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Morocco and the US Free Trade Agreement: A specific factors model with unemployment and energy imports

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ABSTRACT

This paper examines the impact in Morocco of its pending free trade agreement with the US in a specific factors model with unemployment and energy imports. Projected price scenarios across eight industries lead to adjustments in outputs, energy imports, rural wages, urban wages, and the unemployment rate. The model predicts substantial adjustments for reasonable price scenarios. Rural wages fall unless agriculture is subsidized. Unemployment, assumed inversely related to output, is sensitive to price changes. Factor substitution only affects the degree of output adjustments. Adjustments in capital returns lead to industrial investment and subsequent long run output adjustments.

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The US Morocco Free Trade Agreement USMFTA promises to eliminate trade barriers between the two countries over a period of 25 years. Morocco will import more agricultural products, manufacturing, telecommunications, and financial services from the US. The net gains from trade, however, will come with economic adjustments. Brown, Kiyota, and Stern (2005) predict that USMFTA will have small employment effects in Morocco. The present specific factors model separates urban from rural labor, adds energy imports, and finds more substantial effects. Adjustments in energy imports and outputs across the eight industries are also substantial under various price scenarios.

The model includes unemployment in the urban sector based on Okun's (1962) law linking the unemployment rate to output. The present application is the first to include Okun's law in a general equilibrium model as developed by Thompson (1989). The model of production and trade developed is developed by Jones (1965), Jones and Scheinkman (1977), Chang (1979), Takayama (1982), and Thompson (1995).

The present specific factors model includes eight industrial capital inputs with urban labor, rural labor, and imported energy mobile between industries. There is ample motivation to include energy imports, critical to the economy of Morocco. Separate adjustments in the returns to industrial capital lead to long run investment and output adjustments. The paper includes sensitivity analysis for a number of assumptions including the degree of factor substitution and various price change scenarios.

The World Bank ranks Morocco as a middle income developing country. Morocco is similar to California in both land area and has a population of 34 million. About half the labor force is rural with very low wages. Labor intensive agriculture accounts for one fifth of GDP and one third of export revenue. Urban wages are much higher but unemployment is endemic. The economy is fairly diversified. Morocco has about two thirds of global phosphate reserves and is the third largest producer. Mining accounts for 6% of GDP and includes barite, cobalt, fluorspar, and lead. Tourism is the second source of foreign exchange following remittances. Table 1 lists the major merchandise trade categories. Leading imports from the US are aircraft, soybeans, corn, and wheat.

Morocco has been integrating into the global economy with privatization, more transparent business regulation, and open foreign investment (USITC, 2004). Economic and trade ties are mostly with the EU due to proximity and history. France, Portugal, and Spain account for almost all foreign direct investment. USMFTA is likely to increase investment from the US.

Table 2 summarizes tariff rates in Morocco and the US. Tariff rates in Morocco are quite high. Tariff rate quotas on agricultural imports reach over 300%. The average tariff rate on US imports is over 20% suggesting sizeable industrial price changes under USMFTA.

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Table 1
Merchandise trade in Morocco, 2005.

Exports	$mil	Imports	$mil
Apparel & footwear	2616	Computers	3576
Fish & shellfish	918	Yarn & fabric	1483
Electronics	883	Petroleum	1386
Inorganic chemicals	471	Machinery	906
Phosphates	364	Cereals	749
Fertilizer	332	Motor vehicles	582
Petroleum	286	Medicines	181
Exports to the US	446	Imports from the US	481
Total merchandise	11,190	Total merchandise	20,790

The first section below presents the model, followed by sections on the data and the comparative static elasticities. The fourth section discusses projected price scenarios followed by a section on the resulting economic adjustments in the specific factors model. A sixth section considers sensitivity analysis and long run adjustments due to industrial investment.

1. The specific factors model with unemployment and energy imports

The present model assumes neoclassical production with competitive markets for products and factors of production. Each of the eight industries has its own capital input K_j. Shared inputs are urban labor L_U, rural labor L_R, and imported energy E. Industrial prices p_j are projected to change in USMFTA leading to comparative static adjustments in the urban wage w_U, rural wage w_R, industry capital returns r_j, outputs x_j, national output Y, and the unemployment rate u. The model extends to the effects of long term industrial investment responding to adjusting capital returns in USMFTA.

Okun's (1962) law is the regular empirical relationship between the unemployment rate u and output Y. Prachowny (1993), Moosa (1997), Apel and Jansson (1999), Cuaresma (2003), Knotek (2007), and Malley and Molana (2008) find evidence of Okun's law across a wide range of countries and time periods. Okun's law is stated

$$du = -\beta Y', \tag{1}$$

where ′ represents percentage change.

The International Monetary Fund (2010) reports that the average β has increased during the recent decades, from 0.25 during the 1990s to 0.36 in the 2000s after some decline in the 1980s. Spain has the highest β at 0.8. Sweden and the UK have high β's reflecting labor market reforms. Norway and Denmark have the lowest β's. France, Germany, Italy, and the US have average β's with high volatility.

Output Y is exhausted by factor payments,

$$Y = w_U N + w_R L_R + eE + \Sigma_j r_j K_j, \tag{2}$$

where N is the number of employed urban workers, e is the international price of imported energy, and K_j is the capital input in industry j.

The endogenous unemployment rate u is linked to the endogenous number of employed urban workers N according to $N = (1 - u)L_U$ implying

$$N' = L_U' + (1\text{–}u)^{-1} du. \tag{3}$$

The first equation in the comparative static system (9) below is based on full employment of urban labor, $N = \Sigma_j a_{Uj} x_j$ where a_{Uj} is the cost minimizing amount of urban labor per unit of output in industry j. Differentiate to find $dN = \Sigma_j x_j da_{Uj} + \Sigma_j a_{Uj} dx_j$. Unit inputs are functions of input prices assuming homothetic production. Introducing elasticities leads to

$$N' = \sigma_{UU} w_U' + \sigma_{UR} w_R' + \sigma_{Ue} e' + \Sigma_j \sigma_{Uj} r_j' + \Sigma_j \lambda_{Uj} x_j', \tag{4}$$

where σ_{Ui} is the substitution elasticity of urban workers with respect to the price of input i and λ_{Uj} is the industry share of urban workers in industry j. The first equation in Eq. (9) combines Eqs. (3) and (4). The second equation in Eq. (9) is a similar condition for employment of rural labor L_R.

Substitution elasticities in each industry are derived from Allen (1938) cross price elasticities S^j_{ik} between the input of factor i and the payment to factor k in industry j according to $\sigma^j_{ik} \equiv \hat{a}_{ij}/\hat{w}_k = \theta_{kj} S^j_{ik}$. The own price elasticity σ^j_{ii} is derived assuming linear homogeneity, $\Sigma_k \sigma^j_{ik} = 0$. Cobb–Douglas production implies unit Allen elasticities, $S^j_{ik} = 1$. Economy wide substitution elasticities are weighted across industries, $\sigma_{ik} \equiv \Sigma_j \lambda_{ij} E^j_{ik}$. Cobb–Douglas production implies $\sigma_{ik} = \Sigma_j \lambda_{ij} \theta_{kj}$.

Sensitivity to substitution is examined with constant elasticity of substitution CES that scales the Allen elasticity to values other than one. For instance, the stronger CES elasticity of 2 doubles the Cobb–Douglas substitution elasticities.

The third equation in Eq. (9) is energy imports, $E = \Sigma_j a_{Ej} x_j$. Differentiating and introducing substitution elasticities similar to Eq. (4),

$$E' = \sigma_{EU} w_U' + \sigma_{ER} w_R' + \sigma_{Ee} e' + \Sigma_j \sigma_{Ej} r_j' + \Sigma_j \lambda_{Ej} x_j'. \tag{5}$$

The international price of energy e is exogenous, the small open economy assumption. Energy imports E are endogenous.

Similar to labor employment, each of the eight industrial capital inputs are fully utilized according to $K_j = a_{Kj} x_j$. Differentiating,

$$K_j' = \sigma_{jU} w_U' + \sigma_{jR} w_R' + \sigma_{je} e' + \sigma_{jj} r_j' + x_j'. \tag{6}$$

Substitution elasticities for capital inputs with respect to input prices vary by industry. Capital input in an industry is not sensitive to prices of other industrial capital inputs.

Competitive pricing for each industry is stated $p_j = a_{Uj} w_U + a_{Rj} w_R + a_{Ej} e + a_{jj} r_j$. Differentiate and apply the cost minimizing envelope result to find

$$p_j' = \theta_{Uj} w_u' + \theta_{Rj} w_R' + \theta_{Ej} e' + \theta_{jj} r_j', \tag{7}$$

where θ_{ij} is the factor share of revenue in industry j paid to factor i. The competitive pricing condition (7) provides a set of eight equations in Eq. (9).

The next to the last equation in Eq. (9) accounts for changes in output Y. The total differential is $dY = N dw_U + L_R dw_R + E de + \Sigma_j K_j dr_j +$

Table 2
Import tariffs by commodity, GTAP %.

	Morocco	US
Wheat	23.6	2.6
Other cereals	10.0	0.6
Vegetables, fruits	31.7	4.7
Oil seeds	24.5	17.7
Red meat	199.5	5.3
Other animal products	22.4	0.6
Other agriculture	18.8	11.7
Fishing	0	0
Other minerals	1.0	0.04
Energy, metals	2.8	1.2
Vegetable oils and fats	101.5	4.3
Dairy products	69.2	42.5
Beverages and tobacco	29.1	3.0
Other food	46.0	13.0
Wearing apparel	22.6	11.8
Chemical products	15.9	1.7
Electronic equipment	8.0	0.1
Machinery and equipment	12.7	3.3
Other industrial manufacturing	10.6	2.6

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$w_U dN + w_R dL_R + edE + \Sigma_j r_j dK_j$. In elasticity form substituting for N′ in Eq. (3),

$$Y' = \theta_U w_U' + \theta_R w_U' + \theta_E e' + \Sigma_j \theta_j r_j' + \theta_U L_U' + (1\text{-}u)^{-1} du + \theta_R L_R' + \theta_e E' + \Sigma_j \theta_j K_j'. \tag{8}$$

The last equation in Eq. (9) is Okun's law in Eq. (1).

The comparative static system collects exogenous variables on the right hand side,

$$\begin{pmatrix} \sigma_{UU} & \sigma_{UR} & \sigma_{Uj} & \lambda_{Uj} & 0 & 0 & (1\text{-}u)^{-1} \\ \sigma_{RU} & \sigma_{RR} & \sigma_{Rj} & \lambda_{Rj} & 0 & 0 & 0 \\ \sigma_{EU} & \sigma_{ER} & \sigma_{Ej} & \lambda_{Ej} & 0 & -1 & 0 \\ \sigma_{jU} & \sigma_{jR} & \sigma_{jj} & \lambda_{jj} & 0 & 0 & 0 \\ \theta_{Uj} & \theta_{Rj} & \theta_{jj} & 0 & 0 & 0 & 0 \\ \theta_U & \theta_R & \theta_j & 0 & 1 & \theta_E & (1\text{-}u)^{-1} \\ 0 & 0 & 0 & 0 & -\beta & 0 & 1 \end{pmatrix} \begin{pmatrix} w_U' \\ w_R' \\ r_j' \\ x_j' \\ Y' \\ E' \\ du \end{pmatrix} = \begin{pmatrix} L_U' - \sigma_{UE} e' \\ L_R' - \sigma_{RE} e' \\ \sigma_{EE} e' \\ dK_j - \sigma_{Ej} e' \\ p_j' \\ \theta_R L_R' + \theta_j K_j' + \theta_E e' \\ 0 \end{pmatrix} \tag{9}$$

Inverting the system leads to partial derivatives of each of the 21 endogenous variables (w_U w_R E r_j x_j Y u) with respect to each of the 19 exogenous variables (L_U L_R e K_j p_j). The present comparative static exercise focuses on changes in industrial prices p_j holding constant labor forces L_U and L_R, the price of energy e, and industry capital inputs K_j.

The Okun parameter β is scaled to 2003, a year of economic liberalization in Morocco. The number of unemployed declined over 2 percentage points as national output increased over 6%. The derived Okun coefficient is β = 0.425. Sensitivity to β is discussed.

2. Production data for Morocco

The model is built from the national income data. Table 3 reports the total payment matrix for 2005 from *Haut Commissariat au Plan: Direction de la Statistique*. Value added for 20 industries in millions of Dirhams ($1 = Dh9) is from *Comptes De La Nation: valeur ajoutées par branche*. Rural and urban employment data is from *Indicateurs d'Activité et de Chômage*. The data cover the eight major industries,

A	Agriculture
F	Fisheries
P	Mining
M	Manufacturing
T	Textiles, leather, shoes
C	Construction, real estate
H	Hotels, restaurants
S	Services

Based on the major commodity trade categories in Tables 1 and 2 export industries are taken to be fisheries F, mining P, and manufacturing M, and import industries agriculture A and textiles T. Construction C, hotels H, and services S depend to a large extent on trade. Urban labor L_U and rural labor L_R are assumed mobile across industries. Petroleum in the data is treated as energy imports E. The specific capital inputs K_j are residuals of industrial value added.

Factor shares θ_{ij} in Table 4 report portions of value added for factor i in industry j. For instance, value added in agriculture is Dh209 billion from Table 3 implying that the rural labor factor share is 123/209 = 59%. Agriculture employs very little energy or urban labor. The largest factor shares for industrial capital K_j are in manufacturing M and hotels H. The largest factor shares for urban labor U are in textiles T and construction C. The largest factor shares for energy E are in services S, fisheries F, and mining P. The 8 × 11 factor share matrix θ includes zeroes for other industrial capital inputs.

Table 4 also reports the factor intensities of energy relative to capital E/K and rural relative to urban labor L_R/L_U. Services S, fisheries F, mining P, and textiles T are the most energy intensive industries relative to capital. The high energy intensity of services S is due to its very low capital input. Agriculture A is by far the least energy intensive industry. Rural labor L_R is extremely intensive in agriculture A, followed distantly by textiles T, manufactures M, and fisheries F. These factor intensities largely account for the relative effects on factor prices.

The industry shares in Table 5 report the distribution of factors across industries. Competition equalizes each factor price across industries allowing derivation of the industry shares in Table 5. For example, rural labor has total income of Dh194 billion and an industry share in agriculture of 123/194 = 63%. Services employs 37% of urban workers followed by manufacturing at 23% and textiles at 16%. Energy imports go mostly to services at 64% and manufactures at 14%. Manufacturing, services, and agriculture have 80% of the capital stock. The 8 × 11 industry share matrix λ has zeroes for other industrial capital inputs.

3. Comparative static elasticities

Table 6 reports substitution elasticities σ for Cobb–Douglas production. Constant elasticity of substitution CES scales elasticities accordingly. For instance CES = 2 doubles the substitution elasticities in Table 6.

The strongest own price Cobb–Douglas elasticity is −1.76 for energy E and the weakest is −0.38 for textile capital K_T. Energy and labor inputs have stronger own substitution than industrial capital. There is stronger substitution relative to the urban wage w_U than relative to the rural wage w_R. Factors are generally weak substitutes with Cobb–Douglas production.

Table 7 reports comparative static elasticities of factor prices with respect to product prices derived by inverting the system matrix in Eq. (1). The effects are uneven with some factor prices rising and others falling. Every 1% decrease in the agricultural price p_A lowers the return r_A to capital in agriculture by −2.41% and the rural wage w_R by −0.27%. The rural wage w_R has fairly strong positive links with prices in services p_S and textiles p_T.

Table 3
Factor payments, Dh bil.

	$Capital_j$	Energy	Urban	Rural	Total
Agriculture	72.5	3.7	10.1	123	209
Fisheries	15.5	11.6	17.1	4.5	48.8
Mining	4.2	2.7	3.8	0.9	11.6
Manufacturing	142	25.9	70.2	25.3	263
Textiles	22.9	14.9	49.7	15.7	103
Construction	31.1	8.4	38.2	6.2	83.8
Hotels	6.5	1.6	4.6	0.6	13.3
Services	92.9	122	115	18.1	348
Total	388	191	309	194	1082

Table 4
Factor shares θ_{ij} and intensities.

	$Capital_j$	Energy	Urban	Rural	E/K	LR/LU
Agriculture	0.35	0.02	0.05	0.59	0.06	11
Fisheries	0.32	0.24	0.35	0.09	0.75	0.26
Mining	0.36	0.24	0.33	0.08	0.67	0.22
Manufacturing	0.54	0.10	0.27	0.10	0.19	0.37
Textiles	0.22	0.14	0.48	0.15	0.64	0.31
Construction	0.37	0.10	0.46	0.07	0.27	0.15
Hotels	0.49	0.12	0.34	0.05	0.24	0.15
Services	0.27	0.35	0.33	0.05	1.3	0.15

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Table 5
Industry shares λ_{ij}.

	$Capital_j$	Energy	L_U	L_R
Agriculture	0.19	0.02	0.03	0.63
Fisheries	0.04	0.06	0.06	0.02
Mining	0.01	0.01	0.01	0.00
Manufacturing	0.37	0.14	0.23	0.13
Textiles	0.06	0.08	0.16	0.08
Construction	0.08	0.04	0.12	0.03
Hotels	0.02	0.01	0.01	0.00
Services	0.24	0.64	0.37	0.09

Table 8 reports price elasticities of outputs on the production frontier. A higher industrial price raises that output, attracting labor and energy from other industries where outputs generally fall. The only exception to this pattern is for agriculture output x_A that increases with prices in fisheries p_F, mining p_P, and hotels p_H. A decrease of −1% in the price of agriculture p_A lowers its output by −1.41% suggesting quite a bit at stake in USMFTA. The largest own output elasticities are 2.72 for textiles x_T and 2.03 for services x_S.

Table 8 also reports elasticities of energy imports E with respect to industrial prices. Energy imports fall weakly with higher prices for mining p_P, construction p_C, and hotels p_H. These industries have small energy shares and attract labor to expand. Energy imports are tied to prices in agriculture p_A and services p_S. Agriculture is highly intensive in rural labor. The largest effect on E is for the price of services p_S with an elasticity of 0.49 due to its energy intensity and large size.

4. Projected price changes in USMFTA

The literature includes projections of changes in prices and trade in USMFTA. Agricultural prices are expected to fall. Gilbert (2003) estimates that imports from the US will increase 88%. Rosen (2003) predicts increased grain imports. Abdelmalki et al. (2007) consider subsidized US agriculture a threat. Average tariffs between 1998 and 2003 were 18% on corn, 28% on durum wheat, and 83% on bread wheat. The present simulations project price declines of 20% and 10%. In a scenario with government subsidies p_A is held constant.

The Atlantic coast is a rich fishing ground and fishing a major industry. The present simulations assume that Morocco will remain an exporter with the price of fish p_F rising by 5% and 10%.

The mining industry is also projected to gain with increased prices p_P set to 5% and 10%. The size of the mining industry leads to large effects. These same two price changes are simulated for construction p_C, hotels p_H, and services p_S.

The price of manufactures is more difficult to predict due to its mixture of exports and imports. Effects of 5%, 0%, and −5% changes in p_M are compared.

5. Comparative static adjustments in Morocco

Table 9 reports adjustments to four price change scenarios. In the moderate price scenario MOD the price of agriculture p_A falls by −10%, the price of textiles p_T is held constant, and the other prices all increase 5%.

In the strong price scenario STR the price of agriculture p_A falls by −20% while prices of manufactures p_M and textiles p_T fall by −5% and other prices rise 5%.

In the polarized price scenario POL the agriculture price p_T falls by −20%, prices of manufactures p_M and textiles p_T are constant, and all other prices rise 10%.

The agriculture scenario AGR assumes that subsidies maintain p_A with the other price changes set to the moderate price scenario MOD.

To find the factor price adjustments in Table 9 multiply the matrix of factor price elasticities in Table 7 by the vector of price changes. In the moderate price scenario MOD the urban wage w_U increases 5% while the rural wage w_R decreases by −2%. The largest increased capital return is for services r_S at 14%. The agriculture capital return r_A decreases by −27%. Capital returns rise considerably in fisheries r_F at 11% and mining r_P at 10%. The falling textiles capital return r_T is substantial at −10%. Effects on specific capital returns are larger than price changes due to the Jones (1965) magnification effect. Labor mobility mitigates wage adjustments that are smaller than capital return adjustments. National output Y falls by −3% leading to the increase in the unemployment rate u by 1 point.

Output adjustments in Table 9 are found by multiplying the vector of predicted price changes by the matrix of price elasticities in Table 8. Adjustments in industrial outputs generally shadow their capital returns. In the moderate scenario MOD agriculture output x_A suffers the largest decline at −17%. The only other industrial decline is for textiles x_T at −10%. The services industry is the largest winner with output x_S rising 9%. Fisheries output x_F rises 6% and mining output x_P 5%. Energy imports E decline by −1%.

The strong price scenario STR assumes a 20% reduction in the agriculture price p_A coupled with decreases in manufactures p_M and textiles p_T of −5% and increases of 5% in other prices. The outcome is catastrophic for agriculture with reductions in the capital return r_A of −48% and output x_A of −29%. The rural wage w_R falls by −6% while the urban wage rises 3%. Outputs and capital returns in manufactures and textiles fall considerably while other industries expand. The aggregate outcome is positive with output rising 14% and unemployment falling 6 points. Energy imports fall by −5%. This scenario is the best for the aggregate economy but by far the worst for agriculture.

The polarized scenario POL leads to larger adjustments across industries but smaller aggregate effects. The urban wage w_U rises 9% but national output Y rises only 1% and unemployment u falls by only 1 point. Even with no changes in prices of manufacturing and textiles, these industries decline due to rising prices in other industries. Services, fisheries, and mining are the big winners. Energy imports fall by −2%.

Table 6
Cobb–Douglas substitution elasticities σ_{ik}.

Factor prices unit inputs	w_U	w_R	e	r_A	r_F	r_P	r_M	r_T	r_C	r_H	r_S
a_U	−1.53	0.54	0.34	0.03	0.04	0.01	0.08	0.10	0.07	0.01	0.23
a_R	0.43	−1.37	0.35	0.26	0.02	0.00	0.07	0.07	0.03	0.00	0.09
a_E	0.64	0.39	−1.76	0.02	0.05	0.01	0.07	0.07	0.04	0.01	0.40
a_A	0.05	0.59	0.02	−0.65	0	0	0	0	0	0	0
a_F	0.35	0.09	0.24	0	−0.68	0	0	0	0	0	0
a_P	0.33	0.08	0.24	0	0	−0.64	0	0	0	0	0
a_M	0.22	0.08	0.08	0	0	0	−0.38	0	0	0	0
a_T	0.48	0.15	0.14	0	0	0	0	−0.78	0	0	0
a_C	0.46	0.07	0.10	0	0	0	0	0	−0.63	0	0
a_H	0.34	0.05	0.12	0	0	0	0	0	0	−0.51	0
a_S	0.32	0.05	0.36	0	0	0	0	0	0	0	−0.73

U urban labor, R rural labor, e,E energy, A agriculture, F fisheries.
P mining, M manufacturing, T textiles, C construction, H hotels, S services.

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Table 7
Price elasticities of factor prices.

Prices factor prices	p_A	p_F	p_P	p_M	p_T	p_C	p_H	p_S
w_U	−0.01	0.26	0.23	0.15	0.27	0.23	0.18	−0.02
w_R	0.27	−0.06	−0.10	0.00	0.22	0.01	−0.08	0.44
r_A	2.41	0.07	0.15	−0.02	−0.42	−0.04	0.12	−0.77
r_F	−0.34	2.86	−0.22	−0.18	−0.41	−0.25	−0.17	−0.48
r_P	−0.29	−0.24	2.60	−0.15	−0.34	−0.21	−0.14	−0.40
r_M	−0.08	−0.09	−0.07	1.57	−0.14	−0.08	−0.05	−0.12
r_T	−0.39	−0.53	−0.42	−0.33	3.72	−0.50	−0.32	−0.58
r_C	−0.14	−0.31	−0.26	−0.18	−0.40	2.41	−0.20	−0.20
r_H	−0.10	−0.18	−0.15	−0.11	−0.23	−0.16	1.92	−0.15
r_S	−0.53	−0.33	−0.24	−0.20	−0.45	−0.27	−0.19	3.03

U urban labor, R rural labor, A agriculture, F fisheries.
P mining, M manufacturing, T textiles, C construction, H hotels, S services.

The agricultural subsidy in scenario AGR rescues agriculture by keeping its price constant. Output x_A and the return to capital r_A both nevertheless fall slightly due to the other expanding industries. The rural wage w_R rises 1% but falls 4% relative to the urban wage. Output Y falls by −8% and unemployment u rises 4 points in the worst outcome for the aggregate economy. Energy imports E increase 3%. The textile industry suffers considerably even with its constant price. Galal and Lawrence (2003) point to restrictive fiber forward rules of origin that force apparel manufacturers to use higher cost inputs and further weaken the industry. Effects on other industries are moderate since labor does not leave agriculture to the same extent as the other scenarios.

One basic lesson of the simulations is that the unemployment rate is sensitive to price changes. It falls in the strong STR and polar POL scenarios but increases in the moderate MOD and agriculture subsidy AGR scenarios.

The relative rural wage w_R/w_U falls in every scenario ranging from −12% in POL to −4% in AGR. Skilled workers earn six times the unskilled wage according to Karshenas (1994). Löfgren (1999) notes that employment in kind represents over half of rural income. Ravillion and Lokshin (2004) analyze changes in household welfare due to trade liberalization and find the losers will be the rural poor. The outlook for rural labor is grim under USMFTA even with agriculture subsidies.

While free trade leads to aggregate gains Thompson (1986) shows that wages may polarize between countries when there are three or more factors. Goldberg and Pavcnik (2007) document evidence that trade has raised the wage gap between skilled and unskilled labor across a number of developing countries. Helpman, Itskhoki, and Redding (2008) show trade can increase the wage gap and unemployment given labor market frictions consistent with the present model. The present results suggest that rural wage inequality will evolve as a critical issue under USMFTA.

6. Substitution and long run adjustments

In the applied production literature, estimated substitution elasticities are typically larger than Cobb–Douglas with cross price elasticities ranging up to 1. Consider simulations with the CES elasticity set to 2 implying substitution elasticities twice as large as those in Table 6.

Thompson and Toledo (2005) show for any degree of CES substitution that the factor price adjustments are identical to those in Table 7. The energy import elasticity is also the same as in Table 7. Adjustments to the various price scenarios are also identical for national output and the unemployment rate to those in Table 9. Output adjustments, however, would be twice as large as those in Table 8.

Regarding sensitivity to price changes, the adjustments in Table 9 scale to monotonic price changes. For instance, doubling the price change vectors doubles all of the adjustments.

Results are robust to a wide range of values for the Okun β. With β about half as large at −2 the only noticeable differences are somewhat smaller effects on national output adjustments of (−1%, 3%, 0%, −2%) in price scenarios (MOD, STR, POL, AGR).

Output adjustments are more modest than capital return adjustments but long run investment would generate larger output adjustments. The percentage adjustment in an industry output is about equal to the percentage change in its industrial capital stock. Assuming unit elasticity of the capital stock with respect to its return, outputs adjust in the same direction. Long run output adjustments add percentage adjustments in their capital returns to the output adjustments in Table 9. With such long run industrial investment, the economy becomes much more specialized. For instance, in moderate scenario MOD the long run decline in agriculture output x_A climbs to −44%.

7. Conclusion

The present specific factors model provides insight into the substantial economic adjustments facing Morocco as it moves toward free trade with the US. There will be gains for export industries including mining, fishing, and manufacturing. Import competing industries including agriculture and textiles, however, stand to lose. The urban wage rises while the rural wage falls. Energy imports fall. Subsidies for agriculture would support the rural wage but be costly for the economy.

Table 8
Price elasticities of outputs and energy.

Prices outputs, energy	p_A	p_F	p_P	p_M	p_T	p_C	p_H	p_S
x_A	1.41	0.07	0.15	−0.02	−0.42	−0.04	0.12	−0.77
x_F	−0.34	1.86	−0.22	−0.18	−0.41	−0.25	−0.17	−0.48
x_P	−0.29	−0.24	1.60	−0.15	−0.34	−0.21	−0.14	−0.40
x_M	−0.08	−0.09	−0.07	0.57	−0.14	−0.08	−0.05	−0.12
x_T	−0.39	−0.53	−0.42	−0.33	2.72	−0.50	−0.32	−0.58
x_C	−0.14	−0.31	−0.26	−0.18	−0.40	1.41	−0.20	−0.20
x_H	−0.10	−0.18	−0.15	−0.11	−0.23	−0.16	0.92	−0.15
x_S	−0.53	−0.33	−0.24	−0.20	−0.45	−0.27	−0.19	2.03
E	0.36	0.03	−0.01	0.02	0.06	−0.01	−0.01	0.49

U urban labor, R rural labor, E energy, A agriculture, F fisheries.
P mining, M manufacturing, T textiles, C construction, H hotels, S services.

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Table 9
Price scenarios, %Δ.

	MOD	STR	POL	AGR		MOD	STR	POL	AGR		MOD	STR	POL	AGR
p_A	−10	−20	−20	0	w_U	5	3	9	5	Y	−3	14	1	−8
p_F	5	5	10	5	w_R	−2	−6	−3	1	U	1 pt	−6 pt	−1 pt	4 pt
p_P	5	5	10	5	r_A	−27	−48	−53	−3	x_A	−17	−28	−33	−2
p_M	5	−5	0	5	r_F	11	18	24	8	x_F	6	13	14	3
p_T	0	−5	0	0	r_P	10	16	22	7	x_P	5	11	12	2
p_C	5	5	10	5	r_M	7	−8	−2	6	x_M	2	−3	−2	1
p_H	5	5	10	5	r_T	−10	−21	−16	−13	x_T	−10	−16	−16	−13
p_S	5	5	10	5	r_C	8	13	17	6	x_C	3	8	7	1
					r_H	7	10	15	6	x_H	2	5	5	1
E	−1	−5	−2	3	r_S	14	24	31	9	x_S	9	19	21	4

U urban labor, R rural labor, E energy, A agriculture, F fisheries, P mining, M manufacturing.
T textiles, C construction, H hotels, S services, y Output, u Unemployment.
MOD moderate, STR strong, POL polar, AGR agriculture subsidy.

National income and unemployment will depend on industrial price changes. Under any price scenario, there are noticeable adjustments in outputs and industrial capital returns. In the long run, investment will follow capital returns leading to substantial output adjustments.

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