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ECONOMETRIC ESTIMATION OF ARMINGTON IMPORT ELASTICITIES FOR REGIONAL CGE MODELS OF THE CHICAGO AND ILLINOIS ECONOMIES

BY

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Econometric Estimation of Armington import elasticities for regional CGE models of the Chicago and Illinois economies

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Abstract

Our current research program is concerned with developing regional and interregional computable general equilibrium models for Chicago and the Midwest respectively. One of the main concerns associated with regional CGE modeling is determination of the empirical parameters of models, particularly elasticities and share parameters. A common problem is the lack of appropriate regional data for econometric estimation. Consequently, it is important to identify key parameters that are likely to be important in determining quantitative results and prioritise these for estimation where appropriate data are available.

In this paper we focus on estimating regional trade (import) substitution parameters, both because these will generally be important in analysis for regional economies, which tend to be more open than national economies, and also because one of the main areas of our current research is to model the pollution content of trade flows between regions and the impacts on pollution 'trade balances' in response to changes in activity. While our work will eventually encompass the five Midwest states of Illinois, Indiana, Michigan, Ohio and Wisconsin, our first step in the process of parameter estimation for our intended suite of regional and interregional CGE models is to estimate commodity import elasticities for the Illinois economy (to be applied also to our single region Chicago model, in the absence of appropriate data for region-specific estimation at that level). We apply a model where we take account of market size and distance in estimating the substitutability between commodities produced in Illinois and other US states.

Keywords : Computable general equilibrium model, regional modelling, import elasticity

JEL classification: C68, R13, F10

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1. Introduction

One of the main issues in any economic model is the fact that the uncertainty and errors exist in data, assumptions and estimations. Input-output models, commonly used to analyze the regional economic impact of policy changes, are linear and impose significant rigidities, including fixed prices, zero-substitution elasticities in consumption and production and multipliers estimated by taking the Leontief inverse of the estimated input-output coefficients. These rigidities are usually viewed as the trade-off necessary to achieve a more complete depiction of sectoral linkages. Therefore, since the beginning of its application, many studies pointed out several sources of the uncertainty and errors and developed the methodologies to solve bias and sensitivity of multipliers in input-output analysis, for example, addictive and multiplicative method (Lawson, 1980), over-and under-estimation of the Leontief inverse (Lahiri and Satchell, 1985), field of influence analysis (Sonis and Hewings, 1992).

On the other hand, computable general equilibrium (CGE) models allow analysts to relax some of the rigidities of input-output model while retaining depiction of sectoral linkages, by introducing nonlinear functions in production and consumption and allowing endogenously determined prices. In addition to the problems associated with the input-output framework which is embedded in CGE model, the uncertainty in CGE models is further compounded by a variety of estimated or imposed features of the model. Harrison *et al.*(1993) categorized them into : (1) the equilibrium structure imposed on the model; (2) the functional forms used to represent tastes and technology; and (3) the empirical magnitudes inherent in the models (elasticity and share parameters).

Even though those problems inherent in CGE models have been acknowledged, many variations of CGE models of the U.S. national economy have demonstrated the value of these systems for assessing the potential long-run effects of government policies, impacts of environmental actions as well as the effects of proposed and enacted free trade agreements. At the regional level, the analyses of those effects within countries have been more limited and problematical. Part of the reason for the lack of regional CGE studies can be attributed to the fact that the necessary regional data are either not available or not available in a suitable form, and a number of unresolved behavioral issues remain, including the extent of interregional factor mobility and the uniqueness of regional goods. As a result, the level of uncertainty and the magnitude of errors in regional CGE models may be higher than those in national-level models.

For example, although elasticities of import substitution have been extensively estimated for U.S. trade (Stern *et al*., 1976; Shiells *et al*., 1986; Shiells and Reinert, 1993), limited information is available for elasticities of substitution for regional imports. Therefore, regional CGE modelers often use elasticities estimated from national commodity or industry classifications that are inconsistent with those maintained in the model or outdated estimates from past literature or complete guesses when no published figures are available (Partridge and Rickman, 1998). However, once all parameters are specified without representing regional characteristics, an inaccurate "replication" equilibrium is obtained with the benchmark data. Another significant reason to use regional data in estimation of the elasticities is that users of the simulation results have virtually no way to assess the evidence supporting the choice of most parameter values from just single year data (Lau, 1984; Hansen and Heckman, 1996). These expediencies detract from the ability of the model to represent the real regional economic conditions under study. Hence, knowledge of trade elasticities is important for CGE modeling because of the degree to which a policy change will affect a trade balance, level of income, and employment depends on the magnitude of the elasticity used in the model. The regional trade-substitution elasticity will be a key behavioral parameter that drives the quantitative results used by policymakers. Further, regions are much more open than national economies; hence, the magnitude of trade and its impact on the regional economy are likely to more significant.

As debates over appropriate values for behavioral parameters in regional CGE have remained highly controversial, CGE analysts have directed attention to the issue of uncertainty and error of behavioral parameters and many researches have tested the uncertainty and error surrounding these parameters in terms of their impact on the model (Hertel, 1985; Harrison and Vinod, 1992; Harrison *et al*., 1993; Wigle, 1991; Arndt, 1996; DeVuyst and Preckel, 1997; Domingues *et al*., 2004). After all, sensitivity analysis is considered as an important step in the application of CGE models to evaluate the sensitivity of the results to parameters and exogenous shocks. Thus, sensitivity analysis should always be included to improve the understanding of the relationships between input and output in the structure of CGE model (for example, see Turner, 2008), even where parameter estimation is possible.

In this paper we focus on estimating regional trade (import) substitution parameters for the Illinois economy, initially for the sectoral and commodity breakdown identified for our single region model of the Chicago economy (Illinois data are applied to the Chicago case in the absence of appropriate data for region-specific estimation for the latter). We focus initially on US regional import substitution parameters because these are generally important in analysis for regional economies, which tend to be more open than national economies, but also because one of the main areas of our current research is to model the pollution content of trade flows between regions and the impacts on pollution 'trade balances' in response to changes in activity. While our work will eventually encompass the five Midwest states of Illinois, Indiana, Michigan, Ohio and Wisconsin, our first step in the process of parameter estimation for our intended suite of regional and interregional CGE models is to estimate commodity import elasticities for the case of Illinois and the Rest of the US. We apply a model where we take account of market size and distance in estimating the substitutability between commodities produced in Illinois and other US states.

The current paper is organized as follows. In Section 2, we outline the production structure of each industry in our intended regional and interregional CGE models to give context to the parameter estimation to follow. In Section 3 we provide theoretical background for our regional import elasticity estimates. We outline our analytical model and data in Section 4, before presenting our initial results in Section 5. Our provisional conclusions are given in Section 6.

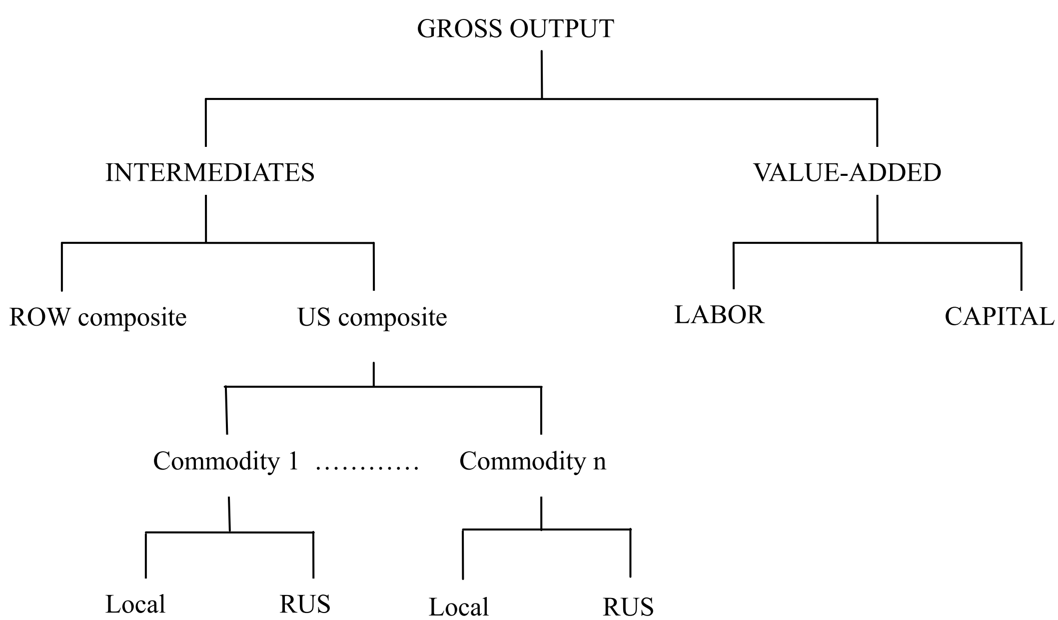
2. Intended production structure in the single region Chicago and interregional MidWest CGE modelling frameworks

A Chicago CGE model has been constructed using the AMOS[1] framework with a 1997 Chicago Social Accounting Matrix (SAM). AMOS is a well crafted model based on a variety of perspectives concerning the operation of markets in for small open economies, with particular attention to to labor markets. AMOS also offers a high degree of flexibility available for the choice of key parameter values, model closures and even aggregate structure which allow the modeler to choose appropriate condition for particular applications. Thus it can be applied to small open regional economy such as Chicago linked to larger economy. Detailed descriptions of the single region AMOS modeling framework can be found in Harrigan *et. al*. (1991), Hanley *et al*. (2007) and Ferguson *et al*. (2007), and of the interregional framework in Gilmartin *et al*, 2007a,b, 2008. Here we focus our attention on the production structure that we intend to specify in the US regional and interregional applications of the AMOS framework.

[1] AMOS is an acronym for a macro-micro model of Scotland.

A characteristic of the production structure in this model is that production takes place in perfectly competitive industries using cost minimization in production with multi-level production functions, generally of a constant elasticity of substitution (CES) form but with Leontief and Cobb-Douglas being available as special cases. In the CES functions, elasticities of substitution, σ, as with all parameter values, can be set for individual applications according to econometric or 'best guess' estimates. The production inputs are labor (L), capital (K) and intermediates (J), with a choice between locally produced intermediate commodities and imports from the RUS or ROW. Intermediate purchases of locally produced goods and services in the base year (long-run) equilibrium are determined by the industry-by-industry block of the IO table and are substitutable for imported commodities via an Armington link. The composite input then combines with value-added (capital and labor) in the production of each sector's gross output.

Figure 1 Production structure for each sector *i* in the Chicago regional and Midwest interregional CGE models



The output structure and corresponding basis for prices in each production sector *i* (where *i*=1,….,*n*) are shown in Figure 1. All local input prices are endogenous to the system, while all import prices are exogenous. The intermediate composite *k* depends on relative prices and the possibilities for substitution between different sources and types of intermediate input at each level. The price of value-added is determined by the rental rates of capital and labor. Gross output and the intermediate composite prices are determined in the same way. The estimation in this paper will focus on the substitutability between each local commodity, k (where k=1,..,n) at the bottom of the hierarchy.

The consumption function will also be hierarchical and cost minimization in consumption imposed. Going by the current AMOS specification, final consumption demand for each sector's output is allocated between the household and non-household sectors using a share vector that is based on that in the base year. Household consumption of the commodities produced by the traded sectors will be a composite made up of US and ROW commodities, where the US consumption commodity is a composite of locally produced and RUS goods as in the production function. An Armington assumption will be adopted concerning the demand for traded commodities. Locally produced goods and imports will be imperfect substitutes for one another, but combine to make a composite consumption good in the case of all traded commodities. In a manner similar to the case of production, the consumer attempts to minimize the cost of a given consumption composite, and will substitute against commodities whose price has risen. The choice for the aggregation function will again be CES, CD, and Leontief.

3. Regional import elasticities – theoretical background

Regional economic policy can affect the price of traded goods relative domestically produced goods. For example, tax and subsidy policy or any type of government regulation that affects the behavior of firm or consumers induce the trade between regions. As a result, a key relationship for regional CGE analysis is the degree of substitution between intraregional and interregional traded goods, which is commonly identified as the Armington elasticity. Commodities produced at different locations are seldom perfect substitutes. Because of real or apparent differences, discriminating buyers evaluate their willingness to substitute between imports and domestic goods within comparable product categories. This has lead to the adoption of the Armington (1969) assumption, which recognizes that imports may be substituted imperfectly for domestically produced products. Thus, there exists a potential for price differences between domestically produced and imported products from comparable product categories (Reinert and Roland-Holst, 1992). The factors determining the different price of goods are various; the demand for consumption and industrial inputs, the supply of production (labor costs, costs of materials), and technology progress in the transportation sector and of improving transaction institution.

The hypothetical representative consumer obtains utility from a composite (*Q*) of imported (*M*) and domestic (*D*) goods, and we assume there are continuous substitution possibilities between the two options. The individual consumer's decision problem is to choose a mix of *M* and *D* that minimizes expenditure, given respective prices p_m and p_d and the desired level of *Q*. In other words, *c*onsumers purchase quantities of domestic versus imported goods depending on their willingness to substitute and the ratio of the two prices. In the Armington specification, a CES functional form is chosen for *Q*:

$$Q = \alpha\left[\beta M^{(\sigma-1)/\sigma} + (1-\beta)D^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)} \tag{1}$$

where α and β are calibrated parameters and σ is the elasticity of substitution between imports and domestic goods. The solution to the consumer's optimization problem will be to choose imports and domestic goods whose ratio satisfies the first-order condition:

$$M / D = \left[(\beta/(1-\beta))(p_D / p_M)\right]^{\sigma} \tag{2}$$

that is the familiar equivalence between rates of substitution and relative prices. The parameter σ also can be interpreted as the compensated price elasticity of import demand.

Industry-level estimates of Armington elasticities for the U.S. have appeared over the last few decades. One of well-known studies for U.S. imports-demand elasticities was carried out by Stern *et al*. (1976). They offer estimates of U.S. imports-demand elasticities for 28 industries at the three-digit SIC level and divide them into three categories, extremely import sensitive, moderately import sensitive, and import inelastic. Shiells and Reinert (1993) used quarterly data over the period 1980-1988 and obtained estimates for 128 mining and manufacturing sectors according to three different specification: 1) generalized-least-squares using a Cobb-Douglas price aggregator; 2) maximum-likelihood estimation using a CES price aggregator; and 3) simultaneous equation estimation using a Cobb-Douglas price aggregator and a distributed lag model. As one of the most widely cited studies in the literature, Reinert and Roland-Holst (1992) estimated Armington elasticites for 163 U.S. mining and manufacturing sectors using quarterly data from 1980 to 1988.

However, application of the Armington assumption has mainly been at the international or country level because of the data limitation of commodity trade among regions. U.S. Census Bureau, U.S. Department of Commerce, and the Bureau of Transportation Statistics have undertaken the Commodity Flow Survey (CFS). This survey produces interstate commodity flow data in the United States. It provides information on commodities shipped, their value, weight, and mode of transportation, as well as the origin and destination of shipments of selected manufacturing, mining, wholesale, and retail establishments. Also they only cover physical commodities and no differentiation is made in the flows between intermediate and final demand flows. However, commodity trade among states within the same country may reflect quality differences among products or just consumer love of variety. Differences in product mixes within the same category produced at each location may also account for imports and exports of the same category of goods. This has led to the common use of the uniform Constant Elasticity of Substitution (CES) class of function, in which a single nonnegative substitution elasticity across all pairs of factors is imposed or, alternatively, a Cobb-Douglas production function has been adopted in which the elasticity of substitution equals one.

4. Analytical model and data

To estimate regional import elasticities using the regional data for the Chicago CGE model, Illinois data are selected from recently published information on 2002 commodity flows data (CFS). Although a number of trade models have been developed, the CES structure is relatively easy to explain and estimate so that the analytical specification follows Bilgic *et al.* (2002) and Erkel-Rousse & Mirza(2002). For the first specification, a CES function is adopted to represent the direct commodity satisfaction (utility) index:

$$U_{ILk} = \left(\sum_j \beta_{ILk} X_{ILjk}^{\rho} \right) = \sum \left(\beta_{1k} X_{ILk}^{\rho} + \beta_{2k} X_{jk}^{\rho} \right) \qquad (3)$$

where j=1,…r for region (state); k=1,…n for commodity group; $\beta_{1k} + \beta_{2k} = 1$; ρ is a substitution parameter; X_{ILk} refers to intraregional commodity consumption of Illinois for commodity k; and X_{jk} refers to interregional commodity consumption by Illinois from other states j for commodity k. The CES is linear in parameters, which is more easily estimated (Chung, 1994).

Maximizing equation (3) subject to the total expenditure constraint yields:

$$M_{ILk} = \sum_j P_{ILijk} X_{ILjk} \quad (4)$$

and produces a system of demands that estimates intraregional and interregional consumption:

$$\left[\frac{x_{ILk}}{x_{jk}}\right] = m^{\sigma}\left[\frac{p_{jk}}{p_{ILk}}\right]^{\sigma} \quad (5)$$

where $m = \left[\frac{\beta_{1k}}{\beta_{2k}}\right]$, $\sigma = [1/(1-\rho)]$ is the elasticity of substitution,

p_{ILk} = [Illinois intraregional commodity *k* value ($ millions) /Illinois intraregional commodity *k* weights (thousand ton)]*1000 is the unit price for Illinois and k^{th} commodity intraregional consumption

P_{jk} = [Interregional commodity *k* value ($ millions) /Interregional commodity *k* weights (thousand ton)]*1000 is the unit price for interregional consumption from j^{th} region and k^{th} commodity:

$$m = \left[\frac{\beta_{1k}}{\beta_{2k}}\right] = \exp(\delta_0 + \delta_1 \ln Q_{jk} + \delta_2 \ln d_{ILj}) \quad (6)$$

where *m* depends on states' characteristics defined as Q_{jk} and d_{ILj}, which represent market size and distance factor, respectively[2]. δ_s is the set of parameters associated with state *j* characteristics.

The market size factor is included as an explanatory variable to capture the share of the amount of intraregional demand to interregional demand. Presumably, larger markets are able to support more production and thus imports from larger market increase relative to intraregional goods. The market size variable is measured as the proportion of Illinois gross state product to the other region's gross state product by each industry sector. Owing to the potentially important influence of spatial effects, the distance factor is included in the price expression in order to indicate that the closer the state is located to Illinois, the more likely the volume of interregional goods increases. Distance is calculated as the centroid distance between Illinois and the other 49 states.

Taking natural logs of both sides of equation (5) produces:

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[2] More details to derive market size and distance factor in Erkel-Rousse and Mirza (2002).

$$\ln\left[\frac{X_{ILk}}{X_{jk}}\right] = \sigma \ln m + \sigma \ln\left[\frac{P_{jk}}{P_{ILk}}\right] \tag{7}$$

Substituting for the term *m* defined by equation (6) into equation (7) produces:

$$\ln\left[\frac{X_{ILk}}{X_{jk}}\right] = \left[\alpha_0 + \alpha_1 \ln Q_{jk} + \alpha_2 \ln d_{ILj}\right] + \sigma \ln\left[\frac{P_{jk}}{P_{ILk}}\right] \tag{8}$$

where $\alpha_0 = \sigma\delta_0,\ \alpha_1 = \sigma\delta_1,\ \alpha_2 = \sigma\delta_2$,

$\ln\left[\frac{P_{jk}}{P_{ILk}}\right]$ is the natural log of the price ratio for interregional goods to intraregional goods.

$\delta_0 = \frac{\hat{\alpha}_0}{\hat{\sigma}},\ \delta_1 = \frac{\hat{\alpha}_1}{\hat{\sigma}}$ *and* $\delta_2 = \frac{\hat{\alpha}_2}{\hat{\sigma}}$

The estimated parameters capture the effects of market size and distance as well as the constant term. The left hand side of equation (8) is the natural log of the ratio of the demand for intraregional consumption to the demand for interregional consumption.

In addition to equation (8), another testable specification is considered. A weighted distance has been applied using the same calculation method (Head and Mayer, 2000) for Illinois and the rest of states in U.S. Let weighted distances be expressed as follows:

$$wd_{ILj} = s_{IL} s_j d_{ILj} \tag{9}$$

where s_{IL} is population weight of Illinois in all states, s_j is employment weight of *j* state in all states and d_{ILJ} is the Euclidian distance between Illinois and state *j*.

As the centroid distance between Illinois and other states in equation (8) is replaced with a weighted distance expressed as equation (9), another specification is proposed:

$$\ln\left[\frac{X_{ILk}}{X_{jk}}\right] = \alpha_0 + \alpha_1 \ln Q_{jk} + \alpha_2 \ln wd_{ILj} + \sigma \ln \frac{P_{jk}}{P_{ILk}} \tag{10}$$

where $\alpha_0 = \sigma\delta_0,\ \alpha_1 = \sigma\delta_1$, and $\alpha_2 = \sigma\delta_2$

Based on the 2002 Commodity Flow Survey (CFS, from U.S. Department of Commerce), the intraregional and interregional quantity and price variables were computed. The survey provides information on commodities shipped, their value, and weight as well as the origin state and destination state of shipments of manufacturing, mining, wholesale, and select retail establishments. Since no interregional commodity flow data between Chicago and other regions exist in CFS, we consider Illinois state level data instead of Chicago region for this study. Also, the commodities shown in the CFS are classified by Standard Classification of Transported Goods (SCTG) coding system that does not cover some industry categories such as government and retail. Therefore, 43 industries by SCTG in CFS are mapped into 14 sectors among 25 industry sectors in Chicago CGE. Sector 3 and sector from 15 to 25 are excluded in the estimation of their elasticities because commodity data that matched with those sectors does not exist. Annual wages data for each state are extracted from Quarterly Census of Employment and Wages (QCEW/ES-202) Data Files from the Bureau of Labor Statistics. Gross State Product and employment data for each state are derived from the REIS (Regional Economic Information System) data set from the Bureau of Economic Analysis.

5. Results

Tables 1 and 2 summarize the results of ordinary least squares estimation of equation (8) and (10). We find significantly different results for most parameters by industries. All estimated elasticities are statistically significant at the 10 percent or greater probability level in the results of estimating equation (8) and, for the equation (10), only the estimated elasticity in apparel and textile products industry is not statistically significant at the 10 percent level. The estimation from the equation (8) presents interregional price elasticities that range from 0.068 for apparel and textile products (sector 5) to 1.517 for transportation equipment (sector 12). Additionally, the estimation derived from the equation (10) is a little higher than those resulting from the first estimations. Those range from 0.186 for medical, precision and optical instrument (sector 13) to 2.169 for non-metallic mineral products (sector 9). Six industries out of 13 are associated with elasticities that are higher than unity.

The coefficient for market size is statistically significant at the 10 percent probability level and positive. The interpretation of this elasticity is that the market size is positively related to the ratio of intraregional to interregional goods demand, which suggests that the share of intraregional goods increases relative to interregional goods if total gross state product of the k^{th} industry in Illinois is larger. However, it should be noted that the industries with relatively lower price elasticities appear to have higher coefficients of market size. This only suggest that the market size is correlated with Illinois' capability to provide more intraregional goods relative to interregional goods within some industries which have relatively lower price elasticities, for example, agriculture, forestry and fisheries (sector 1), apparel and textile products (sector 5), and medical, precision and optical instrument (sector 13).

Table 1 First results of trade elasticities by commodity

Sector	Commodity	Elasticity σ	Market Size δ_1	Distance Factor δ_2
1	Agriculture, Forestry and Fisheries	0.919***	2.699***	2.282***
		0.156	*0.165*	*0.111*
2	Mining	0.814***	0.968***	3.401***
		0.082	*0.138*	*0.092*
4	Food and Tobacco Products	1.282***	0.513***	1.022***
		0.169	*0.100*	*0.106*
5	Apparel and Textile Products	0.068*	9.909***	17.287
		0.112	*0.050*	*0.048*
6	Wood Products and Furniture	0.941***	1.082***	1.343***
		0.079	*0.126*	*0.088*
7	Paper Products	0.850***	1.099***	1.327***
		0.076	*0.080*	*0.070*
8	Chemical and Petroleum Products	0.712***	1.336***	1.746***
		0.055	*0.064*	*0.074*
9	Non-Metallic Mineral Products	1.357***	0.489***	0.945***
		0.083	*0.094*	*0.099*
10	Primary Metals Products	0.922***	1.057***	1.390***
		0.078	*0.078*	*0.056*
11	Machinery and Electric Equipment	1.012***	0.986***	0.898***
		0.090	*0.072*	*0.067*
12	Transportation Equipment	1.517***	0.415***	0.922***
		0.231	*0.079*	*0.063*
13	Medical, Precision and Optical Instrument	0.286***	2.428***	2.722***
		0.102	*0.047*	*0.023*
14	Miscellaneous Manufacturing	0.619***	1.506**	1.919***
		0.121	*0.058*	*0.068*

1) Standard errors are in Italics
2) *** significant at 1%, ** at 5%, and * at 10%

The coefficient for the distance factor is statistically significant and positive for 12 out of 13 commodities in table 1. For the coefficient for weighted distance factor, table 2 shows that the result for 8 out of 13 commodities is statistically significant and positive. This result generally suggests that the closer region or the lower transport cost, the more interregional goods trade. In both estimations, the coefficient on the distance or transport cost is not higher than the price elasticities in food and tobacco products (sector 04) and transportation equipment (sector 13), which could be inferred that those two commodity goods in Illinois specially tend to be more affected by price difference although distance or transport cost effect exist.

Table 2 Second results of trade elasticities by commodity

Sector	Commodity	Elasticity σ	Market size δ_1	Distance factor δ_2
1	Agriculture, Forestry and Fisheries	0.645**	3.458***	1.403***
		0.302	*0.431*	*0.283*
2	Mining	0.963***	0.669***	0.974**
		0.147	*0.254*	*0.383*
4	Food and Tobacco Products	1.093***	1.329***	0.900***
		0.229	*0.288*	*0.278*
5	Apparel and Textile Products	0.421*	1.512***	0.062
		0.251	*0.132*	*0.191*
6	Wood Products and Furniture	0.947***	1.416***	0.433***
		0.084	*0.170*	*0.151*
7	Paper Products	0.868***	1.611***	0.772***
		0.086	*0.118*	*0.122*
8	Chemical and Petroleum Products	0.675***	1.935***	0.682***
		0.076	*0.093*	*0.113*
9	Non-Metallic Mineral Products	2.169***	0.443***	0.047
		0.125	*0.242*	*0.106*
10	Primary Metals Products	1.016***	1.245***	0.349**
		0.169	*0.168*	*0.181*
11	Machinery and Electric Equipment	1.336***	0.753***	0.065
		0.117	*0.158*	*0.159*
12	Transportation Equipment	1.905***	0.491***	0.184**
		0.338	*0.129*	*0.149*
13	Medical, Precision and Optical Instrument	0.186	2.884*	0.535
		0.330	*0.316*	*0.374*
14	Miscellaneous Manufacturing	1.007***	1.098***	0.167
		0.283	*0.200*	*0.234*

1) Standard errors are in Italics
2) *** significant at 1%, ** at 5%, and * at 10%

When comparing the price elasticities between industries, transportation equipment (1.517 and 1.905), non-metallic mineral products (1.375 and 2.169), food and tobacco products (1.282 and 1.093), and machinery and electric equipment (1.012 and 1.336) have relatively larger price elasticities of interregional commodity trade. This indicates that price differences between intraregional goods and interregional goods in Illinois are relatively important to transportation equipment, non-metallic mineral product, food and tobacco product and machinery and electric equipment rather than the industries that have relatively lower elasticities. Furthermore, the elasticity levels of those 4 industries seem to be higher than the range of their elasticities found in other literatures for US studies (see table 3).

Table 3   Comparison of current elasticity estimates with others

Sector	Commodity	Eq. (8)	Eq. (10)	Bilgic et al. (2002)	Reinert and Roland-Holst (1992)	Shiells, Stern, and Deardorff (1983)	Erkel-Rousse and Mirza (2002)
1	Agriculture, Forestry and Fisheries	0.919	0.645	1.477	N/A	N/A	N/A
2	Mining	0.814	0.963	1.837	1.012	N/A	N/A
4	Food and Tobacco Products	1.282	1.093	0.516	1.049	0.338	0.75~ 3.898
5	Apparel and Textile Products	0.068	0.421	0.290~ 0.625	0.815~ 0.858	1.620~ 2.580	0.625~ 6.258
6	Wood Products and Furniture	0.941	0.947	0.931~ 1.429	0.050~ 1.838	0.260~ 12.130	0.898~ 9.583
7	Paper Products	0.850	0.868	1.184	1.351	1.800	1.023~ 5.687
8	Chemical and Petroleum Products	0.712	0.675	0.891~ 2.872	0.400~ 1.097	6.740~ 6.979	1.021~ 5.881
9	Non-Metallic Mineral Products	1.357	2.169	0.843~ 1.106	0.661~ 0.706	1.540~ 2.696	0.758~ 12.695
10	Primary Metals Products	0.922	1.016	1.745	0.915	2.598	0.927~ 5.146
11	Machinery and Electric Equipment	1.012	1.336	0.596~ 0.848	0.347~ 0.834	3.340~ 7.460	0.781~ 2.511
12	Transportation Equipment	1.517	1.905	0.600	0.969	3.010	0.793~ 7.547
13	Medical, Precision and Optical Instrument	0.286	0.186	0.396	0.788	0.450	0.986~ 2.176
14	Miscellaneous Manufacturing	0.619	1.007	0.654	0.140	3.550	0.861~ 1.607
		IL		US	US	US	OECD

6. Conclusions

Notwithstanding the fundamental difference in methodology and data between studies, the evidence from this analysis suggests that the interregional trade of transportation equipment, non-metallic mineral product, food and tobacco product and machinery and electric equipment are more sensitive with the price difference. Conversely, more natural-resources based industries are likely to have lower price elasticities, which mean that their trade is regionally specialized and less dependent on price. This interpretation that we obtain seems to match the exploration of

Midwestern trade flows in Munroe *et al.*(2007). Using a Grubel-Lloyd Index, they shows that Illinois appears to have high trade overlap in high-tech industries (e.g. food products, fabricated metal products, and machinery) and more specialized trade in low-tech industries (e.g. fish, coal, ordinance or accessories, petroleum or coal, and clay, concrete, class or stone).

Additionally, it should be noted that most of estimated interregional trade elasticities in each industry sector are positive but relatively lower than those estimated with US data or international trade data in other literature (see table 3). Compared to the US or international trade elasticities, this result suggests that trade elasticities for a regional CGE model should be considered less sensitive to differences in prices of intraregional trade goods versus interregional trade goods than the country or international cases. A possible explanation is that regional trade elasticities are less elastic or less price responsive than comparable commodity group elasticities for US or international trade because the regional economy tends to specialize with the amount of interregional trade driven by non-price barriers and lower transport cost.

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Appendix. Sectoral breakdown of the Chicago CGE Model

25 sectors	Name	SIC
1	Agriculture, Forestry and Fisheries	01, 07
2	Mining	10
3	Construction	15
4	Food and Tobacco Products	20, 21
5	Apparel and Textile Products	22
6	Wood Products and Furniture	24, 25
7	Paper Products	26, 27
8	Chemical and Petroleum Products	28, 29, 30, 31
9	Non-Metallic Mineral Products	32, 34
10	Primary Metals Products	33
11	Machinery and Electric Equipment	35, 36
12	Transportation Equipment	37
13	Medical, Precision and Optical Instrument	38
14	Miscellaneous Manufacturing	39
15	Transportation Service	40, 41, 42, 44, 45, 46
16	Communications	48
17	Electricity, Gas and Water Supply	49
18	Wholesale and Retail Trade	50, 52
19	Financial Institution and Insurance	60, 62, 63, 64
20	Real Estate	65
21	Eating and Lodging Services	58, 70
22	Personal and Business Services	72, 73, 75, 76, 78
23	Amusement Recreation Services	79
24	Social Services	80, 81, 82, 83, 84
25	Government Enterprises	FGE, SLGE