The *Hollowing Out* Process in the Chicago Economy, 1975–2011

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Abstract

The metropolitan economy of Chicago has experienced a significant transformation in its economic structure over the past twenty years. Using a method for extraction of input–output tables that has been described elsewhere, it has been possible to produce an economic photograph of the Chicago region, annually, for the period 1975–2011. This paper explores the nature of these structural changes through examination of the changes in the composition of the Leontief multipliers and changes in the economic landscapes interpreted through application of the multiplier product matrix. The resulting picture, at the nine-sector level of detail, reveals a hollowing out process, with intra-metropolitan dependence replaced by dependence on sources of supply and demand outside the region. Furthermore, the analysis reveals a complex internal transformation, as dependence on locally sourced manufacturing inputs is replaced by dependence on local service activities.

Introduction

A great deal is known about the ways in which the macro structure of major metropolitan economies evolve; there is a voluminous body of literature devoted to the internal spatial reorganization of businesses, people, and land use (see the excellent theoretical discussion in Fujita, 1989), but little information has been assembled and evaluated on the processes of change associated with the interaction between sectors within an economy. The present paper explores some of these issues, drawing upon a recently developed model of the Chicago metropolitan economy to provide the empirical base upon which a number of conjectures and hypotheses about intrametropolitan structural evolution could be tested.

In the next section, some of these hypotheses are developed, drawing on the small set of literature that has been oriented towards this problem. In the third section of the paper, a brief description of the Chicago model and the data extraction exercise will be reviewed. The methodology employed in the interpretation of these data will be explained in the fourth section while the empirical interpretation will follow this part. Some summary remarks and directions for future research inquiries will conclude the paper.

Metropolitan Structural Evolution in North America

General Remarks

Thompson's (1965) evolutionary approach to the development of urban areas departed from prior attempts in that the primary focus was on the *internal* structural changes that accompanied growth and development. Instead of merely charting the way in which the economy would evolve in terms of allocations of activity to primary, secondary, or tertiary categories, Thompson examined the ways in which development would be accompanied by an essential deepening of the intensity of interaction between sectors, replacing an early orientation that might be characterized as extrinsic in focus. This is not to suggest that metropolitan areas turned inwards in terms of markets for their goods and services but rather that greater *intermediation* in production characterized the structure of the economy. Greater intermediation may be considered to represent a process of in-filling that takes place in the structure of connections between sectors in an economy; the process may be manifested in the establishment of direct links between sectors where there had been no link previously or through increases in the volume of flows between sectors along established links. Increasing intermediation may also be considered to reflect a process of import substitution generated by increasing local demand surpassing a threshold that makes local production feasible. The various multiplier effects associated with increases in local production in one sector will potentially generate even more local activity in other sectors. In a series of papers, Jensen, West, and Hewings (1986, 1988) and Jensen et al. (1988) explored the evolution further at the regional level and proposed the development of a taxonomy of economies based on their economic structure as manifested in the structure of the input–output connectivity. However, their analysis and progress in this area has been hampered by a dearth of data, especially a time series of input–output tables. The spirit of this approach has been taken up recently by Markusen (1996) in her attempt to define types of industrial districts, basing the taxonomy in large part on the nature of the linkage mechanisms.

Thompson's story did not extend beyond the initial growth phases in the evolution of the urban area. Is it likely that there will be a continuation of the intensification of interaction between sectors in the economy, that is, a continuous increase in intermediation? Is it possible that there may be differential forces at work, with some sectors experiencing increases while others decrease? Will changes in the macro indicators of an economy provide some consistent signals for the interpretation of changes in the internal organization of production? These are some of the questions that provided the motivation for the present paper.

In an earlier study of the Japanese economy, Okazaki (1989) noted that the degree of intermediation in the Japanese economy had begun to exhibit evidence of decline; he referred to this process as a *hollowing out* effect. In contrast to the positive evolutionary path suggested by Thompson (1965), Okazaki noted that the level of dependence on local purchases and sales was declining in Japan; he likened the process to scooping out the inside of large fruit. The size of the fruit did not change but its density decreased—the analogy to the loss of flows between sectors within the economy. In Japan's case, Okazaki pointed to competition from South Korea, China, and Indonesia as reasons for this hollowing-out process.[1] In essence, Okazaki's findings might be displayed in figure 1; here, the evolution over time of the process of increasing complexity in an economy is presented. Note that, consistent with Thompson's ideas, the evolution is logistic, with a slow accumulation of interaction effects characterizing the early metropolitan region before a takeoff into an accelerated period of growth. As the metropolitan region reaches maturity, the deepening of the interactions slows down. It is here that, for the most part, the empirical evidence ends. In Chicago, Israilevich and Mahidhara (1991) noted that there had been an important exchange (see figure 2). At a seven-sector aggregated level, firms were becoming less dependent on sources of manufactured inputs produced in Chicago and more dependent on services that were being produced in the metropolitan region over the period 1970–90. Hence, the Chicago economy (and probably the Japanese one as well) might be experiencing an important bifurcation—with manufacturing exhibiting evidence of decline while service activities might continue to increase (as shown in figure 3). Furthermore, the apparent asymptotic properties of the distribution in figure 1 may be but one stage of a series of processes of complexity development in a metropolitan region. In fact, the parallels with economic niche development and theories of competitive exclusion of economic activities might be drawn. The obvious question facing many regions that have moved through similar phases is whether the nonmanufacturing industries will follow a similar path—and when.

Figure 1 Relationship between Complexity and Time

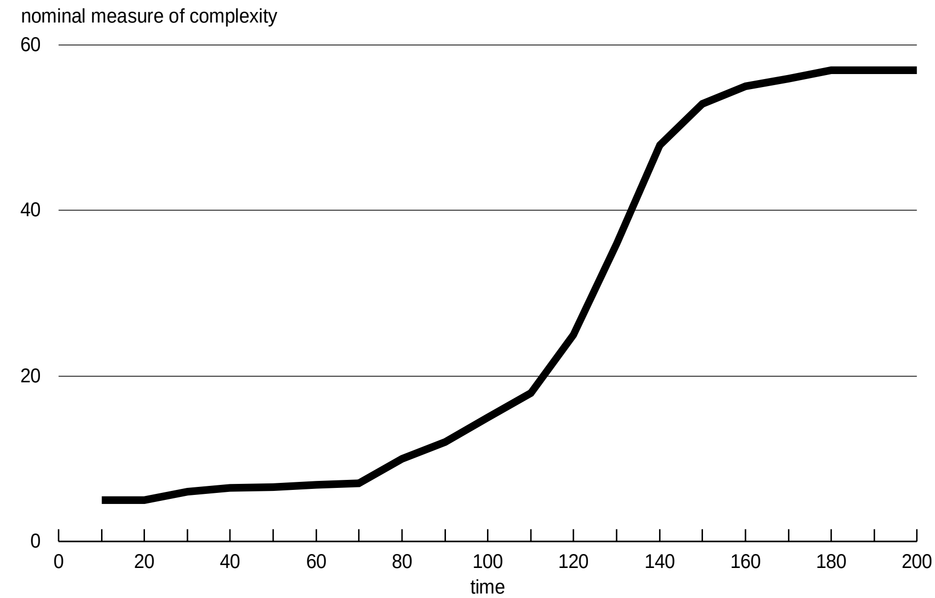


Figure 2 Changes in Consumption of Services and Manufacturing (1970s vs. 1980s)

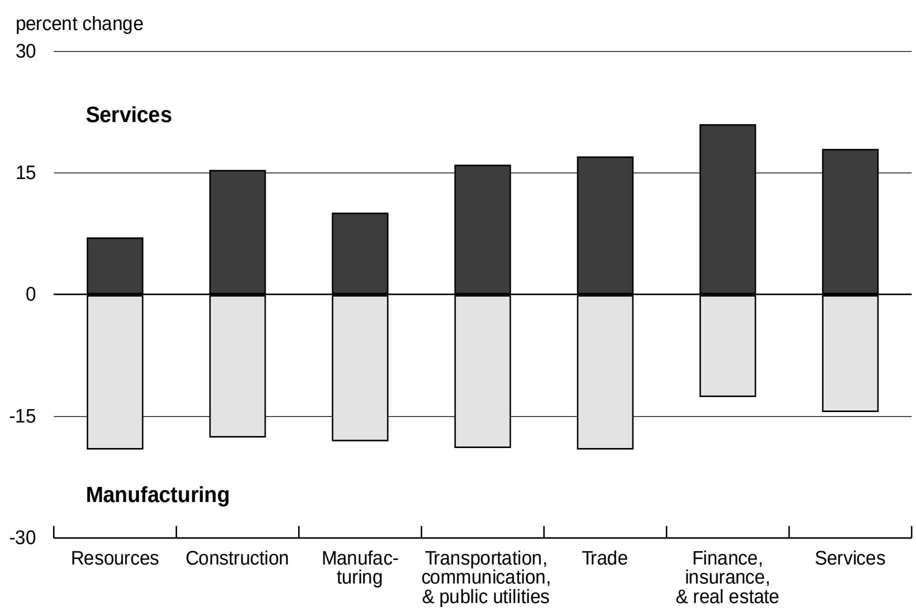
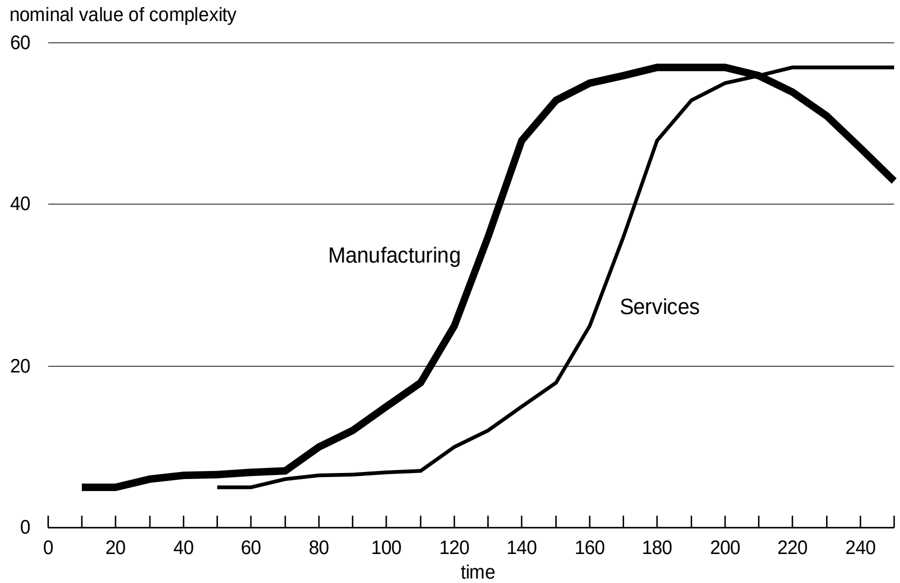


Figure 3 Complexity Changes by Major Sector



Recent work by Markusen (1996) suggested a typology of linkage structures; our sense is that the typology presented therein misses two important dimensions. First, the size of firms, and, second, the age of firms. Our research suggests that smaller firms tend to be more connected locally—both in terms of purchases of intermediate inputs and sales of output; larger firms, which tend to be part of multiestablishment (and often multiregion) enterprises, tend to be less connected with the region. Hence, the mix of firm sizes is likely to play an important part in the evolution of linkages in a region. The second issue addresses the evolutionary aspects more directly; one could claim that it is the expectation of significant local linkages that attracts firms to a region in the first place; in recent years, the labor dimension embodied in skills, training and what Israilevich et al. (1996b) have referred to as occupational capital have assumed an ever increasing role. Thus, more mature firms (maturity defined in terms of tenure in the region) may tend to weaken traditional linkage structures that attracted them to the region in the first place, replacing them, for example, with attachments to skill endowments. Unfortunately, the data are not available for the type of extensive testing of these hypotheses (see Florida, 1996, for example).

Hypothesis Development

Drawing on the limited empirical and theoretical contributions that are available, a set of hypotheses can be proposed:

> *The process of increasing intermediation in the internal interactions between sectors is likely to exhibit evidence of approaching an upper bound and this evidence will be manifested in decreases in the rates of growth or even declines in the levels of outputs in many sectors of the metropolitan economy.*
>
> *Changes in internal intermediation will not be homogeneous across all sectors.*
>
> *Macro indicators for the metropolitan economy will tend to be poor predictors of the nature and extent of internal changes in dependence.*

In the next section, a brief description will be provided of the model that was used to generate the data necessary to test the hypotheses advanced here.

The Chicago Model and the Data Extraction Process[2]

The Chicago Region Econometric Input–Output Model [CREIM] generates forecasts of the Chicago economy on an annual basis, with the forecast horizon extending up to 25 years. The model is comprised of two major components, an input–output module and an econometric module. The modeling system is one designed and implemented for the state of Washington by Conway (1990, 1991); the reader is referred to Conway's papers for more complete descriptions of the model. The input–output structure is derived from the whole system and is not a separable entity that is abstracted without reference to the rest of the economic interactions. As will be explained below, the input–output tables may be thought of as a summary visualization of the processes of structural change that would be necessary to ensure consistency in the set of macro forecasts for the Chicago economy. The model is a system of linear and nonlinear equations formulated to predict the behavior of 151 endogenous variables and consists of 123 behavioral equations, 28 accounting identities, and 68 exogenous variables. CREIM identifies 36 industries and three government sectors. For each industry, there are projections of output, employment, and earnings. Thus, out of 150 equations, only 36 relate to the linear input–output components. Many of the non-input–output equations are nonlinear and estimated in a recursive fashion (usually, incorporating autoregressive lags of order one or two). As a result, the relationships of one sector to another include the formal input–output link as well as a set of complex linkages through a chain of actions and reactions that could potentially involve the whole economy. However, the output of one industry can be related to the output of another industry; in CREIM, this is specified through first derivatives. It would be very difficult to obtain these derivatives analytically due to the nonlinearity of many of the equations and their incorporation of autoregressive components; in the solution to the model, these derivatives are calculated numerically. Then, the whole system is tested to ensure that these numerical derivatives are stable with respect to the shocks that were used in the process of estimating the derivatives.

Among the other variables depicted by the model are gross regional product, personal consumption expenditures, investment, state and local government expenditures, exports, labor force, unemployment rate, personal income, net migration, population, and the consumer price index.

The Input–Output Module

This module was constructed from establishment-level data obtained from the U.S. Bureau of the Census. Three models have been developed, based on 1982, 1987, and 1992 data. Since survey-based systems are prohibitively expensive, researchers developing regional input–output models have relied on a variety of adjustments of national-level data. There are many problems with this approach; first, for many years, the latest available U.S. national table was for 1982, and this table only appeared in mid-1991.[3] The 1987 benchmark tables appeared in April 1994. While updates have been made annually, the reliability of these updates is not known. Second, the numerical adjustment process in developing regional from national tables relies on a large number of assumptions, the most critical being the one that assumes the technology at the regional and national level is identical. Since there has been little survey work done to test this assumption, it often reverts to an assertion.[4] Preliminary analysis of the census data suggests that differences between national and regional technology may be significant.

The approach to table construction avoids many of these problems, since survey data are used to build the manufacturing portions of the tables. Because the data have already been collected by the Bureau of the Census, the tables are constructed at a fraction of the time and expense usually associated with survey-based methods. Once constructed, the input–output table reveals the linkages that exist between the sectors in the region. Thirty-six sectors were identified for Chicago—essentially, the two-digit SIC manufacturing sectors and somewhat more aggregated sectors for nonmanufacturing. While data are available at the individual establishment level, federal disclosure rules preclude the publication of data that would reveal the transactions of individual firms or would allow a reasonable estimation from the information presented.

In addition to the transactions between sectors, the table also records the purchases made from labor (wages and salaries), capital (profits and undistributed dividends), and imports from outside the state. Complementing the sales made to other sectors are sales to households (consumers), government, investment, and exports outside of Chicago. With this table one has, in essence, an economic photograph of the state of Chicago, captured at one point in time. Adding the econometric component enables the analyst to extend this photograph back in time to test the reliability of the system in tracking the changes that have been observed in the economy and to redevelop this photograph each year for the next 20 to 25 years, producing the annual forecasts.

Extracting the Input–Output Tables

The method of extracting the input–output tables is described in detail in Israilevich, Hewings, Schindler, and Mahidhara (1996). The input–output coefficients provide the endogenous mechanism that enables markets to clear. The original formulation of the system (Conway, 1990, 1991) that was utilized in Chicago equilibrates outputs demanded by both intermediate and final sectors with the supply of output. Hence, to draw on Takayama (1985), the dynamic output adjustment equation for this system of markets can be presented as:

(1) $$\dot{q} = \tilde{k}[D(q) - S(q)],$$

where both demand, *D(q)* and supply *S(q)* are expressed as functions of output and $\tilde{k}$ is the speed of adjustment of the market. The process described above may be referred to as an adjustment along the lines of a Marshallian output adjustment process (see Takayama, 1985, pp. 295ff).[5] Takayama noted that there has been some confusion about the differences between Walrasian and Marshallian adjustment processes; he notes that

> the Marshallian adjustment is better suited [for the case in which] the adjustment of output is explicitly considered. It is important to note that the Marshallian output adjustment process is ... perfectly relevant for a competitive market. (p. 299)

In CREIM, there is an underlying (though not observed) price adjustment process, but the operation of the model focuses on the market-clearing quantity adjustment mechanisms. Hence, the system shares more of a Marshallian character in the terms defined by Takayama. Since regional price differentials for goods and services are generally unavailable, Marshallian equilibrium adjustment is easier to model than a Walrasian process.

From this system of extraction, input–output tables for the period 1975–2011 can be derived; these tables reflect the dynamics of changes in the region's economy and thus may be thought of as reflecting the changes in the region's internal complexity. In the next section, a set of methods used to interpret these data and their changes will be described.

Analytical Methods for Comparison

Two general approaches are adopted here; one uses the concept of a multiplier product matrix to reveal the general economic landscape of the Chicago region's economy. The second method examines the finer structure of linkages by exploiting the notions of self- and non-self-induced changes. The two methods are introduced below. The focus of attention will be on the changes in the level of intermediate flows, $Z_t = A_t \hat{X}_t t = 1975,..., 2011$, where Z_t is an *n* x *n* matrix of intermediate flows in constant 1987 dollars, A_t is the *n* x *n* matrix of input coefficients, and $\hat{X}_t$ is a diagonal matrix of total outputs as well as changes in the A_t matrix itself.

The Multiplier Product Matrix[6]

The definition of the multiplier product matrix is as follows: let $A = \|a_{ij}\|$ be a matrix of direct inputs in the usual input–output system, let $B = (I - A)^{-1} = \|b_{ij}\|$ be the associated Leontief inverse matrix and let $B_{\bullet j}$ and $B_{i\bullet}$ be the column and row multipliers of this Leontief inverse. These are defined as:

(2) $$B_{\bullet j} = \sum_{i=1}^{n} b_{ij}, \quad B_{i\bullet} = \sum_{j=1}^{n} b_{ij}.$$

Let V be the global intensity of the Leontief inverse matrix:

(3) $$V = \sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}.$$

Then, the input–output multiplier product matrix (MPM) is defined as:

(4) $$M = \frac{1}{V}\left\|B_{i\bullet} B_{\bullet j}\right\| = \frac{1}{V}\begin{pmatrix} B_{1\bullet} \\ B_{2\bullet} \\ \vdots \\ B_{n\bullet} \end{pmatrix}\left(B_{\bullet 1}\ B_{\bullet 2}\ \cdots\ B_{\bullet n}\right) = \left\|m_{ij}\right\|.$$

The properties of the MPM will now be considered in the context of the hierarchy of backward and forward linkages and their economic landscape associated with the cross-structure of the MPM.

Economic Cross-Structure Landscapes of MPM and the Rank-Size Hierarchies of Backward and Forward Linkages

The concept of key sectors is based on the notion of backward and forward linkages and has been associated with the work of both Rasmussen (1956) and Hirschman (1958). The major thrust of the analytical techniques, and subsequent modifications and extensions, has been towards the identification of sectors whose linkages structures are such that they create an above-average impact on the rest of the economy when they expand or in response to changes elsewhere in the system Rasmussen proposed the following two types of indices, drawing on entries in the Leontief inverse.

1. Power of dispersion for the backward linkages, BL_j, as follows:

(5) $$BL_j = \frac{1}{n}\sum_{i=1}^{n} b_{ij} \Big/ \frac{1}{n^2}\sum_{i,j=1}^{n} b_{ij} = \frac{1}{n}B_{\bullet j} \Big/ \frac{1}{n^2}V = B_{\bullet j} \Big/ \frac{1}{n}V.$$

2. The indices of the sensitivity of dispersion for forward linkages, FL_i, as follows:

(6)
$$FL_i = \frac{1}{n}\sum_{j=1}^{n} b_{ij} \Big/ \frac{1}{n^2}\sum_{i,j=1}^{n} b_{ij} = $$
$$= \frac{1}{n} B_{i\bullet} \Big/ \frac{1}{n^2} V \ .$$

The usual interpretation is to propose that $BL_j > 1$ indicates that a unit change in final demand in sector *j* will create an above-average increase in activity in the economy; similarly, for $FL_j > 1$, it is asserted that a unit change in all sectors' final demand would create an above-average increase in sector *i*. A key sector, *K*, is usually defined as one in which both indices are greater than 1. It should be noted here that similar ideas were developed by Chenery and Watanabe (1958) for the definition of backward and forward linkages based on the matrix of direct inputs, $A = \|a_{ij}\|$

The definitions of backward and forward linkages provided by equations 5 and 6 imply that the rank-size hierarchies (rank-size ordering) of these indices coincide with the rank-size hierarchies of the column and row multipliers. It is important to underline in this connection that the column and row multipliers for MPM are the same as those for the Leontief inverse matrix:

(7)
$$\sum_{j=1}^{n} m_{ij} = \frac{1}{V}\sum_{j=1}^{n} B_{i\bullet} B_{\bullet j} = B_{i\bullet}$$

$$\sum_{i=1}^{n} m_{ij} = \frac{1}{V}\sum_{i=1}^{n} B_{i\bullet} B_{\bullet j} = B_{\bullet j} \ .$$

Thus, the structure of the MPM is essentially connected with the properties of sectoral backward and forward linkages.

The structure of the matrix, *M*, can be ascertained in the following fashion: consider the largest column multiplier, $B_{\bullet j}$, and the largest row multiplier, $B_{i\bullet}$, of the Leontief inverse. Then, the element, $m_{i_0 j_0} = \frac{1}{V} B_{i_0\bullet} B_{\bullet j_0}$, located in the place (i_0, j_0) of the matrix, *M*, will be the largest element in *M*. Moreover, all rows of the matrix, *M*, are proportional to the i_0^{th} row, and the elements of this row are larger than the corresponding elements of all other rows. The same property applies to the j_0^{th} column of the same matrix. Hence, the element located in (i_0, j_0) defines the center of the largest *cross* within the matrix, *M*. If this cross is excluded from *M*, then the second-largest cross can be identified and so on. Thus, the matrix, *M*, contains the rank-size sequence of crosses. One can reorganize the locations of rows and columns of *M* in such a way that the centers of the corresponding crosses appear on the main diagonal. In this fashion, the matrix will be reorganized in such a way that a descending *economic landscape* will be apparent.

This rearrangement also reveals the descending rank-size hierarchies of the Hirschman-Rasmussen indices for forward and backward linkages. Inspection of that part of the landscape with indices > 1 (the usual criterion for specification of key sectors) will enable the identification of the key sectors. However, it is important to stress that the construction of the economic landscape for different regions or for the same region at different points in time would create the possibility for the establishment of a taxonomy of these economies. Moreover, the superposition of the hierarchy of one region on the landscape of another region provides a clear visual representation of the similarities and differences in the linkage structure of these regions (see Sonis, Guo, and Hewings, 1996, for an application to Chinese urban areas).

Inner Structure of Column and Row Multipliers

While the applications of the MPM method will reveal some of the macro-level changes in the structure of the economy, it will be important to examine the finer structure of changes. For example, if a sector's multiplier value increases or decreases, how are the relative shares accounted for by supplying sectors changing, and would it be reasonable to assume that the relative rankings would also remain the same? The fine structure can be analyzed by viewing both row and column components on the Leontief inverse matrix.

In this application, attention was focused on the ordinal rankings of the elements of the row and columns of the Leontief inverse net of the initial injection:

(8) $$[B(t)-1]\ .$$

Furthermore, the relative contributions of each element was evaluated:

(9) $$[b_{ij}(t)/B_{\bullet j}(t)] \quad \text{or} \quad [b_{ij}(t)/B_{i\bullet}(t)] \quad \forall i,j,t\ .$$

Notions of Self- and Non-Self-Changes

Each component of the change in gross output in sector *i* can be divided into two parts, the *self-* and *non-self-generated changes*; in the former case, the change in output can be traced to changes in the sector itself (i.e., a final demand or technological change), while in the latter case the change occurs in another sector. Empirical evidence suggests that the allocation between these two components can be rather varied across sectors. The notions were used here to explore the time paths of dependence of changes of each sector on forces originating within the sector and those originating outside the sector.

The definition of the parts, where *s* refers to self-generated and *ns* as non-self-generated, is as follows:

(10) $$s_{j(I)} = b_{it} - 1;\ \ ns_{j(I)} = B_{\bullet j} - 1 - s_{j(I)}$$

$$s_{i(o)} = b_{it} - 1;\ \ ns_{i(o)} = B_{i\bullet} - 1 - s_{j(o)}\ ,$$

where $s_{j(I)}$, $ns_{j(I)}$, $s_{i(0)}$, and $ns_{i(o)}$ refer to a unit change in inputs generated within the sector *j*, a unit change in the rest of the sectors (non-self), and unit changes in outputs generated within sector *i* and in the rest of the sectors.

Moreover, the relative self- and non-self-generated output change may be given by:

(11)
$$\begin{cases} ps_{j(I)} = \dfrac{s_{j(I)}}{s_{j(I)} + ns_{j(I)}} \\ pns_{j(I)} = \dfrac{ns_{j(I)}}{s_{j(I)} + ns_{j(I)}} \end{cases},$$

where $ps_{j(I)}$, and $pns_{j(I)}$ are the percentages of self- and non-self-generated total inputs; similar definitions would apply to the proportions of output accounted for the self- and non-self components. Of course, it would be possible to further decompose these changes into those associated with coefficient changes and those with final demand changes as well as to a synergetic interaction factor (see Sonis, Hewings, and Guo, 1996)

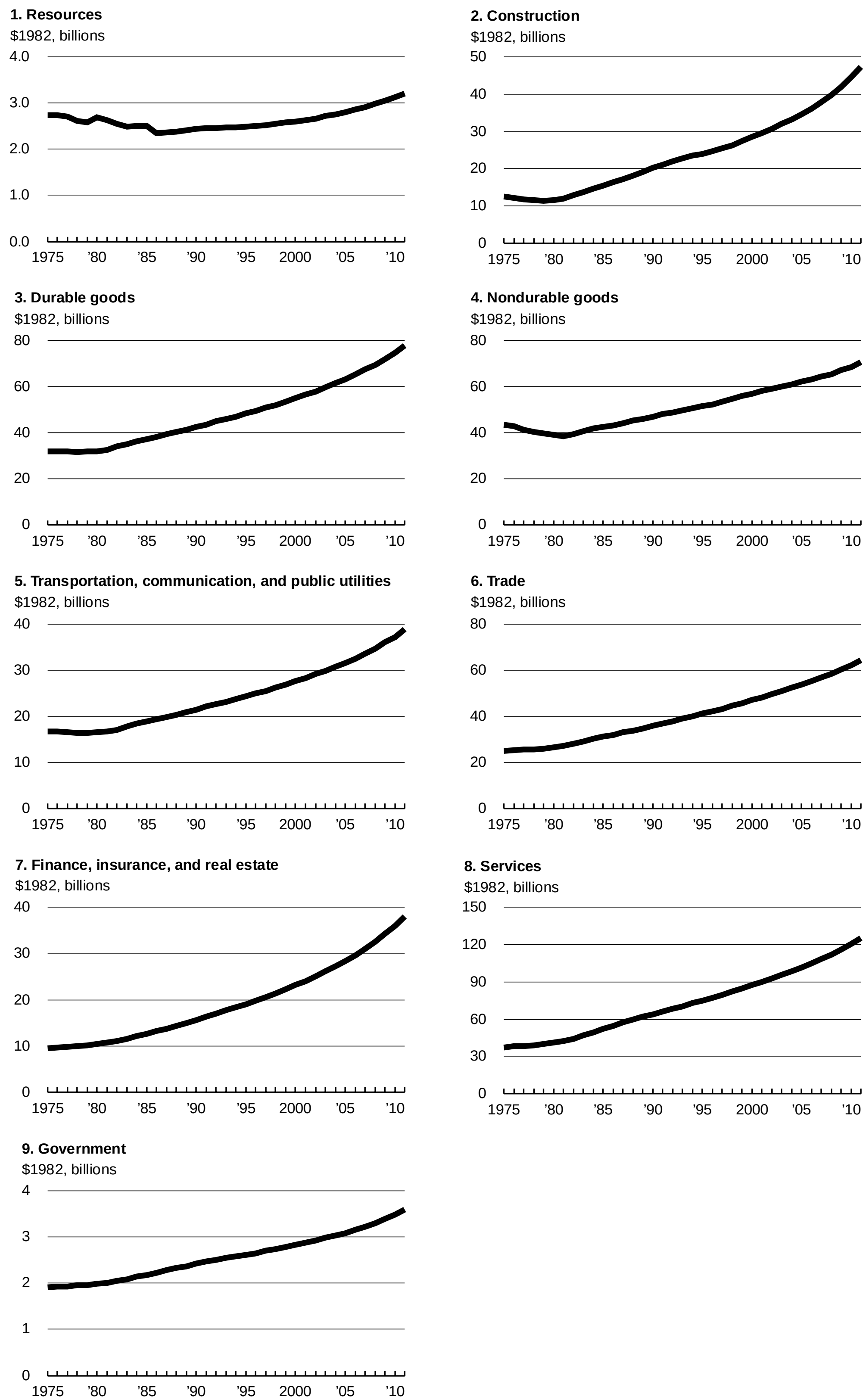
Empirical Interpretation

Although the Chicago input–output tables that were extracted from CREIM were available at the 36-sector level of detail, for purposes of this exposition the sectors were collapsed into nine categories. In the first part of the analysis, attention was directed at more macro-level changes in the structure. Figure 4 shows the levels of output (in $1982 constant) for each of the nine sectors over the period 1975–2011; all sectors are forecasted to grow in real terms, although the rate of growth varies significantly from modest increments in the resources sector (1) to substantial changes in trade (6) and finance, insurance, and real estate (FIRE)(7). While the economy is expected to grow in real terms, this information provides an indication about potential changes in the structure of interdependencies.

Table 1 shows the rankings of each sector based on forward and backward linkages. The transformation of the economy becomes evident; note that nondurable manufacturing (sector 4) is the first ranked sector in terms of backward linkages until the year 2000, when its position in usurped by services, which has moved up from rank 3 in 1975. With some minor exchanges, the remaining backward linkage rankings are relatively stable. There are more significant changes in the forward linkages; while government's role (sector 9) remains unchanged, construction drops from the second rank to the seventh rank by 1995. On the other hand, nondurable manufacturing moves up from the sixth rank to the third rank by 2005. The services sector moves from rank four to three to five and then to six over the period 1975–95.

The story thus far reveals an economy that is growing in absolute terms but there appears to be some reorganization of the internal structure of production. Tables A1 and A2 in the appendix detail the changes in the structure of individual input and output direct and indirect coefficients based on equation 8. The results reveal some very different patterns of change at the level of individual coefficients. Consider the resources sector (1): here, the dominant input (nondurable manufactur-

Figure 4 Output by Sector for Chicago, 1975–2011



Note: Data for 1992 on are projections.
Source: Calculations by authors.

Table 1 Chicago's Backward and Forward Linkage Hierachy, 1975–2011

Backward

Rank	1975	1980	1985	1990	1995	2000	2005	2010
1	4	4	4	4	4	8	8	8
2	3	3	3	8	8	4	3	4
3	8	8	8	3	3	3	4	3
4	5	5	5	2	2	2	2	2
5	6	6	2	5	5	5	5	5
6	2	2	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7
8	9	9	9	9	9	9	9	9
9	1	1	1	1	1	1	1	1

Forward

Rank	1975	1980	1985	1990	1995	2000	2005	2010
1	9	9	9	9	9	9	9	9
2	2	2	2	1	1	1	1	1
3	6	8	8	6	5	5	4	4
4	8	6	6	2	6	4	5	6
5	5	5	5	8	4	6	6	5
6	4	4	4	5	8	8	8	8
7	3	3	1	4	2	2	2	2
8	7	1	3	3	3	3	3	3
9	1	7	7	7	7	7	7	7

Note: See figure 4 to determine sector numbers.
Source: Calculations by authors.

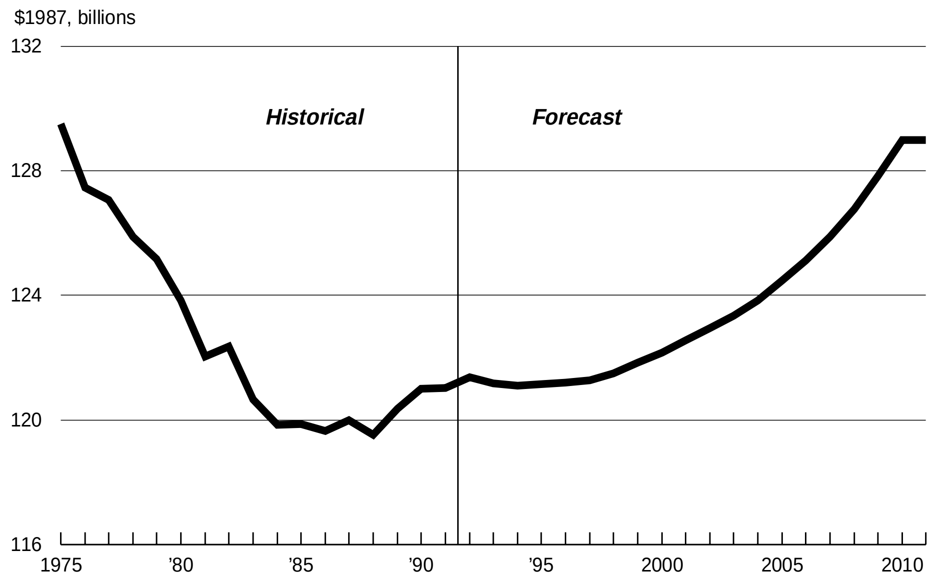
ing) is declining in importance and is replaced by durable manufacturing (3) and then by construction (2), but the overall trend is for the dominant input to decline from 23% of total inputs to less than 20%. Furthermore, the overall multiplier (shown in the *total* column) declines from 2.523 to 1.743 between 1975 and 2010. For the construction sector (2), the proportion of total inputs accounted for by the dominant input changes very little (a small decline from 29% to 28%) and the same sector is involved. For durable manufacturing (3), the dominant sector increases from 25% to

35% and remains the same—in this case an intrasectoral input. Nondurable manufacturing has a similar dominant self-dependency but this dominance is declining over time (29% to 24%). Sector 5 (transportation) exhibits little change although there are some exchanges in the identification of the dominant input. Sector 6 (trade) reveals a small increase and an exchange of dominant inputs, whereas sector 7's dominant input moves in the opposite direction while also experiencing some changes. Sector 8 (finance, insurance, and real estate) behaves rather like sector 2 (little change in dominance by percentage and nonchange by location), while sector 9 (government) declines and then increases and changes the location of the dominant sector. A similar variety of patterns can be found for the row entries.

Hence, the exchange in rankings needs to be considered as an exchange taking place for shares of a total that is shrinking over time. Does the volume of intermediate flows follow this monotonic decline evidenced by these coefficients? Figure 5 provides the answer; the hollowing-out process began in the first year of the model's calibration and is expected to continue until the turn of the century. The upturn might suggest some transformation of the economy; however, when the volume of intermediate flows is compared with total output for all sectors (figure 6), one can immediately appreciate that in relative terms the hollowing-out process is projected to continue throughout the projection period. The simple correlation between the two series in figure 6 is 0.51. Figures 7 and 8 provide graphical presentations of intermediate inputs and outputs by sector. It can be clearly seen that there are some important differences, reflective of the findings highlighted in figure 2. For intermediate inputs, construction, TCPU, trade, and government follow paths similar to the overall economy (shown in figure 5); manufacturing, both nondurable and durable, evidence a trend that continues downward sloping. In fact, for both manufacturing sectors combined, the simple correlation between intermediate inputs and total output for all sectors is 0.19. Both FIRE and services reveal a positive trend in inputs, a trend that is also reflected in intermediate outputs (figure 8). However, the other output patterns do not mirror those for the input inside. Note the differences in nondurable and durable manufacturing, with the latter revealing a 'U'-shaped pattern while the latter follows a slight downward sloping demand for its outputs.

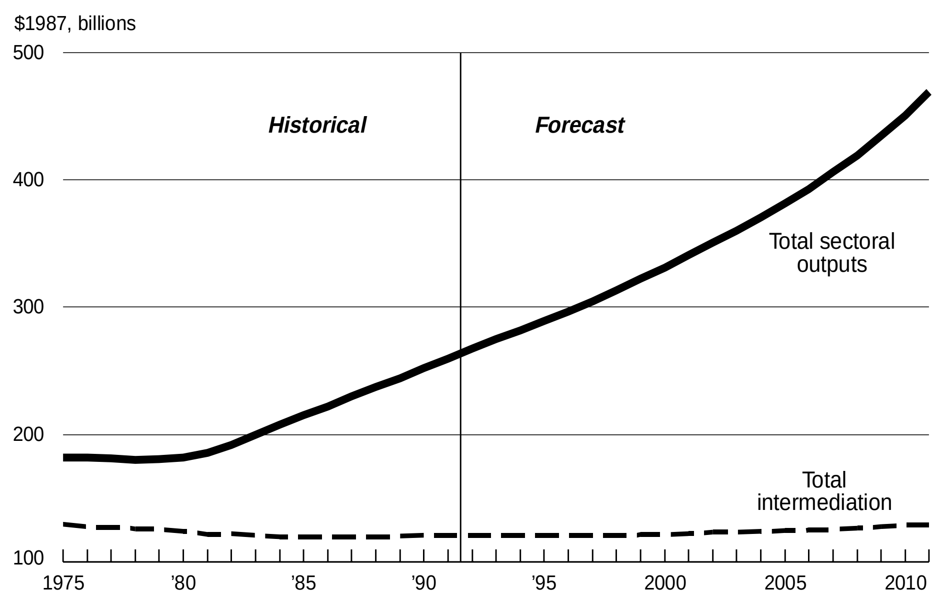
Figures 9, 10, and 11 provide some additional perspectives. Figure 9 plots the annual rates of change for total output, total intermediate inputs (outputs), and intermediate inputs for selected sectors. The contrast between the behavior of the overall economy and the pattern of intermediate demands is clearly brought out, with durable manufacturing's year-to-year changes more extreme in the historical period than the other sectors that are shown. Figures 10 and 11 show the ratios of total intermediate inputs and outputs by sector. With the exception of the resource sector (a very small one in the Chicago economy), all curves trend downward with apparently few significant variations in slope.

Figure 5 Changes in Volume of Intermediate Flows, 1975–2011



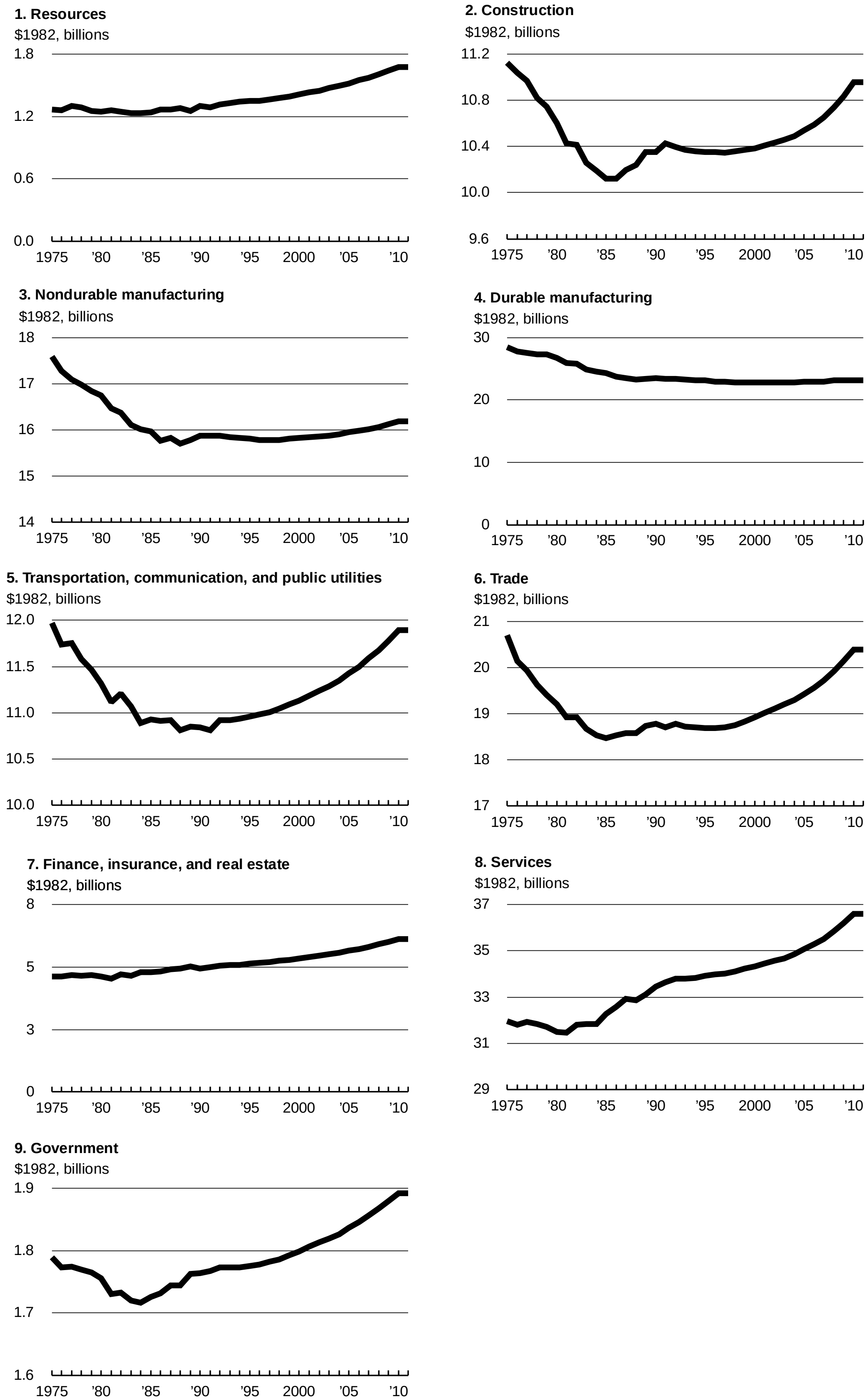
Source: Calculations by authors.

Figure 6 Relationship between Total Sectoral Outputs and Intermediation, 1975–2011



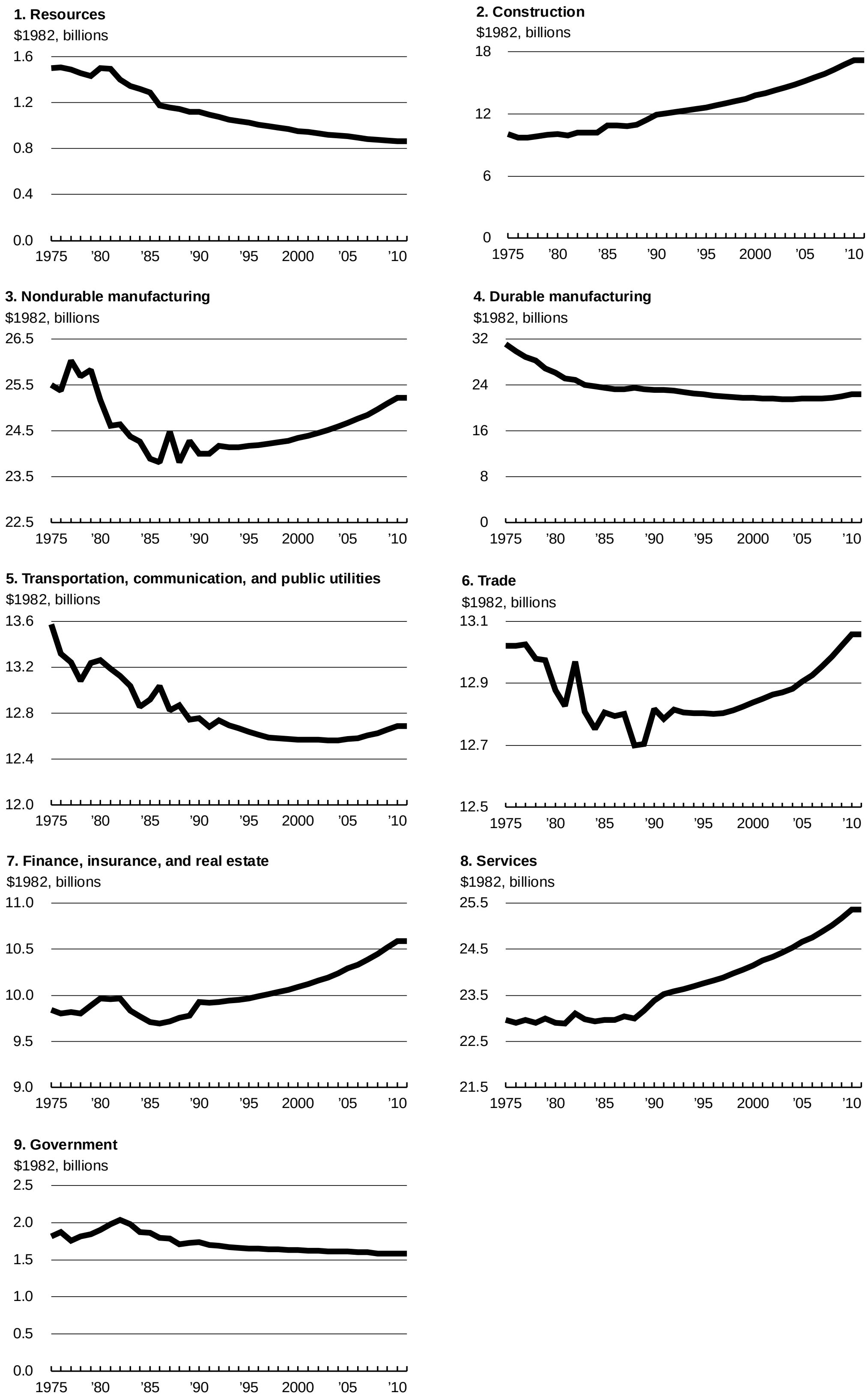
Source: Calculations by authors.

Figure 7 Changes in Intermediate Inputs



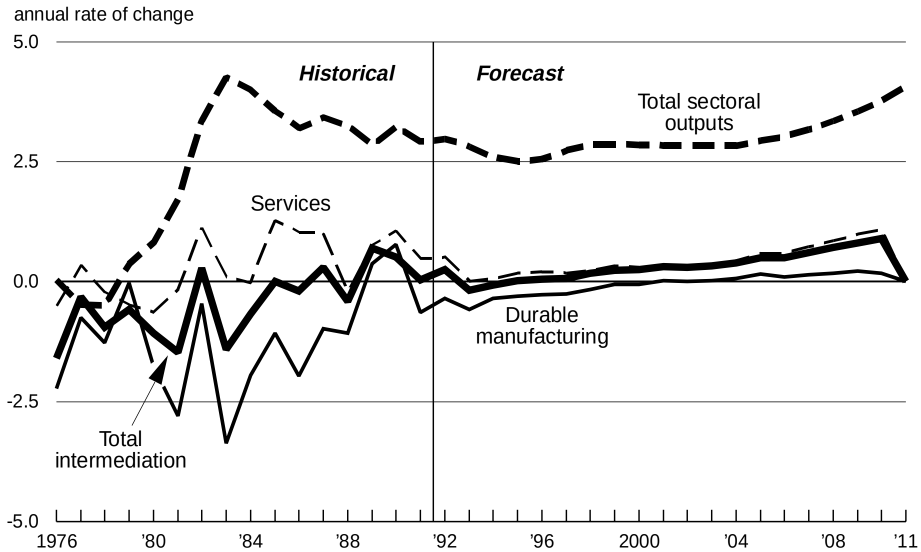
Note: Data for 1992 on are projections.
Source: Calculations by authors.

Figure 8 Changes in Intermediate Outputs



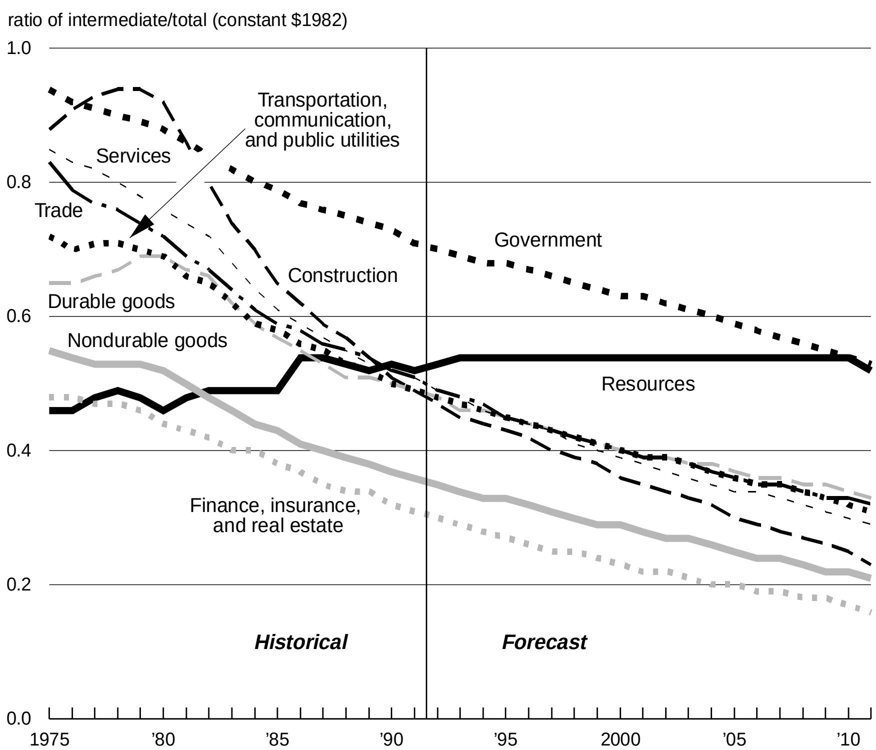
Note: Data for 1992 on are projections.
Source: Calculations by authors.

Figure 9 Rates of Change of Total Output, Total Intermediation, and Selected Sectors



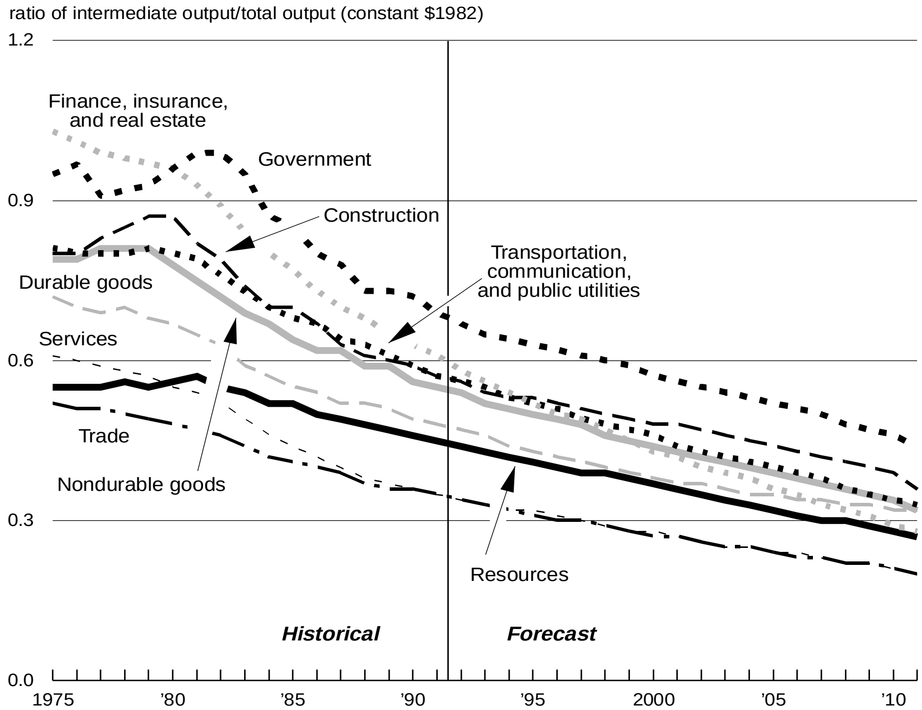
Source: Calculations by authors.

Figure 10 Ratio of Intermediate Input to Total Output by Sector



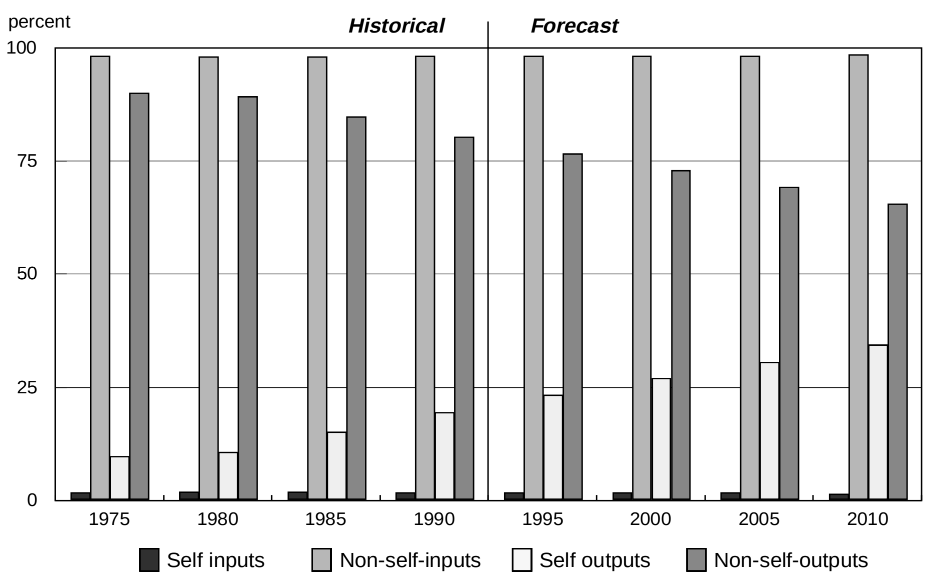
Source: Calculations by authors.

Figure 11 Ratio of Intermediation Output to Total Output by Sector



Source: Calculation by author.

Figure 12 Changes in Self- and Non-Self Dependency in Resources



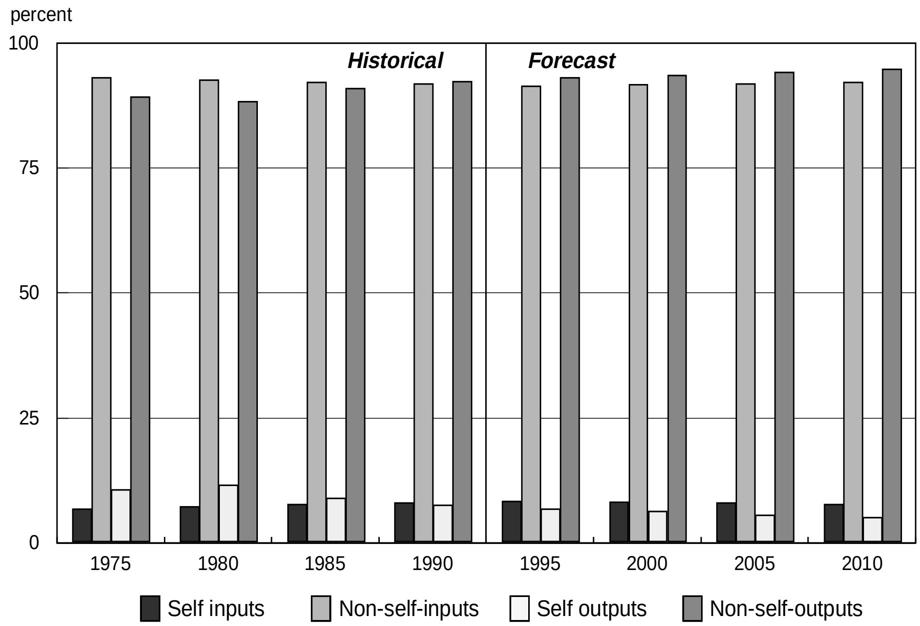
Source: Calculations by authors.

Figures 12 through 20 portray changes in the finer structure of the linkages; here the data shown in appendix tables A1 and A2 are summarized into a binary division of self- and non-self-dependency reflected in equations 10 and 11 above. The distinction enables analysts to view the degree to which exchange is changing from intra- (self) to interindustry (non-self) dependence or vice versa. In the case of resources (figure 12), there is little change in the nature of input dependency; however, over the period 1975–2010, more sales are made intraindustry rather than interindustry. In contrast, for durable manufacturing (figure 14), the output pattern is relatively stable; intraindustry inputs increase at the expense of interindustry inputs. Perhaps this reflects a trend noted by Krugman (1990) that the presence of scale economies can result in increased intraindustry trade between countries; in the limit, there is no reason why this process should not be in evidence within large metropolitan regions. In a related paper, Helpman and Krugman (1985) noted that "if intermediate goods produced with economies of scale are not tradeable, the result will be to induce the formation of 'industrial complexes'—groups of industries tied together by the need to concentrate all users of a nontradeable intermediate in the same country." Again, similar reasoning may propel the same processes at the metropolitan scale, although the reasons for limited tradability have to lie outside simple appeals to transport cost differentials. In this regard, the notion of *occupational capital* (see Israilevich, Schindler, and Hewings, 1996) provides a useful measure to help in explaining the continuance of industrial complexes that theory would suggest should have dissipated long ago.

At the same time, while trade may be concentrating in intraindustry terms for nondurable manufacturing, recall that the data in figure 10 revealed that the size of the overall input coefficient is decreasing. A typology of the self- and non-self-components of dependency can be extracted from these figures, and these are summarized in table 2.

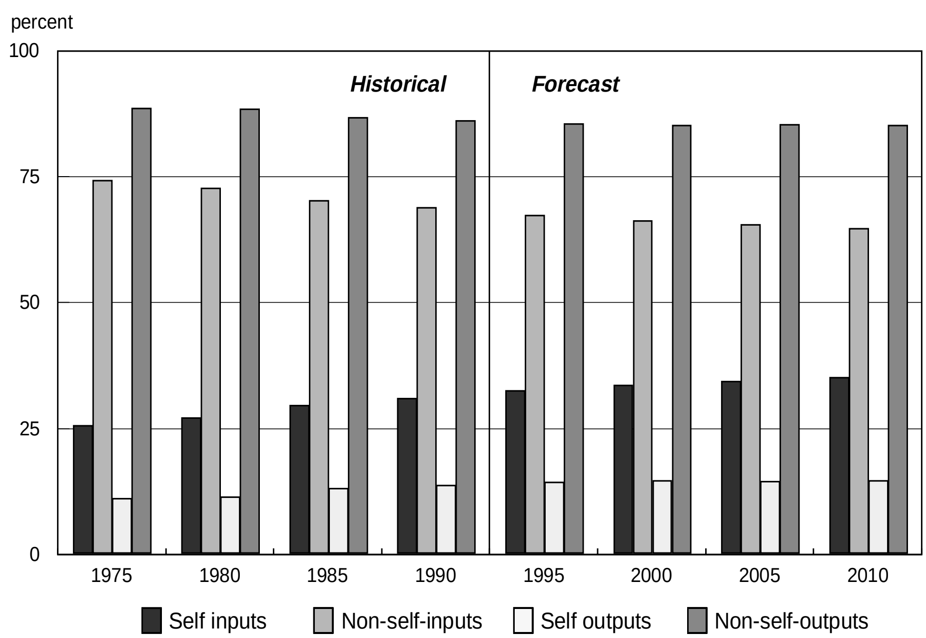
Figure 21 shows the multiplier product matrix landscapes for Chicago for the period 1975–2010. As noted in the methodology section, the landscape for any year provides an order that may be mapped into the hierarchy of backward and forward linkages. In order to facilitate comparison over time, the order for one time period is used as a numeraire; subsequent landscapes are then placed in this ordering system and changes can be visually inspected. In the present case, the order for 2010 was adopted as the numeraire; the eight landscapes, representing five-year increments in time, are shown in figure 21. The overall impact of the hollowing out process is clearly visible; the landscape shifts from one with some rather pronounced variations in relief to one that might characterize the actual physical landscape in which Chicago is located—flat! However, the five-year changes do not exhibit a monotonic process until the first decade of the next century. In part, this reflects the fact that the forecasting system, although nonlinear, tends to reflect trends rather than year-to-year business cycle fluctuations. However, the purpose of the exercise was not to focus on the detail but to capture the nature of the trends and to inspect the degree to which the macrobehavior fully reflected the behavior of individual sectors. These landscapes provide a visual summary picture of the detailed findings that were reported in the earlier figures and tables, and they especially highlight the nature of the hollowing out process as one that essentially denudes the *economic landscape*, reducing intraregional dependencies.

Figure 13 Changes in Self- and Non-Self Dependency in Construction



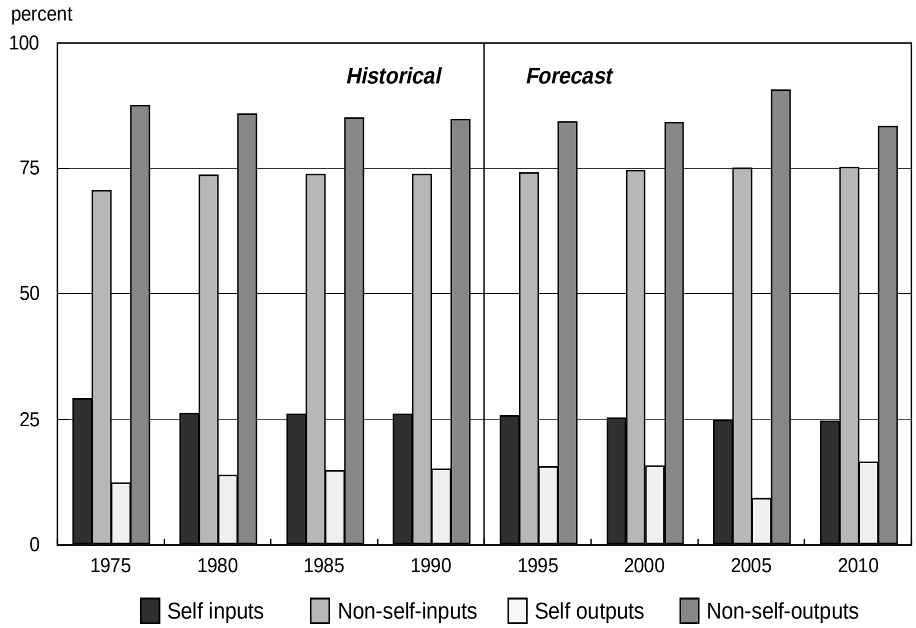
Source: Calculations by authors.

Figure 14 Changes in Self- and Non-Self Dependency in Durable Manufacturing



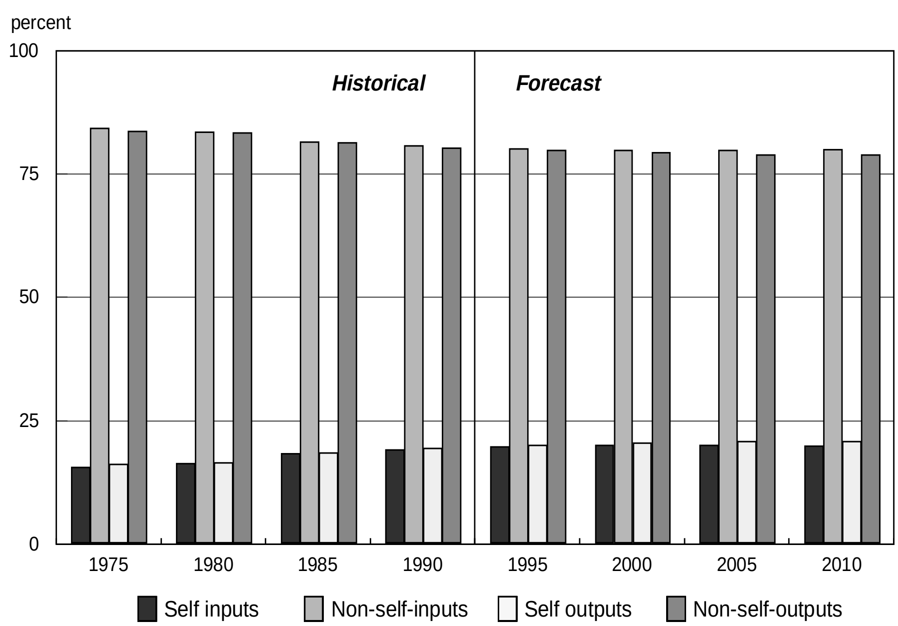
Source: Calculations by authors.

Figure 15 Changes in Self- and Non-Self Dependency in Nondurable Manufacturing



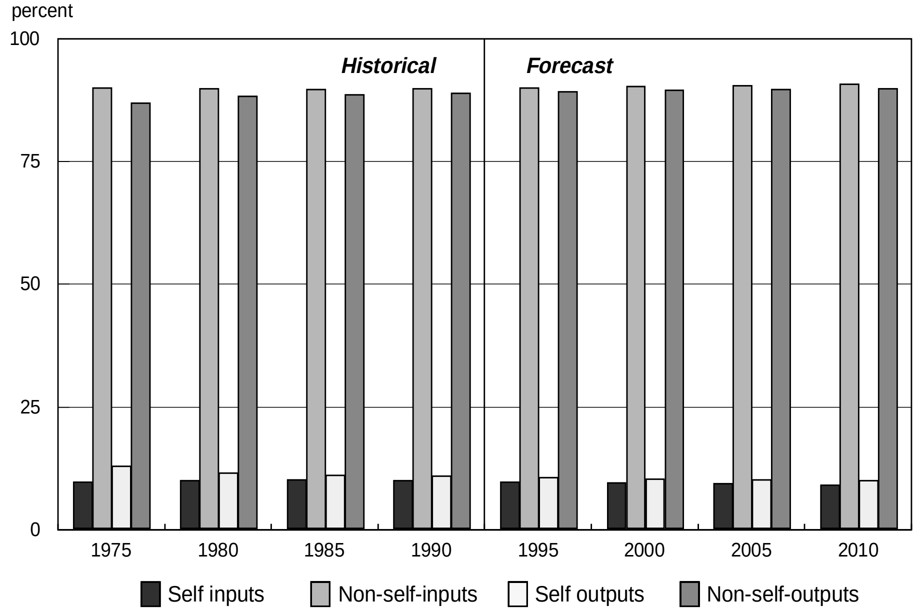
Source: Calculations by authors.

Figure 16 Changes in Self- and Non-Self Dependency in Transportation



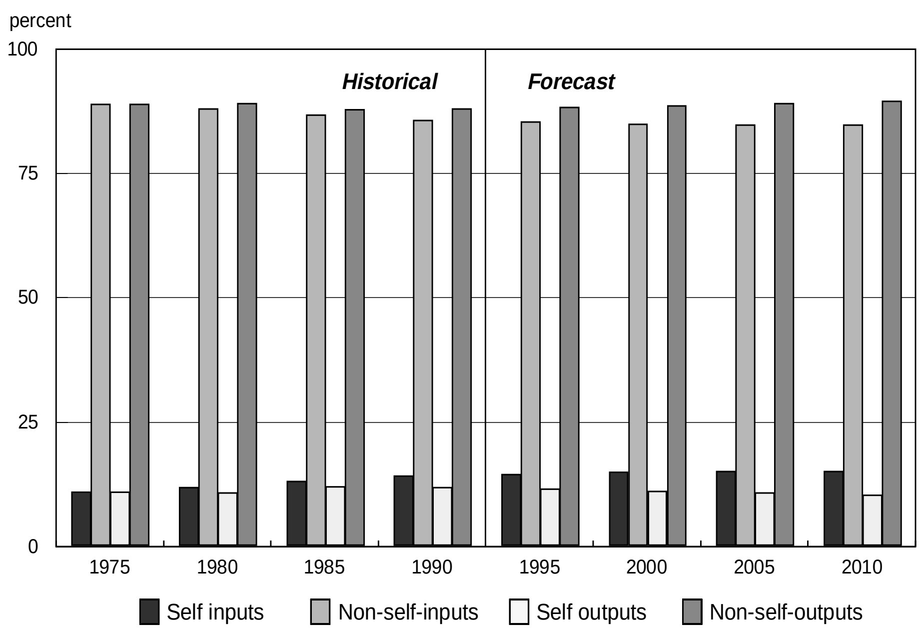
Source: Calculations by authors.

Figure 17 Changes in Self- and Non-Self Dependency in Trade



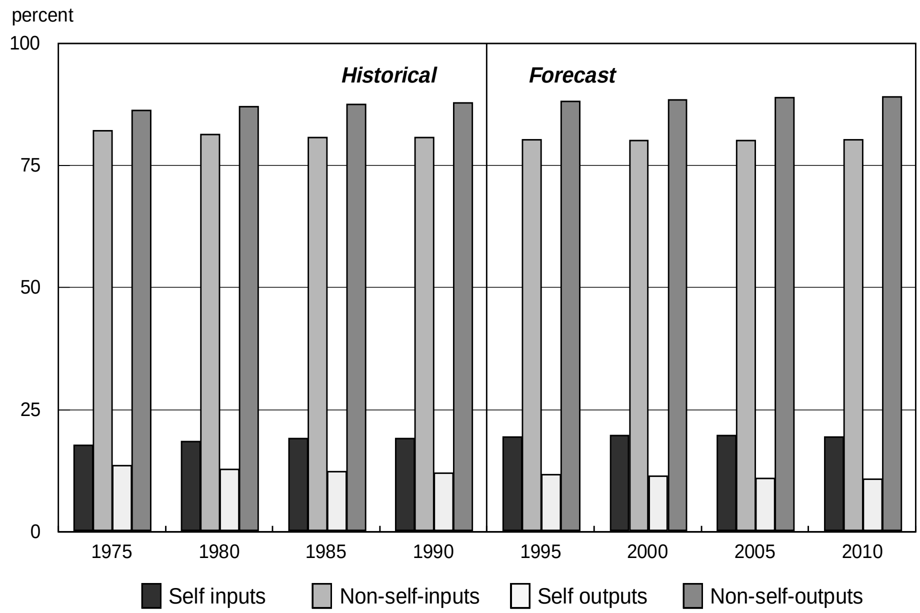
Source: Calculations by authors.

Figure 18 Changes in Self- and Non-Self Dependency in FIRE



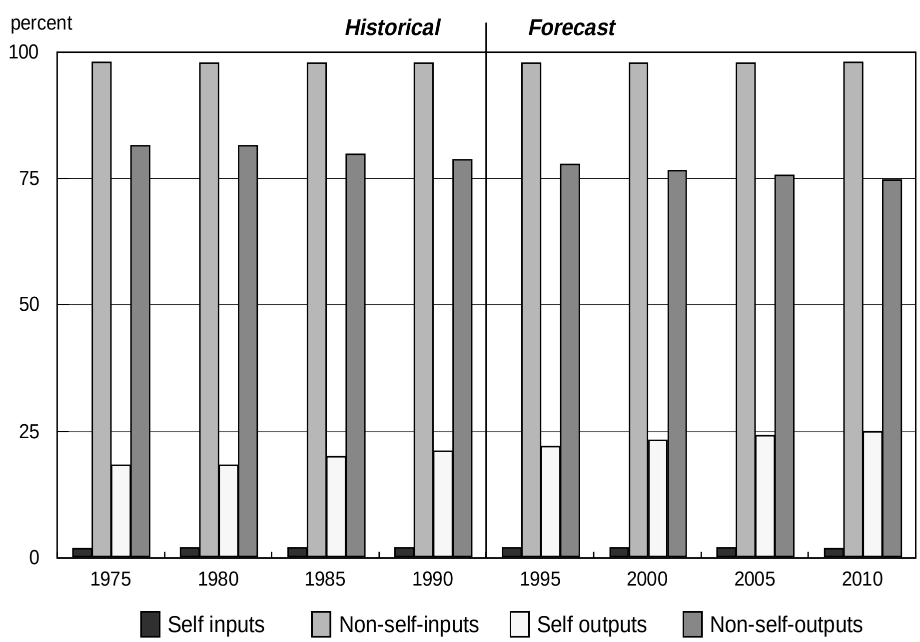
Source: Calculations by authors.

Figure 19 Changes in Self- and Non-Self Dependency in Services



Source: Calculations by authors.

Figure 20 Changes in Self- and Non-Self Dependency in Government



Source: Calculations by authors.

Recapitulation

In this penultimate section, an assessment will be made of the findings in relation to the hypotheses that were advanced.

The process of increasing intermediation in the internal interactions between sectors is likely to exhibit evidence of approaching an upper bound, and this evidence will be manifested in decreases in the rates of growth or even declines in the levels of outputs in many sectors of the metropolitan economy.

Evidence for the presence of an upper bound could not be discerned directly, but all sectors revealed a slow process of decline in the level of intermediation. In general, all the internal multipliers declined, continuing a trend that began in the late 1960s and appears to be continuing into the next century. This change has not been accompanied by declines in levels of output, however; the Chicago region has thus exchanged its prior internal dependence on intermediation for external dependence, reflecting a congruence of trends that involve the interplay of outsourcing, changes in ownership patterns, and increased intrasector specialization in the face of a general trend for regions to become more similar in terms of their macroeconomic structure.

Changes in internal intermediation will not be homogeneous across all sectors.

While all sectors decreased their levels of internal dependence, there were some important differences, reflected in large part in the dominance or lack of it of intrasectoral sales and purchases. At higher levels of disaggregation, an alternative picture might be presented but the main patterns seem to be evidence of some important distinctions in the reorganization of production relationships.

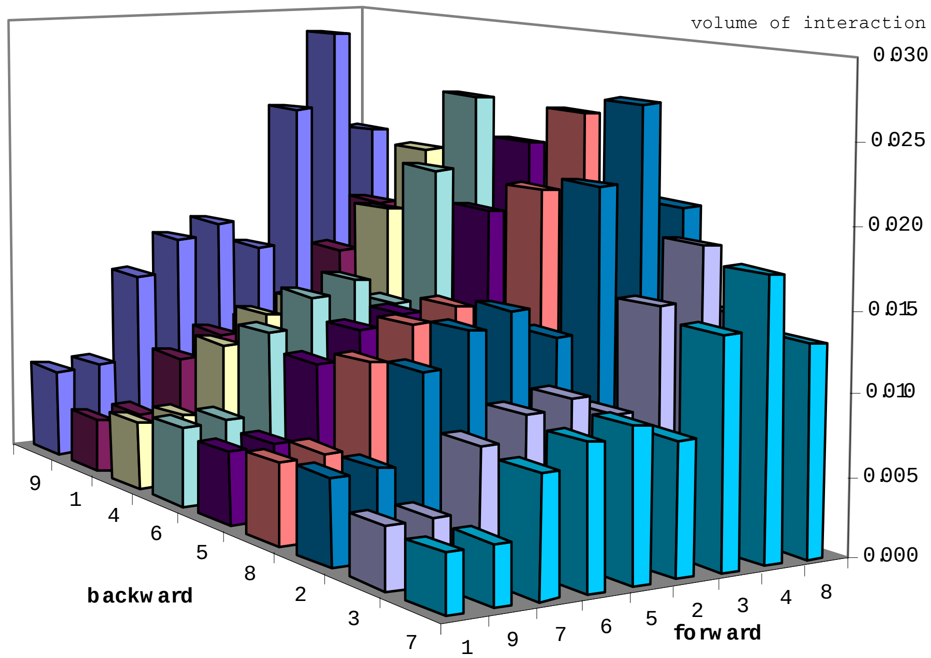
Macro indicators for the metropolitan economy will tend to be poor predictors of the nature and extent of internal changes in dependence.

Table 2 Taxonomy of Changes in the Proportions of Non-Self-Inputs and Outputs

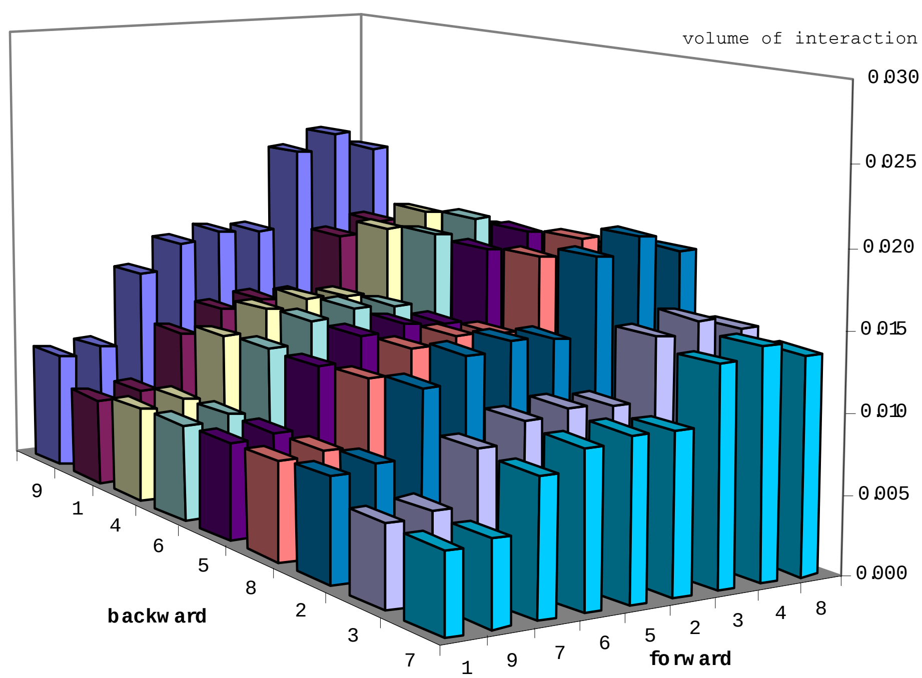
	Typology of Changes								
Direction of Changes in Non-Self-Inputs	↑	↑	↑	↔	↔	↔	↓	↓	↓
Direction of Changes in Non-Self-Outputs	↑	↔	↓	↑	↔	↓	↑	↔	↓
Sectors					Const. Nondur. Trade	Resources Govt.	Services	FIRE	Durable Transp.

Figure 21 Multiplier Product Matrix Landscapes for Chicago

1975 landscape in 2010 hierarchy



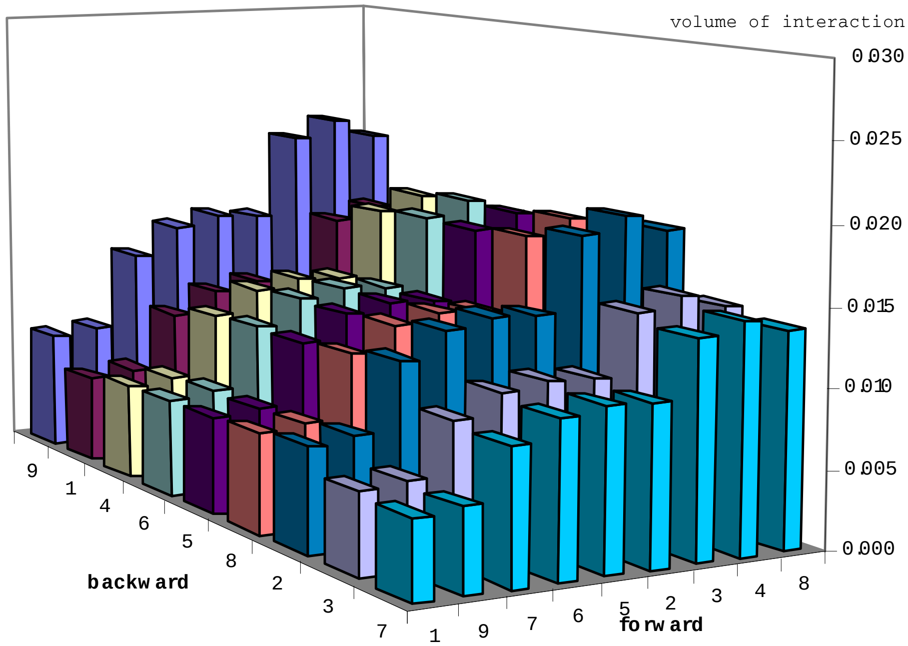
1980 landscape in 2010 hierarchy



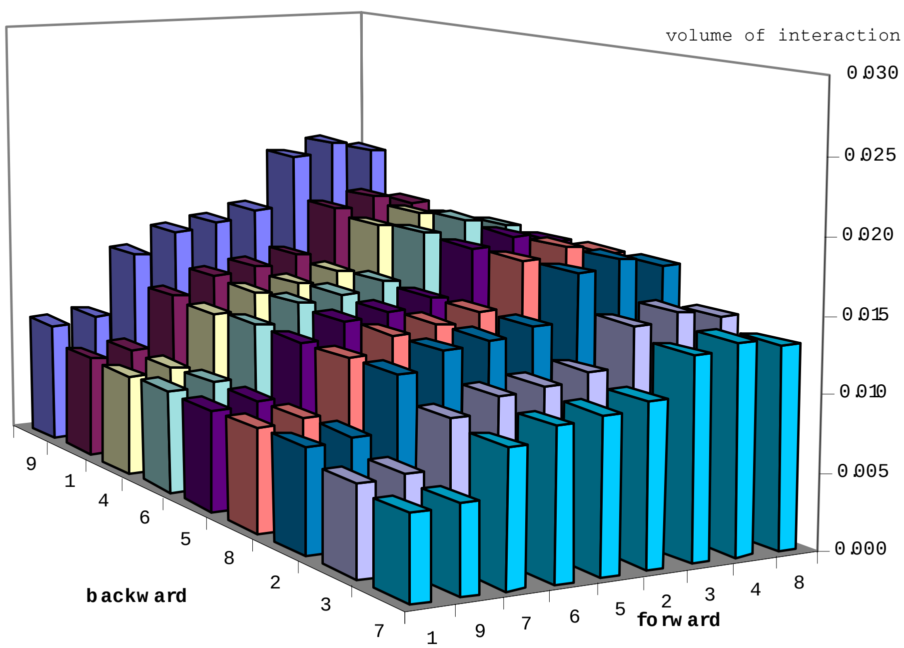
Source: Calculations by authors.

Figure 21 *(con't)* Multiplier Product Matrix Landscapes for Chicago

1985 landscape in 2010 hierarchy



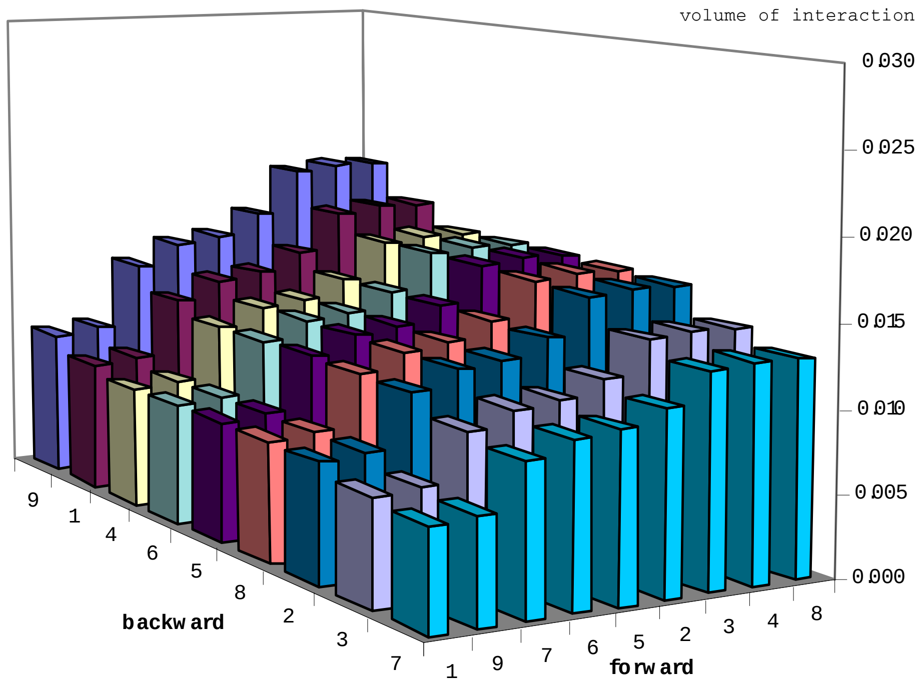
1990 landscape in 2010 hierarchy



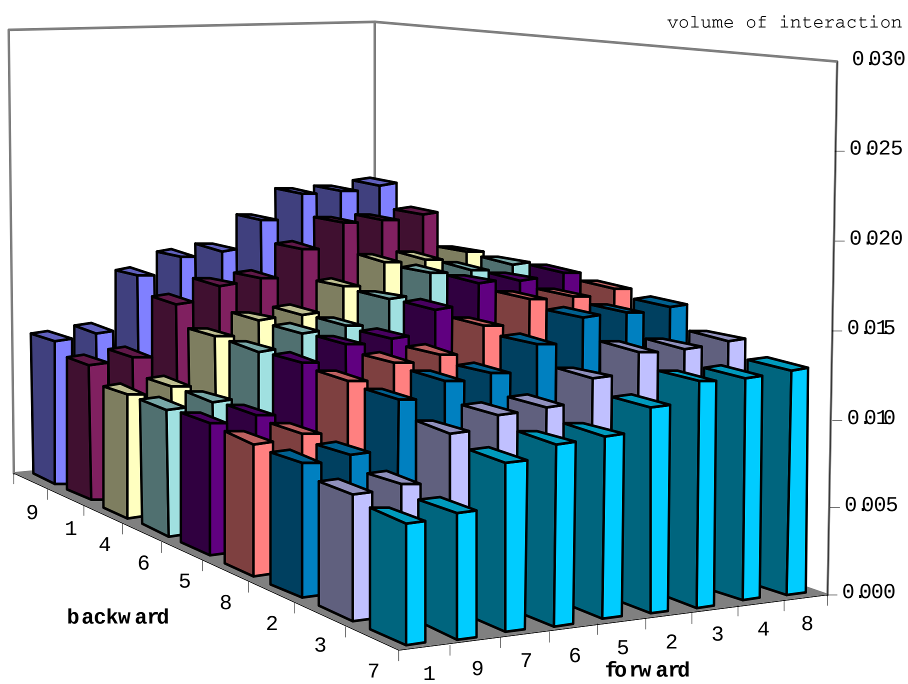
Source: Calculations by authors.

Figure 21 *(con't)* Multiplier Product Matrix Landscapes for Chicago

1995 landscape in 2010 hierarchy



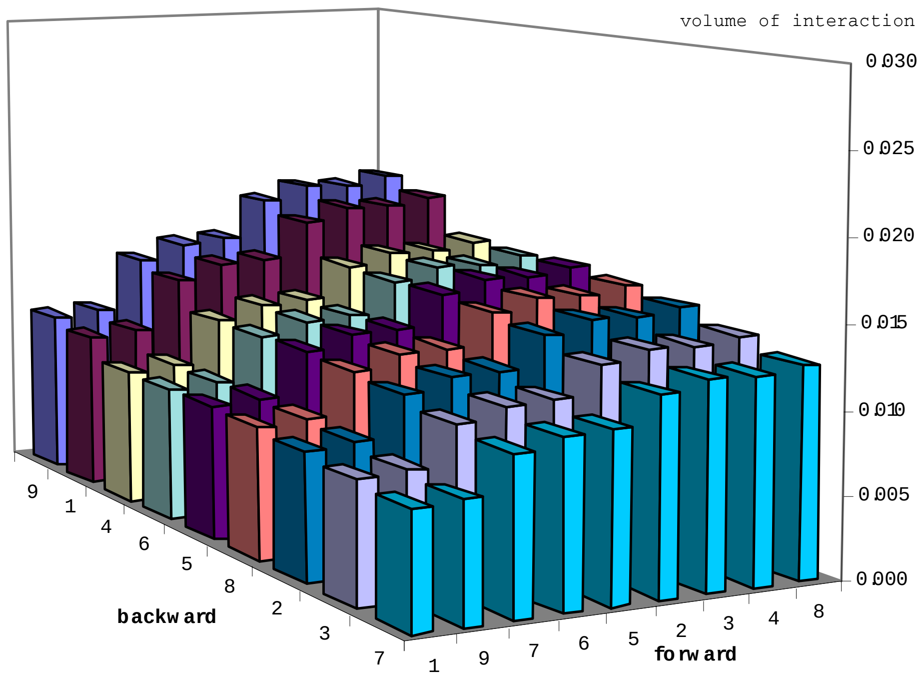
2000 landscape in 2010 hierarchy



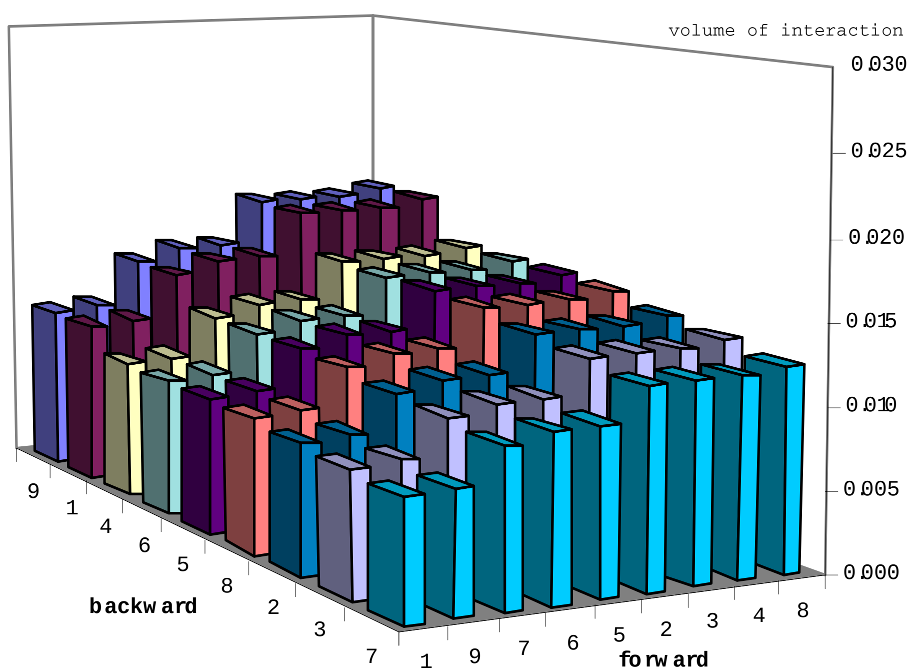
Source: Calculations by authors.

Figure 21 *(con't)* Multiplier Product Matrix Landscapes for Chicago

2005 landscape in 2010 hierarchy



2010 landscape



Source: Calculations by authors.

Examination of the forecasts for output would have provided almost no indication of the processes of internal reorganization that were observed and forecasted to occur in Chicago. While there seems to be overwhelming evidence that regional specialization is decreasing, the indicators that are used in the analysis are based on vector realizations of the distribution of output or employment. A more important issue, which the present paper clearly supports, centers on the degree to which regions are moving closer together in terms of the structure of interdependence. Further, research is needed on the geography of interregional interdependence and its potential for change over time.

Conclusions

The focus of this paper and the analysis introduced have suggested some important new directions for research about the structure of regional interdependence and its evolution over time. Regional analysts have tended to ignore these issues—in large part because of a dearth of reliable data—and have concentrated on more macroanalyses that, it would appear, may obfuscate some important processes of change characterizing the development of regional economies in developed societies. If interregional interdependence is expected to grow at the expense of internal exchange, then this will have important implications for infrastructure development, both in the traditional sense of highways, airports, and rail systems and in terms of telecommunications. While considerable attention has been drawn to the issues of regional and international import and export linkages, these are often very small in comparison to the size of interregional flows.[7] If the hollowing out processes revealed for the Chicago economy turn out to be significant predictors of the experience of most regions, then an important transformation in the U.S. economy is underway, one that will rival in importance the earlier shift in dominance from manufacturing to services.

Footnotes

1 Subsequently, the strengthening of the yen against the dollar has produced a second wave of hollowing out manifested in the location of several Japanese automobile assembly plants in the U.S. Formerly, this production would have occurred in Japan.

2 This section draws heavily on Israilevich et al. (1997).

3 The 1987 benchmark tables appeared in April 1994.

4 The work of Stevens and Trainer (1976) would refute this claim (in favor of the importance of the regional purchase coefficients), while Giarratani and Garhart's (1991) work offers support. Israilevich, Hewings, Schindler, and Mahidhara et al. (1996) show that the choice of input–output table is an important consideration in undertaking impact analyses and forecasting with econometric input–output tables.

5 As Takayama notes, the Walrasian equilibrium system would solve $\dot{p} = k[D(p) - S(p)]$ where demand and supply are functions of prices, *p*.

6 This section draws on Sonis *et al.* (1995)

7 Israilevich, Schindler, and Hewings et al. (1996) recently estimated that only 6% of the Chicago region's 1995 manufacturing employment could be directly and indirectly attributed to international exports.

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Appendix Table A1 Chicago Internal Column Multiplier Structure (based on B-I Matrix)
Ranking by sectors with % of each column element

Year	1		2		3		4		5		6		7		8		9		Total
Resources																			
1975	23.39	4	18.63	3	15.78	8	10.11	2	9.94	5	9.88	6	9.24	7	1.66	1	1.37	9	1.523
1980	20.55	4	19.09	3	16.31	8	10.81	2	10.22	6	10.01	5	9.72	7	1.81	1	1.47	9	1.407
1985	18.68	4	18.19	3	16.32	8	12.90	2	10.46	6	10.45	7	9.71	5	1.83	1	1.46	9	1.089
1990	18.20	4	17.96	3	16.23	8	14.26	2	10.72	7	10.41	6	9.23	5	1.68	1	1.31	9	1.006
1995	17.84	3	17.38	4	16.36	8	15.33	2	10.86	7	10.46	6	8.90	5	1.65	1	1.22	9	0.915
2000	17.58	3	16.64	4	16.61	2	16.45	8	10.90	7	10.49	6	8.55	5	1.63	1	1.15	9	0.847
2005	17.90	2	17.19	3	16.55	8	16.18	4	10.82	7	10.49	6	8.19	5	1.59	1	1.08	9	0.795
2010	19.38	2	16.64	3	16.61	8	16.02	4	10.63	7	10.43	6	7.78	5	1.52	1	0.99	9	0.743
Construction																			
1975	29.62	4	17.90	8	17.12	3	10.65	6	9.27	5	6.90	2	6.52	7	1.13	9	0.89	1	2.933
1980	26.87	4	18.83	8	17.50	3	11.18	6	9.46	5	7.21	2	6.82	7	1.21	9	0.92	1	2.822
1985	27.05	4	19.89	8	16.11	3	11.78	6	9.18	5	7.66	2	6.52	7	1.11	9	0.70	1	1.461
1990	27.80	4	20.14	8	15.50	3	11.81	6	8.72	5	8.09	2	6.42	7	0.96	9	0.56	1	0.982
1995	27.82	4	20.56	8	15.18	3	11.93	6	8.46	5	8.41	2	6.30	7	0.86	9	0.48	1	0.741
2000	27.64	4	20.84	8	14.87	3	11.98	6	8.98	2	8.23	5	6.24	7	0.79	9	0.42	1	0.580
2005	27.66	4	20.91	8	14.56	3	11.90	6	9.66	2	7.99	5	6.19	7	0.73	9	0.38	1	0.454
2010	28.13	4	20.66	8	14.14	3	11.63	6	10.63	2	7.68	5	6.13	7	0.66	9	0.34	1	0.348
Nondurable Manufacturing																			
1975	25.57	3	19.94	4	16.28	8	10.59	5	9.87	6	6.91	2	6.38	7	2.89	1	1.58	9	1.738
1985	29.52	3	16.82	8	14.14	4	10.85	5	10.20	6	7.18	2	6.11	7	3.33	1	1.85	9	0.919
1990	31.01	3	16.72	8	13.38	4	10.73	5	10.06	6	7.29	2	5.94	7	3.11	1	1.76	9	0.690
1995	32.57	3	16.73	8	12.35	4	10.67	5	9.96	6	7.31	2	5.75	7	2.95	1	1.71	9	0.548
2000	33.64	3	16.69	8	11.57	4	10.58	5	9.87	6	7.52	2	5.63	7	2.80	1	1.69	9	0.447
2005	34.46	3	16.61	8	11.07	4	10.48	5	9.73	6	7.79	2	5.54	7	2.65	1	1.66	9	0.369
2010	35.08	3	16.47	8	10.83	4	10.37	5	9.55	6	8.13	2	5.47	7	2.49	1	1.62	9	0.299

Appendix Table A1 *(con't)* Chicago Internal Column Multiplier Structure (based on B-I Matrix)
Ranking by sectors with % of each column element

Year	1		2		3		4		5		6		7		8		9		Total
Durable Manufacturing																			
1975	29.18	4	16.84	3	16.42	8	10.65	6	10.20	5	7.44	2	7.03	7	1.33	9	0.91	1	2.169
1980	26.37	4	17.18	3	17.18	8	11.18	6	10.46	5	7.81	2	7.41	7	1.45	9	0.94	1	2.108
1985	26.05	4	17.58	8	16.12	3	11.81	6	10.47	5	8.40	2	7.35	7	1.47	9	0.75	1	1.274
1990	26.14	4	17.70	8	15.72	3	11.95	6	10.27	5	8.85	2	7.41	7	1.37	9	0.60	1	0.957
1995	25.80	4	17.90	8	15.70	3	12.09	6	10.16	5	9.14	2	7.37	7	1.31	9	0.53	1	0.770
2000	25.26	4	18.03	8	15.67	3	12.19	6	10.03	5	9.68	2	7.38	7	1.28	9	0.47	1	0.636
2005	24.92	4	18.05	8	15.68	3	12.19	6	10.26	2	9.87	5	7.35	7	1.25	9	0.43	1	0.551
2010	24.80	4	17.96	8	15.69	3	12.11	6	10.85	2	9.70	5	7.30	7	1.21	9	0.39	1	0.476
TCPU																			
1975	21.66	4	18.27	3	15.86	8	15.58	5	9.33	6	8.95	2	6.91	7	1.95	9	1.51	1	2.407
1980	18.65	3	18.64	4	16.38	8	16.35	5	9.53	6	9.47	2	7.19	7	2.17	9	1.63	1	2.111
1985	18.32	5	17.01	3	16.57	8	16.48	4	11.00	2	9.56	6	7.16	7	2.39	9	1.52	1	1.298
1990	19.25	5	16.73	3	16.43	8	15.53	4	11.94	2	9.25	6	7.18	7	2.35	9	1.33	1	0.965
1995	19.76	5	16.59	8	16.38	3	14.65	4	12.73	2	9.18	6	7.19	7	2.30	9	1.22	1	0.775
2000	20.01	5	16.67	8	16.03	3	13.89	4	13.69	2	9.08	6	7.23	7	2.28	9	1.12	1	0.641
2005	20.07	5	16.70	8	15.64	3	14.69	2	13.42	4	8.94	6	7.27	7	2.24	9	1.03	1	0.539
2010	19.95	5	16.65	8	15.86	2	15.16	3	13.23	4	8.75	6	7.30	7	2.17	9	0.93	1	0.447
Trade																			
1975	22.73	4	19.79	8	18.27	3	10.61	5	9.79	6	8.34	7	8.15	2	1.43	9	0.90	1	2.781
1980	21.01	8	19.59	4	18.53	3	10.93	5	10.05	6	8.88	7	8.51	2	1.57	9	0.92	1	2.203
1985	22.98	8	17.53	4	17.07	3	11.08	5	10.13	6	9.60	2	9.31	7	1.61	9	0.68	1	1.318
1990	23.88	8	17.00	4	16.36	3	10.79	5	10.45	2	9.94	6	9.57	7	1.49	9	0.53	1	0.995
1995	24.87	8	16.09	4	15.88	3	11.10	2	10.65	5	9.82	6	9.72	7	1.43	9	0.44	1	0.775
2000	25.53	8	15.37	4	15.34	3	12.06	2	10.45	5	9.81	7	9.68	6	1.40	9	0.38	1	0.632
2005	25.88	8	15.01	4	14.80	3	13.15	2	10.19	5	9.81	7	9.48	6	1.35	9	0.33	1	0.533
2010	25.84	8	15.19	4	14.58	2	14.16	3	9.81	5	9.68	7	9.17	6	1.27	9	0.29	1	0.456

Appendix Table A1 *(con't)* Chicago Internal Column Multiplier Structure (based on B-I Matrix)
Ranking by sectors with % of each column element

Year	1		2		3		4		5		6		7		8		9		Total
FIRE																			
1975	23.68	4	16.92	3	16.77	8	11.08	7	10.54	2	9.86	6	9.06	5	1.23	9	0.87	1	1.590
1980	20.82	4	17.45	8	17.03	3	11.86	7	11.27	2	10.23	6	9.14	5	1.32	9	0.89	1	1.350
1985	19.11	4	17.83	8	15.31	3	13.51	2	13.14	7	10.50	6	8.69	5	1.25	9	0.67	1	0.840
1990	18.57	4	17.77	8	15.07	2	14.41	3	14.09	7	10.32	6	8.12	5	1.11	9	0.54	1	0.591
1995	17.95	8	17.72	4	16.30	2	14.55	7	13.88	3	10.33	6	7.78	5	1.01	9	0.48	1	0.454
2000	18.02	8	17.76	2	16.90	4	14.95	7	13.29	3	10.27	6	7.44	5	0.95	9	0.43	1	0.359
2005	19.27	2	17.99	8	16.30	4	15.18	7	12.74	3	10.13	6	7.09	5	0.89	9	0.40	1	0.289
2010	21.07	2	17.79	8	16.14	4	15.14	7	12.14	3	9.86	6	6.69	5	0.80	9	0.37	1	0.234
Services																			
1975	22.56	4	21.81	3	17.73	8	9.96	6	9.82	5	8.00	7	7.76	2	1.35	9	1.02	1	2.767
1980	22.62	3	19.68	4	18.43	8	10.29	6	9.95	5	8.39	7	8.14	2	1.45	9	1.05	1	2.270
1985	22.72	3	19.11	8	17.94	4	10.55	6	9.69	5	9.23	2	8.55	7	1.41	9	0.81	1	1.342
1990	22.82	3	19.27	8	17.57	4	10.45	6	10.07	2	9.23	5	8.67	7	1.27	9	0.65	1	0.975
1995	23.15	3	19.54	8	16.77	4	10.76	2	10.41	6	8.94	5	8.69	7	1.18	9	0.56	1	0.760
2000	23.26	3	19.68	8	16.06	4	11.70	2	10.31	6	8.72	7	8.65	5	1.13	9	0.49	1	0.610
2005	23.21	3	19.69	8	15.62	4	12.76	2	10.14	6	8.70	7	8.34	5	1.08	9	0.44	1	0.502
2010	22.88	3	19.49	8	15.61	4	14.19	2	9.86	6	8.61	7	7.97	5	1.00	9	0.39	1	0.419
Government																			
1975	23.29	4	17.29	3	15.35	8	13.14	2	12.21	5	9.53	6	6.41	7	1.76	9	1.03	1	3.233
1980	20.55	4	17.54	3	15.91	8	14.18	2	12.35	5	9.86	6	6.64	7	1.91	9	1.05	1	2.843
1985	18.57	4	17.98	2	15.92	3	15.70	8	12.61	5	9.93	6	6.36	7	2.07	9	0.85	1	1.807
1990	20.39	2	17.87	4	15.39	3	15.37	8	12.34	5	9.72	6	6.26	7	1.99	9	0.68	1	1.399
1995	22.27	2	16.98	4	15.32	8	15.01	3	12.09	5	9.64	6	6.16	7	1.94	9	0.58	1	1.167
2000	24.22	2	16.19	4	15.20	8	14.60	3	11.73	5	9.54	6	6.08	7	1.93	9	0.51	1	1.005
2005	26.02	2	15.65	4	15.05	8	14.21	3	11.31	5	9.38	6	6.02	7	1.91	9	0.45	1	0.877
2010	27.82	2	15.32	4	14.85	8	13.80	3	10.82	5	9.17	6	5.96	7	1.86	9	0.40	1	0.755

Note: Data for 1995 on are forecasts
Source: Calculations by authors.

Appendix Table A2 Chicago Internal Row Multiplier Structure (based on B-I Matrix)
Ranking by sectors with % of each row element

Year	1		2		3		4		5		6		7		8		9		Total
Resources																			
1975	19.46	3	14.09	5	12.86	9	10.91	8	10.16	2	9.81	1	9.68	6	7.68	4	5.35	7	0.258
1980	19.98	3	14.37	5	12.51	9	10.82	2	10.64	1	9.96	8	8.43	6	8.30	4	5.00	7	0.239
1985	23.41	3	15.26	1	15.02	5	11.71	9	8.33	8	7.83	2	7.30	4	6.85	6	4.29	7	0.131
1990	24.75	3	19.50	1	14.84	5	10.92	9	7.32	8	6.67	4	6.29	2	6.02	6	3.69	7	0.087
1995	24.88	3	23.27	1	14.55	5	10.44	9	6.53	8	6.28	4	5.46	2	5.25	6	3.33	7	0.065
2000	27.04	1	24.52	3	14.06	5	10.02	9	5.92	4	5.88	8	4.81	2	4.71	6	3.04	7	0.051
2005	30.66	1	23.74	3	13.45	5	9.61	9	5.78	4	5.39	8	4.34	6	4.20	2	2.82	7	0.041
2010	34.40	1	22.70	3	12.69	5	9.13	9	5.71	4	5.04	8	4.09	6	3.61	2	2.64	7	0.033
Construction																			
1975	22.52	9	12.01	6	11.42	5	11.38	8	10.73	2	8.88	7	8.55	4	8.16	1	6.36	3	1.887
1980	23.00	9	11.60	2	11.41	5	10.70	6	10.55	8	9.39	4	8.68	1	8.68	7	5.99	3	1.753
1985	25.85	9	11.35	5	11.18	1	10.07	6	9.85	8	9.03	7	8.90	2	8.52	4	5.25	3	1.257
1990	27.18	9	13.66	1	10.97	5	9.90	6	9.35	8	8.49	7	8.07	4	7.57	2	4.79	3	1.050
1995	28.45	9	15.36	1	10.80	5	9.42	6	8.95	8	8.11	7	7.71	4	6.82	2	4.39	3	0.913
2000	29.30	9	16.95	1	10.57	5	9.18	6	8.59	8	7.67	7	7.42	4	6.27	2	4.05	3	0.830
2005	29.69	9	18.50	1	10.31	5	9.13	6	8.34	8	7.36	4	7.25	7	5.71	2	3.73	3	0.769
2010	29.45	9	20.19	1	9.95	5	9.32	6	8.34	8	7.25	4	6.91	7	5.18	2	3.41	3	0.713
Nondurable Manufacturing																			
1975	15.18	8	14.06	9	12.79	6	12.63	2	11.18	3	11.06	5	9.19	4	7.14	1	6.77	7	3.975
1980	14.35	8	13.94	9	13.80	2	11.42	3	11.41	6	11.01	5	10.13	4	7.51	1	6.43	7	3.577
1985	14.68	8	13.85	9	13.06	3	11.34	2	10.83	6	10.62	5	9.89	4	9.54	1	6.19	7	2.077
1990	14.41	8	13.94	9	13.85	3	11.70	1	10.54	6	10.45	5	9.85	2	9.74	4	5.52	7	1.545
1995	14.40	3	14.19	8	14.13	9	13.18	1	10.25	5	9.93	6	9.76	4	9.08	2	5.09	7	1.239
2000	14.72	3	14.58	1	14.37	9	13.89	8	10.07	5	9.77	4	9.50	6	8.45	2	4.67	7	1.021
2005	15.93	1	14.81	2	14.54	3	13.59	4	10.08	5	9.83	6	9.21	7	7.71	8	4.30	9	0.858
2010	17.33	1	14.71	3	14.60	9	13.44	8	10.49	4	9.51	5	9.05	6	6.89	2	3.98	7	0.713

Appendix Table A2 *(cont')* Chicago Internal Row Multiplier Structure (based on B-I Matrix)
Ranking by sectors with % of each row element

Year	1		2		3		4		5		6		7		8		9		Total
Durable Manufacturing																			
1975	16.99	2	14.73	9	12.38	4	12.37	6	12.21	8	10.20	5	7.37	7	6.97	1	6.78	3	5.112
1980	18.99	2	14.63	9	13.92	4	11.19	8	10.81	6	9.86	5	7.24	1	7.04	7	6.32	3	3.993
1985	17.63	2	14.96	9	14.80	4	10.74	8	10.30	6	9.54	5	9.07	1	7.16	7	5.80	3	2.242
1990	16.55	2	15.18	4	15.16	9	11.11	1	10.39	8	10.26	6	9.09	5	6.66	7	5.60	3	1.649
1995	16.15	2	15.58	4	15.53	9	12.47	1	9.98	8	9.77	6	8.91	5	6.31	7	5.30	3	1.276
2000	15.93	9	15.74	4	15.70	2	13.80	1	9.59	8	9.52	6	8.72	5	5.93	7	5.06	3	1.021
2005	16.21	5	16.19	3	15.17	1	14.81	8	9.45	7	9.26	4	8.53	6	5.56	9	4.81	2	0.848
2010	16.65	1	16.54	4	16.18	9	13.69	2	9.69	6	9.16	8	8.28	5	5.28	7	4.53	3	0.714
TCPU																			
1975	17.10	9	16.24	5	12.77	6	11.78	2	11.76	8	9.58	4	7.97	3	6.56	1	6.24	7	2.309
1980	16.91	9	16.63	5	12.86	2	11.60	6	10.88	8	10.62	4	7.77	3	6.79	1	5.94	7	2.076
1985	18.47	5	17.70	9	11.35	6	10.42	2	10.36	4	10.10	8	8.21	1	7.74	3	5.67	7	1.288
1990	19.46	5	18.08	9	11.25	6	10.30	4	9.73	1	9.43	8	8.97	2	7.76	3	5.03	7	0.955
1995	20.13	5	18.54	9	10.84	6	10.71	1	10.29	4	8.92	8	8.24	2	7.68	3	4.64	7	0.761
2000	20.60	5	18.92	9	11.63	1	10.61	6	10.24	4	8.46	8	7.66	2	7.59	3	4.28	7	0.623
2005	20.86	5	19.13	9	12.55	1	10.49	4	10.48	6	8.08	8	7.45	3	7.00	2	3.96	7	0.519
2010	20.94	5	19.14	9	13.56	1	10.84	4	10.49	6	7.83	8	7.27	3	6.26	2	3.67	7	0.426
Trade																			
1975	14.86	2	14.65	9	13.11	8	12.95	6	10.98	4	10.68	5	8.16	3	7.46	7	7.16	1	2.102
1980	16.41	2	14.59	9	12.27	4	12.16	8	11.53	6	10.48	5	7.88	3	7.48	1	7.19	7	1.921
1985	14.99	9	14.38	2	12.56	4	11.83	8	11.16	6	10.37	5	9.52	1	7.83	3	7.37	7	1.197
1990	15.25	9	13.01	2	12.83	4	11.75	1	11.43	8	11.09	6	10.01	5	7.79	3	6.85	7	0.892
1995	15.68	9	13.34	1	12.98	4	12.31	2	11.02	8	10.60	6	9.92	5	7.61	3	6.54	7	0.717
2000	16.11	9	14.94	1	13.04	4	11.68	2	10.57	8	10.29	6	9.78	5	7.41	3	6.19	7	0.595
2005	16.62	1	16.40	9	13.39	4	10.77	2	10.15	8	10.07	6	9.61	5	7.15	3	5.84	7	0.502
2010	18.50	1	16.53	9	13.78	4	9.98	6	9.87	8	9.66	2	9.35	5	6.82	3	5.51	7	0.419

Appendix Table A2 *(con't)* Chicago Internal Row Multiplier Structure (based on B-I Matrix)
Ranking by sectors with % of each row element

Year	1		2		3		4		5		6		7		8		9		Total
FIRE																			
1975	14.51	6	13.85	8	12.97	9	11.97	2	11.02	7	10.40	5	9.54	4	8.80	1	6.93	3	1.598
1980	13.31	6	13.10	2	12.95	8	12.84	9	10.89	7	10.63	4	10.33	5	9.31	1	6.65	3	1.470
1985	13.42	6	12.57	9	12.54	8	12.44	1	12.07	7	10.42	2	10.24	4	10.15	5	6.14	3	0.915
1990	15.34	1	13.55	6	12.46	9	12.04	8	11.86	7	10.09	4	9.85	5	8.97	2	5.84	3	0.703
1995	17.46	1	13.22	6	12.62	9	11.61	7	11.60	8	9.97	4	9.79	5	8.19	2	5.53	3	0.569
2000	19.38	1	13.01	6	12.81	9	11.24	7	11.15	8	9.85	4	9.72	5	7.59	2	5.27	3	0.477
2005	21.13	1	12.97	9	12.86	6	10.79	7	10.74	8	9.96	4	9.63	5	6.91	2	5.02	3	0.407
2010	22.90	1	13.05	9	12.81	6	10.47	8	10.28	7	10.09	4	9.47	5	6.19	2	4.75	3	0.345
Services																			
1975	15.33	6	14.62	2	13.82	9	13.66	8	10.63	5	9.92	4	7.88	3	7.43	7	6.70	1	3.590
1980	16.16	2	14.08	6	13.75	9	12.72	8	11.01	4	10.52	5	7.62	3	7.16	7	6.98	1	3.288
1985	14.74	6	14.15	2	13.81	9	12.48	8	10.90	4	10.46	5	8.65	1	7.52	3	7.29	7	2.055
1990	15.32	6	13.88	9	12.76	2	12.13	8	10.93	4	10.54	1	10.22	5	7.44	3	6.78	7	1.550
1995	15.27	6	14.17	9	12.07	2	11.87	1	11.77	8	10.93	4	10.20	5	7.26	3	6.46	7	1.261
2000	15.30	6	14.47	9	13.21	1	11.45	2	11.37	8	10.87	4	10.13	5	7.06	3	6.12	7	1.055
2005	15.37	6	14.70	9	14.64	1	11.08	4	11.01	8	10.57	2	10.02	5	6.82	3	5.79	7	0.898
2010	16.28	1	15.55	6	14.79	9	11.29	4	10.78	8	9.83	5	9.48	2	6.50	3	5.49	7	0.758
Government																			
1975	18.32	9	15.07	5	12.79	6	11.98	8	10.69	2	9.28	4	8.85	3	6.73	1	6.29	7	0.311
1980	18.28	9	15.40	5	11.67	6	11.51	2	11.07	8	10.29	4	8.82	3	6.98	1	5.97	7	0.297
1985	19.99	9	16.59	5	11.37	6	10.11	8	10.02	4	9.09	3	8.69	2	8.54	1	5.60	7	0.187
1990	21.05	9	17.15	5	11.26	6	10.01	1	9.91	4	9.37	8	9.19	3	7.11	2	4.96	7	0.132
1995	22.19	9	17.43	5	10.94	1	10.87	6	9.86	4	9.16	3	8.80	8	6.23	2	4.51	7	0.102
2000	23.31	9	17.57	5	11.75	1	10.60	6	9.79	4	9.07	3	8.28	8	5.53	2	4.10	7	0.083
2005	24.28	9	17.55	5	12.44	1	10.43	6	10.01	4	8.90	3	7.85	8	4.83	2	3.72	7	0.069
2010	25.11	9	17.36	5	13.10	1	10.38	6	10.35	4	8.68	3	7.53	8	4.11	2	3.37	7	0.056

Note: Data for 1995 on are forecasts
Source: Calculations by authors.