THE CHANGING STRUCTURE OF TRADE AND INTERDEPENDENCE IN A MATURE ECONOMY: THE US MIDWEST

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The Changing Structure of Trade and Interdependence in a Mature Economy: The US Midwest[1]

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1. Introduction

Four questions are addressed in this chapter. *First*, as regions mature, what happens to their overall economic trade relationships, both internally and with other regions? *Second*, is the process similar at all spatial scales, i.e. for metropolitan, regional, macroregional and national economies? *Third*, are regions becoming more alike in terms of economic structure? *Fourth*, what are the implications for regional competition and policy intervention, as regions become more similar and interdependent?

For the past three decades, changes in the spatial interconnections in the production process have been one of the more visible characteristics defining the reorganization of trade, both international and interregional. In international trade the process of globalization finds firms specializing production in establishments, often in different nations, in order to exploit such locational advantages as proximity to markets and easier access to relatively advantageous production inputs (Hummels *et al*., 2001). Within nations interregional trade appears to be motivated less by advantages of cheaper input costs, labor mobility, etc., than by centripetal forces generated by cumulative causation, such as the interaction of scale economies, transportation costs, and specialized labor pools (Fujita and Thisse, 1996; Krugman, 1998; Ciccone and Hall, 1996; Wheeler, 2001). This self-reinforcing process may thus result in greater 'spatial dispersion' of production across regions, suggesting that vertical relations within the productive process may now be more spatially complex than in past decades (Parr *et al*., 2002). For example, as the data in table 1 reveal, interstate flows have grown more rapidly than the US

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gross domestic product over the period 1993-2002. What of changes in the spatial organization of production and interdependence within metropolitan areas? A recent analysis (Hewings and Parr, 2007) finds that the nature of interdependence is different from that characterizing regions or larger areas.

<<insert tables 1 and 2 here>>

In order to show the changing significance of internal trade within the US, table 1 contrasts the national growth rates of gross domestic product with the growth rates in the interstate flows of commodities for three recent periods. Our focus, however, is on the Midwest states of Wisconsin, Illinois, Indiana, Ohio and Michigan, and their interactions with the rest of the US (defined as a *de facto* sixth region). Throughout the chapter the term 'region' refers to each of the 5 constituent states of the Midwest and to the 'Rest of the US region' (RUS), while the Midwest is regarded as a 'multi-state area', as is the RUS when it is being compared to the Midwest. In 1996 the gross area product for the Midwest reached $1.1 trillion, representing about 16% of the GNP of the US, as indicated in table 2, which also shows the contribution of the Midwest to the US economy in other categories such as total output, employment, and income. Furthermore, the Midwest exhibited a higher level of labor productivity (output per employee) than the nation as a whole. The Midwest provides an appropriate case study for examining linkages among regions and sectors, since it can still claim to be enjoying certain spatially-specific economies advantages, especially with respect to intrasectoral linkages in durable manufacturing, involving the exploitation of economies of scale, scope and complexity (Parr *et al*., 2002; Sonis *et al*., 2002; Swonk, 1996). The Midwest has also been chosen as the main focus of analysis primarily because it typifies a mature economy that has undergone dramatic structural changes throughout period since 1980. The availability of a set of models and related databases further reinforces the relevance of this case study.

The chapter is organized as follows. Section 2 discusses certain background issues, while Section 3 examines the spatial structure of trade flows over the period 1980-2000. A method of measuring vertical linkages is outlined in Section 4, and Section 5 then provides the results of an application of this measure. In Section 6 the focus of attention shifts to the metropolitan level, where the examination of interdependence is expanded to include more than simply intersectoral flows. A final section provides an interpretive commentary on the empirical analysis, and considers some of the policy implications.

2. Research Design and Data Sources

To capture industrial interdependencies in sequential production processes, this study adapts the method proposed by Maddigan (1981) for measuring the vertical linkages of firms, and applies this to a multiregional general-equilibrium model. The approach is based on an input-output matrix, in order to identify sectoral interdependencies in the sequential production process, from which the forward/backward linkages are derived. These linkages also reflect a complex sequence of signals from various sources of demand: regional (within state), interregional (within the Midwest) and external (the RUS and international). The focus on linkages is in contrast to a recent series of geographic concentration measures (Maurel and Sedillot, 1999; Ellison and Glaeser, 1997). These are essentially modifications of the Herfindahl index, and thus only provide a limited perspective on economic structure. More importantly, such measures are unable to utilize the abundant information on linkages embedded in an input-output table, and may generate misleading interpretations about industrial structural change. As an alternative, feedback-loop analysis, elaborated by Hewings *et al*. (1998) and Sonis *et al*. (1993; 1995) offers another way of interpreting the sequential production process, when an input-output table or a trade flow matrix is available. A complementary approach (structural-path analysis) has the great advantage of being able to identify the spatial structure of trade flows, and thus examine the nature and strengths of interregional connectivity. However, although these methods highlight the value of trade flows within interregional and/or intersectoral feedback loops, there are difficulties of measuring in detail the degree of sequential-production linkage at the sector level.

In order to achieve a comprehensive coverage of internal and external effects among sectors and regions, the Midwest Regional Input-Output Econometric Model (MW-REIM) is utilized, details of which are provided in Israilevich *et al.* (1997). The model is based on 1992 and 1997 multiregional input-output tables (compiled using state input-output tables and interstate trade derived from the Commodity Flow Survey for 1993 and 1997), as well as annual regional data that were available from 1969 to 2000. The primary focus of the model is on manufacturing sectors. The MW-REIM is a multiregional, dynamic general-equilibrium model, which covers five Midwest regions and the RUS, and includes 13 sectors for each region. This model is able to develop quantitative economic linkages among the system variables via its two major components (an input-output module and a time-series module), and can also identify comprehensively the sectoral and regional linkages. In addition, it is possible to extract forward and backward linkages by generating annual input-output tables and forecasts for the period 2001-2030 for the 13 sectors specified in the model. The procedure for extracting the annual (derived) input-output tables is explained in Israilevich *et al*. (1997). Table 3 illustrates the output levels by sector for the 6 regions, and the sectors are described in Table A1 of the Appendix.

<<insert tables 3, 4 and 5 here>>

3. The Spatial Structure of Trade Flows

Using this 13-sector, 6-region framework, a flow analysis was utilized to identify major linkages within the system, the method for estimating the interregional-trade flows being identical to that used by Sonis *et al*. (2002). These flows are presented in table 4, and the trade-flow matrix is summarized in table 5. The upper part of the table shows that the intraregional trade flows for the six regions (i.e. the diagonal sum of regional flow matrices) reached $4.8 trillion in 2000, and accounted for more than 80% of total trade flow in the US. Within the diagonal summation, intrasectoral flows (flows between establishments within the same sector) sharply increased from 37.3% (= 31.0/83.23) of intraregional flows in 1980 to 46.4% (=37.5/80.8) in 2000, while the intersectoral component in intraregional flows decreased from 62.7% to 53.6% over the same period. These findings are consistent with current trade theory which would suggest that trade between regions with high levels of per capita income, similar endowments and good inter-connectivity moves from domination by intersectoral trade to domination by intrasectoral trade, as firms exploit scale economies at the establishment level and produce multiple products to meet consumer demands for greater choice in goods that are close substitutes. Using a more disaggregated set of trade flows for interaction among the Midwest regions only, Munroe *et al*. (2007) found a similar domination by intrasectoral trade.

Interregional flows are also decomposed into their intrasectoral and intersectoral components, from the off-diagonals of the flow matrix, and the results are shown in the middle part of the table 5. The total trade flows were identified through five feedback loops, hierarchically ordered according to the intensity (sum of flows) of trade through the loops. Sonis *et al*. (2002) identified five interregional trade loops in the six regions for year 1992, and showed that the Midwest economy is well developed and bilaterally balanced: for each flow, there exists a corresponding counter-flow of comparable size. This part of the table indicates that although interregional trade only gradually increased, the intrasectoral component increased from 7.5% in 1980 to 10.0% in 2000, while the intersectoral component remained about the same (at around 9.2%) over the same period.

The lower part of table 5 summarizes the trade flows at the aggregated level of the two multi-state areas: the Midwest (MW) and the RUS. In the absence of detailed analyses of these tables (i.e. without more sectoral disaggregation), there is no clear evidence of the time trends of this trade. A case might be made for a tendency toward consolidation within the overall Midwest economy. Thus, the sum of Midwest trade flows (the Midwest-to-Midwest matrix) has increased in a logarithmic manner with increases in both the diagonal and off-diagonal sums. Flows between the Midwest and the RUS also increased in both directions over the period. Meanwhile, the percentage of trade within the RUS decreased, mainly due to its larger geographical scale. This trend partially reflects the increased level of international trade over these decades and the more rapid increase in population and employment in the RUS relative to the Midwest.

The flow analysis of this section provides a clear indication that over past decades intrasectoral trade has expanded significantly, with respect to intraregional as well as interregional trade. In addition, the Midwest-to-Midwest flow increased over time, providing a possible interpretation that while hollowing out may be occurring at the regional and metropolitan-area levels, the process does not appear to be evident at the Midwest level. The increased density of the freeway network and the associated reductions in real transportation costs (Parr *et al*., 2002) have increased the geographical range over which it is economically feasible to ship products, even for just-in-time production regimes. However, the flow analysis needs to be extended in sectoral detail, since an aggregated sectoral analysis is only of limited use in measuring the strength of sequential production linkages.

4. Measuring Vertical Linkages

The Maddigan (1981) approach to measuring sectoral interdependencies is based on an input-output matrix, and involves a method of linking sectors through production functions via forward/backward linkages in this matrix. Production relationships in the measure thereby capture simultaneous network characteristics, e.g. two sectors may serve as input suppliers to each other. Traditional methods (such as analyzing relationships among outputs, or the use of value-added-to-sales ratios) understate a firm's or a sector's participation in a linear succession of production stages. Simply put, it is too restrictive to define a sector's production function in a single processing chain.

The core of the Maddigan index is its utilization of the forward- and backward-matrix derived from the Leontief framework. Her method is applied in a multiregional framework in the following way. Two matrices, *A* and *B,* represent relative net inputs and relative net outputs, respectively, and capture net production relationships for each sector's upstream and downstream linkage. Thus:

$$A = I - [x_{ij} / (z_j - x_{jj})] + [y_{ij}]$$

$$B = [x_{ij} / (z_i - x_{ii})] - [y_{ij}] - I$$

where

I = identity matrix, (m x m);

x_{ij} = the value of the output of sector i used as an input by sector j;

z_j = the total value of the output of sector j, (where $j = 1, \ldots, m$);

$y_{ij} = \{ x_{ii} /(z_i - x_{ii})$ if $i=j$; 0 if $i \neq j$; $i, j = 1, \ldots, m\}$.

The dimension of m in the model is 78 (i.e. 13 sectors in each of the 6 regions), and each i and/or j represents a particular sector in a given region. The elements in matrix *A* are negative, since vertically-linked input values reduce the value of net output consumed internally, while the elements of the matrix *B* are positive values, and represent the allocation of sector outputs.

An index synthesizing these two matrices now can be formulated for an explicit expression of the production-line linkage of this sector. Using the rows and columns of matrices *A* and *B*, respectively, a sector is characterized by two matrices, *C* and *D*, where the column vector of $c_{ij} \in C$ is the column *i* of the input matrix of sector *j*, and the row vector of $d_{ij} \in D$ is the row *i* of the output matrix of sector *j*. Formally, for *i*, *j*=1, …, *n* ($n \leq m$) each element is defined as follows:

$$c_{ij} = a_{s(i)s(j)}$$

$$d_{ij} = b_{s(i)s(j)}$$

where

$s(i)$ = region *s* in which sector *i* is located;

c_{ij} = percentage value of the net output of regional sector $s(j)$ contributed by regional sector $s(i)$;

d_{ij} = percentage value of the net output of regional sector $s(i)$ used as an input to regional sector $s(j)$.

Finally, in the multiregional framework, what we term the vertical connection index *VC* for sector *k* can be defined as follows:

$$VC_k = 1 - \left[1 \Big/ \prod_{r=1}^{6} \left(\sum_{R=1}^{6} \sum_{j=1}^{13} c_{kr,jR}^{2} \right) \left(\sum_{R=1}^{6} \sum_{j=1}^{13} d_{jR,kr}^{2} \right) \right]$$

The diagonal elements of *C* and *D* are unit values, since *j*=*k* and *R*=*r*. The *VC* index lies between 0 and 1, and retains three of the properties noted by Maddigan (1981).[2]

<<*insert table 6 here*>>

By its construction the *VC* index does not include the intrasectoral component of intraregional trade. However, in our multiregional setting, it is a comprehensive measure, covering a sector's forward and backward linkages to different sectors (the intersectoral components in intraregional and interregional trade) and to the same sector (the intrasectoral components of trade). The values of the *VC* index for each sector in the 5 Midwest regions and the RUS are shown in table

[2] The three properties of the Maddigan index are as follows: i) the index increases (decreases) when an input sector becomes relatively more (less) important by accounting for a larger (smaller) percentage of the total value of output of the sector being supplied; ii) the index increases (decreases) when relatively more (less) of the output of a supplying sector is used as an input to another sector; iii) the index increases if there is any increase in vertical

6. For a flow analysis of the Midwest alone (i.e. excluding the RUS), the value of R and r is reduced to 5 (from 6), and the two matrices are reduced to a dimension of 65x65 (from 78x78). This partitioning can be applied to a single region, or even to a single sector, even though the index will become significantly smaller with reductions in the total value of in-flows and out-flows for smaller C and D matrices.

5. Results and Interpretation of the *VC* Index

In this section the analysis is concerned solely with the two multi-state areas (the RUS and the Midwest), and the results are displayed in table 7. In the upper part of this table the estimated values of the *VC* index are presented for the RUS and the Midwest in 1980, 1990 and 2000. The *VC* index for each sector of the Midwest economy is necessarily less than that for the RUS, since the total values of the input coefficients are lower. The *VC* index for a given sector in an area measures the strength of sequential production linkage. For both areas the *VC* index was high in resources (sectors 1, 2, and 3) and low in services (sector 13), and varied widely within manufacturing.

<<insert table 7 here>>

From 1980 to 2000 most sectors exhibited smooth transitions. However, for the transportation-equipment sector (sector 10) the Midwest showed a major, temporary retreat in 1990, toward less interdependence. This reflected a downturn of production by domestic automobile producers in the 1990s, and also a more dispersed pattern of direct investment by foreign-owned automobile producers, involving locations other than Southeast Michigan. Nevertheless, along with the two metal sectors (sectors 6 and 7), sector 10 has remained one of the most vertically-connected sectors, both in the Midwest and the RUS. Regarding the downward trend for resources (sector 1), this might be explained by increased exports of agricultural output, with the agriculture part of the sector becoming more dependent on international trade and more internally interdependent (Frank and Henderson, 1992).[3] This upper part of table 7 provides an overall indication that the

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connections (other than as a result of conglomerate merger activity) between a new sector and the sector's established product line.

[3] Over the past decades vertical connections have increased significantly in US agriculture in order to exploit economies of scale economies of scale economies and monopolistic market power in the supply of more versatile and differentiated products.

increase in Midwest-to-Midwest flows, which has contributed to the hollowing-out process in individual regions, resulted from: i) a significant increase in intra-area, intrasectoral trade in services (sector 13) within each area; and ii) steady increases in such interaction in most manufacturing sectors; and also iii) increased values for the *VC* index in sectors 2, 3, 5 and 13. Perhaps the time interval of twenty years (from 1980 to 2000) is not long enough to judge structural changes for all sectors, but their overall trend is consistent with intuition and the results from previous studies.

The middle part of table 7 indicates the rank order of the *VC* index for the 13 sectors in each of the two areas. The heavily-shaded areas denote the four highest-ranked sectors for 1980 and 2000, while the lightly-shaded areas represent the four lowest-ranked sectors. Within this hierarchy of values for the *VC* index, sectors 1, 2, 6 and 10 are the highest-ranked sectors in year 2000 both in the RUS and the Midwest. In the same year, the lowest-ranked sectors were 4, 8, 12 and 13 in the RUS, and 8, 9, 12 and 13 in the Midwest. The low rank of the service sector is mainly due to the fact that most of its production is for final consumption, so that its output linkage becomes less important, accounting for a smaller percentage of the total value of output. The rank is improving significantly in both areas, however, implying that its outflows and inflows are becoming more linked to the production of other sectors. In both areas this upward trend is also observed in sectors 2, 5 and 6, while there is a downward trend in sectors 1, 7 and 8.

The lower part of table 7 shows the intra-area, intrasectoral flows as a percentage of total US flows. As can be observed, it is only sectors 5 and 13 that contributed to such internal trade expansion within the RUS. In other words, intrasectoral trade actually decreased in percentage terms in the other eleven sectors of the RUS trade flows. For the Midwest, by contrast, it can be seen that such trade has increased not only in sectors 5 and 13 but also in most of the manufacturing sectors. Note that sector 13 covers all private and government services, as well as transportation, communication, and utilities. The sector accounts for about 60% of the total output, and given its upward growth trend, this sector must have been the major force boosting the total value of intrasectoral trade within each area.

An alternative way of looking at the *VC* index for each sector in the Midwest is to take its value, and divide this by the corresponding value for the RUS. The sectors are then ordered as 10, 1, 8, 6, 3, 7, 11, 2, 12, 4, 9, 5, 13 in 1980, and 10, 8, 3, 1, 6, 2, 7, 11, 4, 5, 12, 13, 9 in 2000. The ratios (not shown here in tabular form) indicate the relative levels of interdependence, as well as their trends, e.g. compare sectors 1 and 10 for both years. It transpires that along with its high level of production (shown in table 3) heavy manufacturing (sectors 8 and 10) provides the underpinning for sectoral interdependence within the Midwest. This modified *VC* index generally registers low values in sectors having high levels of product diversification (sector 9), leading to increased monopolistic competition, or high sunk costs (sector 5), or final-stage consumption (sector 13). The main contribution of the electronics industry (sector 9) is not generated by its backward dependence on intermediate inputs (since many of the components are imported from overseas) but through the provision of a variety of products.

<<insert table 8 here>>

Finally, the original *A* and *B* matrices were reduced, in order to examine intrasectoral flows between the two areas (the RUS and the Midwest), and to derive an interarea-intrasectoral measure of linkage for the 13 sectors. This modification allowed us to identify the major sectors that contributed to increases in the intrasectoral components of interarea trade in the feedback-loop analysis. Table 8 shows that in 2000, sector 10 in the RUS recorded the highest value, followed by sector 13, and the remainder in the order 1, 8, 11, 6, 9, 4, 5, 7, 2, 12, 3. In 1980 the order was approximately the same, but only the service sector showed a significantly increasing trend. In the Midwest, the order was also approximately the same for both years (though somewhat different from that of the RUS in each year), but displayed an increasing trend in the majority of sectors.

6. The Intrametropolitan Scale

The nature of interdependence within metropolitan areas could be expected to follow the structures revealed between nations and between regions within nations. In both of the latter cases, greater trade between nations (regions) has come at the expense of intranational (intraregional) flows. In addition, an examination of the Chicago metropolitan economy revealed that a similar process had also occurred when the metropolitan economy was viewed as a single area. Essentially, a hollowing out process has occurred with greater dependence on external markets for inputs and outputs (Hewings *et al*., 1998). Hence, there would be an expectation that a similar process might have occurred *within* the metropolitan area, thus providing a consistent pattern at the national, regional and metropolitan scales.

<<insert tables 9, 10 here>>

In a recent study by Hewings and Parr (2007), the Chicago metropolitan area was divided into four zones (central area or CBD, rest of the City of Chicago, inner suburbs, and outer suburbs). An examination was made of the interzonal impacts in a series of layers, beginning with only intersectoral trade flows, then adding the impacts associated with income flows (from journeys to work) and finally the impacts generated by the spatial distribution of consumption expenditures. The summary results, shown in tables 9 and 10, provide a different outcome from the interregional results. Table 9 shows the entries from the interzonal-intersectoral flows analysis and the associated Leontief matrix reveals a structure that is dominated by intrazonal flows. The degree of interzonal interdependence so revealed is very small. However, when the effects of income generation and flows (from workplace to home) and together with the spatial distribution of consumption expenditures are considered, a very different picture of interdependence within the metropolitan area is revealed (table 10). In contrast to table 9, there is much more interzonal dependence, reflecting the fact that the nature of the interdependencies within a metropolitan area are derived from commuting flows and consumption-expenditure flows rather than intersectoral flows.

7. Closing Comments

This chapter has introduced and compared various complementary methods for measuring inter-connection in the production processes within the Midwest economy. Employing a flow analysis, attention was first given to the values of intraregional and interregional trade flows over the past two decades. Being consistent with previous literature, this method provided clear evidence that intrasectoral trade had grown noticeably in intraregional trade and even in interregional trade. Furthermore, the Midwest-to-Midwest flows increased during the period of estimation (1980-2000). It remains to be seen whether the hollowing out process observed for the Chicago metropolitan area represents a spatially-hierarchical process, evident first at a small geographic scale. It would seem reasonable to expect that continued improvements in logistics and communications would effectively undermine any (short-term) advantages offered by the

Midwest. Between 1990 and 2004, the economy of the economy of the Midwest lost 12% of its manufacturing jobs (for Illinois the loss was much higher, almost 24%, while for the nation the loss was 19%). As has been noted, however, job losses may not be entirely reflected in losses of production, since productivity gains in the Midwest have been dramatic.[4]

It has been have argued that traditional notions of agglomeration economies as a dominant factor in location may need to be revised by consideration of economies that are less spatially constrained (Parr *et al*., 2002). With lower transaction costs, firms can optimize production at establishments located in different states through specialization, in order to take advantage of economies of scale. The production of intermediate goods in an establishment located in one region that previously may have undergone two or more transformations have now been redistributed across several regions. Thus, linkages in the commodity chain are now more spatially dispersed. The evidence provided in this chapter would suggest that there still exist some spatially-specific economies, but these are realized at the scale of the Midwest rather than an individual region or metropolitan area. The evidence for this is derived from the observed substitution of interregional for intraregional trade in the regions of the Midwest.

Examining the structure of trade at the national level, we find that there has been significant growth in the intrasectoral component of trade, although it is the service sector (covering about 60% of total output) that has heavily contributed to such an expansion. In percentage terms intrasectoral trade has actually diminished in most sectors of RUS trade flows. Compared with the RUS, vertical linkages in the Midwest are the most significant in heavy manufacturing sectors such as transportation equipment (particularly automobile production) and industrial machinery. Apart from the transportation-equipment sector, the intrasectoral component in interregional trade has not been prominent in many manufacturing sectors in the RUS, nor in the Midwest. As with other methodologies used to measure economic activity, this index approach has certain limitations, including loss of sectoral detail within intersectoral relationships, as well as the difficulty of measuring the statistical significance level of the *VC* index, and incorporating differences due to geographic scale. Yet, the index approach, combined with the information on internal flows, provides a useful tool for analysis at the sectoral level and some important insights on structural change in the Midwest economy.

[4] In the Chicago metropolitan area, for example, manufacturing production fluctuated over the period 1970-1990. However, the 1990 level was greater (in real terms) than in 1970 level, although there were 44% fewer employees.

Given the nature of this volume, it is appropriate to reflect briefly on the policy implications of the foregoing analysis. To do so, we first consider the overall nature of the Midwest economy. This has been established for well over 100 years, during which period it has undergone numerous structural transformations, the one described above being the most recent. From virtually any perspective the Midwest economy must be considered a successful one, which continues to be a major contributor to the US economy. One of the important axioms of sub-national development is that successful economies are ones that are able to adjust to changing external (and sometimes internal) conditions, thus continuing to be competitive. Generally speaking, this adjustment process involves the re-marshalling of resources, broadly defined. It includes the redeployment of factors of production across sectors and over space, the re-utilization and rationalization of social and economic overhead capital, the encouragement of inflows of capital and specialized labor, etc. Such a process of adjustment is driven primarily by the market, through a variety of price signals, although the market may not always operate efficiently nor sufficiently promptly. Moreover, the process of adjustment may be seriously impaired by such influences as resource depletion, factor immobility and factor specificity, inappropriate spatial structures, and isolation from national cores. The presence of these influences (individually or severally) typically causes the emergence of a problem region. The Midwest has generally not suffered from difficulties of this kind, except for localized or temporary instances. It has thus avoided overall economic decline, and maintained a degree of competitiveness. For this reason alone, policy intervention would seem to be largely unnecessary or inappropriate, particularly in view of the highly complex nature of technical and economic change that has occurred over recent decades. But denying a role for public policy in the development process is probably too extreme a stance to adopt.

In considering the role of policy, we begin at the level of the individual state (treated above as a region) within the Midwest. Clearly, each state has a perception (not always clearly defined) of its own economic and social circumstances. It also has a set of concerns with respect to current needs, the internal distribution of state expenditures, and the overall impact of these. Furthermore, each state has a set of policy instruments, although these tend not to differ substantially among states. Bearing in mind what was said above the ability to adapt to change, there appear to be several emphases that the individual state may usefully pursue. These include: i) a realistic assessment of the factors likely to influence development over the medium and long term, along with the specification of a set of attainable objectives (political systems are usually averse to such approaches); ii) the efficient delivery of services for which the state has a primary responsibility or over which it exerts a strong influence, particularly in the areas of public health, education and certain aspects of infrastructure provision, including the support of public transport; iii) the identification and elimination of physical bottlenecks and related frictions (both spatial and temporal), an emphasis which may take various forms, ranging from the upgrading of skills in the workforce to the strategic programming of major transportation projects, notably highway development. One difficulty of policy intervention at the state level is that is usually unrelated to comparable interventions taking place in neighboring states of the Midwest. At this level, there is still scope within public policy intervention for avoiding bottlenecks, especially in relation to larger infrastructure projects. While no multi-state tier of government for the Midwest exists (nor is this likely to emerge), serious attention might be given to the possibility of interstate compacts, either on a bi-lateral or multi-lateral basis, by which states are able to co-operate, in order to avoid incompatibility of investment decisions or the wasteful duplication of facilities.

Historically, the fostering of interstate relations has been the responsibility of the federal government or its agencies. And one possibility here is for the federal government to avoid these problems of incompatibility and duplication by allocating funds among states in such a manner that difficulties of this kind are minimized. There is also the potential for federal government to play a pivotal role in the interstate regulation of transportation and telecommunications. These sectors lie at the heart of the information economy, upon which so many of the developments described in this chapter depend. In the past the federal government has also made various forays into regional policy with the creation of multi-state entities such as the Tennessee Valley Authority, the Bonneville Power Administration, and the Appalachia Regional Commission, each representing a significant intervention. However, political realities, together with the present levels of development and prosperity within the Midwest, would appear to rule out intervention along these lines. We conclude this chapter by asserting that just as the regional economy has become more structurally sophisticated in recent decades, so must the nature and scope of policy intervention, if this is to be effective. The days of ‘smokestack chasing’ and ‘industry retention’ or ill-judged spending on infrastructure are long gone (or certainly should be), and in settings such as the Midwest many of the traditional approaches to regional policy are likely to be blunt and ineffectual. Successful regional policy at any level must involve an appreciation of existing economic and technological complexities, as well as a carefully-designed response to these.

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APPENDIX

Table A1 Sector mnemonics in the Midwest-REIM

Mnemonic	Sector title	SIC
1	Agriculture, forestry and fisheries	01,02,07,08,09
2	Mining	10,12,13,14
3	Construction	15,16,17
4	Food and kindred products	20
5	Chemicals and allied products	28
6	Primary metal industries	33
7	Fabricated metal industries	34
8	Industrial machinery and equipment	35
9	Electronic and other electric equipment	36
10	Transportation equipment	37
11	Other non-durable manufacturing products	21-23,26,27,29-31
12	Other durable manufacturing products	24,25,32,38,39
13	TCU, service, and government enterprises	40-42,44-65,67,70,72,73,75,76
Aggregation scheme		
1, 2, 3	Primary	
4, 5, 11	Non-durable manufacturing	
6, 7, 8, 9, 10, 12	Durable manufacturing	
13	Services	

Table 1 Growth rates of GDP and interstate commodity flows in the US, 1993-2002

	Percentage growth rates		
	Gross domestic product	Interstate flows of commodities by value	Difference in percentage points
1993-1997	15.54	18.78	3.24
1997-2002	15.85	22.20	6.35
1993-2002	33.86	45.10	11.24

Table 2 Basic statistics for the Midwest and the RUS, 1996

Multi-state area	Gross area product	Output	Employment	Income	Flows
Midwest	1,119,158 (16.0)	1,965,876 (18.5)	22,610 (15.1)	682,445 (16.8)	(16.7)
RUS	5,875,182	8,646,034	126,986	3,384,501	67.2

Note: Monetary values are measured in 1992 $m, and employment is expressed in thousands of full-time and part-time employees. An entry in parentheses is the Midwest value as a percentage of the corresponding US value. The column marked ‘Flows’ refers to the value of intra-area commodity flows as a percentage of the total US flows. The remaining 16.1% (=100-16.7-67.2) represents the flows between the two multi-state areas as a percentage of total US flows.

Table 3 Percentage of sector output and value of total output for each region

	Region					
Sector	IL	IN	MI	OH	WI	RUS
1	1.7	1.8	0.7	1.1	1.3	2.7
2	0.4	0.4	0.3	0.5	0.2	1.3
3	**5.4**	5.5	4.9	5.1	5.7	**6.0**
4	5.1	3.7	2.6	3.9	**8.3**	3.7
5	3.3	4.3	2.4	3.3	1.9	3.2
6	1.8	**6.8**	1.9	3.9	1.8	1.2
7	2.8	3.9	4.3	4.4	3.4	1.3
8	**5.7**	5.3	**5.5**	**5.6**	**8.9**	2.5
9	3.9	4.2	1.1	3.7	5.2	2.5
10	2.9	**11.7**	**22.1**	**11.9**	4.8	2.5
11	**7.2**	**7.2**	**5.5**	**6.2**	**9.9**	**7.8**
12	2.5	4.5	3.8	3.6	4.9	**3.7**
13	57.3	40.7	44.8	46.6	43.6	61.6
Total output	562,573	264,978	425,662	485,934	226,729	8,646,034

Note: The projected output levels are obtained from the MW-REIM. Value of total output is in 1992 $m. The three most important sectors, apart from sector 13, are shown as bold for each region (IL = Illinois; IN = Indiana; MI = Michigan; WI = Wisconsin; RUS = Rest of the US region).

Table 4 Interregional flow,1980, 1990 and 2000

	Region					
	IL	IN	MI	OH	WI	RU
1980						
IL	166,547	5,265	6,454	3,008	7,360	108,959
IN	5,556	67,589	7,834	4,283	1,639	42,983
MI	5,629	5,377	111,447	8,650	4,050	85,895
OH	3,187	3,646	16,729	141,792	1,671	71,706
WI	12,525	1,715	7,725	2,631	38,944	74,011
RUS	66,399	28,981	79,177	55,792	57,524	3,375,637
1990						
IL	194,114	5,129	7,503	3,374	8,407	114,071
IN	5,888	80,577	9,057	5,149	2,009	45,116
MI	6,445	6,244	129,992	10,899	4,097	95,311
OH	3,739	4,632	21,846	166,148	1,980	78,525
WI	14,248	2,345	8,534	3,430	39,437	85,095
RUS	75,465	33,485	84,414	61,209	65,737	3,480,674
2000						
IL	250,092	6,575	11,074	4,831	12,750	138,268
IN	7,667	117,757	15,072	7,331	3,341	55,170
MI	8,830	9,980	182,003	15,648	7,130	119,586
OH	4,940	6,813	32,691	225,379	3,135	94,225
WI	17,354	3,680	14,351	5,216	54,958	114,564
RUS	94,582	44,694	108,467	77,607	91,839	3,965,839

Note: Values are expressed in 1992 $m.

Table 5 Summary of trade flows, 1980, 1990, 2000

	1980	1990	2000
Total US flows	4,688,314	4,964,328	5,933,438
Intraregional flows	3,901,955 (83.2)	4,090,943 (82.4)	4,796,029 (80.8)
Intrasectoral	(31.0)	(35.5)	(37.5)
Intersectoral	(52.2)	(46.9)	(43.3)
Interregional flows	786,359 (16.8)	873,385 (17.6)	1,137,409 (19.2)
Intrasectoral	(7.5)	(8.5)	(10.0)
Intersectoral	(9.3)	(9.1)	(9.2)
MW and RUS flows			
MW to MW	(13.7)	(15.0)	(17.3)
MW to RUS	(8.2)	(8.4)	(8.8)
RUS to MW	(6.1)	(6.5)	(7.0)
RUS to RUS	(72.0)	(70.1)	(66.8)

Note: Values are expressed in 1992 $m. An entry in parentheses indicates percentage of total US flows.

Table 6 Value of VC index in each sector by region, 1980 and 2000

	Sector												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1980													
IL	.56	.08	.12	.09	.08	.28	.16	.06	.09	.06	.10	.11	.010
IN	.14	.03	.12	.08	.05	.07	.11	.05	.08	.05	.07	.06	.012
MI	.05	.04	.09	.05	.09	.34	.15	.08	.09	.03	.11	.05	.010
OH	.07	.06	.07	.06	.10	.27	.12	.08	.12	.08	.08	.10	.009
WI	.06	.01	.07	.08	.02	.09	.02	.01	.01	.01	.01	.01	.004
RUS	.27	.23	.09	.19	.15	.15	.12	.05	.11	.14	.14	.11	.015
2000													
IL	.18	.12	.13	.08	.10	.25	.13	.05	.07	.07	.11	.09	.008
IN	.12	.04	.12	.10	.07	.09	.14	.04	.05	.05	.08	.05	.012
MI	.08	.06	.07	.05	.11	.30	.14	.08	.06	.04	.12	.05	.012
OH	.10	.09	.09	.06	.10	.23	.13	.08	.09	.07	.09	.08	.010
WI	.13	.02	.08	.02	.02	.11	.02	.01	.01	.02	.02	.01	.004
RUS	.20	.27	.10	.17	.12	.11	.09	.03	.13	.15	.16	.11	.017
Trend													
IL	-	+	+	-	+	-	-	-	-	+	+	-	-
IN	-	+		+	+	+	+	-	-		+	-	+
MI	+	+	-		+	-	-		-	+	+		+
OH	+	+	+		+	-	+		-	-	+	-	+
WI	-	+	+	-		+				+	+		-
RUS	-	+	+	-	-	-	-	-	+	+	+		+

Note: The notation +/- indicates the increase/decrease in the *VC* index for each sector in each region from 1980 to 2000.

Table 7 VC index and internal consumption in RUS and Midwest, 1980, 1990 and 2000

	Sectors												
VC	1	2	3	4	5	6	7	8	9	10	11	12	13
RUS 1980	.92	.64	.62	.55	.54	.90	.67	.48	.58	.74	.60	.49	.40
RUS 1990	.84	.69	.66	.51	.56	.88	.65	.40	.57	.71	.60	.50	.45
RUS 2000	.77	.71	.67	.51	.58	.87	.66	.37	.56	.73	.62	.48	.48
RUS trend	-	+	+	-	+	-	-	-	-	-	+	-	+
MW 1980	.83	.45	.49	.37	.33	.74	.51	.41	.38	.67	.43	.34	.23
MW 1990	.72	.53	.53	.33	.35	.69	.47	.35	.33	.64	.41	.33	.27
MW 2000	.62	.56	.54	.33	.37	.69	.49	.32	.29	.66	.43	.30	.29
MW trend	-	+	+	-	+	-	-	-	-	-		-	+

Ranking	Numbered sectors arranged in rank order of *VC* value												
RUS 1980	1	6	10	7	2	3	11	9	4	5	12	8	13
RUS 2000	6	1	10	2	3	7	11	5	9	4	13	12	8
MW 1980	1	6	10	7	3	2	11	8	9	4	12	5	13
MW 2000	6	10	1	2	3	7	11	5	4	8	12	13	9

	Sectors												
Flows	1	2	3	4	5	6	7	8	9	10	11	12	13
RUS 1980	39	9	3	19	22	28	6	18	15	15	30	17	48
RUS 2000	35	4	3	14	23	20	5	14	12	14	21	13	58
RUS trend	-	-		-	+	-	-	-	-	-	-	-	+
MW 1980	26	6	2	11	19	27	5	6	10	12	13	6	30
MW 2000	15	1	2	12	21	21	5	9	11	14	14	7	34
MW trend	-	-		+	+	-		+	+	+	+	+	+

Note: The shading is explained in the text. The notation +/- indicates an increase/decrease in the value of *VC* for each sector over the period 1980-2000. The lower part of the table marked 'Flows' refers to intra-area, intrasectoral flows as a percentage of total US flows, together with the trends. The RUS total internal consumption (which is intra-area, intrasectoral trade as a percentage of total RUS flows) amounts to 17.8, 18.6, 19.1% in 1980, 1990, 2000, respectively, and for the Midwest the corresponding figures are 15.1, 15.4, 15.7%. The trend of sectoral internal consumption for the U.S as a whole is approximately the same as that for the RUS.

Table 8 Interarea-intrasectoral VC measures for RUS and Midwest, 1980 and 2000

	Sector												
	1	2	3	4	5	6	7	8	9	10	11	12	13
RUS 1980	.402	.026	7E-6	.041	.018	.140	.018	.170	.050	.550	.133	.008	.334
RUS 2000	.143	.004	4E-6	.033	.015	.059	.009	.083	.039	.521	.072	.004	.434
RUS trend	-	-	-	-	-	-	-	-	-	-	-	-	+
MW 1980	.073	.009	7E-9	.005	.002	.054	.005	.008	.001	.475	.019	.001	.001
MW 2000	.019	1E-4	5E-9	.009	.004	.032	.004	.012	.001	.485	.023	.001	.001
MW trend	-	-	+	+	+	-	-	+	+	+	+	+	+

Note: The expression 7E-6, for example, is equal to .000007. The notation +/- indicates an increase/decrease in the value of the *VC* index over the period 1980-2000.

Table 9 Interzonal interdependence within the Chicago metropolitan area derived from intersectoral trade flows only

	1	2	3	4
1	**89.96**	2.40	2.17	2.21
2	2.97	**90.30**	2.77	2.83
3	1.44	1.49	**89.81**	1.38
4	5.63	5.81	5.25	**93.58**
Total	100.00	100.00	100.00	100.00

Note: Entries show the percentage (of the total) of each column entry from the Interzonal Leontief inverse matrix based on trade flows (the bold diagonal entries are the intrazonal values).

Table 10 Interzonal interdependence within the Chicago metropolitan area derived from trade, income and consumption flows

	1	2	3	4
1	**48.90**	11.29	17.48	13.82
2	5.97	**47.47**	5.69	6.60
3	18.98	11.56	**49.87**	14.69
4	26.15	29.67	26.96	**64.89**
Total	100.00	100.00	100.00	100.00

Note: Entries show the percentage (of the total) of each column entry from the Interzonal Total Impact inverse matrix based on trade, income and consumption flows (the bold diagonal entries are the intrazonal values).