Spillovers from economic development: an interregional perspective

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Outline

- Why do we need interregional models?
  - Accounting
  - Spillovers
  - Supply chain analysis
- Applications
  - Great Hanshin earthquake
  - Spillover effects – asymmetry
  - Trade and economic development
  - Hollowing out
  - Intra metropolitan analyses
- The New Challenge – Supply Chain Analysis

Introduction

- For many decades, development agencies paid little attention to the ***intra***-national dimensions of economic development
- It was assumed that a similar project located in one region would generate the same spatial and total impact as one located in another region.
- The development of multiregional input-output and computable general equilibrium models has revealed that, contrary to Tom Friedman,
  - **the world *inside* nations is not flat.**

Introduction (2)

- Space is spiky and it is uneven
- Projects generate different spatial distributive impacts depending on:
  - The nature of the project (highway, new business, investment in human capital)
  - Location of the initial place of the project
- Further, spillover effects are not necessarily symmetric:
  - A project in Hokkaido may generate larger impacts on Kanto than a project in Kanto generates on Hokkaido
  - Projects may disturb the spatial equilibrium – with factors, such as capital and labor responding to changes in opportunities and rents by re-locating

Introduction (3)

- In this presentation, analysis will center on some empirical findings from Indonesia, Japan, Brazil and the Midwest of the US
- Since spillovers occur at all spatial scales, will explore how an interregional system of the Miyazawa style can help understand economic development processes *within* metropolitan regions.
- As the processes of **fragmentation** and **hollowing-out** continue, **interregional dependency** will assume even greater importance in understanding the growth and development paths of economies.
- Fukushima earthquake and Thailand floods revealed risks associated with extensive supply chains

Introduction (4)

- Regional economies are becoming both
  - **More competitive**
  - **More integrated**

  at the same time, creating new challenges for policy analysts
- To understand the new challenges to economic development, it is essential to develop and maintain tools – such an *interregional models* – that can assist in tracking changes

Accounting Frameworks

- In some multiregional CGE models (e.g. B-MARIA-27 for Brazil), national impacts estimated as sum of regional impacts (*bottom-up* model)
- In a series of articles, Miller (1966, 1969, 1986) introduced the notion of ***interregional feedback effects*** into the literature of regional analysis
- Miller's interpretation can be reconsidered in terms of an extended or augmented Leontief inverse (see Yamada and Ihara, 1969).
- Expanded to embrace notion of feedback loops by Sonis and Hewings

Accounting Frameworks

- Feedback loops provide the *building blocks* for the identification of the myriad economic interactions within an input-output system
- In a multi-regional system, methods are now available to:
  - first identify the paths (geography) of influence across regions and then
  - proposing an hierarchical extraction method to identify the paths in terms of the order of their economic importance.
- Thus, if feedback effects prove to be important, the methods presented here will highlight the nature and significance of the spatial paths of influence across the interregional system.

Spillover Effects

- In Miller's original work, the magnitude of the feedback effects was relatively modest – around 5%
- However, the spillover effects can be much larger
  - These are the impacts on other regions due to imports
  - But the geography of these impacts can vary by sector
- Further, the spillover affects may be non symmetric
  - Impact of change in region 1 on region 2 can be larger or smaller than the impact of a change in region 2 on region 1
  - The **geographical patterns of spillovers** and the **timing of the spillovers** can vary as well because of the nature of supply chains

Supply Chains

- The New Economic Geography associated with the work of Nobel Laureate **Krugman** and **Fujita** has stressed two important aspects of the spatial economy
  - The important role of economies of scale
  - The critical role that transportation costs play in the spatial organization of production
- To which one might add the changing role of ownership (firm consolidation)
- In the last 3 decades, transportation costs in real terms have declined significantly
- Firms are now able to organize their supply chains to optimize production

Supply Chains (2)

- In the average plant, the number of products produced has declined as firms optimize production across plants to take advantage of economies of scale in the production of any component
- The impacts: the sequencing (or **fragmentation**) of production now involves movement of components from one plant to another
- As a result, intra-regional trade has decreased relative to inter-regional trade
- Hence, the need for multiregional models

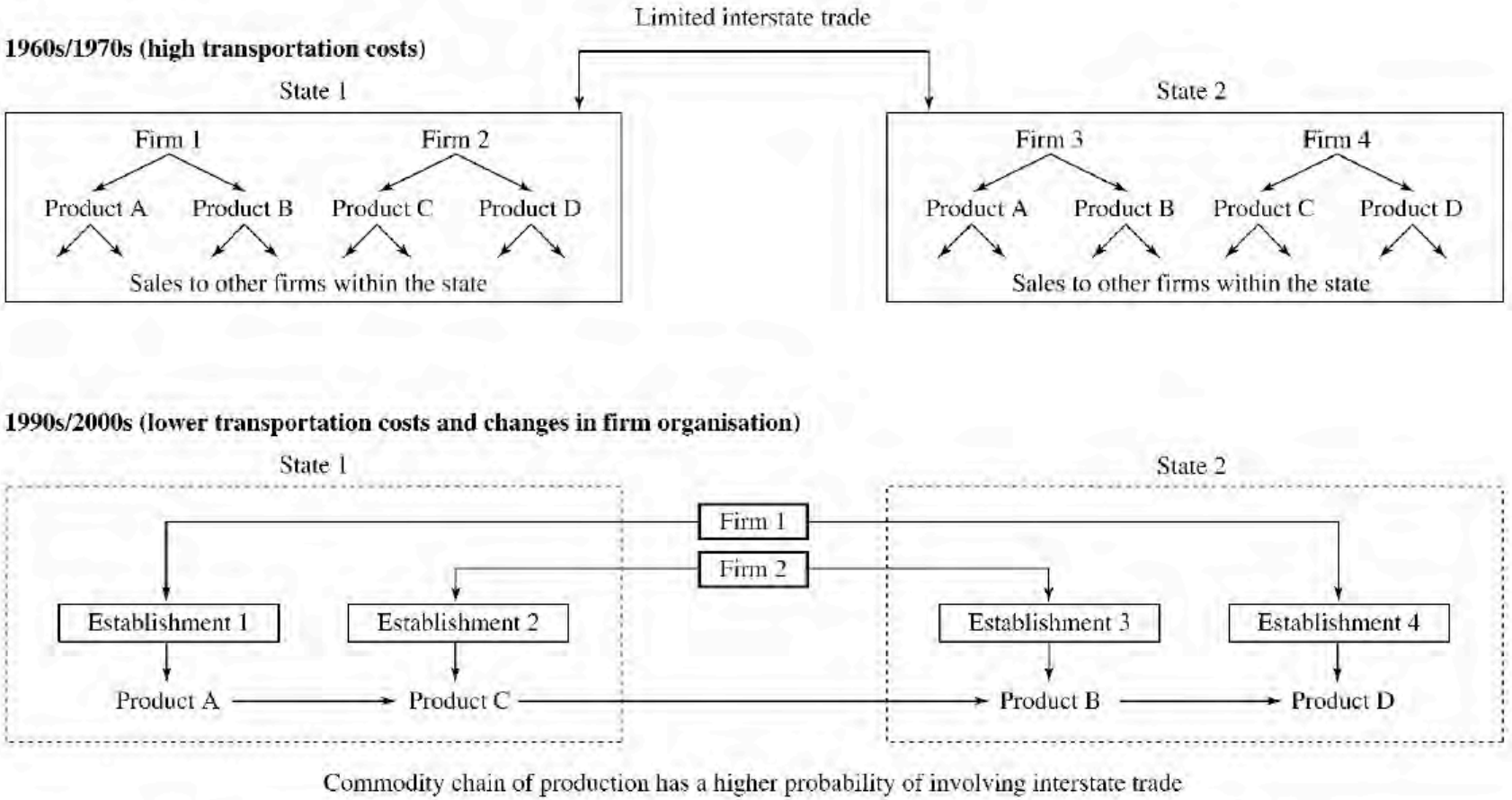


Fig. 2. Changing spatial organization of firms (from four firms to two firms/four establishments)

Applications of Interregional Models

- Earthquakes – Unexpected Events
- Recent earthquakes emphasized need to consider indirect effects
  - On other regions within an economy
  - On other countries through international trade
- Okuyama *et al.* (1999) found larger indirect impacts in rest of Japan from Kobe earthquake
- Appropriate recovery and reconstruction plans, especially on interregional lifeline damages, are necessary to minimize the further indirect effects and to plan a smooth and timely recovery process for the economy.

Interregional Impacts: Indonesia

- Decades of policy initiatives had failed to reduce the income disparities between Java and Eastern Islands
- Built a 5-region multiregional model to estimate how changes in one region would spillover to other regions
- Results:
  - Intra-regional impacts of a change in final demand always >70% within Java
  - In Eastern Islands, less than 30% in all but agriculture
  - For Java – interregional outflows small but interregional inflows large
  - Reverse is true for Eastern Islands

Java

Sector	Sumatera	Java	Kaliman	Sulawesi	Eastern Islands	Inter Regional Sum
1	6.4	83.2	2.7	3.6	3.3	17.8
2	17.2	72.4	7.2	1.0	1.9	27.6
3	14.0	74.5	5.9	2.4	2.9	25.5
4	6.1	89.0	2.6	1.0	1.1	11.0
5	8.9	83.9	3.8	1.4	1.7	16.1
6	5.0	89.0	2.1	1.6	1.6	11.0
7	4.1	92.2	1.7	1.0	1.0	7.8
8	3.0	94.2	1.3	0.5	0.6	5.8
9	4.2	92.3	1.8	0.7	0.7	7.7
10		100.0				
11	5.4	89.6	2.3	1.1	1.3	10.4

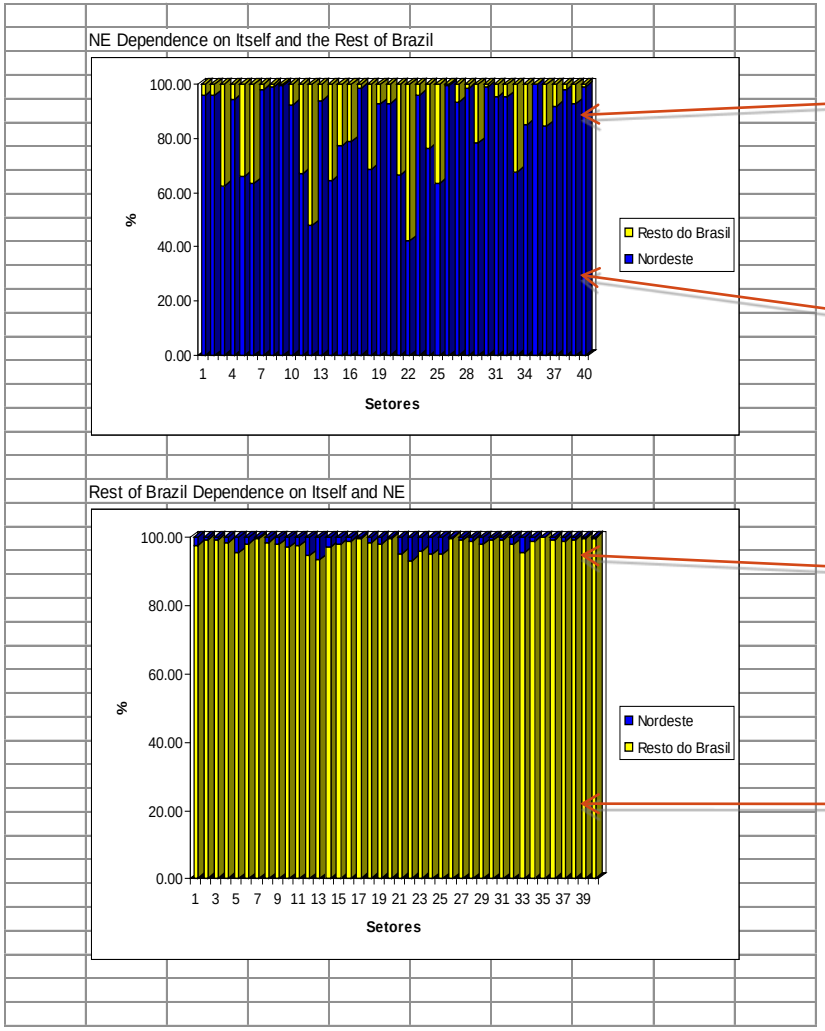
Asymmetry of Impacts

Eastern Islands

Sector	Sumatera	Java	Kaliman	Sulawesi	Eastern Islands	Inter Regional Sum
1	20.7	21.0	9.2	4.7	43.9	56.1
2	32.8	33.3	14.5	7.5	10.8	89.2
3	29.4	28.9	13.0	6.7	21.8	78.2
4	34.1	34.4	14.7	7.7	8.9	91.1
5	33.5	32.8	14.9	7.9	10.7	89.3
6	28.9	29.6	12.7	6.9	21.3	78.7
7	31.0	30.9	13.8	7.0	16.8	83.2
8	29.0	30.1	12.5	7.5	20.5	79.5
9	25.0	26.3	10.8	6.1	31.3	68.7
10					100.0	
11	33.7	33.3	15.0	7.9	9.9	80.1

Interregional Impacts: Brazil

Dependency of the NE of Brazil and Rest of Brazil 1985-1995



Internal dependency in NE

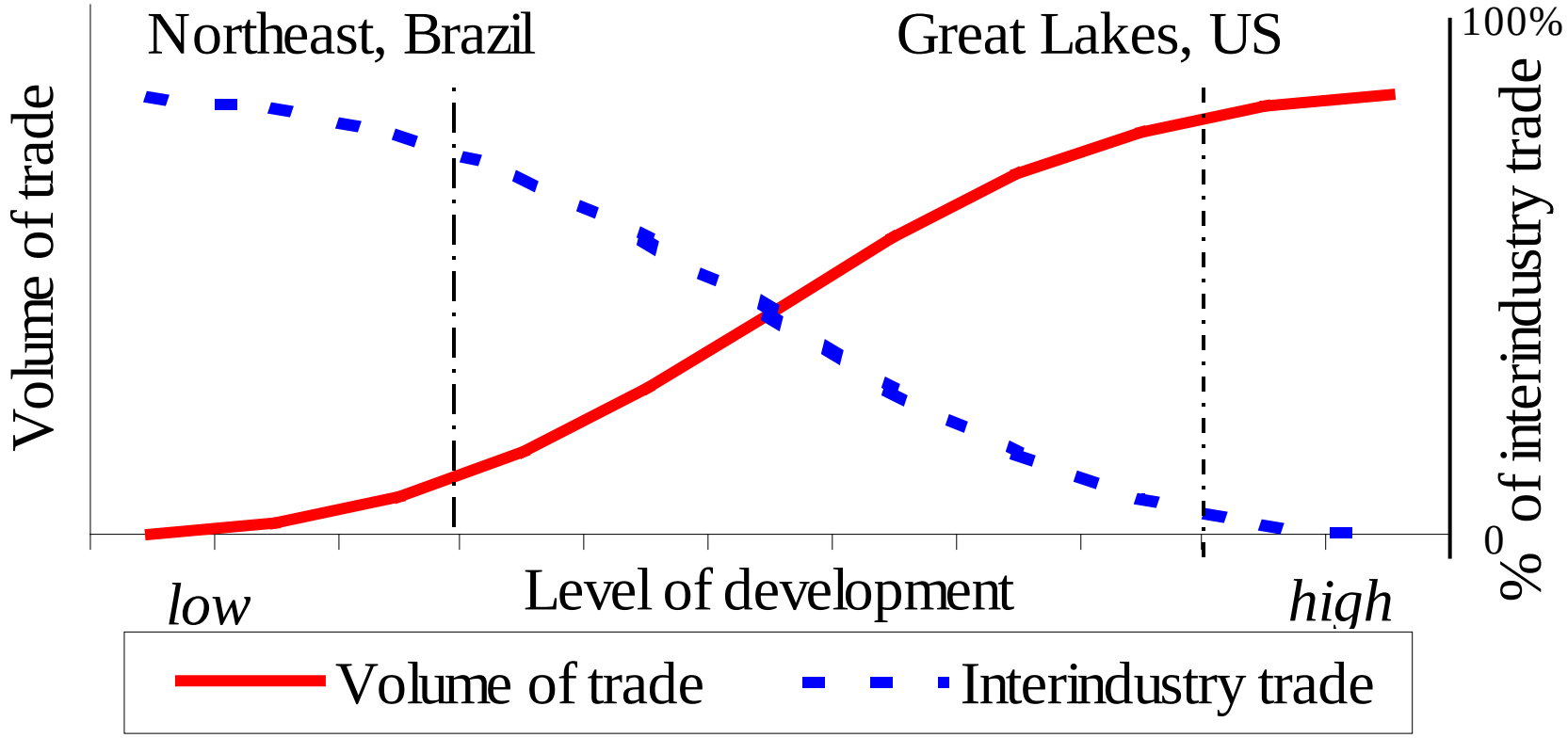
NE imports from Rest of Brazil

Rest of Brazil imports from NE

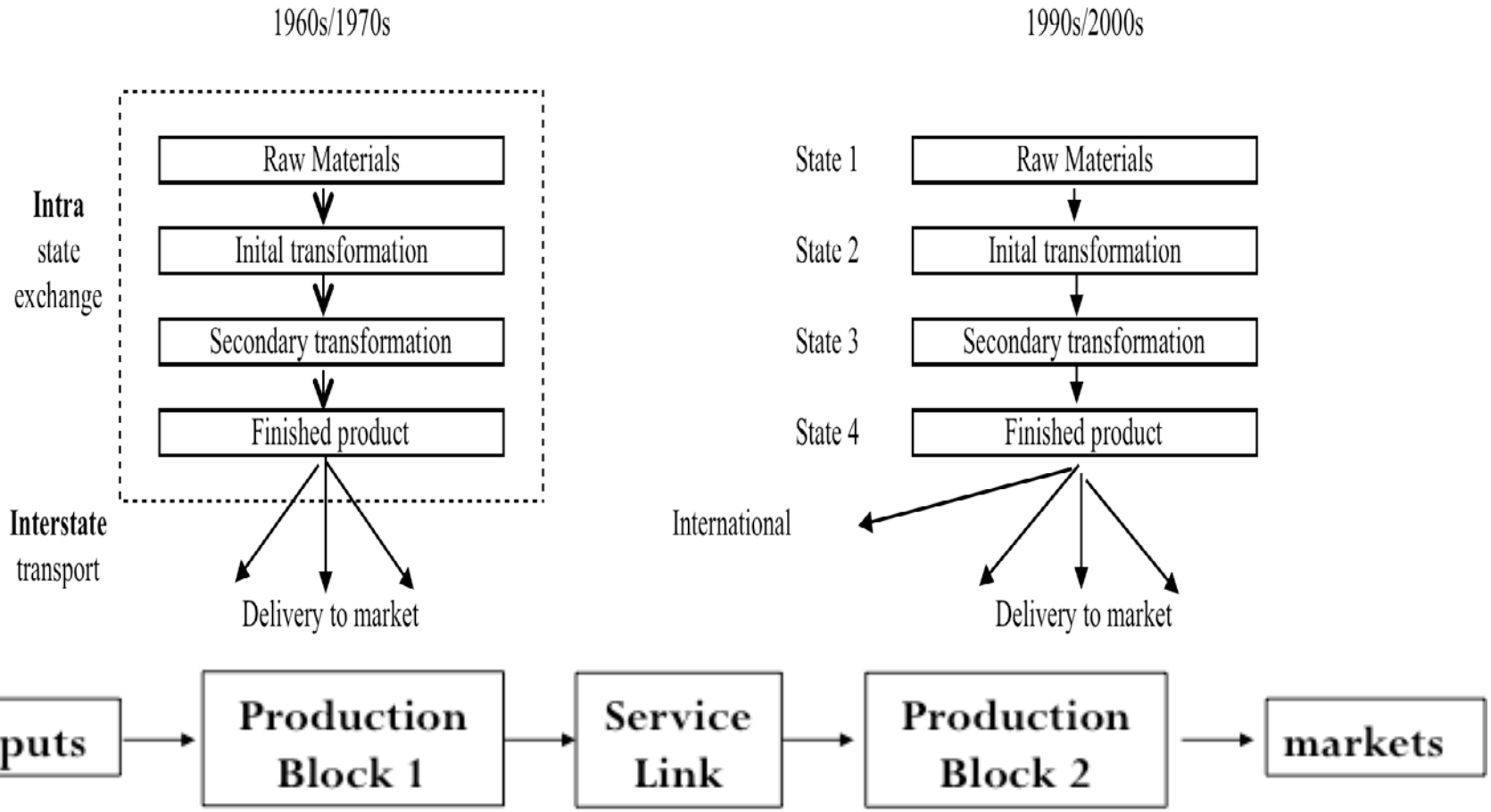
Internal dependency in Rest Of Brazil

Why differences between NE and RB?

- Competition and complementarity in the regional economies of the NE of Brazil
- Compare two regions with similar share (15% NE Brazil, 16% Midwest US) of their respective national GDP
- Expectations?
- Thus higher levels of development imply larger volumes of trade with a lower percentage of interindustry trade
- the volume of trade within the Northeast of Brazil would be considerably smaller than within the Midwest, and highly concentrated in interindustry trade
- level of interaction among the Midwest states would be larger that the level of interaction among the Northeast ones


Northeast, Brazil
Great Lakes, US
Volume of trade
100%
0
% of interindustry trade
low
Level of development
high
Volume of trade
Interindustry trade

Fragmentation Leads to Increased Interregional Trade



Interregional Trade: Midwest US

- Domestic trade still far more important than international trade for the Midwest states but significant share of Midwest interstate flows end up in international exports
- Dependency on the other Midwest states prominent
- Midwest export trade to other Midwest states in 2007 was $450 billion – would rank 7th in World

	($ million)			%	%	% Domesti
	Domestic	Foreign	Total	Foreign	Domestic	Midwest
IL	$399,913	$48,896	$448,809	10.89%	89.11%	32.40%
IN	$252,023	$25,956	$277,979	9.34%	90.66%	33.82%
MI	$226,875	$44,555	$271,430	16.41%	83.59%	32.29%
OH	$369,824	$42,562	$412,386	10.32%	89.68%	27.62%
WI	$172,125	$18,825	$190,950	9.86%	90.14%	33.19%

Interregional Dependence Brings Positive and Negative Outcomes

Spillover Effects of Jobs Losses in Midwest

Percentage Distribution in other states

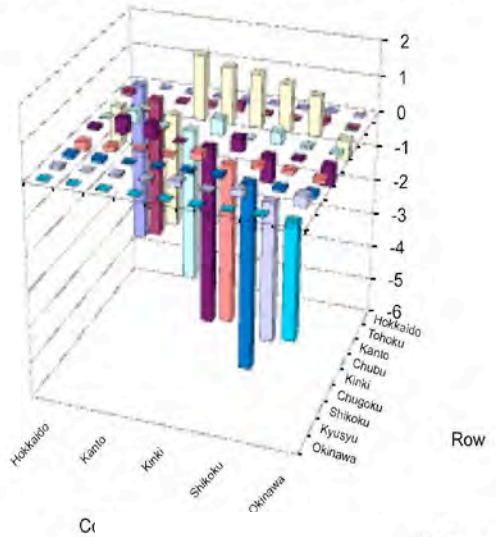
Change in state → Impacts in

	IL	IN	MI	OH	WI	Rest of Midwest Total	RUS
IL	-	5.98%	4.70%	5.13%	3.85%	19.66%	80.34%
IN	9.36%	-	6.19%	12.00%	2.33%	29.88%	70.12%
MI	5.78%	5.73%	-	13.10%	5.06%	29.66%	70.34%
OH	4.54%	6.47%	8.24%	-	1.98%	21.24%	78.76%
WI	7.91%	3.64%	8.35%	5.00%	-	24.91%	75.09%

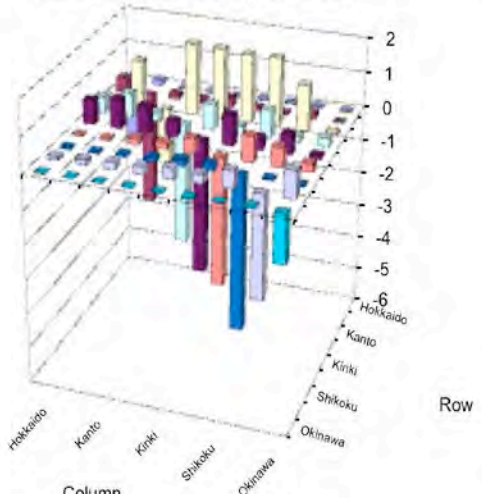
Interregional Impacts: Japan

- Using modified interregional model of Japan, explored role of trade in generating impacts across the regions 1980-90
- Following Yamada and Ihara's notion of an enlarged Leontief inverse, this was decomposed into three parts:
  - contribution of domestic purchasing coefficients,
  - contribution of interregional trade coefficients and
  - contribution of technical coefficients.
- Figures show these factor contributions to the change in the enlarged inverse evaluated by block multipliers.

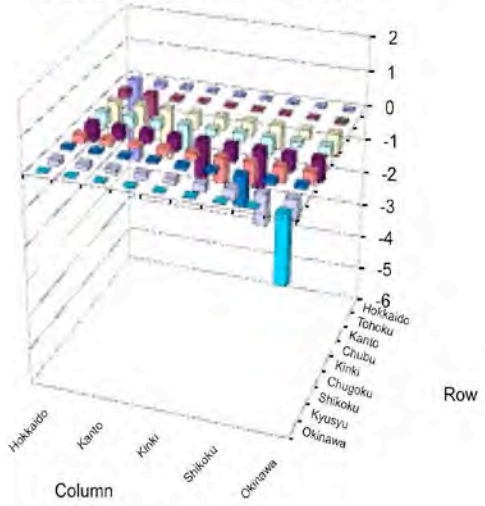
(1) Difference in the Enlarged Leontief Inverse 1980-1985



(3) Contribution of Inter-regional Trade Coefficients to Difference in the Inverse 1980-1985



(4) Contribution of Technical Coefficients to Difference in the Inverse 1980-1985



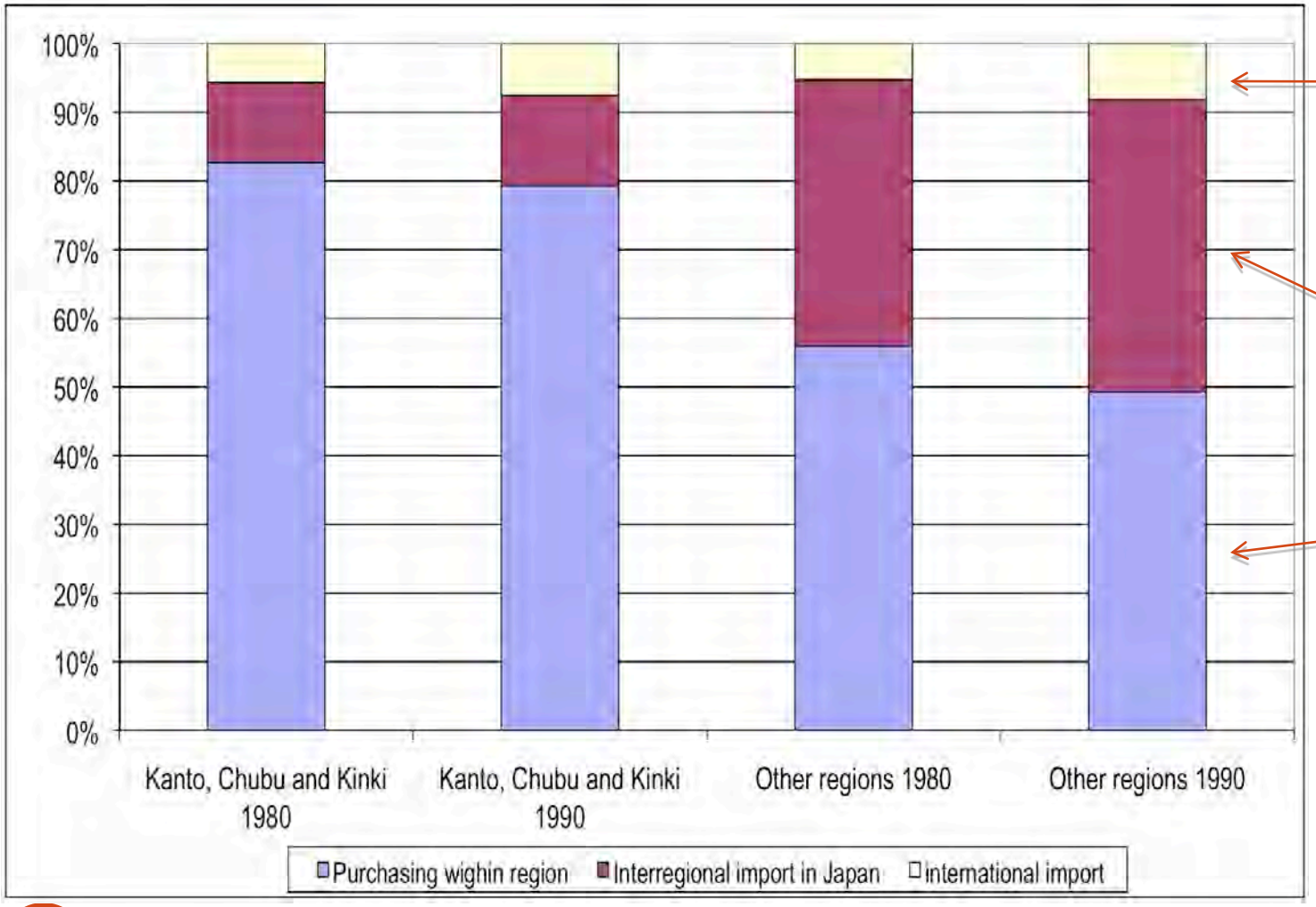
Interregional Impacts: Japan (2)

- The **intraregional** multiplier declined over the period 1980-1990
- The major factor accounting for the decline in the intraregional multiplier is clearly the dispersing of interregional trade.
  - All the regions decreased intraregional purchases and dispersed their interregional trade but
  - interregional purchases from Kanto significantly increased.
- interregional feedbacks, are increasing over the period 1980± 1990, while the direct effect of demand generated in Kanto on the output of Kanto is decreasing.
- This evidence indicates that the dependence of other regions on the Kanto region increased during this period; these interpretations support Akita' s (1999) findings, especially important role demand in Kanto has on Chugoku

Interregional Impacts: Japan (3)

- **International imports** have little effect at the regional level, whereas the changes generated by interregional trade are much more important
- While the effect of interregional trade was dispersing and intraregional multipliers are decreasing, the contribution of **technology change** is declining in importance.
- Clearly, this results in part from decreasing intermediation.
- In an earlier study, Okazaki (1989) reported that the degree of intermediation in the Japanese economy as a whole had begun to decline; he referred to this process as a `*hollowing-out*' effect.
- The results in the present analysis confirm this hollowing out process and indicate that it is still proceeding in the Japanese economy
- [Hewings *et al.* (1998) found the same process occurring in the Chicago economy.]

Manufacturing Structure, Japan 1980, 1990



Little change in international imports

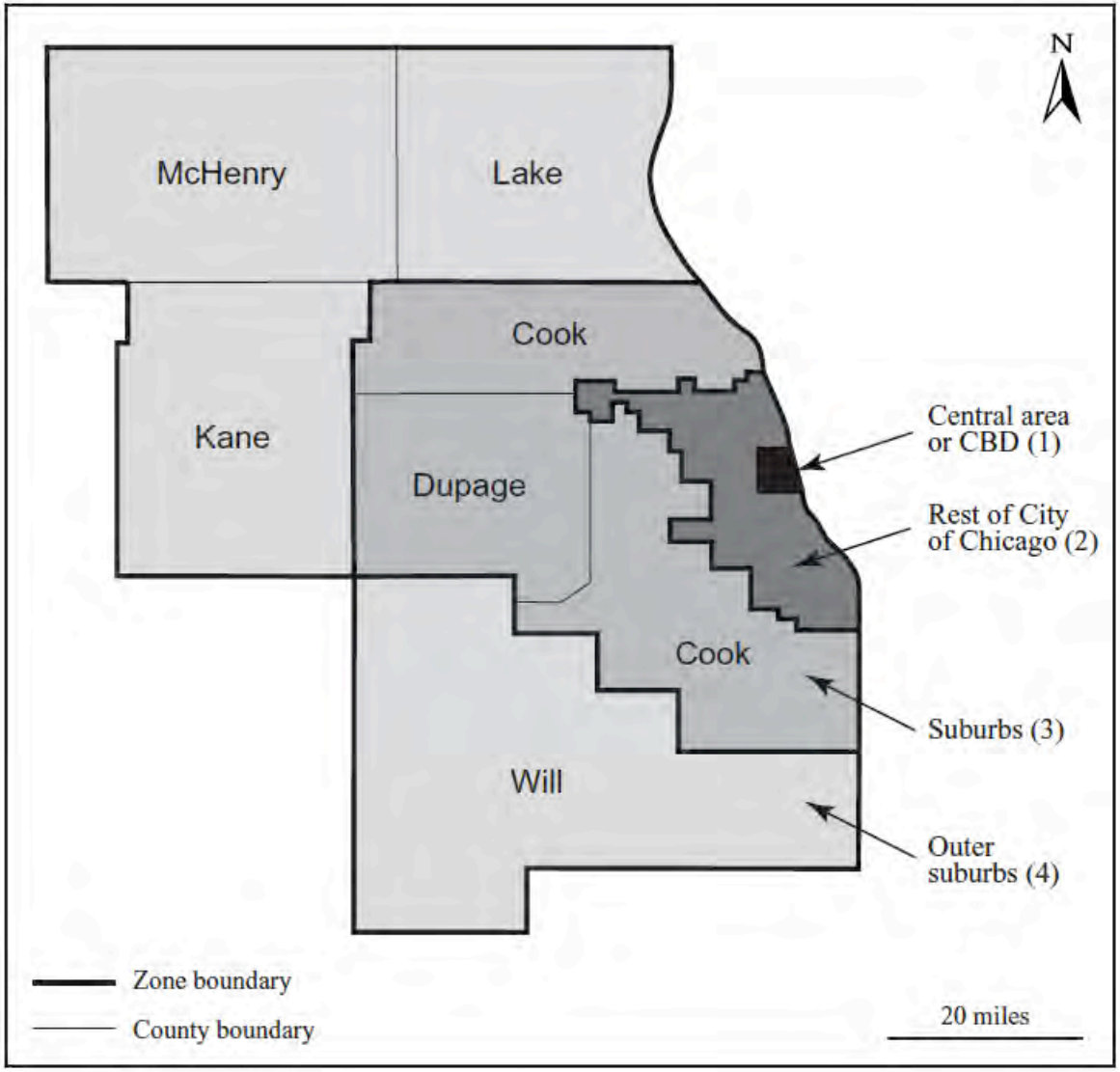
Increasing inter-regional inputs

Decreasing intra-regional inputs

What is Happening Inside Metropolitan Regions?

- Krugman has argued that patterns and impacts of trade have similar impacts
  - Between countries
  - Between regions inside countries
- What about within large metropolitan regions?
- Detailed analysis of the Chicago economy provides some insights into the nature and strength of trading relationships
  - Goods and services
  - Flows of people (commuting)
  - Flows of expenditures by households

Spatial Divisions of the Chicago Region



Chicago Intra Metropolitan Flows

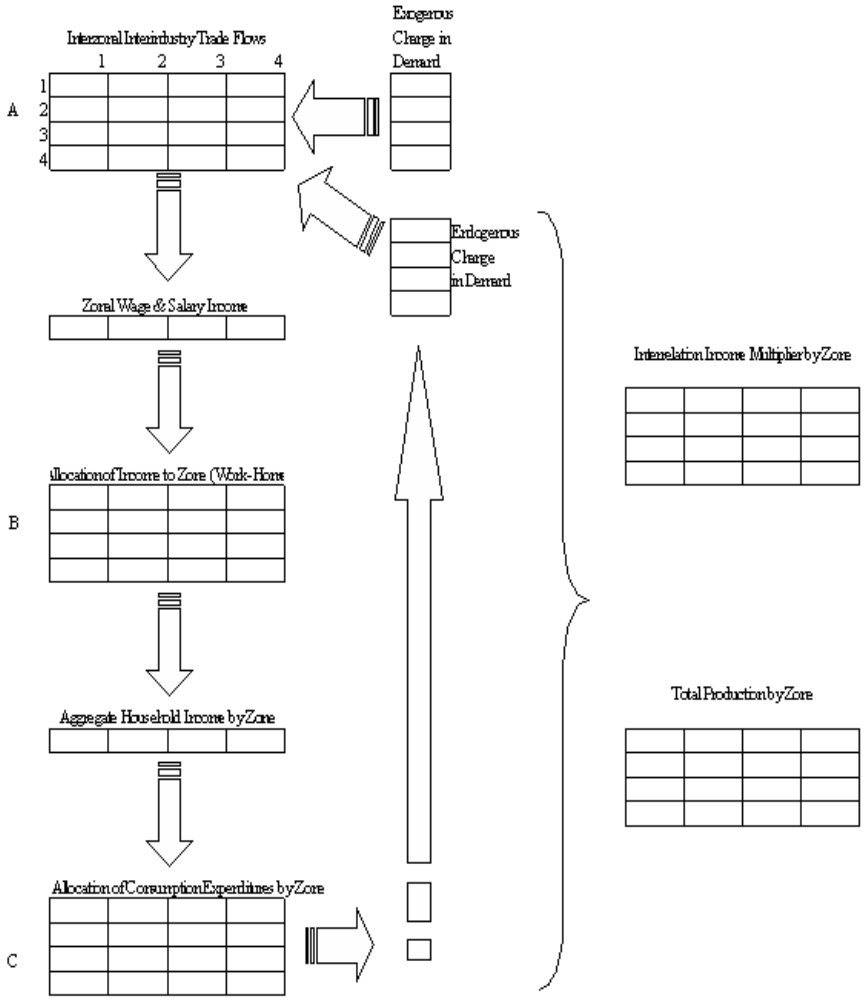
Goods and Services Flows

Wages and salaries

Flows of commuters and their incomes by zone

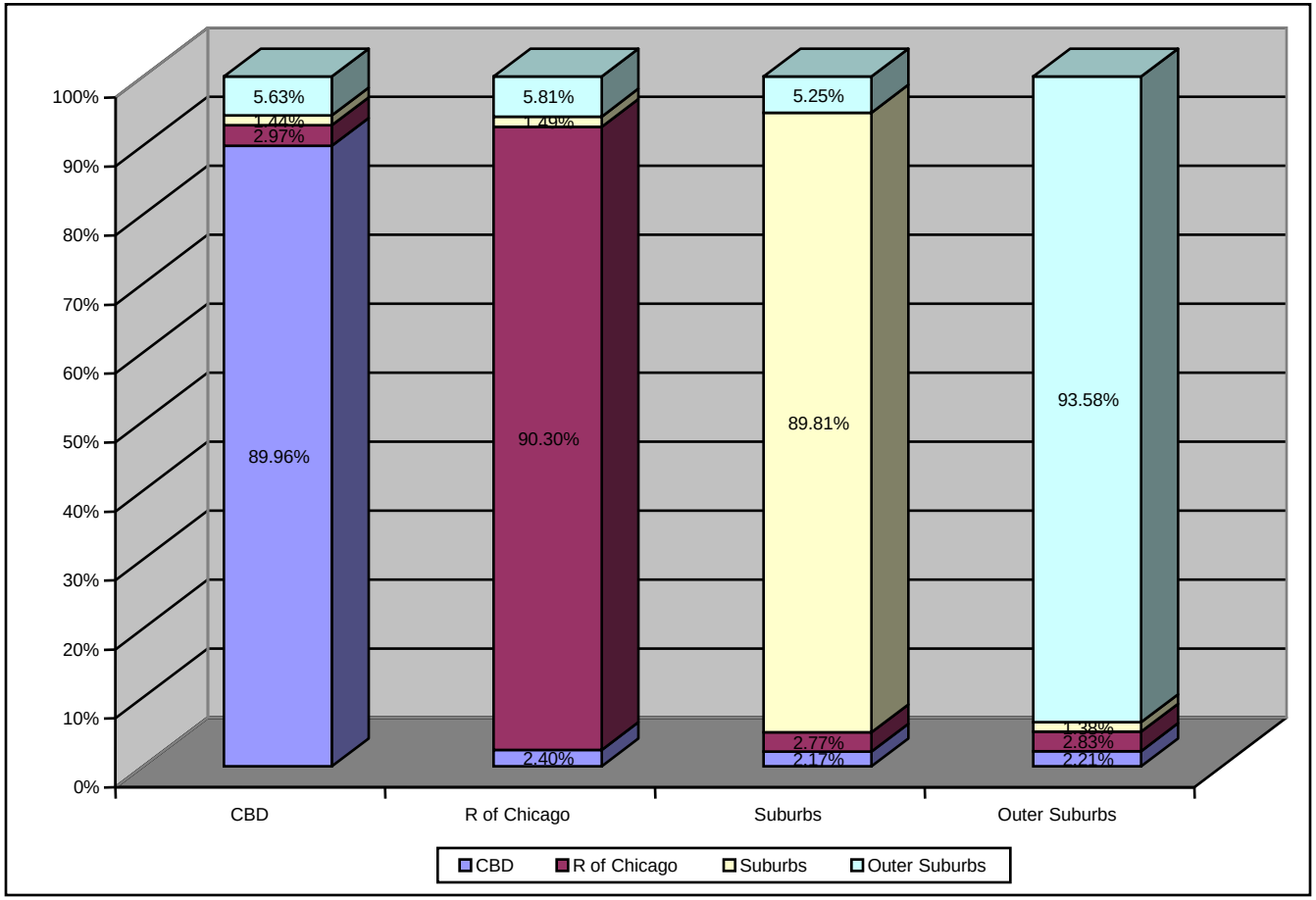
Household expenditures

Flows of expenditures by zone



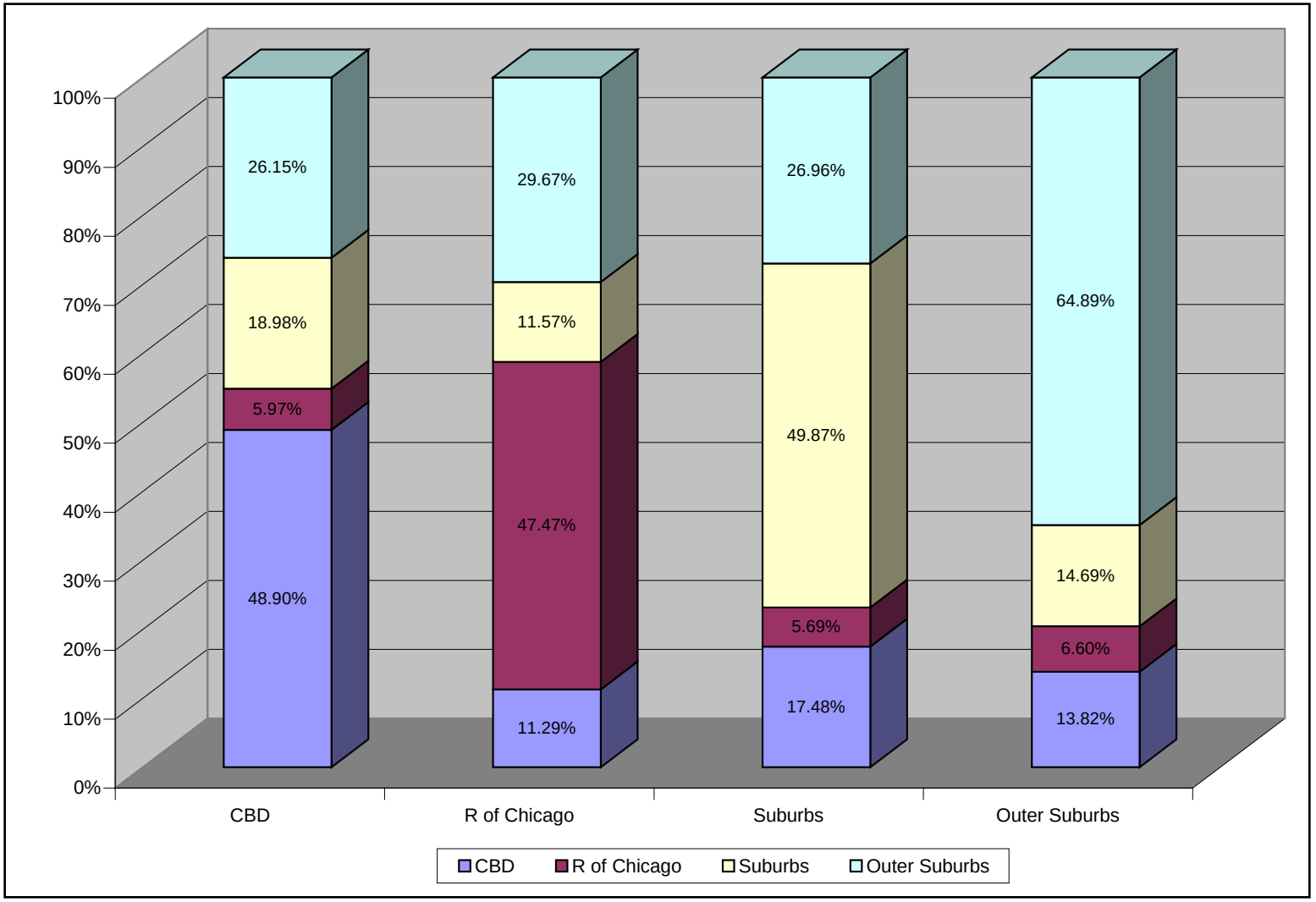
Interindustry interdependence

- Limited intra-zonal flows of goods and services



Total interdependence

- Substantial interdependence when all interactions considered



Unexpected Result: The Miyazawa Interrelational Income Multiplier

Miyazawa's Interrelational Income Multipliers

	region of income origin			
	Region 1	Region 2	Region 3	Region 4
Region 1	1.23	**0.12**	0.16	0.07
Region 2	0.11	**1.28**	0.13	0.05
Region 3	0.03	**0.03**	1.06	0.01
Region 4	0.44	**0.56**	0.50	1.77 ← suburbs
Total	1.81	**1.99**	1.85	1.90

- Region 2 – least prosperous but generated largest income multiplier
- Significant asymmetric spillovers – suburbs benefit more from income growth in other regions than vice versa

Summary Evaluation

- The patterns of increasing trade dependencies observed at the international level are found at the regional level within countries
- However, flows of goods and services and complemented by flows of labor (commuting and migration) generating an enhanced pattern of interdependence
- Single-region models now need to be enhanced by more extensive consideration of interregional trade

Summary Evaluation (2)

- As regions become both more competitive and interdependent at the same time, it will be even more important to know:
  - The nature and importance of external trade
  - The geography of this trade – important trading partners
  - Sustainability of trade and the nature of economic vulnerability (e.g. supply chain disruptions)
  - Policy instrument that a single region can employ to enhances its competitiveness
- Without access to formal models, none of this will be possible

The Challenge of Fragmentation and Supply Chains

- Work at the country level (e.g. Kukasaku, Meng and Yamano, 2011) has revealed greater country integration in Asia as a result of fragmentation of production
- Expectations:
  - Decrease in diagonal elements as production value chains involve more establishment to establishment flows
  - More interregional and international flows
  - But process may not be homogenous – trade-off between increase in complexity and increase in spatial fragmentation

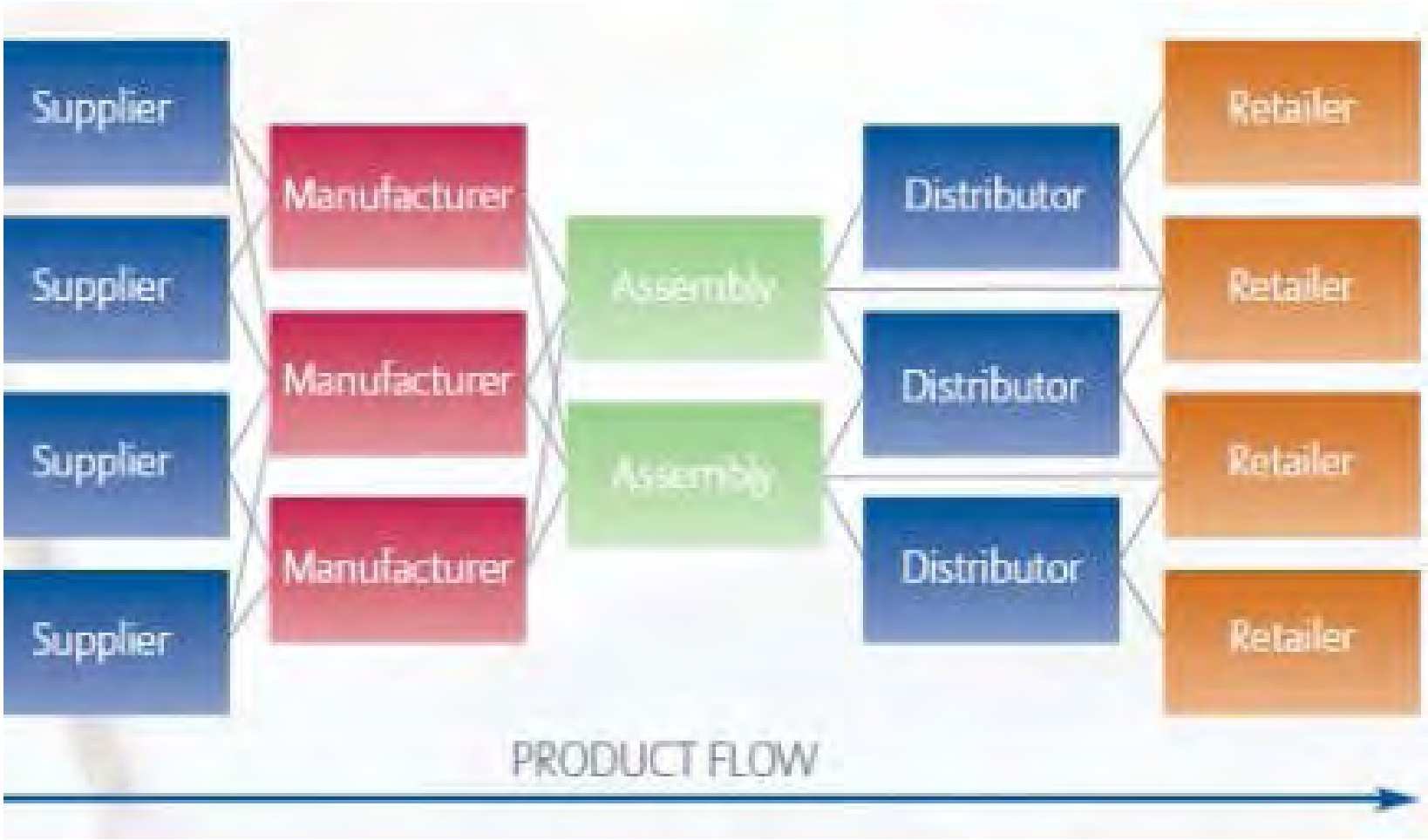
The Challenge of Fragmentation and Supply Chains

- In analysis of Chicago economy, two dimensions are differentiated within the fragmentation process:
  - Spatial: decrease in the complexity of production systems inside any given economy
  - Functional: outsourcing may increase the density of transactions and linkages within a given economy
- Implications for the Chicago region were studied from a set of input-output tables estimated for the period 1978-2014 using Average Propagation Lengths (APLs).

The Challenge of Fragmentation and Supply Chains: Chicago Results

- (1) The Chicago economy has experienced a process of hollowing out due to spatial fragmentation, causing an overall reduction in intermediation.
- (2) A decrease in the variety of goods and services produced in any one sector (i.e. secondary product production has decreased).
- (3) An increase in the specialization of production in each sector.
- This latter observation is consistent with the NEG ideas of the dominance of scale economies and the ability of an individual establishment to serve more extensive geographic markets.

Simple Supply Chains: Auto Industry



Modeling Challenges: Supply Chains

- Supply chains
  - Business literature focus on optimization methods
  - In many cases the input-output links not considered
- Potential clear role for CGE models with a quasi optimization structure but…
  - The Leontief world dominates many supply chains since contracts specific volume, quantity and delivery schedule
    - CGE nested production function would have to accommodate the non-competitive nature of the input structure in the short-run (fixed contract)
    - Further, in the short-run, may be no possibilities for input substitution both technically and spatially (e.g. Toyota, Honda)

Modeling Challenges: Supply Chains

- Fragmentation over multiple planst and locations
- Coordination (sequencing), timing and risk – space time issues rarely addressed in IO modeling
- Temporal linkages
  - Purchase of an automobile will generate series of future demands for gasoline, servicing, insurance etc. – but at future points in time
  - Inter-temporal consumption thus needs to be addressed in multi-period input-output models

Modeling Challenges: Supply Chains

- Example of recent case study. Ford
  - Know total volume of inputs
  - But do not know sequencing – with multiple inputs into the final assembly generating their own supply chains
  - Need measure of risk – how to assist firm reduce complexity of dealing with multiple suppliers of components but not to expose them to potential risk of over-reliance on too small a number

Modeling Challenges: Supply Chains

- Some potential modifications:
- Modify *APL* to account for simultaneity across value chains
- Explore the Dietzenbacher-Los *hypothetical extraction* or the Somis-Hewings *field of Influence* method to focus on disruption in one or more components and to posit effect of disruption in one chain on production systems
- Explore multi-period nature of household's purchase of one good on future demands for ancillary services – a new task for sequential input-output modeling

Final Thoughts

- Supply chain analysis points to production systems that seem to lean on a more dominant role for Leontief systems in production processes
- The inter-temporal nature of consumption has to be embraced to fully understand how purchases at one time can generate future demands
- Supply chain modeling specialists seem not to have been exposed to notions of economic interdependence…..