METHODOLOGY PAPER: DEVELOPING SQUARE U.S. INPUT-OUTPUT TABLES FROM B.E.A. MAKE AND USE TABLES

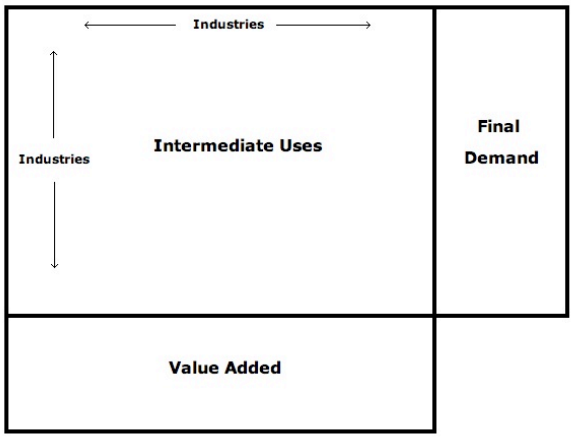
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The Chamberlain Economics, L.L.C. U.S. Input-Output Tables are based on data from the 2002 benchmark input-output accounts from the U.S. Bureau of Economic Analysis.[1] This memo outlines the methodology and data sources used to develop the tables.

Rather than producing traditional "square" input-output tables, the U.S. Bureau of Economic Analysis (BEA) produces rectangular "use" and "make" tables. That is, BEA's tables have different numbers of industries and commodities. The "make" table presents data on the commodities produced by each industry, while the "use" table shows which commodities are used as productive inputs by industries, consumers, government and the rest of the world.

By contrast, traditional input-output tables used in Leontief economic models are square industry-by-industry tables, with the same number of rows and columns—one for each industry, which is assumed to produce one product. Figure 1 illustrates the conceptual structure of the square input-output table. The table consists of three distinct elements: (1) a square "intermediate uses" section; (2) a rectangular "final demand" section; and (3) a rectangular "value added" section. We discuss the derivation of each section below.

FIGURE 1. CONCEPTUAL STRUCTURE OF THE INPUT-OUTPUT TABLE



Source: Chamberlain Economics, L.L.C.

[1] See U.S. Bureau of Economic Analysis, "Benchmark Input-Output Accounts," available at http://bea.gov/industry/io_benchmark.htm.

BEA releases benchmark input-output data every five years. The most recent data are for 2002, and are available in three levels of detail: sector (15 sectors), summary (133 industries) and detailed (426 industries). Chamberlain Economics, L.L.C. offers U.S. input-output tables at the summary and detailed level. However, the following method can easily be applied to sector-level tables as well.

A. ADJUSTMENTS TO BEA DATA

Before BEA's "make" and "use" tables can be merged into a square input-output table, three adjustments must be made to the raw data. First, any industries coded with alphabetic letters (rather than purely numeric 6-digit codes) must be recoded to create a consistent numerical ordering of industries. This assures that as industries are sorted into an industry-by-industry matrix by statistical or database software, the ordering of row industries will match that of column industries.

Second, rows labeled "non-comparable imports" and "ROW adjustment" in the "use" table must be removed from the table. These figures represent statistical adjustments by BEA to reflect commodities produced overseas that are used in U.S. production. Thus, because there is no domestic industry that produces these items, they must be removed from the "use" table before industry-by-industry relationships can be estimated.

Finally, rows labeled "scrap" and "used and second-hand goods" in the "use" table must be merged into the other row commodities in the table. These items do not correspond to a specific commodity group, instead representing ancillary sales of scrap and used items from a variety of products. Before an industry-by-industry table can be derived, these data must be attributed to specific row commodities. We merge these data proportionally into the other categories of row commodities utilized by column industries. That is, for each column industry, their use of scrap and used goods is distributed proportionally among all other commodities purchased by them as intermediate inputs.

B. BUILDING THE INPUT-OUTPUT TABLE

Using the adjusted "make" and "use" tables described above, we can construct the three components that make up the U.S. input-output table: (1) intermediate uses, (2) final demand, and (3) value added.[2]

[2] In constructing the square input-output table, we follow what is known as the "industry technology" assumption to avoid the possibility of negative entries in the table. For more information on this approach, see Jiemin Guo, Ann M. Lawson, and Mark A. Planting, "From Make-Use to Symmetric I-O Tables: An Assessment of Alternative Technology Assumptions," *U.S. Bureau of Economic Analysis Working Paper WP2002-03* (October 2002).

INTERMEDIATE USES

We begin with the "make" table, which is an *n x m* matrix of the *m* column commodities produced by each of the *n* row industries. Label this matrix "M." Also let *z* be an *m x 1* vector of total outputs for each of the *m* commodities. We construct a new table $N = M \cdot \hat{z}^{-1}$, where $\hat{z}$ is an *m x m* matrix with the elements of *z* along the main diagonal and zeros elsewhere. The elements of *N* are simply the elements of the make table divided by their column totals. This is an *n x m* matrix showing for each the *m* column commodities what percentage is produced by each of the *n* row industries. This is sometimes referred to the "market share" matrix.

Moving on to the "use" table, label the intermediate uses portion of the table be *U*. This is an *m x n* matrix of *m* row commodities that are used by each of the *n* column industries as intermediate inputs. The intermediate uses portion *Z* of the input-output table is then calculated by multiplying *Z = N*U*, as defined above. The resulting *Z* matrix will be an *n x n* array showing how the output of each *n* row industry is used as a productive input by each *n* column industry.[3]

FINAL DEMANDS

Next we calculate the final demands portion of the table. This section shows the amount of output from each row industry that is consumed as final demand by consumers, governments and the rest of the world. In the "use" table, label the *m x k* final demands portion *D*. We then create a matrix *Di* by multiplying *N*D*. This yields an *n x k* matrix of *n* industries and *k* final demands. This *Di* matrix is the final demand portion of the input-output table. We then add an *n x 1* column vector labeled *Y* on the right-hand edge of the final demands section, which sums the intermediate uses and final demand for each row industry. This vector *Y* gives total output for each row industry.

VALUE ADDED

Finally, we construct the value added section of the table. A basic accounting identity is that row totals in input-output tables must match column totals for each industry, since intermediate sales plus final demand must also equal intermediate purchases plus value added for each industry. To adjust the table to reflect this identity, we transpose total industry output vector *Y* and place it below the bottom edge of the table, forcing row industry output to equal column industry output for all industries. We then use the "Gross Operating Surplus" row in the value added section as a balancing item to equate row and column totals.

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[3] Note that the intermediate portion *Z* of the input-output table can also be estimated directly as $Z = (I - T^{-1}) \cdot \hat{y}$, where *I* is an *n x n* identity matrix, $\hat{y}$ is an *n x 1* vector of total industry outputs, and *T* is the industry-by-industry total requirements table published by the B.E.A. This expression is derived directly from the definition of the total requirements table. At the 15-industry "sector" level this method provides a close approximation to the above method. However, this method produces negative entries at the 430-industry "detailed" level due to B.E.A.'s use of a hybrid "industry" and "product" technology assumption when constructing their total requirements tables. For more detail, see Karen J. Horowitz and Mark A. Planting, "Concepts and Methods of the U.S. Input-Output Accounts," available at www.bea.gov/papers/pdf/IOmanual_092906.pdf.

The result is a square *n x n* input-output table of the U.S. economy, available from Chamberlain Economics, L.L.C. at www.chamberlaineconomics.com/data/. These tables can then be used to develop Leontief economic models for estimating geographic effects of economic policies, the carbon content of consumer products, the household impact of climate policies, and more.

FIGURE 2. SAMPLE VIEW OF THE 2002 U.S. INPUT-OUTPUT TABLE

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	2002 Detailed U.S. Input-Output Table															
2	426 Industries															
3	($ Millions)															
4			111170	111180	111200	111335	111370	111400	111910	111920	111970	111980	112120	112170	112300	112700
5	Industry Code	Description	Oilseed farming	Grain farming	Vegetable and melon farming	Tree nut farming	Fruit farming	Greenhouse, nursery, and floriculture production	Tobacco farming	Cotton farming	Sugarcane and sugar beet farming	All other crop farming	Dairy cattle and milk production	Cattle ranching and farming	Poultry and egg production	Animal production, except cattle and poultry and eggs
6	111170	Oilseed farming	$1,041	$64	$37	$6	$32	$14	$8	$7	$3	$45	$10	$11	$6	$8
7	111180	Grain farming	$352	$2,097	$76	$14	$67	$29	$52	$28	$6	$1,070	$668	$1,952	$1,903	$482
8	111200	Vegetable and melon farming	$4	$12	$550	$1	$25	$3	$0	$2	$1	$11	$2	$2	$1	$2
9	111335	Tree nut farming	$1	$4	$3	$30	$3	$1	$0	$1	$0	$4	$1	$1	$1	$1
10	111370	Fruit farming	$6	$20	$14	$3	$110	$6	$1	$3	$1	$18	$4	$4	$2	$3
11	111400	Greenhouse, nursery, and floriculture production	$2	$7	$5	$1	$4	$1,505	$0	$1	$0	$6	$1	$1	$1	$1
12	111910	Tobacco farming	$2	$7	$5	$1	$4	$2	$60	$1	$0	$6	$1	$1	$1	$1
13	111920	Cotton farming	$208	$14	$10	$2	$9	$4	$1	$295	$1	$13	$3	$3	$2	$2
14	111970	Sugarcane and sugar beet farming	$3	$8	$6	$1	$5	$2	$0	$1	$145	$7	$2	$2	$1	$1
15	111980	All other crop farming	$10	$351	$26	$2	$7	$5	$1	$3	$6	$369	$2,199	$6,846	$1	$1,021
16	112120	Dairy cattle and milk production	$5	$17	$12	$2	$11	$5	$1	$2	$1	$15	$45	$86	$2	$16
17	112170	Cattle ranching and farming	$38	$140	$85	$12	$57	$29	$2	$14	$9	$61	$512	$14,178	$7	$283
18	112300	Poultry and egg production	$4	$12	$8	$2	$8	$3	$1	$2	$1	$16	$2	$3	$2,981	$2
19	112700	Animal production, except cattle and poultry and eggs	$20	$87	$31	$5	$22	$11	$38	$4	$2	$51	$68	$10	$3	$1,492
20	113300	Logging	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
21	113700	Forest nurseries, forest products, and timber tracts	$0	$0	$0	$0	$0	$2	$0	$0	$0	$0	$0	$0	$0	$0
22	114100	Fishing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
23	114200	Hunting and trapping	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
24	115000	Support activities for agriculture and forestry	$632	$2,013	$1,425	$257	$1,273	$570	$85	$277	$120	$1,820	$396	$425	$248	$309
25	211000	Oil and gas extraction	$34	$125	$35	$4	$17	$44	$5	$14	$7	$112	$33	$58	$19	$21
26	212100	Coal mining	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$118	$0
27	212210	Iron ore mining	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
28	212230	Copper, nickel, lead, and zinc mining	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
29	212270	Gold, silver, and other metal ore mining	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
30	212310	Stone mining and quarrying	$21	$116	$23	$1	$7	$8	$3	$4	$3	$77	$28	$14	$6	$14
31	212320	Sand, gravel, clay, and ceramic and refractory minerals min	$0	$1	$0	$0	$0	$0	$0	$0	$0	$1	$0	$0	$0	$0
32	212390	Other nonmetallic mineral mining and quarrying	$5	$60	$4	$1	$3	$1	$0	$2	$1	$146	$7	$0	$1	$2
33	213111	Drilling oil and gas wells	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
34	213112	Support activities for oil and gas operations	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
35	213117	Support activities for other mining	$0	$1	$0	$0	$0	$0	$0	$0	$0	$1	$0	$0	$0	$0
36	221100	Electric power generation, transmission, and distribution	$186	$335	$435	$61	$286	$179	$29	$77	$57	$759	$457	$434	$306	$253
37	221200	Natural gas distribution	$18	$232	$23	$6	$29	$176	$4	$26	$7	$93	$24	$158	$112	$29
38	221300	Water, sewage and other systems	$10	$27	$19	$3	$15	$2	$0	$6	$3	$41	$1	$0	$2	$1
39	230101	Nonresidential commercial and health care structures	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

2002 Detailed Level

Source: Chamberlain Economics, L.L.C.

Questions about Chamberlain Economics, L.L.C.'s U.S. input-output tables may be directed to:

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