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NAFTA and Industrial Adjustment: A Specific-Factors Model of Production

HENRY THOMPSON

The North American Free Trade Agreement (NAFTA) will continue to attract political debate as U.S. manufacturing industries adjust in the face of increased import competition and export opportunities. This study applies the specific factors model of production to manufacturing industries in Alabama to examine the pending adjustment. As industrial prices change, there will be small output adjustments in the short run and downward pressure on the wages of production workers. Projected changes in industrial investment will lead to substantial long-run output adjustments.

This paper focuses on predicting industrial adjustments and income redistribution in Alabama manufacturing. The critical question is what will happen to industrial prices. Some industries will experience increasing import competition and falling prices, some will experience rising prices through increased export demand, while others will experience increased intraindustry (two way trade and no predictable price trend.

The present study applies the specific factors model of production in which each industry has its own particular capital input. Manufacturing survey data are used to derive factor shares and industry shares for production workers, nonproduction workers, and capital in seventeen manufacturing industries. Factor intensity is used as a basis for projecting the direction of trade and price changes, which cause outputs to adjust as labor moves between industries. These short run output changes are predicted to be small by the specific factors model.

In the long run, investment will shift across industries. The return to capital in an industry is positively related to the price of output in the industry.

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Investment will follow rising capital returns, causing substantial output adjustment in the long run. These long run output adjustments are predicted to be in the range of ten to twenty percent.

There will also be some redistribution of income both toward and away from nonproduction labor . Also, owners of capital are projected to experience some large changes in the return to capital across industries.

Review of the Literature

Computable general equilibrium (CGE) models are based on a microeconomic structure of production. Brown et al. (1992) present a version of the University of Michigan CGE model to study the effects of NAFTA. The model has a competitive structure with increasing returns to scale and an input-output format. Demand for final products drives results, with prices fixed at world levels. They predict that the effects of NAFTA on gross domestic output will be small in both countries, and that wage changes will be very small in the U.S. Outputs of stone, clay and glass, primary metals, and electrical equipment are projected to fall in the U.S., while outputs of textiles, apparel, furniture, chemicals, plastics, and miscellaneous manufactures are projected to rise. (See Tables 1 and 2 for full names of industries and SIC codes.)

A similar CGE model (Inforum 1990) prepared at the University of Maryland predicts that U.S. industries which will add jobs under NAFTA are chemicals, rubber, metals, and machinery, while the losing industries will be apparel and furniture. In another CGE model, Peat Marwick (1991) predicts little effect in either the U.S. or Mexico unless investment enters Mexico. With incoming foreign investment, Mexico gains substantially and the U.S. benefits by having cheaper imports. Industries which are projected to expand in the U.S. are chemicals, machinery, and transport equipment, while textiles, apparel, furniture, stone, and electrical equipment are projected to decline.

There are also a few computable models which are less detailed. Hinojosa and Robinson (1991) produce a highly aggregated CGE model without detailed industrial structure, and predict small overall gains in the U.S. with increased output in the capital goods industries. Young and Romero (1991) utilize a dynamic model with no industrial detail which allows investment to adjust. They find small effects on aggregate U.S. manufacturing, but industrial output in Mexico is projected to increase significantly with investment. Boyd et al. (1991) examine the effects of tariff removal in the U.S. in a highly aggregated model with no industrial detail, and find very small industrial effects.

Other studies use general economic analysis. The U.S. International Trade Commission (ITC 1991) presents an informal model with a good deal of regional analysis. Little immediate impact on the U.S. is projected, but as Mexico grows U.S. exports will increase. Southwestern states will benefit from NAFTA, but other regions may suffer as resources relocate. The ITC model predicts that chemicals, machinery, and electrical equipment will expand, while textiles, apparel, and stone suffer. Hufbauer and Schott (1992a, 1992b, 1993) use similar general economic analysis to study the impact of NAFTA on specific industries, and predict that results will vary by industry with textiles and apparel the only clear losers. Hansen (1994) uses similar analysis to predict the regional effects of NAFTA, and foresees benefits for the border states and the Midwestern states, with losses forecast for the Southeastern states. Overall, Hansen expects small effects in the aggregate U.S., but noticeable effects in particular states and considerable variation across locales inside states.

Still other studies have focused on particular industries. Hunter et al. (1995) examine the pattern of trade in automobiles, and find little net effect on the U.S. auto industry. Imports from Mexico of car parts and light trucks are projected to increase, while exports of cars to Mexico increase. Investment would create larger changes, but they predict no large investment shifts. Baer and Erb (1991) study automobiles and electronics, and foresee integration between countries. Gains for both countries are predicted in autos, and ultimate gains in electronics are seen after costly transition. Trela and Whalley (1991) discuss textiles, apparel, and steel, predicting that imports from Mexico will rise with prices falling in the U.S.

Using another approach, Wientraub et al. (1991) present chapters written by specialists and business people in the automobile, petrochemical, pharmaceutical, textiles, apparel, computer, and food industries. These practitioners differ in their opinions, some predicting decline in the U.S., especially in automobiles and petrochemicals. Others think the U.S. and Mexican industries are already integrated to a large extent, and that NAFTA will have minimal impact. International patent protection is thought to be important in pharmaceuticals, and should encourage integration. Lustig et al. (1992) present a collection of nontechnical articles by different authors on NAFTA, including a survey of CGE models, labor issues, and industrial effects.

Regarding overall policy, Prestowitz and Cohen (1991) suggest structuring NAFTA so that production in Mexico using U.S. capital and skilled labor and Mexican labor is exported to the rest of the world, not back into the U.S. Mexico would thus become an export zone for the U.S., an arrangement Mexican industry and U.S. consumers would definitely not favor. Morici (1991) proposes to limit Mexican exports in sensitive industries to cushion the shock of transition.

The Department of Commerce (1993) analyzes the effects of NAFTA on industries under the headings of legal requirements, current structure, standards, government procurement, rules of origin, customs administration, intellectual property rights, and foreign investment. Discussion focuses on the growth potential in every industry. Even apparel, universally seen as facing stiff import competition, is pictured with increased export opportunities in particular lines.

Table 1 reports the "consensus" projected trade pattern. Textiles and apparel industries stand out as import competing industries. Furniture is not highly protected, but increased imports are expected. Intraindustry trade occurs with imports and exports in the same classification. There is variation in both the types and qualities of goods in each of these industries. In the food industry, for instance, the U.S. will import cattle to feed lots and export frozen ground beef. In transport equipment, the U.S. will export cars and heavy machinery, while importing car parts and light trucks. Differences in quality may also explain intraindustry trade. The U.S. will, for instance, export higher quality primary metal alloys and import lower quality metal products.

Industries which currently are protected from imports will experience falling prices. Current U.S. tariff rates by industry from Hufbauer and Schoff (1993) are listed in Table 2. These rates are tariffs plus equivalent protection from quotas and other nontariff barriers. Note that the highest U.S. tariffs are in textiles and apparel. These two industries can expect import competition to increase substantially, unless they can maintain protection. Mexico has historically protected its industry from imports, and to a much higher level, with average tariffs in the 30 to 50 percent range only 10 years ago. The Mexican government had for years tried to build its economy on the principle of import substitution, encouraging domestic industry to produce what could have been imported. The most highly protected Mexican industries are apparel, miscellaneous, electrical equipment, machinery, instruments, food, and plastics.

Table 2 also reports the difference between Mexican and U.S. tariffs. A positive number represents an industry with higher protection in Mexico, suggesting the potential for U.S. exports. The largest positive differences occur in instruments, miscellaneous, wood, machinery, electrical equipment, chemicals, transport equipment, fabricated metals, and plastics. Negative numbers indicate industries which are more protected in the U.S., suggesting increased imports and falling prices. Apparel and textiles will feel pressure, but also furniture, paper, and primary metals could see increased imports.

Tables 1 and 2 tell a similar story. The list of potential U.S. exports to Mexico in the first column of Table 1 is similar to those in Table 2 with the largest tariff differences, except for the missing electrical equipment, transport equipment, and miscellaneous. These three industries appear in the intraindustry trade column in Table 1. Two industries with negative signs in Table 2, paper and primary metals, in Table 1 are projected to experience intraindustry trade.

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TABLE 1. CONSENSUS MEXICAN-U.S. TRADE PATTERN UNDER NAFTA

U.S. exports Mexican imports	U.S. imports Mexican exports	Intraindustry trade
wood & lumber	textiles	food
chemicals	apparel	paper
rubber & plastics	furniture & fixtures	printing
fabricated metals	miscellaneous	stone, clay, glass
machinery & equipment		primary metals
instruments		electronic & electrical equipment
		transportation equipment

TABLE 2. CURRENT MEXICAN AND U.S. TARIFF RATES

INDUSTRY	ACRONYM	SIC	MEXICAN PERCENT	U.S. PERCENT	MEX - U.S. PERCENT
food	fod	20	10	8	2
textiles	txt	22	4	30	-26
apparel	app	23	17	49	-32
wood & lumber	wod	24	9	1	8
furniture & fixt	frn	25	1	2	-1
paper	pap	26	2	3	-1
printing	prn	27	1	0	1
chemicals	chm	28	7	1	6
rubber & plastics	pls	30	10	6	4
stone, clay, glass	stn	31	5	3	2
primary metals	prm	33	1	2	-1
fabricated metals	fbm	34	8	3	5
machinery & equip	mch	35	11	3	8
elect equipment	elc	36	12	4	8
transport equip	trn	37	9	3	6
instruments	ins	38	11	2	9
miscellaneous	msc	39	13	4	9

Source: *NAFTA: An Assessment*, by Gary Hufbarer and Jeffrey Schott, Institute for International Economics 1993.

TABLE 3. DATA

INDUSTRY	W	L	wW	$w_L L$	V	%V
food	35.9	27.3	588.8	369.4	1507.6	7
textiles	32.9	30.5	587.8	490.4	1536.9	7
apparel	54.3	49.4	676.8	559.7	1469.8	7
wood & lumber	24.2	20.1	432.8	327.9	888.5	4
furniture & fixtures	11.9	9.5	204.0	141.9	512.8	2
paper	19.5	15.0	771.4	577.1	2764.1	13
printing	12.9	7.6	275.1	145.1	720.7	3
chemicals	13.2	7.8	466.8	245.5	2454.5	13
rubber & plastics	18.4	15.0	501.1	377.3	1266.1	6
stone, clay, glass	5.5	4.2	144.5	103.5	446.9	2
primary metals	23.0	18.3	709.7	522.8	1517.2	8
fabricated metals	26.0	19.3	565.0	370.0	1312.7	7
machinery & equip	24.4	13.9	663.0	279.2	1407.9	7
elect equipment	22.6	15.7	612.8	360.5	1176.3	6
transport equip	16.1	14.1	527.4	420.9	1169.8	6
instruments	4.9	3.2	113.1	55.5	294.1	1
miscellaneous	7.2	5.6	123.3	79.1	288.2	1

W = total number of workers (1,000's)
L = number of production workers (1,000's)
wW = total payroll ($million)
$w_L L$ = payroll of production workers ($million)
V = value added ($million)
%V = percentage of total value added in manufacturing

Source: Department of Commerce, *Annual Survey of Manufactures* 1992.

Industry shares represent the percentage of each productive factor employed across industries. For instance, there is a total of 276,500 production workers in Table 3, with 49,400 in apparel. Thus, 49.4/276.5 = .179 = 17.9 percent of production labor is employed in apparel, as reported in Table 4. This is the largest production labor industry share. The sums of the columns λ_{Lj} and λ_{Nj} differ slightly from 1 due to rounding errors. The largest production labor industry shares are in textiles, apparel, and food, while the smallest are in stone, instruments, and miscellaneous. Industry shares for nonproduction labor are similarly found. The largest nonproduction labor industry shares occur in machinery, transportation equipment, and food, and the smallest in stone, furniture, and miscellaneous.

TABLE 4. FACTOR SHARES θ_{ij} AND INDUSTRY SHARES λ_{ij}

	θ_{Lj}	θ_{Nj}	θ_{Kj}	λ_{Lj}	λ_{Nj}	λ_{Kj}
food	.245	.145	.610	.099	.113	.072
textiles	.319	.064	.617	.110	.031	.074
apparel	.381	.080	.539	.179	.064	.062
wood & lumber	.369	.118	.531	.073	.054	.036
furniture & fixtures	.277	.121	.602	.034	.032	.024
paper	.209	.070	.721	.054	.059	.156
printing	.201	.180	.619	.028	.069	.035
chemicals	.104	.086	.810	.028	.071	.156
rubber & plastics	.298	.098	.604	.054	.045	.060
stone, clay, glass	.232	.092	.676	.015	.017	.024
primary metals	.345	.123	.532	.066	.062	.063
fabricated metals	.282	.149	.569	.070	.088	.059
machinery & equip	.198	.273	.529	.050	.135	.058
elect equipment	.306	.214	.480	.057	.090	.044
transport equip	.300	.091	.549	.051	.026	.050
instruments	.189	.196	.615	.021	.022	.014
miscellaneous	.274	.153	.573	.020	.021	.013

θ_{Lj} = factor share of production labor in industry j
θ_{Nj} = factor share of nonproduction labor in industry j
θ_{Kj} = factor share of capital in industry j
$\theta_{Lj} + \theta_{Nj} + \theta_{Kj} = 1$, for all j
λ_{Lj} = share of production labor in industry j, $\Sigma_j\lambda_{Lj} = 1$
λ_{Nj} = share of nonproduction labor in industry j, $\Sigma_j\lambda_{Nj} = 1$
λ_{Kj} = share of capital in industry j, $\Sigma_j\lambda_{Kj} = 1$

There is no reliable data on the market value of capital input. Firms overdepreciate capital to lower taxes and accounting is done on a historical basis. Some studies impute a value for the capital stock by building on yearly streams of investment spending and depreciation. The method used here is much simpler.

The capital factor share in industry j is $\theta_{Kj} = rK_j / V_j$, where V_j is value added by industry j. Assume the return to capital r is the same across industries. The capital industry share is $\lambda_{Kj} = K_j / K$, where K is the total manufacturing capital stock. The ratio of the capital industry shares in industry j to industry 1 is then related to the ratio of capital factor shares according to

$$\lambda_{Kj} / \lambda_{K1} = (V_j / V_1)(\theta_{Kj} / \theta_{K1}). \qquad (1)$$

Since the sum of the industry capital shares equals 1, each of the 17 λ_{Kj}'s can be found in a system of 17 equations and 17 unknowns. The capital industry shares λ_{Kj} reported in the last column of Table 4 thus indicate the percentage of the total capital stock employed in each industry, given an equal return to capital across industries. Reasonable variation in the return to capital across industries would have only small quantitative impact on the capital industry shares. The largest capital industry shares occur in chemicals and paper, while the smallest occur in miscellaneous, instruments, and furniture.

Factor Intensities

This section examines whether predictions based on factor abundance and factor intensity correspond with the consensus projections in the literature. Table 5 reports factor intensities, a crucial link in the factor endowment theory of international trade. The present study takes as its point of departure that Mexico has an abundance of production labor relative to Alabama (and the U.S.). The literature applying factor proportions models is well summarized and exemplified by Leamer (1984). Low wages for production workers in Mexico are well documented. The implication is that the U.S. would import goods which use production labor relatively intensively. Of course, the same good could be produced with a higher ratio of capital or nonproduction labor in the U.S., but on average the expectation is that Mexico will export goods which are currently labor intensive in the U.S.

The ratio of capital to production workers K_j/L_j is found as capital per unit of output divided by production labor per unit of output, a_{Kj}/a_{Lj}. The production labor factor share in industry j is $\theta_{Lj} = w_L L_j/V_j$, where value added is $V_j = p_j x_j$. Divide both the numerator and denominator by output x_j to find $\theta_{Lj} = w_L a_{Lj}/p_j$, where p_j is the price in industry j and a_{Lj} is the production labor input per unit of output L_j/x_j. The capital factor share is $\theta_{Kj} = r_j a_{Kj}/p_j$, where r_j the return to capital in industry j. The ratio of capital to production labor factor shares is thus $\theta_{Kj}/\theta_{Lj} = ra_{Kj}/w_L a_{Lj}$. Solving for the capital /labor ratio,

$$a_{Kj}/a_{Lj} = (\theta_{Kj}/\theta_{Lj})(w_L/r_j). \qquad (2)$$

All terms in (2), except the return to industrial capital r_j, are known from the data and previous calculations.

TABLE 5. FACTOR INTENSITY RATIOS

	a_{Kj}/a_{Lj} in AL*		a_{Kj}/a_{Lj} in US*	
	RATIO	RANK	RATIO	RANK
food	337	(12)	1014	(3)
textiles	311	(14)	273	(15)
apparel	161	(17)	224	(17)
wood & lumber	227	(16)	265	(16)
furniture & fixtures	325	(13)	297	(14)
paper	1328	(2)	851	(4)
printing	586	(4)	787	(5)
chemicals	2548	(1)	2542	(1)
rubber & plastics	510	(7)	440	(12)
stone, clay, glass	720	(3)	531	(10)
primary metals	441	(9)	563	(9)
fabricated metals	387	(10)	397	(13)
machinery & equipment	536	(6)	640	(8)
electrical equipment	359	(11)	684	(7)
transport equipment	456	(8)	729	(6)
instruments	566	(5)	1041	(2)
miscellaneous	294	(15)	443	(11)

a_{Kj}/a_{Lj} is the ratio of $1000 capital to production worker

For purposes of calculation, the return to capital is assumed to be 0.1 or 10 percent across industries. Owners of capital are thus assumed to receive 10 percent of capital's value each year. Reasonable variation in this return to capital does not grossly affect the factor intensity rankings or the comparative static elasticities of the model.

As an example of the calculations in Table 5, consider the a_{Kj}/a_{Lj} ratio for primary metals. Factor shares come from Table 4: $\theta_{Kj} = .532$ and $\theta_{Lj} = .345$, where j = primary metals. The wage is $w_L L/L = 522.8/18.3 = 28.6$ from Table 3. From (2), $a_{Kj}/a_{Lj} = (.532/.345)(28.6/.1) = 441$ in $1000 of capital stock per worker, assuming $r = .1$. There is thus $441,000 of productive capital per production worker in primary metals, given the 10 percent rate of return on capital. This ranks primary metals as the median industry.

a_{Kj}/a_{Lj} in US*	
RATIO	RANK
1014	(3)
273	(15)
224	(17)
265	(16)
297	(14)
851	(4)
787	(5)
2542	(1)
440	(12)
531	(10)
563	(9)
397	(13)
640	(8)
684	(7)
729	(6)
1041	(2)
443	(11)

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TABLE 5 (CONTINUED)

a_{Kj}/a_{Nj} in AL**		a_{Kj}/a_{Nj} in US**		a_{Lj}/a_{Nj} in AL***		a_{Lj}/a_{Nj} in US***	
RATIO	RANK	RATIO	RANK	RATIO	RANK	RATIO	RANK
1068	(12)	2627	(3)	3.17	(11)	2.59	(9)
3955	(2)	1759	(6)	12.71	(1)	6.44	(1)
1618	(8)	1276	(10)	10.08	(2)	5.60	(2)
1111	(11)	1345	(9)	4.90	(4)	5.08	(3)
1287	(9)	1162	(12)	3.96	(6)	3.92	(4)
4428	(1)	2756	(2)	3.33	(9)	2.24	(11)
841	(15)	894	(17)	1.43	(16)	1.14	(16)
3680	(3)	3326	(1)	1.44	(15)	1.31	(15)
2250	(6)	1511	(7)	4.41	(5)	3.43	(6)
2326	(5)	1836	(5)	3.23	(10)	3.46	(5)
1718	(7)	1889	(4)	3.89	(7)	3.35	(7)
1115	(10)	1116	(14)	2.88	(12)	2.81	(8)
723	(17)	1093	(15)	1.35	(17)	1.71	(14)
817	(16)	1185	(11)	2.28	(13)	1.73	(13)
3212	(4)	1356	(8)	7.05	(3)	1.86	(12)
1065	(13)	1072	(16)	1.88	(14)	1.03	(17)
1031	(14)	1131	(13)	3.50	(8)	2.55	(10)

The intensity ranking of industries is also reported in parentheses. The most capital-intensive industry is chemicals, with about \$2.5 million of capital per production worker, followed by paper and instruments. The most production-labor-intensive industries are those with the lowest a_{Kj}/a_{Lj} ratios, namely apparel, wood, furniture, and textiles.

There are some differences in the a_{Kj}/a_{Lj} ratios between Alabama and the U.S. For instance, the food industry is relatively capital intensive in the U.S. In Alabama, rubber and stone are relatively capital intensive, and electrical equipment is relatively labor intensive. In 9 of the 17 industries, Alabama has lower a_{Kj}/a_{Lj} ratios than the U.S., which may reflect relatively cheap production labor.

Table 5 presents the ratios of capital to nonproduction labor a_{Kj}/a_{Nj} in the middle columns, calculated in a similar manner. The industries most consistently intensive in nonproduction labor relative to capital are printing and machinery. The most consistently capital-intensive industries are paper and chemicals. Food is again an outlier in Alabama, with relatively little capital input. Textiles, on the other hand, is highly capitalized but employs relatively little nonproduction labor in Alabama.

Table 5 finally reports the ratios of production labor to nonproduction labor, L/N. From the definition of factor shares,

$$\theta_{Lj} / \theta_{Nj} = w_L a_{Lj} / w_N a_{Nj} . \qquad (3)$$

The ratio of unit inputs, a_{Lj} / a_{Nj}, can be solved directly. In machinery and equipment, for instance, the ratio of factor shares from Table 4 is $\theta_{Lj} / \theta_{Nj} = .198/.273 = .725$. Nonproduction wages are calculated as $w_N = (wW - w_L L) /(W-L) = (663.0 - 279.2) /(24.4 - 13.9) = 37.3$. The ratio w_N / w_L is then $37.3 / 20.1 = 1.86$, and a_{Lj} / a_{Nj} is $.725 \times 1.86 = 1.35$, which ranks machinery and equipment as the least intensive in production to nonproduction labor. Also, $a_{Lj} / a_{Nj} = (a_{Kj} / a_{Lj}) \div (a_{Kj} / a_{Nj})$ directly from the first two sets of columns in Table 5.

Industries which employ production labor intensively relative to nonproduction labor are textiles, apparel, wood, and furniture. Industries which are clearly intensive in nonproduction labor relative to production labor are printing, instruments, chemicals, and electrical equipment. Transport equipment in Alabama is extremely intensive in production labor relative the U.S., but this may change with the coming Mercedes plant. In fourteen of the industries, Alabama has high production-labor inputs relative to the U.S.

Table 6 summarizes factor intensities, classifying each industry as intensive in one of the inputs. This classification relies on the rankings in Table 5. Each input appears in two rankings. When an industry is ranked higher than the median in both rankings, it is classified as intensive in that input. For instance, chemicals is ranked (1,1) in the a_{Kj} / a_{Lj} ratios in (AL, U.S.) and (3,1) in the a_{Kj} / a_{Nj} rankings. Chemicals is thus called capital intensive (K). As another example, fabricated metals is intensive in L relative to K in Table 5 (10,13), intensive in N relative to K (10,14), intensive in N relative to L in Alabama (12), but slightly intensive in L relative to N in the U.S. (8). The industry is thus classified as intensive in nonproduction labor. Primary metals is ambiguous in this scheme, the median in a_{Kj} / a_{Lj} ratios, slightly K intensive relative to N, and slightly L intensive relative to N.

Textiles, apparel, wood, and furniture are intensive in production labor. Industries which are clearly intensive in nonproduction labor are printing, machinery, electrical equipment, and instruments. Capital intensive industries are paper, chemicals, and transportation equipment. Food, plastics, stone, primary metals, fabricated metals, and miscellaneous manufacturing are all ambiguous in this ranking scheme.

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TABLE 6. FACTOR INTENSITY CLASSIFICATION

	AL	U.S.
food	N	K
textiles	L	L
apparel	L	L
wood & lumber	L	L
furnitures & fixtures	L	L
paper	K	K
printing	N	N
chemicals	K	K
rubber & plastics	K	L
stone, clay, glass	K	L
primary metals	K,L	K,L
fabricated metals	N	L
machinery & equipment	N	N
electricalequipment	N	N
transportation equipment	K	K
instruments	N	N
miscellaneous	L	N

L = production labor intensive
N = nonproduction labor intensive
K = capital intensive

Note how closely the factor intensities in Table 6 align with the consensus projections in Table 1. The three U.S. industries consistently projected to feel the most pressure from import competition (textiles, apparel, furniture) are intensive in production labor. Wood is also labor intensive, but production is tied to forests. Projected exports in Table 1 include capital intensive chemicals and nonproduction-labor-intensive machinery and instruments. Other projected U.S. exports are plastics which is capital intensive in Alabama, and fabricated metals which is intensive in nonproduction labor. Of the 8 industries projected to experience intraindustry trade in Table 1, paper and transportation equipment are capital intensive and printing is skilled-labor intensive. Factor intensity thus forms the foundation for predicting trade. Industries intensive in production labor will see increased imports from Mexico, while industries intensive in capital and nonproduction labor will experience expanding exports.

Only U.S. factor intensities are used in the present study, and no effort is made to develop a two country model including Mexico's factor intensities. Additionally, no explicit link with factor abundance is sought, as for instance in

Moroney (1970). One goal of the present study is to show how commonly available production data can be fashioned into a general equilibrium model of production. Clearly, many other influences will come into play in determining regional industrial adjustment. The present model makes many simplifying assumptions, but arrives at a set of unambiguous results.

While many contend that factor intensity plays a decreasing role in explaining international trade, it is striking that Table 1 and Table 6 basically agree. Predictions of trade based on factor abundance and factor intensity agree with the consensus projections from the literature, which include numerous types of models and a variety of analysis. Industries intensive in production labor in the U.S. can be transferred to Mexico, which has abundant and cheap production labor.

The Industrial Specific-Factors Model

The first step is to specify production functions and factor substitution. This section specifies behavioral assumptions of competitive pricing and full employment, and presents estimates of how output will adjust to price changes projected under NAFTA. The model is a pure production model, without demand considerations or an input-output structure. Outputs are effectively assumed to be final products. The comparative static approach assumes movement from one static equilibrium to another. The formal model is presented in Appendix B.

By assumption, labor moves freely between industries and each industry employs its own specific capital K_j. Firms minimize their cost of producing output. The decision of how to mix inputs is based on input prices. Higher production wages, for instance, would encourage firms to switch to techniques more intensive in nonproduction labor or capital.

Each production process is specified as a Cobb-Douglas production function,

$$x_j = L^a N^b K_j^c. \tag{4}$$

Assuming constant returns to scale, exponents in the production function are factor shares and the positive exponents a, b, and c sum to one. For instance, from Table 4 the production function for chemicals (chm) is

$$x_{chm} = L^{.104} N^{.086} K_{chm}^{.810}.$$

Outcomes of the model can also be discussed for constant elasticity of substitution (CES) production. With higher (lower) elasticities of substitution, firms are more (less) able to substitute among inputs as input prices change. The influence of factor intensity, as reflected by factor shares and industry shares, weighs more heavily than factor substitution in the comparative statics.

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Thus, improved estimates of production functions as in Moroney and Toevs (1977) would not make large differences in the projected comparative static output adjustments.

Substitution in industry j between any two inputs, production labor and nonproduction labor for instance, is represented by the cross price elasticity

$$\sigma_{Nj}^{L} = \hat{a}_{Lj} / \hat{w}_{N}, \tag{5}$$

where ^ represents percentage change. For every 1 percent change in the wage of nonproduction workers, this elasticity reports the percentage change in the cost minimizing production labor input per unit of output in industry j. Substitution takes place in each industry between the three inputs. Under Cobb-Douglas technology, the Allen elasticity of substitution S_{Nj}^{L} equals one. The cross price elasticity σ_{Nj}^{L} is a weighted Allen elasticity: $\sigma_{Nj}^{L} = \theta_{Lj} S_{Nj}^{L}$. It follows that $\sigma_{Nj}^{L} = \theta_{Lj} S_{Nj} = \theta_{Lj}$. Thus the desired cross price elasticity is equal to the factor share. Elasticities are summed across industries to arrive at the aggregate substitution elasticities, as in Thompson (1994). For example, aggregate substitution between production and nonproduction labor is

$$\sigma_{N}^{L} = \Sigma_j \lambda_{Nj} \sigma_{Nj}^{L} = \Sigma_j \lambda_{Nj} \theta_{Lj}.$$

With Cobb-Douglas production, the only information required to estimate substitution elasticities are thus factor shares and industry shares. Table 7 presents a sample of the calculated substitution elasticities. When w_L rises by 1 percent, for instance, production labor input per unit of output falls .702 percent and nonproduction labor input rises .121 percent. Capital input also rises in every industry. In chemicals (chm), capital input rises .023 percent. Capital substitution elasticities are reported only for chemicals and primary metals (prm) since other capital substitution elasticities are similar in magnitude. An increase in the cost of capital causes firms to increase labor inputs. For instance, every 1 percent increase in the cost of capital input in primary metals leads to a .022 percent increase in the input of production labor and a .078 percent increase in the input of nonproduction labor. Capital input in the industry falls by .092 percent. Model estimates with constant elasticities of substitution (CES) are discussed to provide an indication of sensitivity.

The specific-factors model is built on two behavioral assumptions, full employment and competitive pricing. For the typical firm, demand for its output is perfectly elastic at the market price. Price taking firms take the market price and adjust their inputs to produce the output which maximizes profit. Full employment governs the economy's adjustment process. Outputs and returns to capital across industries adjust, as do wages. Labor moves perfectly between industries, attracted to industries with rising wages.

TABLE 7. COBB-DOUGLAS SUBSTITUTION ELASTICITIES IN ALABAMA MANUFACTURING

	%ΔL	%ΔN	$\%\Delta K_{chm}$	$\%\Delta K_{prm}$
1%Δ w_L	-.702	.121	.023	.035
w_N	.261	-.848	.057	.033
r_{chm}	.016	.013	-.030	0
r_{prm}	.022	.078	0	-.092

Capital is treated as industry specific in the short run, with each industry's endowment of capital K_j exogenously held fixed. An alternative is to assume perfect capital mobility between industries. An advantage of using the assumption of industry specific capital is that variation in the return to capital by industry can occur. Subsequent long run changes in investment by industry are then projected, based on these changes in industrial capital returns. The model formally assumes a uniform return to industrial capital across industries in a pre-NAFTA equilibrium, then examines changes in the pattern of capital returns due to projected price changes. In a model with homogeneous capital, the return to capital would be the same across industries.

Comparative Static Adjustments

When price in an industry changes, outputs adjust as summarized in Table 8. Price changes in each industry lead to reported output adjustments in chemicals (x_{chm}) and primary metals (x_{prm}). There are 17 x 17 = 289 price elasticities of outputs, and the others are similar in magnitude. Columns report output adjustments for 1 percent price changes in each sector. As an example, every 1 percent increase in the price of primary metals (*prm*) results in a 0.0024 percent decline in the output of chemicals. Other industrial outputs also decline slightly, contributing to the 0.0519 percent increase in the output of primary metals.

The striking characteristic of the output elasticities in Table 8 is their inelasticity. The Cobb-Douglas specification contributes to this small magnitude. With a higher degree of CES production, these elasticities change proportionately. When CES = 2, for instance, every 1 percent change in the price of inputs causes a 2 percent change in inputs per unit of output, and the elasticities in Table 8 would be doubled. Empirical studies seldom find CES estimates larger than 2. Even with CES = 2, the largest output elasticity, which is in primary metals, would be only 2 x 0.0519 = 0.1038. Every 1 percent

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TABLE 8. COMPARATIVE STATIC ELASTICITIES IN ALABAMA'S CHEMICALS AND PRIMARY METALS

1%Δp	$\%\Delta x_{chm}$ percent	$\%\Delta x_{prm}$ percent	$\%\Delta r_{chm}$ percent	$\%\Delta r_{prm}$ percent
food	-.0039	-.0057	-.0248	-.0903
textiles	-.0027	-.0050	-.0174	-.0791
apparel	-.0046	-.0083	-.0299	-.0132
wood & lumber	-.0023	-.0037	-.0149	-.0590
furniture & fixt	-.0012	-.0018	-.0076	-.0288
paper	-.0021	-.0031	-.0135	-.0496
printing	-.0017	-.0021	-.0107	-.0332
chemicals	.0348	-.0022	.1220	-.0344
rubber & plastics	-.0018	-.0029	-.0117	-.0453
stone, clay, glass	-.0006	-.0008	-.0036	-.0134
primary metals	-.0024	.0519	-.0152	1.82
fabricated metals	-.0029	-.0041	-.0184	-.0656
machinery & equip	-.0033	-.0041	-.0021	-.0642
elect equipment	-.0027	-.0037	-.0171	-.0579
transport equip	-.0014	-.0025	-.0093	-.0390
instruments	-.0006	-.0008	-.0038	-.0122
miscellaneous	-.0007	-.0011	-.0047	-.0174

increase in the price of primary metals would then result in only about a 0.1 percent increase in primary metals output. Output adjustments due to NAFTA are generally projected to be small, and the estimates in Table 8 confirm this perception. Prices may change substantially in some industries, but most output adjustments would remain relatively small even if prices doubled or fell in half.

Table 8 also reports adjustments in capital returns due to 10 percent price changes. These adjustments are larger than the output adjustments, and are independent of the degree of substitution. There are 17 x 17 = 289 capital return elasticities, but the other elasticities are similar in magnitude to these reported for chemicals and primary metals. Every 1 percent increase in the price of chemicals results in a 0.122 percent increase in its return to capital. An example of a cross effect is that every 1 percent decrease in the price of textiles would result in a 0.0791 percent decrease in the return to capital in primary metals.

Elasticities in Table 8 are based on the assumption that only one price changes with all other prices (and factor endowments) held constant. NAFTA, however, will introduce a range of price changes across industries. Table 9 reports adjustments in outputs and returns to capital under three different price scenarios. The first price scenario ΔP1 is based on the consensus trade pattern in Table 1 and the differences between U.S. and Mexican tariffs in Table 2. The difference between tariffs is used as the projected price change in Alabama. For instance, chemicals is projected by Table 1 to be a U.S. export, and Table 2 indicates a difference of 6 percent in tariffs. The price of chemicals is thus projected to rise 6 percent under ΔP1. For the U.S. imports in Table 1, price declines are projected to be 26 percent in textiles, 32 percent in apparel, and 1 percent in furniture. For industries projected to experience increased intraindustry trade, projected price changes are set to zero. Export and price changes for the U.S. are thus projected onto Alabama.

Under ΔP1, only textiles and apparel output fall, both only by about 1 percent. Other outputs rise slightly, typically less than half of 1 percent. Returns to capital, however, are grossly affected in some industries, with significant declines in textiles and apparel.

A further assumption leads to projected long run output adjustments. Suppose capital moves in proportion to the change in its return. Under this assumption, every 1 percent change in the return to capital causes a 1 percent long run adjustment in the capital stock. Under ΔP1, for instance, the capital stock in plastics would rise by 10.0 percent, while the capital stock in apparel would fall by 54.5 percent. When levels of capital adjust, outputs also adjust. In the specific-factors model with CRS, the percentage adjustment in output is about equal to the percentage change in the industry's capital stock. Thus, the columns labeled percent Δr can be interpreted as approximate long run output changes. Output in apparel is thus projected to fall more than 50 percent in the long run under ΔP1, and in textiles by close to 40 percent. Industries projected by ΔP1 to expand more than 10 percent in the long run are wood, rubber, fabricated metals, machinery, and instruments. Every industry except textiles and apparel would expand in the long run under ΔP1.

Production labor suffers falling wages under ΔP1, with production wages falling 6.94 percent. The decrease in production wages for Alabama is larger than generally projected for the entire U.S. Alabama is a relatively heavy producer of goods intensive in production labor, namely textiles apparel, wood, and miscellaneous manufacturing. The large impact on production wages is thus explained by Alabama's pattern of production.

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TABLE 9. INDUSTRIAL ADJUSTMENT IN ALABAMA UNDER THREE NAFTA PRICE SCENARIOS

	ΔP1		ΔP2		ΔP3	
	%Δx	%Δr	%Δx	%Δr	%Δx	%Δr
food	.201%	2.79%	0%	-.409%	.482%	16.7%
textiles	-.930	-38.5	-.457	-16.2	-.397	-15.3
apparel	-1.39	-54.4	-.528	-18.5	-.459	-17.4
wood	.449	20.6	.332	19.3	-.304	-18.9
furniture & fixtures	.061	1.53	-.166	-16.9	-.148	-16.1
paper	.314	2.01	-.014	-.089	.664	14.3
printing	.079	2.26	-.021	-.602	.216	16.2
chemicals	.358	8.30	.332	12.1	.369	12.4
rubber & plastics	.362	10.0	.384	16.4	-.353	-15.9
stone, clay, glass	.056	2.38	-.004	-.161	0	-14.4
primary metals	.284	4.49	-.015	.236	-.504	-18.0
fabricated metals	.422	12.2	.418	17.1	-.417	-17.1
machinery & equipment	.567	17.7	.450	17.7	.497	18.5
electrical equipment	.196	4.44	-.037	-.837	.494	21.2
transport equipment	.229	4.55	-.003	-.050	.463	19.2
instruments	.110	16.8	.079	15.6	.087	16.2
miscellaneous	.043	3.33	-.102	-17.9	.102	17.9
$\%\Delta w_L$	-6.94		-.621		-2.09	
$\%\Delta w_N$	.003		2.75		2.27	

ΔP1 = consensus trade, Mexican-U.S. tariffs
ΔP2 = consensus trade, ± 10%
ΔP3 = intensity trade, ± 10%

$\%\Delta x_j$ = percentage change in output
$\%\Delta r_j$ = percentage change in the return to capital
$\%\Delta w_L$ = percentage change in the wage of production workers
$\%\Delta w_N$ = percentage change in the wage of nonproduction workers

The columns labeled ΔP2 use the same consensus trade pattern, but set price changes at +10 percent for exports and -10 percent for imports. These are larger price increases for exports, and smaller price decreases for imported textiles and apparel. Again, price changes in intraindustry trade industries are set to zero. Output adjustments are again all less than 1 percent in the short run, but long run changes are more striking. Compared to ΔP1, declines in long run output in textiles and apparel are less radical, while declines in furniture and miscellaneous are more than 15 percent. Export industries are again projected to enjoy small output increases in the short run under ΔP2. Returns to capital all rise more than 10 percent, inducing subsequent investment and long run increased output. Chemical output would rise 12.1 percent in the long run under ΔP2. Some of the long run output changes are close to 20 percent. Production labor loses under ΔP2, but by less than under ΔP1. Textiles and apparel employ large shares of production labor, and changes in these two prices drive production wages.

The price scenario ΔP3 is based directly on the U.S. factor intensities in Table 6. Industries which are intensive in production labor are treated as import competing, with price declines set at 10 percent. Primary metals is included as production labor intensive. Outputs fall in the import competing industries, but by less than 1 percent in the short run. Returns to capital fall in the range of 15 percent to 20 percent. Industries which are intensive in nonproduction labor and capital are treated as export industries, with price increases set at 10 percent. Output increases by less than 1 percent in the short run in each of these industries. Capital returns rise substantially in each export industry, signalling increased investment and long run output increases in the range of 15 percent to 20 percent. Wages of production workers fall, while nonproduction labor enjoys gains. All of the gains from trade are thus distributed to nonproduction workers and some capital owners.

Conclusion

Some industries will decline under NAFTA, but short run output adjustments will be negligible. As changing returns to capital alter investment, however, long run output adjustments will be substantial in particular industries. Projecting the results from Alabama to the entire U.S., this paper reaches the consensus opinion that downward pressure on the wages of production labor will continue, increasing the incentive to obtain education and training. The return to education is underestimated if historical wages are used.

Every price scenario has differences, but there are similarities. Under every assumption, Alabama's textiles and apparel industries decline, wages of production workers fall, and wages of nonproduction workers rise. Other likely

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industrial losers are furniture and primary metals. Industrial winners in Alabama under every scenario are chemicals, machinery, and instruments. Other likely winning industries are food, wood, paper, printing, electrical equipment, and transportation equipment. Industries which are "too close to call" are plastics, fabricated metals, and miscellaneous.

The present line of research can be extended in various ways. First, industries can be disaggregated. Estimation of production or cost functions can be refined. The model can be applied to other states, regions, or the entire U.S. Final demand and an input-output structure can be added. Varying degrees of labor and capital mobility can be included. Factor intensity and production can be modelled explicitly in Mexico. International capital flows can be introduced. The influence of factor intensity, however, is strong enough that the basic results presented here would continue to hold.

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Appendix A: Glossary of Symbols

$L_j \equiv$ production labor input in industry j
$N_j \equiv$ nonproduction labor input in industry j
$K_j \equiv$ capital input in industry j
$w_L \equiv$ wage of production labor
$w_N \equiv$ wage of nonproduction labor
$r_j \equiv$ return to capital in industry j
$V_j \equiv$ value added by industry j
$\theta_{Lj} \equiv w_L L_j/V_j$ = production labor factor share in industry j
$\theta_{Nj} \equiv w_N N_j/V_j$ = nonproduction labor factor share in industry j
$\theta_{Kj} \equiv r_j K_j/V_j$ = capital factor share in industry j
$L \equiv \Sigma_j L_j$ = total production labor in all manufacturing
$N \equiv \Sigma_j N_j$ = total nonproduction labor in all manufacturing
$K \equiv \Sigma_j K_j$ = total capital input in all manufacturing
$\lambda_{Lj} \equiv L_j/L$ = share of production labor in industry j
$\lambda_{Nj} \equiv N_j/N$ = share of nonproduction labor in industry j
$\lambda_{Kj} \equiv K_j/K$ = share of capital in industry j
$a_{Lj} \equiv$ production labor input per unit of output in industry j
$a_{Nj} \equiv$ nonproduction labor input per unit of output in industry j
$a_{Kj} \equiv$ capital input per unit of output in industry j
$p_j \equiv$ price of output in industry j
$x_j \equiv$ output of industry j
$\sigma_{ij} \equiv \hat{a}_{ij}/\hat{w}_k$ = elasticity of the unit input of factor i in industry j with respect to the price of factor k
$S^k_{ij} \equiv \%\Delta(a_{ij}/a_{kj})/\%\Delta(w_i/w_k)$ = Allen elasticity of substitution between factors i and k in industry j

Appendix B: Formal Structure of the Model

Competitive pricing in industry j is written

$$p_j = a_{Lj}w_L + a_{Nj}w_N + a_{jj}r_j\ , \tag{B.1}$$

where p_j is the price of good j, a_{Lj} (a_{Nj}) is the cost minimizing amount of production (nonproduction) workers per unit of good j, a_{jj} is the amount of specific capital used per unit of good j, w_L (w_N) is the wage of production (nonproduction) workers, and r_j is the return to capital in sector j. Differentiating (B.1),

$$dp_j = a_{Lj}dw_L + a_{Nj}dw_N + a_{jj}dr_j\ , \tag{B.2}$$

given that $w_L da_{Lj} + w_N da_{Nj} + r_j da_{jj} = 0$ due to the cost minimization envelope result which says that the slope of the isoquant equals the slope of the isocost plane. Convert (B.2) into elasticity form

$$dp_j / p_j = \hat{p}_j = \theta_{Lj}\hat{w}_L + \theta_{Nj}\hat{w}_N + \theta_{jj}\hat{r}_j, \quad \text{(B.3)}$$

where ^ means percentage change. The sum of the factor shares equals one due to competitive pricing: $\theta_{Lj} + \theta_{Nj} + \theta_{jj} = 1$. The 17 equations of (B.3), $j = 1,\ldots,17$, are summarized

$$\hat{p} = \theta\hat{w}, \quad \text{(B.4)}$$

and are included in the comparative static system in (B.13).

Full employment of production and nonproduction workers is written

$$L = \Sigma_j a_{Lj} x_j \text{ and } N = \Sigma_j a_{Nj} x_j, \quad \text{(B.5)}$$

where L and N represent the total number of each type of labor and x_j represents output. Labor moves freely between industries. Supply of labor is perfectly inelastic, and (B.5) says that total labor supply equals the sum of labor demands across industries. Differentiate the first equation in (B.5) to find

$$dL = \Sigma_j a_{Lj} dx_j + \Sigma_j x_j da_{Lj} . \quad \text{(B.6)}$$

The second term in (B.6) can be expanded as

$$\Sigma_j x_j da_{Lj} = \Sigma_j x_j \Sigma_i (\partial a_{Lj} / \partial w_i) dw_i$$
$$= \Sigma_i \Sigma_j x_j (\partial a_{Lj} / \partial w_i) dw_i = \Sigma_i S_L^i \, dw_i , \quad \text{(B.7)}$$

where S_L^i is the economy wide cross price substitution term between production workers and factor i, with i indexing both types of labor and the 17 types of capital. Combine (B.6) and (B.7) and convert into elasticity form:

$$\hat{L} = \Sigma_j \lambda_{Lj} \hat{x}_j + \Sigma_i \sigma_L^i \hat{w}_i , \quad \text{(B.8)}$$

where $\sigma_L^i = \Sigma_j \lambda_{Lj} (\hat{a}_{Lj} / \hat{w}_i)$, the economy's cross price elasticity between factors L and i. For nonproduction workers, a similar derivation leads to

$$\hat{N} = \Sigma_j \lambda_{Nj} \hat{x}_j + \Sigma_i \sigma_N^i \hat{w}_i . \quad \text{(B.9)}$$

Each type of capital K_j is employed only in its sector, and

$$K_j = a_{jj} x_j . \quad \text{(B.10)}$$

Differentiate (B.10) to find

$$dK_j = a_{jj} dx_j + x_j da_{jj} = a_{jj} dx_j + \Sigma_i S_j^i dw_i. \quad \text{(B.11)}$$

In elasticity form,

$$\hat{K}_j = \lambda_{jj} \hat{x}_j + \Sigma_i \sigma_j^i \hat{w}_i = \hat{x}_j + \sigma_L^i \hat{w}_L + \sigma_N^i \hat{w}_N + \sigma_j^j \hat{r}_j . \quad \text{(B.12)}$$

Note that $\lambda_{jj} = 1$, and $\sigma_n^j = 0$ for capital when $n \neq j$.

Combine (B.8), (B.9), (B.12), and (B.4) into the 35 x 35 matrix system

(B.3)

:tor shares equals one due
ations of (B.3),

(B.4)

ı.13).
workers is written

(B.5)

of labor and x_j represents output.
r is perfectly inelastic, and (B.5)
ɔor demands across industries.

(B.6)

(B.7)

:rm between production workers
ɜ 17 types of capital. Combine

(B.8)

ticity between factors
n leads to

(B.9)

ıd

(B.10)

(B.11)

(B.12)

: 35 matrix system

$$\begin{bmatrix} \sigma_{19x19} & \lambda_{19x17} \\ \theta'_{17x19} & 0_{17x17} \end{bmatrix} \begin{bmatrix} \hat{w} \\ \hat{x} \end{bmatrix} = \begin{bmatrix} \hat{v} \\ \hat{p} \end{bmatrix} \qquad \text{B.13}$$

where

$$\sigma = \begin{bmatrix} \sigma_L^L & \sigma_L^N & \sigma_L^1 & \cdots & \sigma_L^{17} \\ \sigma_N^L & \sigma_N^N & \sigma_N^1 & \cdots & \sigma_N^{17} \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ \sigma_{17}^L & \sigma_{17}^N & 0 & \cdots & \sigma_{17}^{17} \end{bmatrix} \qquad \text{(B.14)}$$

$$\lambda = \begin{bmatrix} \lambda_{L1} & \cdots & \lambda_{L17} \\ \lambda_{N1} & \cdots & \lambda_{N17} \\ 1 & \cdots & 0 \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ 0 & \cdots & 1 \end{bmatrix} \qquad \text{(B.15)}$$

$$\theta' = \begin{bmatrix} \theta_{L1} & \theta_{N1} & \theta_{11} & \cdots & 0 \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ \theta_{L17} & \theta_{L17} & 0 & \cdots & \theta_{1717} \end{bmatrix} \qquad \text{(B.16)}$$

$$\hat{w} = \begin{bmatrix} \hat{w}_L \\ \hat{w}_N \\ \hat{r}_1 \\ \cdot \\ \cdot \\ \cdot \\ \hat{r}_{17} \end{bmatrix}, \hat{x} = \begin{bmatrix} \hat{x}_1 \\ \cdot \\ \cdot \\ \cdot \\ \hat{x}_{17} \end{bmatrix}, \hat{v} = \begin{bmatrix} \hat{L} \\ \hat{N} \\ \hat{K}_1 \\ \cdot \\ \cdot \\ \cdot \\ \hat{K}_{17} \end{bmatrix}, \hat{p} = \begin{bmatrix} \hat{p}_1 \\ \cdot \\ \cdot \\ \cdot \\ \hat{p}_{17} \end{bmatrix}. \tag{B.17}$$

The focus is on price changes, holding endowments constant: $\hat{v} = 0$. The system is inverted to find

$$\begin{bmatrix} \sigma & \lambda \\ \theta' & 0 \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ \hat{p} \end{bmatrix} = \begin{bmatrix} \hat{w} \\ \hat{x} \end{bmatrix} \tag{B.18}$$

Changes in endogenous factor prices w and outputs x due to projected exogenous price changes in p induced by NAFTA are examined.

The model is static in nature and does not address disequilibrium or convergence of factor prices. Observations are assumed to take place in an equilibrium before NAFTA. Price changes due to NAFTA are introduced as exogenous shocks, and comparative static effects on factor prices and outputs are reported. The model moves from one equilibrium directly to another.

The contrast of this application of the specific factor model with the putty-clay capital model is insightful. If capital were mobile across sectors, there would be 3 factors of production employed in the 17 sectors. If all 17 industrial prices remain exogenous, there would be more exogenous prices than factors of production, and the model would be overdetermined. Demand or an input-output structure could be introduced to endogenize prices.

Mobile capital is introduced in the paper by the novel approach to long run investment, which is assumed to follow the return to capital. Capital must remain in its industry in the short run, but becomes putty clay and is allowed to move between industries in the long run. Changes in the stocks of capital in each industry subsequently cause long run output adjustment, which in the model are relatively large.

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