elasticities
(standard errors in parentheses)

Endogenous variables	Exogenous variables					
	p_S	p_X	w_M	x_N	x_L	x_K
y_S	0.574	0.209	-0.783	0.190	0.683	0.127
	(0.084)	(0.080)	(0.127)	(0.025)	(0.025)	(0.044)
y_X	0.437	0.159	-0.596	0.005	0.328	0.666
	(0.164)	(0.118)	(0.280)	(0.050)	(0.053)	(0.089)
x_M	1.589	0.578	-2.168	0.278	0.452	0.270
	(0.246)	(0.271)	(0.473)	(0.079)	(0.069)	(0.128)
w_N	3.451	0.045	-2.496	-0.336	-0.439	0.775
	(0.488)	(0.435)	(0.678)	(0.172)	(0.169)	(0.264)
w_L	1.106	0.254	-0.360	-0.039	-0.126	0.165
	(0.039)	(0.040)	(0.053)	(0.013)	(0.017)	(0.026)
w_K	0.407	1.018	-0.425	0.136	0.325	-0.461
	(0.138)	(0.137)	(0.202)	(0.048)	(0.052)	(0.091)