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Accounting for local economic change in regional input-output modeling

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1. Introduction

This paper focuses on the use of input-output (I-O) models and methods in accounting for local economic change. It addresses some of the deficiencies of input-output modeling and discusses how to best deal with these deficiencies (Brucker, Hastings, and Latham 1987; Crihfield and Campbell 1992; Grimes, Fulton, and Bonardelli 1992; Rickman and Schwer 1993; Stevens, Treyz, and Lahr 1989; Taylor and Fletcher 1993). A widespread perception persists that input-output modeling is simply an accountant's approach to estimating the local economic impact of a given change in market demand or public policy. The criticism stems, in part, from the use of fixed price and production coefficients in estimating individual industry multipliers. In comparison, computable general equilibrium (CGE) modeling uses input-output tables, but extends their application through allowances for price-variable product and factor substitution (Hanson and Robinson 1991). This extension occurs at a high cost in time, effort, and creditability because of the complexity of the model and the lack of local data for estimating and validating parameters and variables. Neither input-output nor computable general equilibrium is a recursively linked multiperiod model that may be preferable in accounting for local economic change (Treyz 1993; Treyz, Rickman, and Shao 1992).

2. Problem focus

This assessment departs from the standard literature by suggesting that a flexible model is one that is ready-made and invites coefficient fix-up with superior information. A flexible model would be coupled with "software and/or handbooks that guide the user (professional or lay) through the intricacies of final demand determination" (Bruckner, Campbell, and Latham 1990, p. 137). Continuing in this spirit of constructive criticism we address two sets of concerns that affect the credibility of input-output model forecasts and impact assessments: system bias and specification error. System bias is a consistent over- or underestimate of parameters and variables in the regional economic model and database. System bias arises, in part, from the underlying structural assumptions in model and database estimation. Specification error is the result of an incomplete or otherwise inadequate representation of the causal sys-

tem accounting for the values of parameters and variables in the regional impact model and database. A key culprit in specification error is lack of accurate information about the geographically differentiated determinants of industry production, the productivity of its primary inputs, and the linkages among geographically separated economic activities (Goetz and Debartin 1993).

Efforts to correct the outstanding deficiencies of input-output modeling involve several different strategies: data disaggregation and parameter re-estimation. Such efforts occur within a regionalization scheme based on daily trip-to-work or labor market, areas (LMAs) as delineated in Tolbert and Killian (1987, 1996). The approach presented in this paper provides for the use of the labor market areas in a further regionalization of technology, trade, and final sales structures. Our approach calculates interindustry transactions with place-specific production functions and regional purchase coefficients (RPCs). It also uses commodity margins that convert final sales in purchaser prices to commodity output in producer prices.

We focus on the millwork manufacturing industry in the Minneapolis-St. Paul economic region to illustrate the complexity and importance of interindustry linkages and the difficulties in representing them in an interindustry transactions table. Establishments in this industry are primarily engaged in manufacturing fabricated wood millwork, including wood millwork covered with materials such as metal and plastics, as defined by the Standard Industrial Classification Manual (1987 SIC code 2431). Doors, windows, and related products account for much of the industry output, which is purchased mostly by the domestic construction industry. This is an industry that exists in both the core metropolitan area and the rural periphery. Several large single establishment firms dominate segments of this industry in locally diverse economic environments. A dominant firm accounts for most of the specific local industry output in the case studies. Each of the dominant firms purchases most of its intermediate inputs from sources outside the region and also exports most of its product beyond its region. Its income payments to primary resource owners in the form of value-added payments—employee compensation, indirect business taxes, and property income—account for most of its local impact.

3. Delineating economic activity areas

The Minneapolis-St. Paul economic region extends westward from the eastern tip of Lake Superior and western shores of Lake Michigan to the western half of the Dakotas. We define the term *economic region* as an economically integrated proximity-based system of labor market areas focusing on a high order air transportation and producer services center in a global transportation network. For the U.S. we use an earlier delineation of 380 labor market areas to form 25 economic regions, each centered on one of the 29 air transportation nodes (Maki and Reynolds 1994). The Minneapolis-St. Paul economic region includes all of Minnesota and parts of six other states—a total of 275 counties in 23 multicounty labor market areas. It has a total population of 7.6 million, 4.4 million jobs, and a gross regional product of $147 billion, as shown in Table 1. Most of its labor market areas still depend on farming, mining, and food and forest products manufacturing. Its inner core metro-

Table 1. Selected economic indicators, Minneapolis-St. Paul economic region, 1990

Economic indicator	Units	Economic region	Minneapolis-St. Paul LMA		Duluth-Superior LMA	
			Total	Washington	Total	Roseau
Population	thou.	7,587	2,581	146	393.5	15
Employment	thou.	4,426	1,682	54	190.1	11
Total final demand	mil.$	206,768	86,835	3,196	10,514	642
Total value added	mil.$	147,493	67,075	2,059	6,559	308
Commodity exports	mil.$	84,194	37,489	1,461	5,328	514
Domestic	mil.$	66,049	31,106	1,359	717	465
Foreign	mil.$	18,145	6,383	102	4,612	49
Commodity imports	mil.$	53,353	33,059	2,481	3,309	545
Domestic	mil.$	45,830	28,147	2,083	2,809	480
Foreign	mil.$	7,523	4,912	398	500	64
Gross commodity production	mil.$	278,333	115,322	3,720	2,116	694
Exports per $1 mil gross com prod	mil.$	0.302	0.325	0.366	0.557	0.742
Imports per $1 mil exports	mil.$	0.634	0.882	1.698	0.621	1.060

Source: University of Minnesota IMPLAN System Table Nos. .002, 103, 106, 107

politan area of Minneapolis and St. Paul has a total population of 2.6 million, 1.7 million jobs, and $67 billion in gross area product. It is the largest and most important distribution and manufacturing center in its economic region. The Duluth, Minnesota-Superior, Wisconsin outer core metropolitan area, which includes the smaller of the two dominant millwork firms, has a total population of 394,000, 190,000 jobs, and a gross regional product of $6.6 billion. This labor market area still depends on mining, tourism, and forest products manufacturing for most of its economic base.

A metropolitan core area, such as the Minneapolis-St. Paul labor market area, is an economic region's principal transportation and communications center. It is also the principal center for producing, distributing, and using decision information for the private and public sectors of the region. Thus, the activities concentrating in the metropolitan core area are information intensive. Such activities can afford to pay the high site costs of the metropolitan downtown district because of its market access advantages over other locations. Such activities experience relatively little risk because of location, and they have the capacity to achieve high levels of productivity and flexibility in resource use. Also, a fast-changing global economy makes flexibility in work practices and organization an essential condition for successful business enterprise (Reynolds, Miller, and Maki 1994). Flexibility of access to input supplies and procurement practices is important, too. Flexibility is a function of the learning processes in an organization and the ability to gauge the likely outcomes of improved learning capacities. Successful business organizations have the robustness or capacity for adaptation to changing market conditions and new production technologies. They are successful learning organizations. Such organization tends to concentrate in major metropolitan areas (Reynolds, Miller, and Maki 1994).

Transitional rural areas adjoin the metropolitan core area and extend to the outer commuting limits of the core area workplaces. Within the 60+ mile radius of the core area, farm subdivision is a common practice because of the high demand for part-

time, hobby, and garden-type residential farms. Off-farm employment of one or more family members supplements farming as an income source. Off-farm income sources include manufacturing plants locating or expanding in the transitional rural areas and trade and service establishments of growing rural service centers.

Rural regions, removed from access to large consumer and producer markets, are singularly dependent on farming, fishing, or mining. These regions lack prospects for diversifying their local economic base. In such cases, local credit sources soon disappear while distant credit sources heavily discount high risk loans. Risk, when discounted heavily, adds to production costs (Lipke 1993). High wages and high regulatory and environmental costs also add to the costs of doing business in a particular region. Many rural regions offer cost advantages for export-producing businesses because of low site costs—land and buildings, labor, environmental regulations, and congestion. Transportation, business, and related services cost less in many rural areas than in metropolitan areas. Personal services and housing also cost less in rural areas than in metropolitan areas. For these regions low costs are an advantage when accompanied by low cost access to large consumer and producer markets.

4. Interindustry linkages

A long-established millwork manufacturing company with more than $250 million sales dominates the millwork industry in the Minneapolis-Saint Paul local labor market area. Its proximity to a large metropolitan market gave the company an early market advantage. This advantage was sustained by above average growth of the local housing market and residential construction industry. Product output and value added per worker for the millwork industry rose to levels above the average in other industries as the dominant millwork company cluster improved its own competitive position in regional markets. In the metropolitan county, value added per worker in 1990 was $38,000 for all industry compared to $62,000 in millwork manufacturing.

Another long-established millwork manufacturing company with more than $150 million sales is in the extreme northwest corner of the Duluth (MN)-Superior (WI) labor market area bordering Canada. Its imports of termediate inputs also are much greater than its local purchases. It has a major impact on local economic activity because of the recycling of its large payroll by local residents. Its county has a total population of 15,000, a job count employment of 10,600, and a gross local product of $308 million. A large discrepancy occurs for this county between the resident employed labor force and the job count for local industry because of commuting from nearby counties. In addition, the job count is larger because of multiple job holdings.

4.1 Assessing industry structure

The millwork industry in each of the sets of case studies is an important player in its local community. Even in Washington County, which is also part of the Minneapolis-St. Paul labor market area, it accounts for one-third of the local exports.

Table 2. Millwork industry income payments for specified services, Minneapolis-St. Paul economic region, 1990

Economic indicator	Economic region (mil.$)	Minneapolis-St. Paul LMA Total (mil.$)	Minneapolis-St. Paul LMA Washington (mil.$)	Duluth-Superior LMA Total (mil.$)	Duluth-Superior LMA Roseau (mil.$)
Employee compensation	520.0	256.9	230.3	83.0	79.3
Indirect business taxes	10.7	4.3	3.6	2.9	2.8
Proprietary income	36.3	10.0	8.0	6.4	6.1
Other property income	105.2	52.0	45.0	16.8	15.5
Total value added	672.2	323.2	286.9	109.1	103.7
Total intermediate inputs	779.4	264.6	223.9	162.6	157.7
Own production	487.7	136.6	67.0	83.4	23.9
Imports	291.7	128.0	156.9	79.2	133.8
Total industry output	1,451.6	587.8	510.8	271.7	261.4
Value added per $1 mil output	0.463	0.550	0.562	0.402	0.397
Total output per $1 mil empl comp	2.792	2.288	2.218	3.273	3.296

Source: Source: University of Minnesota IMPLAN System Report No. 114

Its rural counterpart in the same economic region accounts for more than two-thirds of the Roseau County base economy. Table 2 shows the contribution of the millwork manufacturing industry to the local, area, and regional economies. This is the value added by the work force and the capital and entrepreneurial resources of the millwork industry. Other millwork firms join the single, dominant firm and the cluster of small firms at the county level in the larger geographical delineation. The two dominant millwork firm clusters account for 89 percent to 96 percent of production in their multicounty labor market areas and for 50 percent in the economic region.

The millwork industry in the rural county comes close to the overall industry average in the county in value added per worker because of high labor earnings in the second largest employer in the county (a snowmobile manufacturer). A key difference in the income payments of the millwork manufacturers in the rural county and the metropolitan county is in the balance of payments between primary inputs, such as labor and capital. This is true, also, for intermediate inputs, particularly the purchases of imported goods and services used in production or in acquiring production inputs. Contrary to the assumption of a common production function for a given industry in any locale, the production technology differs for this industry in the two counties.

4.2 Estimating interarea trade

A leading measure of the size and viability of a local or regional economy is the value of its exports to market destination outside its own labor market area. Another measure is its propensity to import goods and services from sources outside the area. The primary difficulty with these measures is the lack of accurate monitoring of commodity or product flows from one area or region to another. We have, however, indirect measures of these two indicators of actual shipments from a variety of data sources, including the U.S. Censuses of Transportation that show the gross out-shipments and in-shipments of industries in each state. Once we have the estimates

of gross out-shipments using the indirect measures, we can estimate gross in-shipments, given the total production in the area or region. These estimates measure area-to-area interdependencies in both employment and industry sales and purchases.

The external product markets for the goods and services produced locally define the economic base of the local area or community as delineated by its labor market. The critical economic linkage of each area to the outside world is its export-producing sector and its product sales that generate income from nonresident sources. The total export-producing jobs and payroll attributed to each industry measure its importance in the area's economic base. Neither of the two steps in the delineation of the economic base—export producing and income generating—sufficiently differentiate the industry and activity composition of a local economy to provide useful and practical measures of its vulnerability to economic shocks. Unanticipated change in exports markets and exogenous income flows are endemic with vulnerable rural areas and natural resources-based economies. A third step would take into account the differentiating characteristics of vulnerable and viable regions.

Table 3 compares the commodity disbursements of the millwork industry in each of the two areas to their intermediate demand sectors. In the smaller region, less than one-tenth of one percent of the local millwork industry output is purchased locally, with new residential construction being the largest market. The remaining 99+ percent of the total goes mostly to the private construction industry outside the immediate locale. The larger the economic region, the greater the internalization of both exports and imports within the region. Exports account for over four-fifths of the millwork output in the region and imports for nearly two-fifths of intermediate product inputs. For Roseau County exports account for over 99 percent of millwork output and imports for more than four-fifths of its intermediate product inputs.

Table 4 compares the millwork industry purchases for the economic region, the labor market area, and the locality. Intermediate purchases of the millwork industry from all sources total $779 million in the Minneapolis-St. Paul economic region. Purchases from own production in this region total $488 million of the total intermediate input requirements (shown earlier in Table 2). These purchases are balanced between own production and imports at the labor market level. At the local level, however, local suppliers account for only 15 percent of total input purchases in the rural county and 30 percent in the metropolitan county in this economic region. The distribution of input purchases is the same for all areas. The allocation of total outlays between intermediate inputs and primary inputs, however, will vary because of the priority given the value-added estimates in adjusting the industry data series to their control totals.

Sawmill products, wholesale trade, and transportation are the largest purchases of the millwork industry in the rural county. We add screw machine products, electric services, advertising, and real estate to this list for the metropolitan county. The sawmill output from Oregon and the Pacific Northwest is the principal source of the sawmill lumber used in both the metropolitan and the rural millwork industry clusters in the U.S. Sawmill lumber is the largest single purchase of the millwork industry.

Table 3. Millwork industry sales to specified intermediate demand, Minneapolis-St. Paul economic region, 1990

Demand sector	Economic region (pct.)	Minneapolis-St. Paul LMA Total (pct.)	Minneapolis-St. Paul LMA Washington (pct.)	Duluth-Superior LMA Total (pct.)	Duluth-Superior LMA Roseau (pct.)
New residential structures	11.2	11.7	0.6	3.5	0.1
Industrial & commercial buildings	1.4	1.4	0.1	0.4	0.0
Maintenance	1.1	1.1	0.1	0.3	0.0
Residential repair	0.7	0.6	0.0	0.2	0.0
Farm structures	0.6	0.3	0.0	0.1	0.0
Millwork manufacturing	0.4	0.3	0.4	0.5	0.5
Others	0.3	0.3	0.0	0.0	0.0
Government facilities	0.3	0.2	0.0	0.1	0.0
Intermediate, total	16.0	15.9	1.1	5.1	0.6
Final demand, total	84.0	84.3	98.9	94.9	99.4
Total commodity output	100.0	100.0	100.0	100.0	100.0

Source: University of Minnesota IMPLAN System Table No. 115

The above case study emphasizes the complexity of estimating production technologies, trade flows, and commuting patterns and the strong potential for specification errors in formulating the regional I-O model. Dominant millwork firms located in the same economic region have production technologies that differ significantly depending on whether the firm is located in a metropolitan versus a rural area. The case study also indicates commonalties regardless of location. Estimates of trade flows indicate that dominant millwork firms in both metropolitan and rural communities export almost their entire product to other counties. The next section shows the tendency for regional purchase coefficients to systematically understate such export activity. More importantly, such systematic distortions produce inaccurate impact multipliers and thus suspect impact estimates.

5. System formulation

System formulation refers to both the design and the implementation of regional models. System formulation involves estimates of input-output structures (at the national as well as at the regional level) and model mechanics. We present tabular summaries of the results of this system for estimating the economic impact of a given change in demand on local economic activity in two rural counties and two metropolitan area counties. We relate these results to the broader issue of linkage between regional structures and regional performance and the understanding of their role and importance in regional input-output analysis and forecasting. The source of estimates is the University of Minnesota IMPLAN (Impact Analysis for Planning) regional economic modeling system. IMPLAN is now available commercially from the Minnesota IMPLAN Group (MIG).

Table 4. Millwork industry intermediate input purchases, Minneapolis-St. Paul economic region, 1990

		Economic region		Minneapolis-St. Paul LMA				Duluth-Superior LMA			
				Total		Washington		Total		Roseau	
Rank	Intermediate input	Own (pct.)	Import (pct.)	Own (pct.)	Import (pct.)	Own (pct.)	Import (pct.)	Own (pct.)	Import (pct.)	Own (pct.)	Import (pct.)
1	Maintenance	22.4	32.7	8.2	45.6	28.6	23.8	7.4	34.3	20.5	27.3
2	Sawmills	12.2	9.1	16.4	5.4	12.0	10.1	13.9	9.9	18.0	9.8
3	Hardwood dimension/flooring	15.9	1.6	20.5	0.0	11.3	9.7	13.9	9.2	14.0	10.0
4	Millwork	2.2	13.5	3.9	9.2	0.0	13.2	0.0	9.2	0.0	7.6
5	Veneer and plywood	9.8	0.0	11.9	0.0	12.0	0.0	14.4	2.6	10.1	5.4
6	Reconstituted wood products	6.8	0.0	8.3	0.0	5.7	2.7	11.1	1.3	10.9	3.1
7	Wood products NEC	1.1	7.7	1.1	6.1	0.5	6.7	3.4	3.6	0.1	4.2
8	Paperboard containers	3.6	3.3	2.0	5.0	4.9	1.9	2.0	4.1	2.1	2.6
9	Paints and allied products	4.8	0.5	4.9	1.5	6.0	0.3	9.1	0.7	5.9	2.8
10	Adhesives and sealants	2.8	3.5	2.8	3.3	0.9	5.3	0.8	4.0	4.4	2.8
11	Misc. plastic products	3.6	1.9	0.3	5.8	4.9	0.9	3.4	2.8	3.4	2.9
12	Glass and glass products	1.8	4.8	3.0	2.8	0.9	5.1	0.1	4.1	0.0	3.4
13	Hand and edge tools	2.2	1.5	2.1	1.8	3.5	0.3	5.4	0.5	0.2	2.3
14	Hardware NEC	1.8	2.2	3.7	0.0	1.6	2.3	5.0	0.6	1.5	2.0
15	Screw machine products	0.0	4.1	0.0	3.2	0.0	3.2	0.0	2.2	0.0	1.8
16	Metal stampings	1.3	1.1	1.9	0.5	1.3	1.1	1.5	1.1	0.7	1.3
17	Fabricated metal products	1.6	0.2	2.0	0.0	0.0	2.2	0.0	1.5	0.0	1.3
18	Power-driven hand tools	1.6	0.1	2.0	0.0	1.7	0.3	3.5	0.0	3.4	0.6
19	Woodworking machinery	1.3	0.5	1.8	0.1	1.4	0.6	0.8	1.1	0.0	1.2
20	Motor freight and warehousing	0.0	2.4	0.0	1.9	0.0	1.9	0.0	1.3	0.0	1.1
21	Communications	0.3	2.0	0.3	1.7	0.2	1.7	0.3	1.2	0.0	1.1
22	Electric services	0.5	1.6	0.4	1.7	0.2	1.7	0.2	1.2	0.0	1.1
23	Wholesale trade	0.0	2.3	0.0	1.7	0.0	1.7	0.0	1.2	0.0	1.0
24	Real estate	0.5	1.2	0.7	0.9	0.7	0.9	1.3	0.6	2.5	0.5
25	Advertising	0.8	0.5	0.1	0.8	0.5	0.8	1.4	0.4	2.3	0.4
26	Consulting services	0.7	0.6	1.3	0.6	0.7	0.6	1.0	0.5	0.0	0.8
27	Other	0.3	1.2	0.3	0.8	0.5	0.8	0.0	0.9	0.0	0.8
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: University of Minnesota IMPLAN System Table No. 114

5.1 Regionalization of technology and database

We focus on current shortcomings of input-output modeling with an end view of correcting them, either by system improvements or extension of the existing system. Included among procedures for the regionalization of input-output structures and databases noted in the problem focus section of this paper is the use of labor market areas for a more accurate spatial differentiation of industry production functions and the internalization of commuting patterns. For this purpose, we select four counties in Minnesota cited in Table 5—two in the northern tier of counties bordering Canada and two in the Twin Cities metropolitan statistical area—for these tests, including two counties described above in the millwork section. These counties illustrate an increasingly common occurrence in any regional economy: the concentration of export-producing jobs in one locality and residential activities in another locality.

The businesses located in the City of St. Paul account for most of the economic activity in Ramsey County while Washington County is a residential community with a commuter population largely employed in the higher paying jobs in St. Paul. Lake of the Woods County in the Duluth-Superior labor market area has an abundance of natural amenities but few well paying or even lesser paying jobs. Roseau County has two successful manufacturing businesses—windows and snowmobiles—that employ a total workforce spread over several counties along the U.S.-Canada border. The negative commuter income for Ramsey County and Roseau County denotes a loss of income earned in the county to its nonresident workforce. This amounts to more than $3 billion for Ramsey County and roughly $30 million for Roseau County.

The frequency distributions of IMPLAN's individual industry regional purchase coefficients values, aggregated under the one digit commodity groups in each of the four counties, are listed in Table 6. Each county has the same distribution of industry categories, with private services, for example, accounting for 18.1 percent of the total industry listing. Lack of an industry in an area dictates a zero entry for the corresponding industry group. For the metropolitan area counties a majority of the private service industries have regional purchase coefficients values closer to unity than

Table 5. Total population, resident earnings, and personal income of commuters as percent of resident income, Minnesota, 1990

County	Total population (no.)	Commuter income (pct.)	Resident income (mil.$)
Minneapolis-St. Paul MSA:			
Ramsey	485,765	-32	9,566
Washington	145,896	45	1,400
Northeast Minnesota:			
Lake of the Woods	4,076	15	26
Roseau	15,026	-16	195

Source: U.S. Department of Commerce, Regional Economic Information System; Census of Population, 1990

Table 6. Frequency distributions of RPC values for specified commodity groups in selected counties, Minnesota, 1990

County and RPC	Agriculture (pct.)	Mining (pct.)	Contract construction (pct.)	Manufacturing (pct.)	Transportation, communication, & utilities (pct.)	Wholesale & retail (pct.)	Finance, insurance, & real estate (pct.)	Private services (pct.)	Total (pct.)
Minneapolis-St. Paul MSA (Ramsey and Washington):									
Ramsey	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	2.0	3.6	0.0	12.1	0.0	0.0	0.0	1.1	18.8
0.01 to 0.49	2.7	0.2	0.0	47.1	0.7	0.0	0.2	1.3	52.2
0.50 to 0.99	0.2	0.0	0.9	6.9	1.8	1.6	1.1	15.8	28.3
1	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7
Washington	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	1.4	3.4	0.0	1.3	0.0	0.0	0.0	1.4	7.6
0.01 to 0.49	1.6	0.4	0.0	62.7	1.1	0.9	0.5	6.0	73.2
0.50 to 0.99	1.8	0.0	0.5	2.2	1.4	0.7	0.7	10.7	18.1
1	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.1
Northeast Minnesota (Lake of the Woods and Roseau):									
Lake of the Woods	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	2.2	3.8	0.4	42.2	0.7	0.0	0.0	10.5	59.8
0.01 to 0.49	1.3	0.0	0.2	22.3	0.7	0.9	0.7	4.7	30.8
0.50 to 0.99	1.4	0.0	0.2	1.6	1.1	0.7	0.5	2.9	8.5
1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.9
Roseau	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	1.4	3.4	0.2	44.4	0.4	0.0	0.0	4.7	54.5
0.01 to 0.49	1.4	0.4	0.2	20.5	1.6	0.7	0.7	7.1	32.6
0.50 to 0.99	2.0	0.0	1.1	1.3	0.5	0.9	0.5	6.3	12.7
1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2

Source: University of Minnesota IMPLAN System

zero—just the opposite of the two northern tier counties. Thus the listings for the 0 row are not comparable because of missing industries, mostly in the two northern tier counties. The table shows, however, that in Ramsey County 81.2 percent of the total number of listed industries sell at least part of their production in the county, compared with only 45.5 percent for Roseau County. The findings suggest a general overestimation of regional purchase coefficients values in all areas, with the largest errors of estimate occurring for manufacturing in the northern tier counties. Generally manufacturing establishments in remote areas produce almost entirely for export to markets outside the area (Maki and Reynolds 1994).

The next step is a clarification of the regional purchase coefficients frequency distributions; we show frequency distributions of the estimated industry-specific multiplier values (Table 7). This distribution differs from the one for regional purchase coefficients because it includes only the industries listed for the county. The type 3 multiplier listed here is the sum of the direct and indirect effects, including the indirect effects of recycling labor earnings in the county. Thus, the larger the multiplier, the greater are the linkages to local input-supplying industries that generate the total indirect effects. Washington County has the largest proportion of industries with the highest type 3 multipliers, followed by Ramsey, Lake of the Woods, and Roseau counties. High type 3 multiplier values correlate with high regional purchase coefficients values. The type 3 multiplier values are unexpectedly large for the metropolitan commuter county, particularly for services. Most of the manufacturing industry multipliers in the core county are small, a likely possibility if core area manufacturers depend largely on intermediate input suppliers from rural areas. Large variations may occur, however. This may require additional local data to verify the ready-made estimates of regional purchase coefficients and other local conditions that affect multiplier values.

Model reformulation may be a less viable remedy for some model deficiencies than finding another modeling system that allows for price endogenous effects on local production, consumption, and investment. The classic limitations of the input-output modeling systems apply to a single period IMPLAN. Evaluating the effects of huge shifts in industry exports on the local housing market, for example, calls for a model with local capacity constraints and endogenous price responses to local housing demand or, alternatively, a series of modeling exercises with new coefficients that represent the changed economic environment. The problem focus defines the modeling system, one that incorporates the likely sector responses to the new equilibrium prices and that also meets the information needs of local and regional decision makers.

5.2 Refinements and applications

Several refinements to the preceding steps are available (Alward *et al.* 1989): (1) changing regional supply, (2) modifying industry production function, (3) editing regional purchase coefficients, and (4) controlling for induced effects once better information becomes available. Superior local knowledge warrants changing the ready-made database values in each category and the regional purchase coefficients, by

Table 7. Frequency distributions of Type 3 multiplier values for specified industry groups in selected counties, Minnesota, 1990

County and RPC	Agriculture (pct.)	Mining (pct.)	Contract construction (pct.)	Manufacturing (pct.)	Transportation, communication, & utilities (pct.)	Wholesale & retail (pct.)	Finance, insurance, & real estate (pct.)	Private services (pct.)	Total (pct.)
Minneapolis-St. Paul MSA (Ramsey and Washington):									
Ramsey	3.7	0.7	3.0	64.2	3.4	2.0	4.1	18.9	100.0
0	0.0	0.7	0.3	18.6	1.0	0.0	0.3	0.3	21.3
0.01 to 0.49	3.7	0.0	2.4	38.9	1.0	0.7	1.4	5.4	53.4
0.50 to 0.99	0.0	0.0	0.3	6.8	1.4	1.0	0.7	4.7	14.9
1	0.0	0.0	0.0	0.0	0.0	0.3	1.7	8.4	10.5
Washington	11.1	1.7	5.0	36.7	6.7	5.6	3.9	29.4	100.0
0	0.0	0.6	0.0	3.9	1.1	0.0	0.6	0.6	6.7
0.01 to 0.49	2.8	1.1	3.9	25.6	2.2	0.6	1.1	2.2	39.4
0.50 to 0.99	3.9	0.0	1.1	6.1	1.7	0.0	1.7	7.8	22.2
1	4.4	0.0	0.0	1.1	1.7	5.0	0.6	18.9	31.7
Northeast Minnesota (Lake of the Woods and Roseau):									
Lake of the Woods	21.0	1.2	8.6	11.1	9.9	11.1	7.4	29.6	100.0
0	6.2	1.2	6.2	8.6	4.9	1.2	3.7	8.6	40.7
0.01 to 0.49	14.8	0.0	2.5	2.5	4.9	4.9	2.5	11.1	43.2
0.50 to 0.99	0.0	0.0	0.0	0.0	0.0	4.9	1.2	4.9	11.1
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	4.9
Roseau	18.4	2.9	7.8	12.6	8.7	8.7	6.8	34.0	100.0
0	12.6	2.9	7.8	12.6	8.7	3.9	4.9	19.4	72.8
0.01 to 0.49	5.8	0.0	0.0	0.0	0.0	4.9	1.9	12.6	25.2
0.50 to 0.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: University of Minnesota IMPLAN System

institution, industry, or commodity. The regional purchase coefficients adjustments for an industry or institution result in the given change being applied to all commodities, by industry or by institution. Overlooked, however, is the further regionalization of the final local sales accounts and the industry margins that convert industry output from producer prices to purchaser price. This process requires detailed, regionally differentiated estimates of final product sales to households, governments, and businesses

The dominant basic industry groups usually are the dominant import-dependent industry groups. Export growth means import growth because of the corresponding increases in demand for the imported intermediate production inputs. As an area grows and diversifies, however, import replacement occurs for both intermediate inputs and final purchases. Imported finished goods and services dominate total imports in the periphery of an economic region, while imported intermediate goods and services are dominant in its core area. Again, the import dependencies of the core area contrast sharply with those of the periphery, which is a measure of the opportunities for internalizing the export trade of individual labor market areas.

The lack of capacity limits for industry expansion and the assumption of full resource use or availability, including labor, result in overestimating industry production response to demand changes. Fixed price multipliers add to this problem by overestimating the multiplier effects and underestimating the substitution effects of exogenous changes (Koh, Schreiner, and Shin 1994). Also the current modeling system sidesteps the issue of the effects of commuting on the induced effects of a demand change by introducing estimates of local personal consumption expenditures and employment associated with the demand change as proxies for both the resident and nonresident workforce employed by local industry. These attributes of input-output models ultimately result in underestimating or overestimating factor income responses to market changes.

Future IMPLAN model updates would change model structure not only by incorporating a new social accounting matrix (SAM), but also by replacing existing model features. For example, the identification of the total income payments, receipts, and expenditures, by origin and destination—whether in the given area or outside—provides a direct answer to the journey-to-work problem, subject to various errors of estimation. This feature also addresses the question of capital resource ownership at the work site. Moreover, use of three income classes of personal consumption expenditures helps account for regional differences in (1) the direct and indirect effects and (2) the induced effects of a given change in household expenditures. Differences in the distribution of total households among the three income classes, each with a unique spatial and commodity distribution of expenditures, would account for differences in direct purchases and their indirect effects on suppliers. A persistent system bias will continue to originate, however, from the estimation of industry output for each state and county based initially on U.S. output per worker ratios, adjusted to state-level estimates of gross state product and its components.

6. Summary and conclusions

This paper examines alternative approaches for extending input-output modeling for the more complete analysis of local economic growth and change and for coping with some of the difficulties faced in their integration with existing income and product accounting procedures. Ready-made models are the point of departure for this assessment of regional input-output modeling systems. The comments suggest that an adequately flexible ready-made model must allow the use of superior local data and survey-based trade coefficients in some sectors while continuing to balance the rest of the sectors in an unbiased manner. System effectiveness requires not only a flexible model, but also one that invites the use of superior local information and provides the user manuals and workshops to facilitate this process. Continuing in this spirit of constructive criticism we address two sets of concerns that affect the credibility of input-output model forecasts and impact assessments: system bias and specification error. We combine the comparisons of model results with an examination of the overall framework for model construction and application.

We use the millwork manufacturing industry as a case study. We estimate the total millwork market and the total millwork production in each labor market area. We compare excess production (that is, gross shipments to markets outside the local area) with the total demand for this product in each of the economic regions, starting with the Minneapolis-St. Paul economic region. The total demand for intermediate inputs is partitioned between local sources and imports from sources outside the local production area. The supply sources of other inputs are similarly identified, given information provided by the University of Minnesota IMPLAN System and the millwork companies. The primary inputs—labor, capital, and entrepreneurship—we find are entirely local, including the workers commuting to their respective production sites, largely from adjacent counties in the same labor market area. We show, finally, the results of overestimating the local use of exported products and underestimating the level of imports.

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