

The REAL Midwest Modeling System

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Outline

- Motivation
- Early Model Development
- Recent Work
- Current Model Structures
- Plumbing to date
- Example application
- Future Research

Motivation

- Over the past three decades important structural changes in the US economy
 - Decreasing relative contribution of manufacturing to GNP
 - Changes in location of economic activity
 - Changes in the spatial organization of production
- Midwest has experienced greater absolute impacts from these changes
 - Impacts have not always been uniform across Midwest states
 - For example, IL became a non-manufacturing dominated state 2-3 years ahead of the US as a whole

Motivation

- Midwest characterized by
 - Significant interdependence
 - Both internal markets (i.e. within Midwest)
 - International markets – international trade dominated by exports to Canada and Mexico
 - Structural problems
 - Labor force issues
 - Net out-migration of highly endowed human capital
 - ?underinvestment in high-skill blue-collar human capital?
 - Governance issues – failure to appreciate and exploit economic interdependencies

How has the economy changed?

- Three important characteristics:
 1. Each state is hollowing out – typical establishment is now less dependent on sources of inputs within the state and on markets within the state ---- ripple effects of change within the state are now smaller than 20 years ago
 2. Structure of production is changing – fragmentation is now a characteristic of production
 - The value chain is now longer
 - Firms are organizing production to exploit economies of scale in individual plants in specialized component production and shipping to other plants to add further components



State 1

State 2

How has the economy changed?

- Three important characteristics:
 3. The organization of production is changing
 - More establishments are part of multi-regional and multi-national enterprises
 - Decision-making – on location of new activity, introduction of new production lines and services – is now more often removed from the location of production

The Volume of Midwest Trade

- Domestic trade still far more important than international trade for the Midwest states
- 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)			%	%	% Domestic
	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%

The Costs of Interdependence

Impacts of Job Losses in Illinois

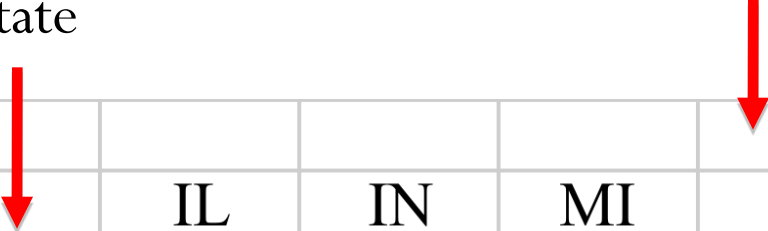
	Job Losses	Percentage of Indirect Impacts
Illinois	-419,000	
Indiana	-14,000	5.98%
Michigan	-11,000	4.70%
Ohio	-12,000	5.13%
Wisconsin	-9,000	3.85%
Rest Midwest Total	-46,000	19.66%
Rest of US	-188,000	80.34%
Total	-653,000	100.00%

The Costs of Interdependence

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%

Early Model Development

- REAL has developed a series of econometric-input-output models for a variety of metropolitan areas, states and regions since 1989
- These REIMS (**R**egional **E**conometric-**I**nput-output **M**odels) offer the following characteristics:
 - Cross section of the interdependence of the economy characterized by the input-output structure
 - Time-series perspective provided by econometric modeling of all relationships – including the input-output structure
 - Endogenous structural change in production

Early Model Development

- The REIMS provide capability for
 - Impact analysis (e.g., Stimulus)
 - Forecasting (e.g. for CMAP “Go to 2040”)
 - Scenario assessment (e.g. import substitution)
- REIMS have been linked to other modules
 - Occupational Toolbox for use in assessing future skill needs by Chicago Community Colleges
 - Environmental assessment – forecasts of pollution by major category taking into account structural change in pollution abatement strategies
 - Links with transportation networks (Midwest Earthquake analysis, CREATE)

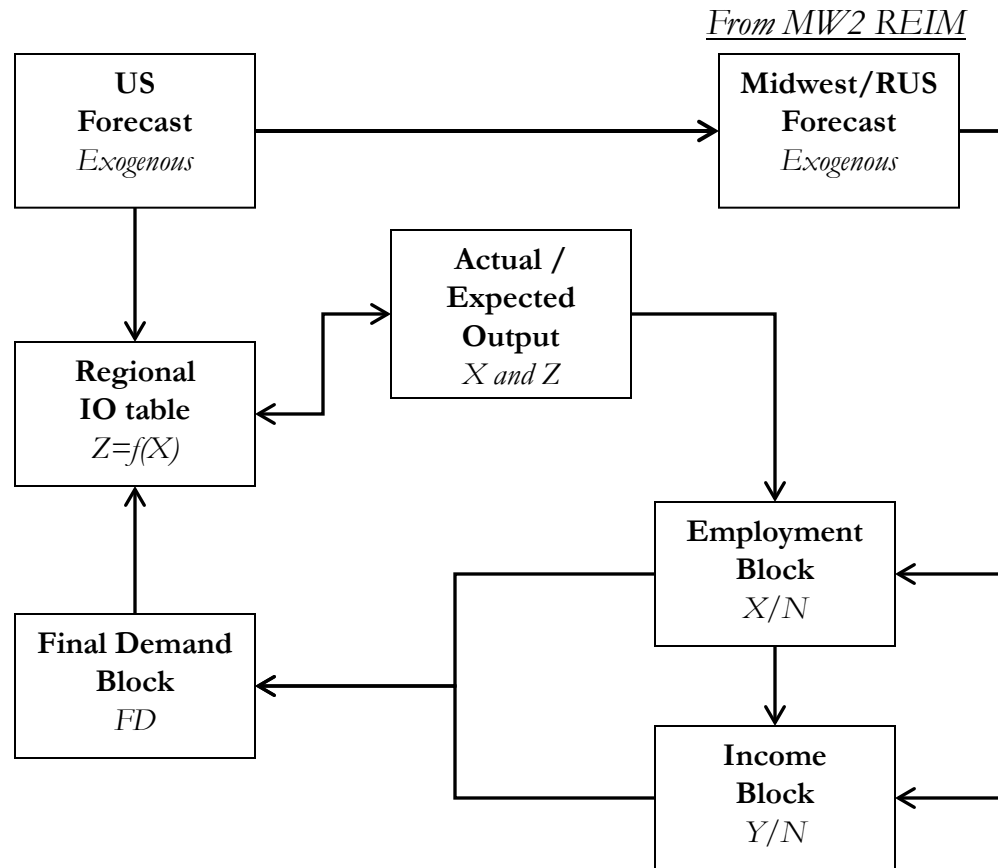
Midwest Model Development

- First Midwest models developed in mid 1990s
- Two versions
 - 2-region (IL, IN, OH, MI and WI aggregated: Rest of US, RUS)
 - 6 region (separate analysis for 5 states and RUS)
- Both models recently updated and expanded from 13 to 24 sectors
- Continuous time version also developed
- Database also being used to construct computable general equilibrium modeling system

Recent Work: Midwest Model Development

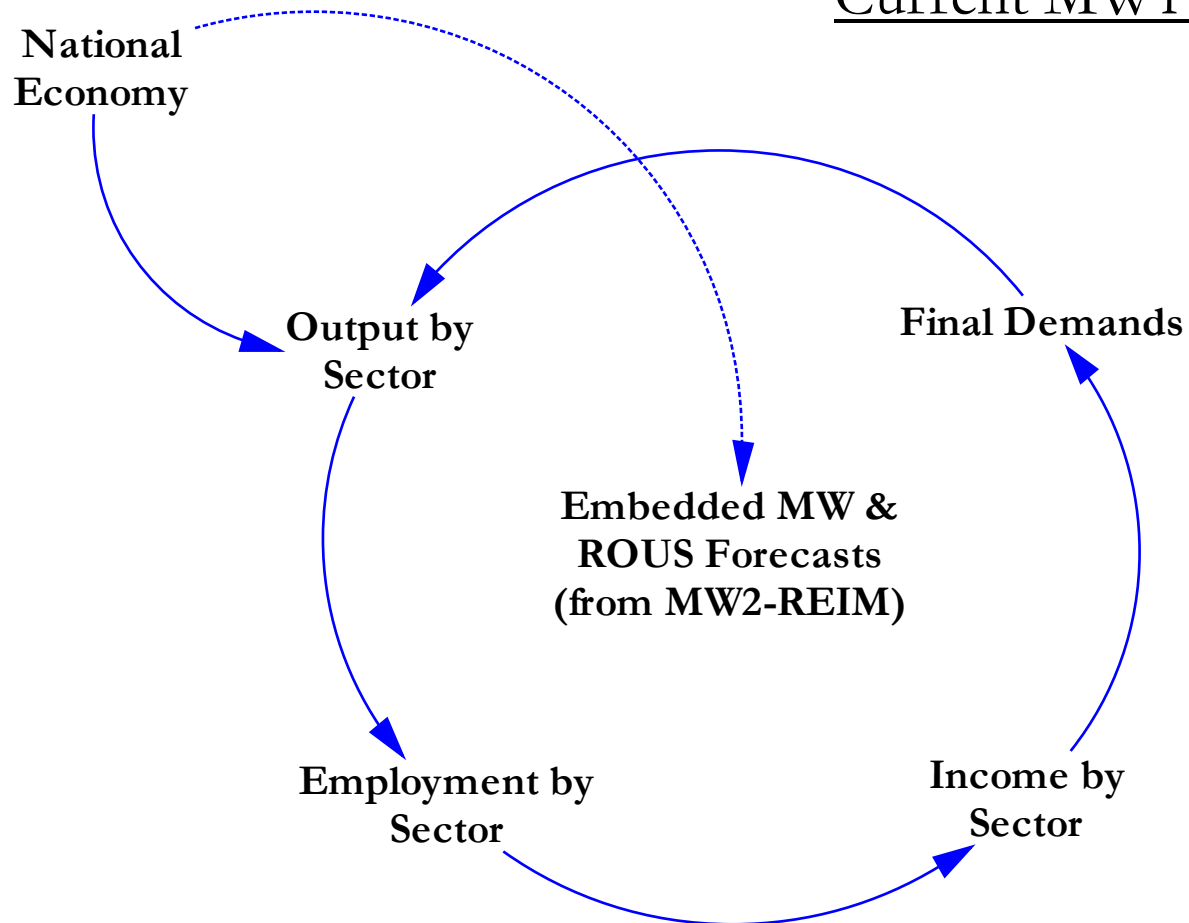
- Expansion of the 6-region version to 11 regions with the additions of IA, KS, MN, MO, NE
- Rest of US now redefined to be the other 40 states
- Integration of occupational structure and migration into the current framework

MW11 REIM: Current Model Structure

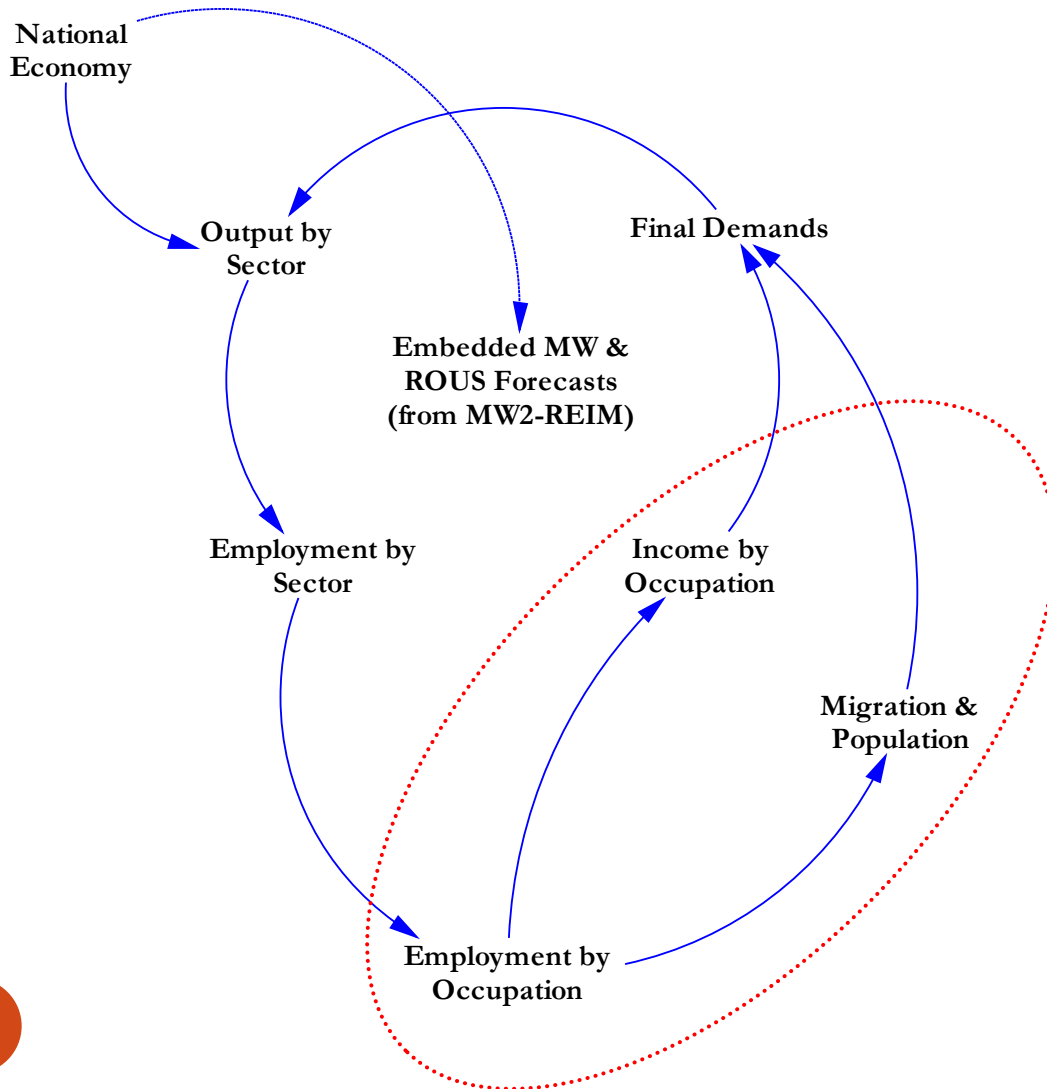


Plumbing [1]

Current MW11-REIM Structure



Plumbing [2]



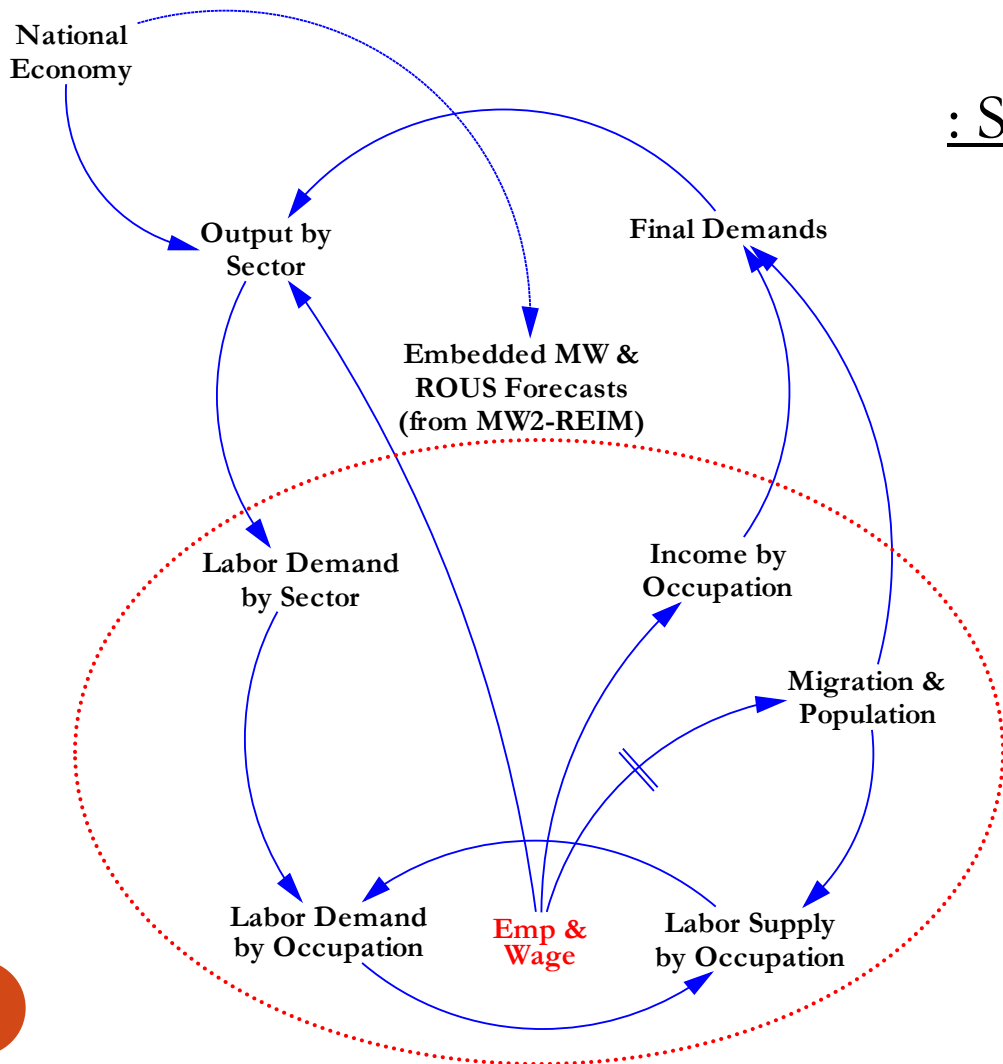
Integrated Framework [1] : Demand-Oriented

New Parts

- Transformation from Industry-based to Occupation-based, which is more suitable to describe migration trends and income changes
- Consideration of the population change and its significant economic impacts

Plumbing [3]

Integrated Framework [2] : Supply – Demand Interactive



New Parts

- Consideration of supply and demand interactions in the labor market system
- Design of the framework in a manner of reflecting supply constraints

Modeling Part: Progress [1]

- Achievements
 - MW6-REIM Development:
Expansion of the existing two-region REIM to a six region (IL, IN, MI, OH, WI, and Rest of US) version
 - Baseline Macroeconomic Forecasting (using the MW6-REIM)
 - MW11-REIM Development
 - Inter-regional SAM Construction, using the most recent statistics (2007 Commodity Flow Survey and Input-Output Data)
 - Construction of a draft version of the model

Modeling Part: Progress [2]

- On-Going Tasks
 - MW11-REIM Test & Verification
 - Review of the baseline forecasts
 - Analysis for testing MW11-REIM performance
 - Model Modification & Improvement
 - Model Use
 - Macroeconomic Forecasting
 - Policy & Impact analyses

Draft Baseline Forecasts [1]: GRP

	Past 15 Years (1992~2007)	DRI Forecasts (2007~2040)	MW2REIM Forecasts (2007~2040)	MW6REIM Forecasts (2007~2040)
US	3.1 %	2.4 %		
MW	1.8 %		1.6 %	1.7 %
IL	2.0 %			1.7 %
IN	2.1 %			1.5 %
MI	1.7 %			1.9 %
OH	1.4 %			1.7 %
WI	2.3 %			1.8 %
ROUS	3.3 %		2.8 %	2.8 %

- Note :
1. DRI forecasts are used as main exogenous (independent) variables both in MW2REIM and MW6REIM.
 2. MW2REIM forecasts for MW variables are also used as main exogenous (independent) variables in MW6REIM.
 3. MW6REIM forecasts for MW variables are derived by summing up the forecasts for five states (i.e. IL, IN, MI, OH, and WI).

Draft Baseline Forecasts [2]: Total Output

	Past 15 Years (1992~2007)	DRI Forecasts (2007~2040)	MW2REIM Forecasts (2007~2040)	MW6REIM Forecasts (2007~2040)
US	2.8 %	N / A		
MW	1.8 %		1.6 %	1.5 %
IL	2.0 %			1.8 %
IN	2.0 %			1.1 %
MI	1.4 %			1.6 %
OH	1.4 %			1.5 %
WI	2.2 %			1.5 %
ROUS	3.0 %		2.5 %	2.5 %

- Note :
1. DRI forecasts are used as main exogenous (independent) variables both in MW2REIM and MW6REIM.
 2. MW2REIM forecasts for MW variables are also used as main exogenous (independent) variables in MW6REIM.
 3. MW6REIM forecasts for MW variables are derived by summing up the forecasts for five states (i.e. IL, IN, MI, OH, and WI).

Draft Baseline Forecasts [3]: Employed People

	Past 15 Years (1992~2007)	DRI Forecasts (2007~2040)	MW2REIM Forecasts (2007~2040)	MW6REIM Forecasts (2007~2040)
US	1.4 % (DRI) 1.3 % (BLS)	0.7 %		
MW	0.8 %		0.6 %	0.5 %
IL	0.9 %			0.6 %
IN	0.9 %			0.3 %
MI	0.6 %			0.6 %
OH	0.7 %			0.4 %
WI	1.0 %			0.6 %
ROUS	1.4 %		0.7 %	0.7 %

- Note :
1. DRI forecasts are used as main exogenous (independent) variables both in MW2REIM and MW6REIM.
 2. MW2REIM forecasts for MW variables are also used as main exogenous (independent) variables in MW6REIM.
 3. MW6REIM forecasts for MW variables are derived by summing up the forecasts for five states (i.e. IL, IN, MI, OH, and WI).

Draft Baseline Forecasts [4]: Total Jobs

	Past 15 Years (1992~2007)	DRI Forecasts (2007~2040)	MW2REIM Forecasts (2007~2040)	MW6REIM Forecasts (2007~2040)
US	1.8 %	N / A		
MW	1.1 %		0.7 %	0.7 %
IL	1.2 %			0.8 %
IN	1.2 %			0.4 %
MI	0.9 %			0.8 %
OH	1.0 %			0.6 %
WI	1.4 %			0.7 %
ROUS	1.9 %		1.3 %	1.3 %

- Note :
1. DRI forecasts are used as main exogenous (independent) variables both in MW2REIM and MW6REIM.
 2. MW2REIM forecasts for MW variables are also used as main exogenous (independent) variables in MW6REIM.
 3. MW6REIM forecasts for MW variables are derived by summing up the forecasts for five states (i.e. IL, IN, MI, OH, and WI).

Draft Baseline Forecasts [5]: Personal Income

	Past 15 Years (1992~2007)	DRI Forecasts (2007~2040)	MW2REIM Forecasts (2007~2040)	MW6REIM Forecasts (2007~2040)
US	3.1 % (DRI) 2.6 % (BEA)	2.8 %		
MW	1.7 %		1.6 %	1.6 %
IL	2.0 %			1.8 %
IN	1.9 %			1.2 %
MI	1.3 %			1.6 %
OH	1.3 %			1.5 %
WI	2.2 %			1.6 %
ROUS	2.8 %		2.6 %	2.6 %

- Note :
1. DRI forecasts are used as main exogenous (independent) variables both in MW2REIM and MW6REIM.
 2. MW2REIM forecasts for MW variables are also used as main exogenous (independent) variables in MW6REIM.
 3. MW6REIM forecasts for MW variables are derived by summing up the forecasts for five states (i.e. IL, IN, MI, OH, and WI).

Motivation of Analyzing and Forecasting the Dynamics of Occupation – Industry Systems

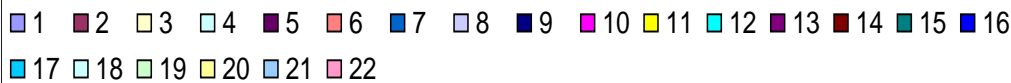
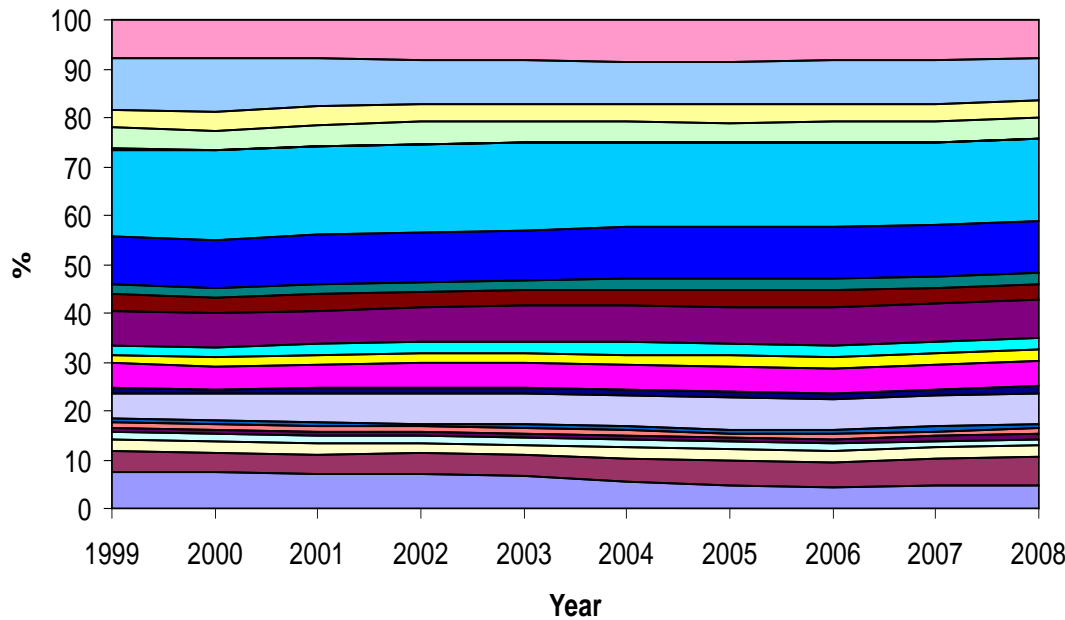
- Occupations are part of the signaling and codification of labor specialization in economic production.
- Change of skill-mix at regional level can be resulted from industrial shift, demographic change, migration flows and technological advancement.
- Our research starts with an occupation – industry employment table which mimics the traditional input – output table used by regional economists.
- Our data are mostly retrieved from Occupational Employment Survey (OES), covering 1999 – 2008.
- By incorporating our analysis with MW-REIM models, we add another layer of information for employment forecasts in Midwest regions.

Occupational Analysis

- Disaggregate national Occupation – Industry Matrix (OIM) into State level.
- Ascertain the stability of staff patterns and allocation coefficients in the dynamic OIM systems.
- Conduct structural change analysis for the OIM systems across examined time periods.
- Identify the drivers of the OIM systems – Industry-driven or Occupation-driven?
- Forecast the occupational demand for the Midwestern States.

Dynamic Occupational Composition for the Overall Employment in Illinois State across 10 Years

**Composition of Total Employment in Illinois State
(from different occupation types)**



Occupation	Description
1	Management Occupations
2	Business and Financial Operations Occupations
3	Computer and Mathematical Science Occupations
4	Architecture and Engineering Occupations
5	Life, Physical, and Social Science Occupations
6	Community and Social Services Occupations
7	Legal Occupations
8	Education, Training, and Library Occupations
9	Arts, Design, Entertainment, Sports, and Media Occupations
10	Healthcare Practitioner and Technical Occupations
11	Healthcare Support Occupations
12	Protective Service Occupations
13	Food Preparation and Serving Related Occupations
14	Building and Grounds Cleaning and Maintenance Occupations
15	Personal Care and Service Occupations
16	Sales and Related Occupations
17	Office and Administrative Support Occupations
18	Farming, Fishing, and Forestry Occupations
19	Construction and Extraction Occupations
20	Installation, Maintenance, and Repair Occupations
21	Production Occupations
22	Transportation and Material Moving Occupations

Stability of Staff Patterns and Occupation Allocation Coefficients in Illinois State

<p>Staff Pattern –</p> <p><i>The employment distribution across occupations in each industrial sector.</i></p>	<p>Stable</p>	Industrial Sector (IREIM Categories)
		<i>Construction</i>
		<i>Robber and Misc. Plastic Products</i>
		<i>Furniture and Related Product Manufacturing</i>
		<i>Educational Services</i>
	<p>Unstable</p>	<i>Food Services</i>
		<i>Retail Trade</i>
<i>Motion Picture and Sound Recording Industries</i>		
		<i>Finance and Insurance</i>
<p>Occupation Allocation Coefficients –</p> <p><i>The employment distribution across industrial sectors in each occupation.</i></p>	<p>Stable</p>	Occupational Groups (OES Categories)
		<i>Office and Administrative Support Occupations</i>
		<i>Construction and Extraction Occupations</i>
		<i>Food Preparation and Serving Related Occupations</i>
	<p>Unstable</p>	<i>Production Occupations</i>
		<i>Farming, Fishing, and Forestry Occupations</i>
		<i>Arts, Design, Entertainment, Sports, and Media Occupations</i>
		<i>Protective Service Occupations</i>
		<i>Life, Physical, and Social Services Occupations</i>

Structural Analysis for OIM Systems in Illinois 1999-2008

- What are the industrial sectors whose staff pattern changes generate more important impact on the entire industrial employment structure?
- Parallel question can be raised about the occupation allocation coefficients and their relative importance.

<i>Industry-side</i>
<i>Retail Trade</i>
<i>Professional and Management Services and Other Support Services</i>
<i>Membership Organization and Private Households</i>

<i>Occupation-side</i>
<i>Sales and Related Occupations</i>
<i>Office and Administrative Support Occupations</i>
<i>Production Occupations</i>
<i>Transportation and Material Moving Occupations</i>

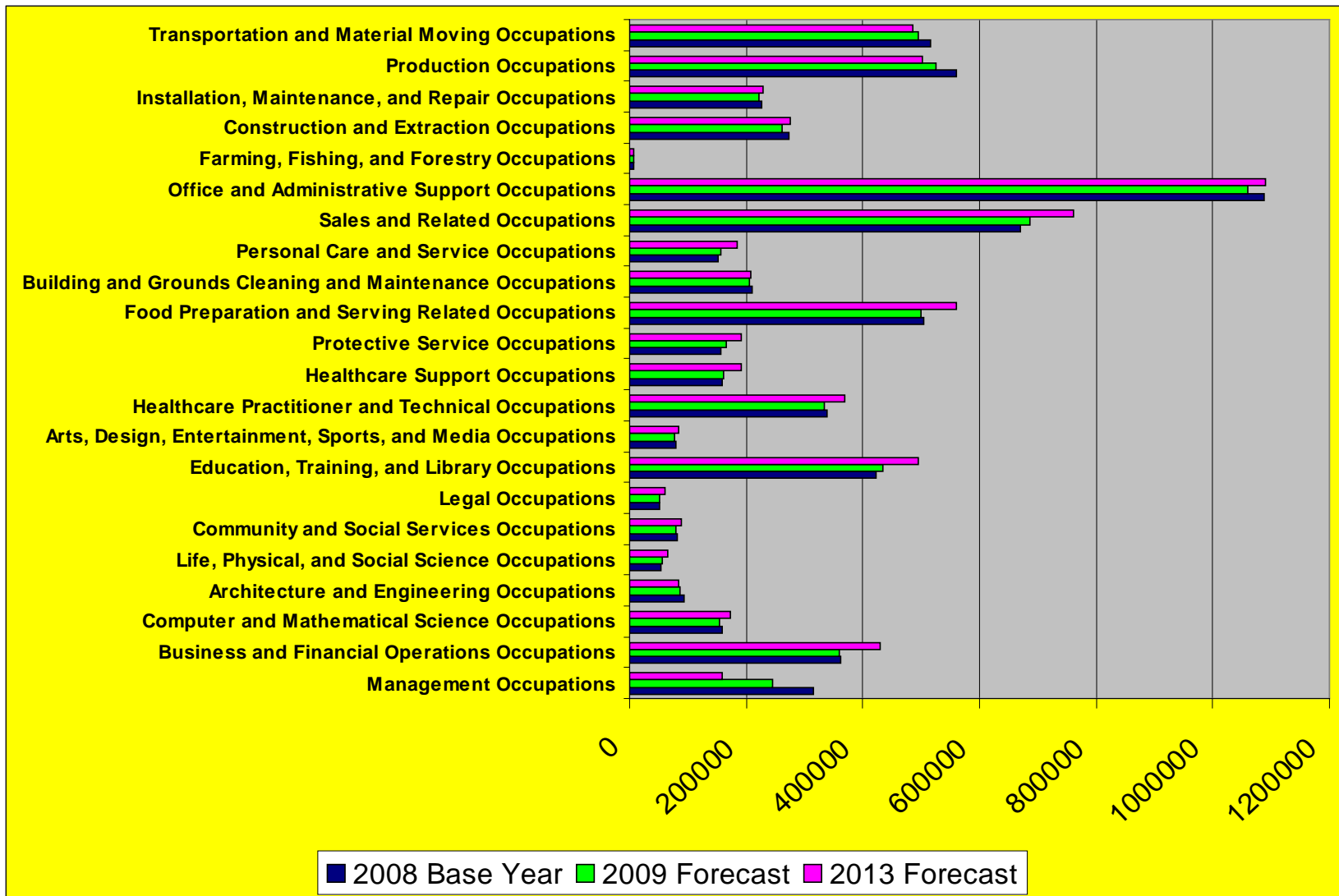
Identify the Driver of OIM System Changes for Illinois State

- Explore OIM evolution dynamics - Industry driven or Occupation driven?
- A doubly-constrained bi-causative matrix approach is applied.
- Results:
 - Under-supplied Occupation: **Community and Social Service Occupations**
 - OIM system is mostly driven by industry side, except for 2nd half of year 2004, and the time between 2007 and 2008.
 - The recession greatly lowers the demand from industry side, and the oversupply of occupations pushes the OIM system to adjust.

Occupational Forecast for Midwestern States

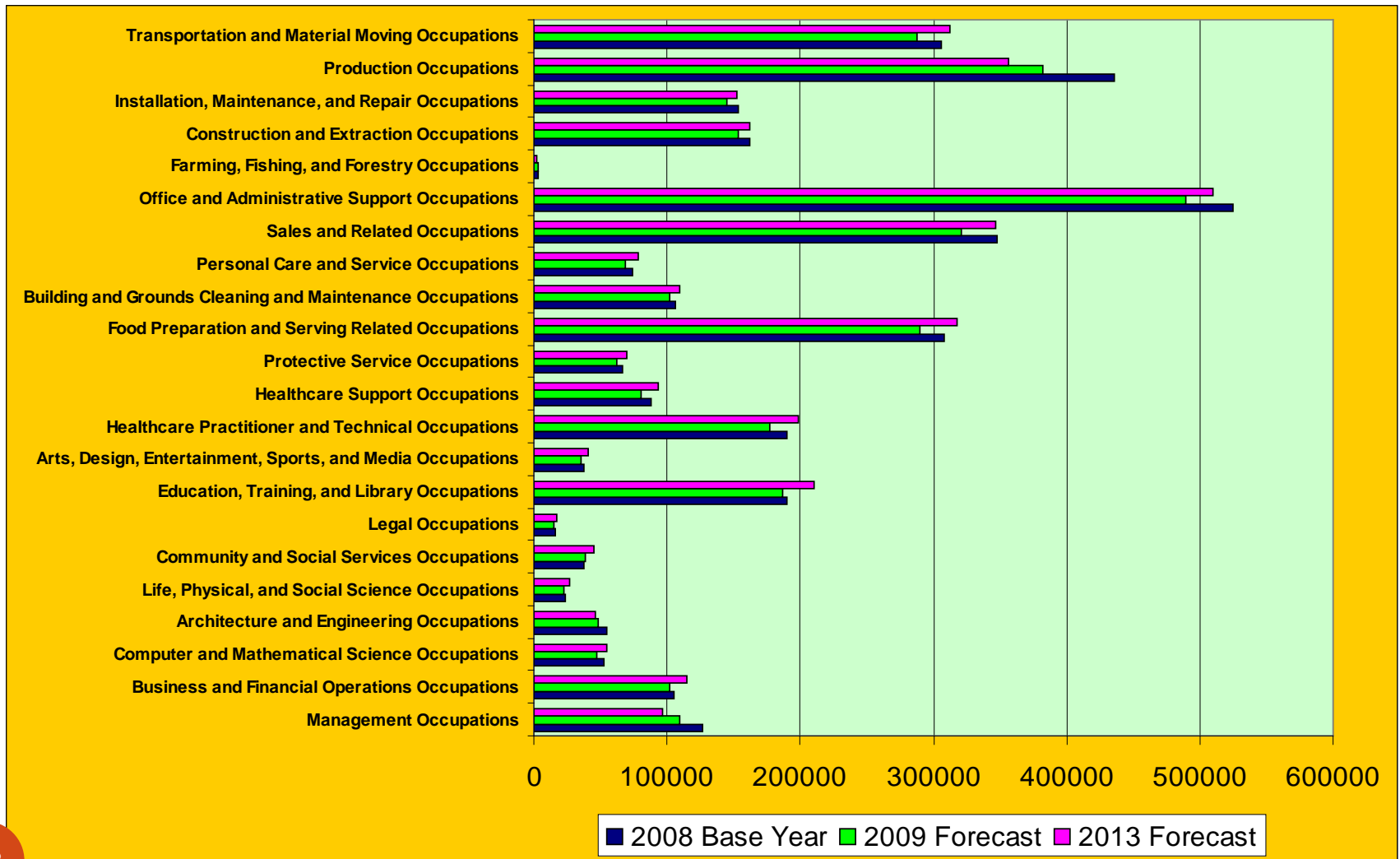
- Methodology: analytical relationship for each occupation group is built through time-series data, in combination with the forecast of total employment from Midwest-REIM model.
- The Dynamic evolution of composition of total employment by different occupation groups is analyzed under a time-dependent linear regression system.
- The forecast from REIM about the total employment level is used to calculate the specific numbers of employees for each individual occupational group.

Forecast of Occupations for Illinois

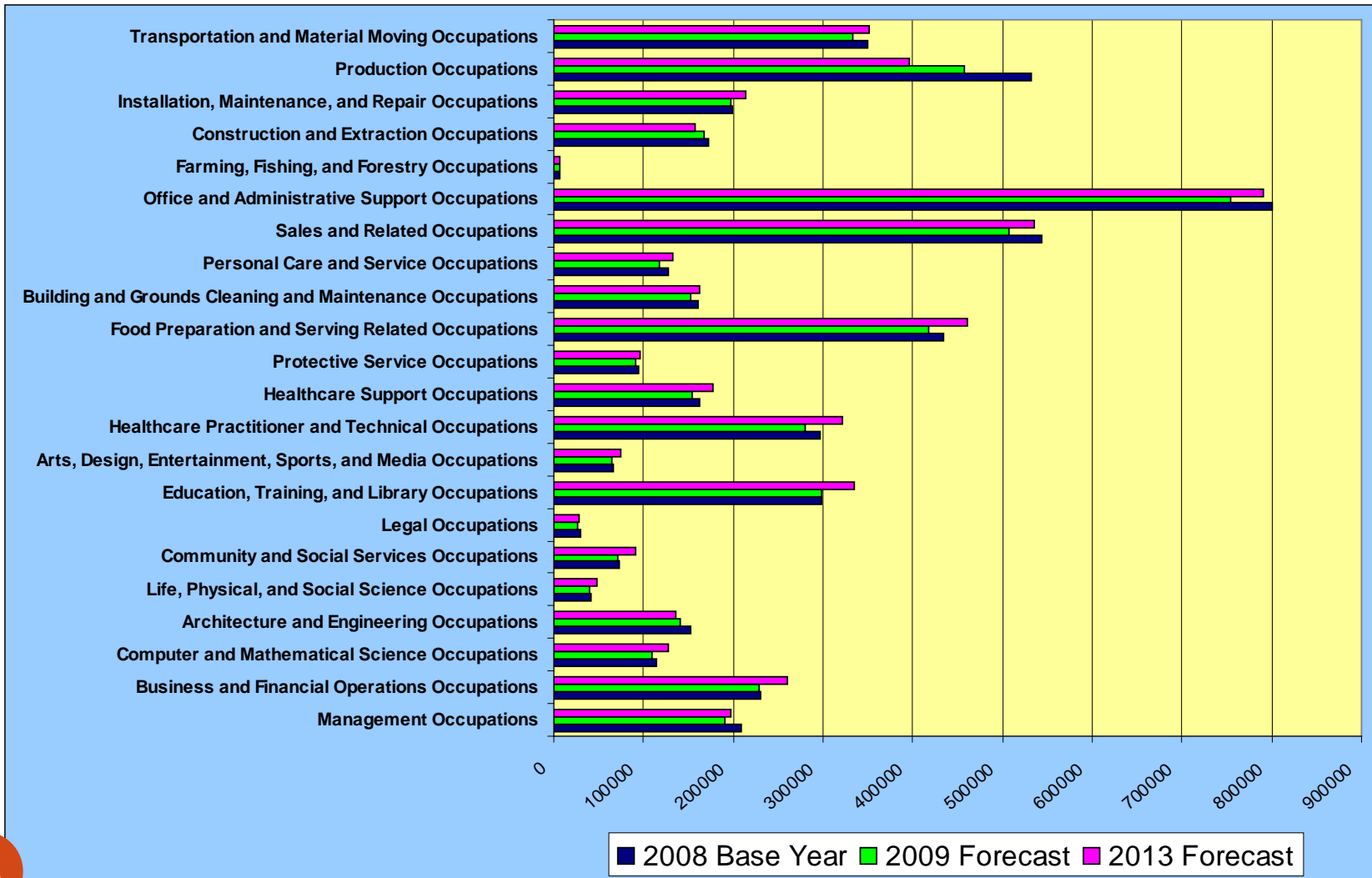


Note: Our forecast is based on Occupational Employment Survey (OES), which is surveyed only among the industrial sectors, excluding agricultural sectors.

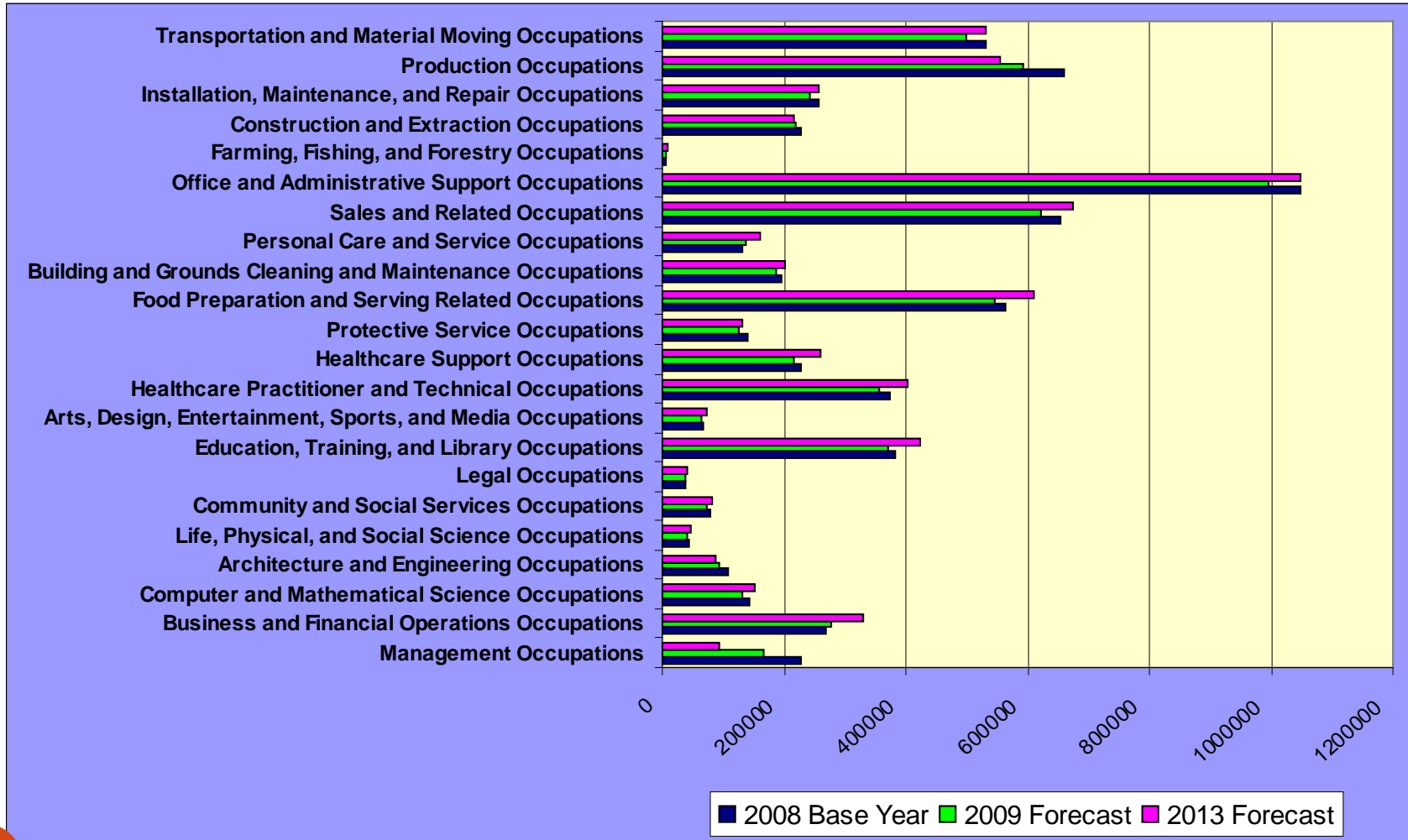
Forecast of Occupations for Indiana



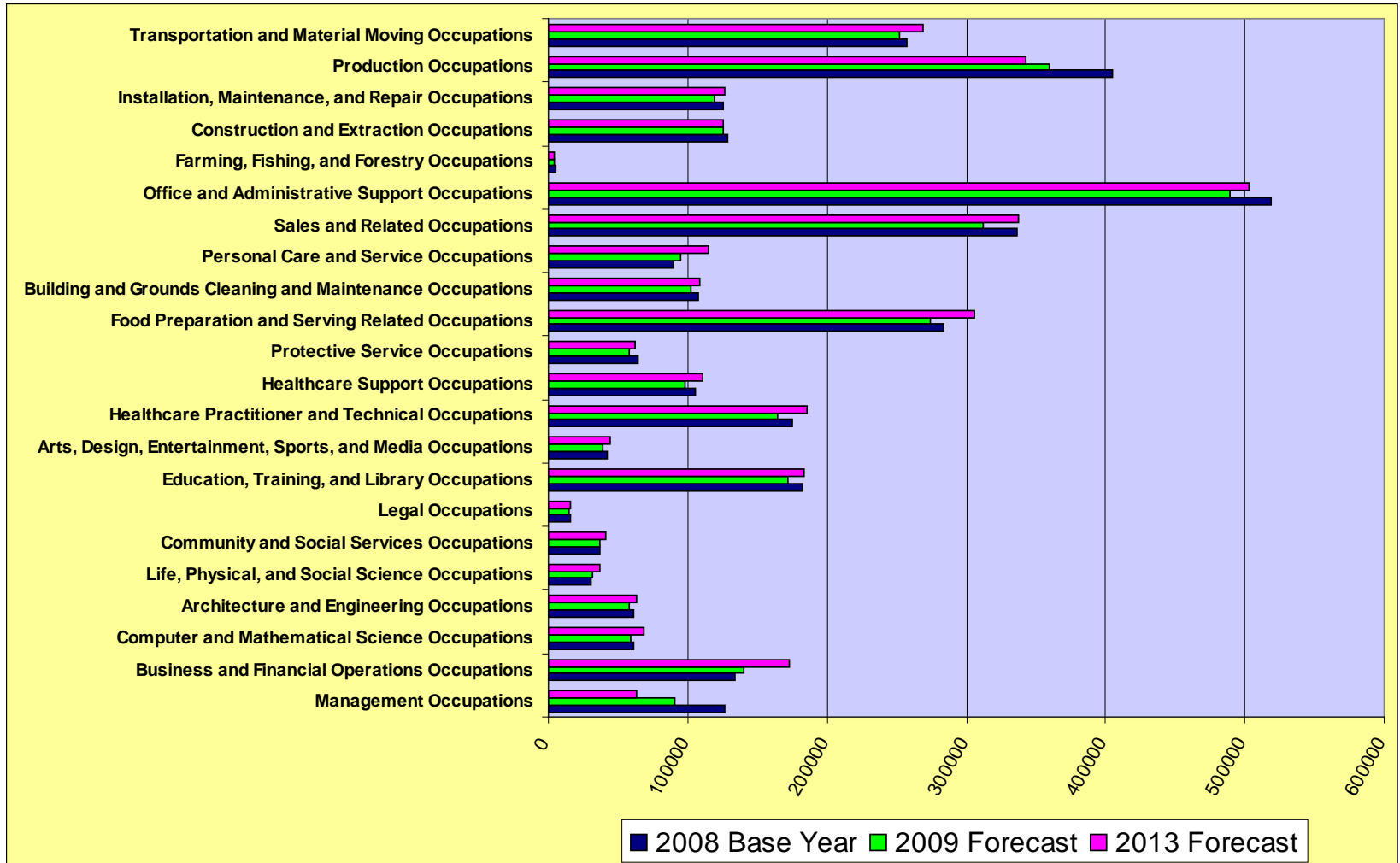
Forecast of Occupations for Michigan



Forecast of Occupations in Ohio



Forecast of Occupations for Wisconsin



Example Application

- Ford Plant Closure

Assumed that the Ford plants in the Chicago area are closed in Year 2007. The existing level of plants' activities are

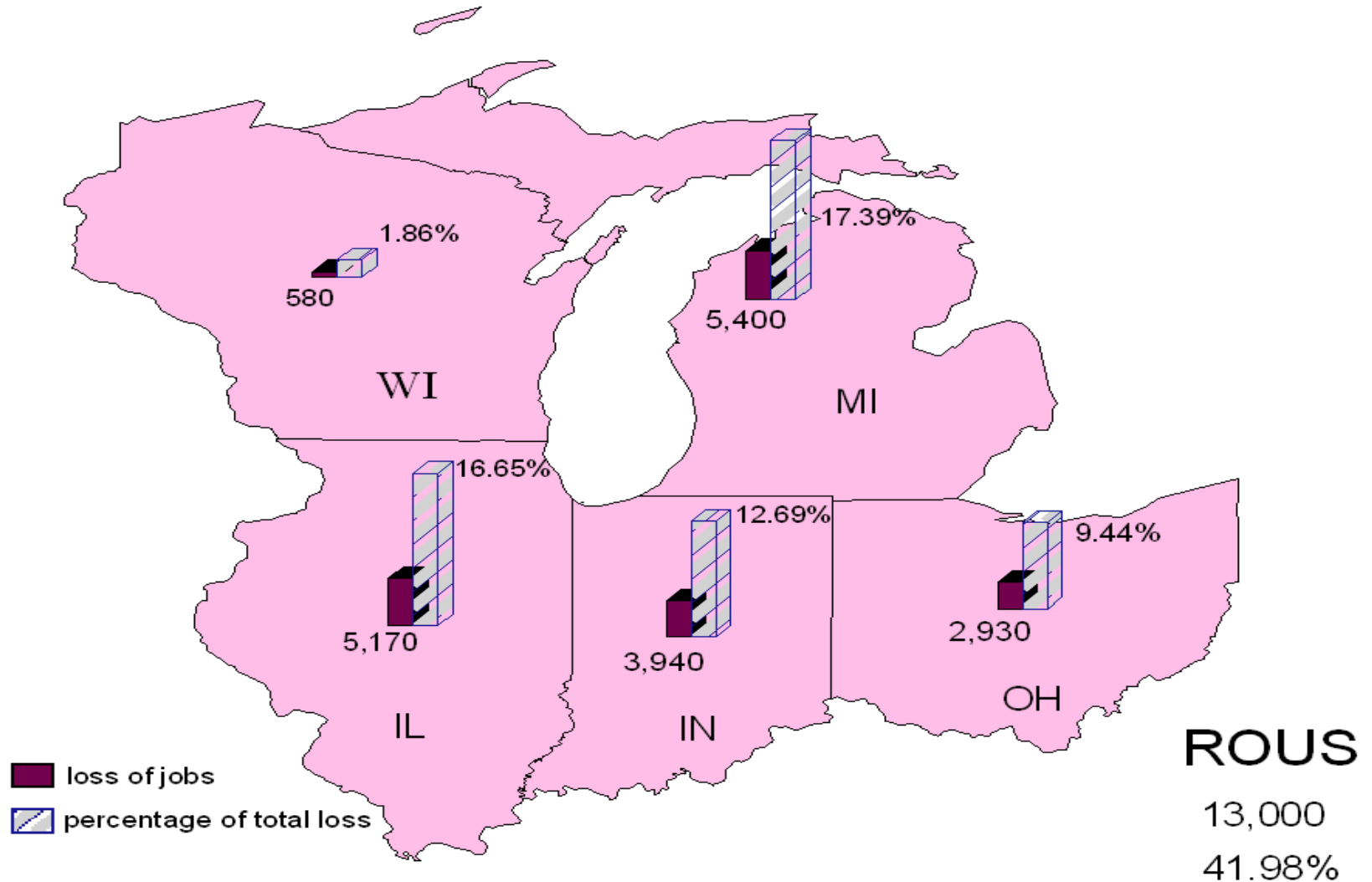
- Output: \$2.1 billion
- Direct Employment: 3,580
- Direct Income: \$374 million
- Purchases from the suppliers: \$1.5 billion

Example Application

- Output (in Chained \$2000)
 - Direct: \$2.1 b
 - Indirect: \$5.2 b
 - Total: \$7.3 b
 - **Spatial Distribution of the Indirect effects**

● IL:	17.3 %	● IN:	12.9%
● MI:	19.7%	● OH:	9.1%
● WI:	1.7%	● RUS:	39.3%
 - **Midwest concentration: 60.7%**
 - Multiplier = 3.51

Indirect Employment Impacts Across States



Occupational Impacts

OCCUPATION GROUPS	IL	IN	MI	OH	WI
Management Occupations	-476	-165	-244	-117	-23
Business and Financial Operations Occupations	-431	-127	-237	-132	-24
Computer and Mathematical Science Occupations	-276	-68	-134	-74	-10
Architecture and Engineering Occupations	-436	-116	-355	-93	-14
Life, Physical, and Social Science Occupations	-50	-24	-34	-21	-4
Community and Social Services Occupations	-22	-25	-23	-22	-3
Legal Occupations	-38	-16	-19	-16	-2
Education, Training, and Library Occupations	-131	-106	-110	-95	-13
Arts, Design, Entertainment, Sports, and Media Occupations	-80	-41	-59	-28	-6
Healthcare Practitioner and Technical Occupations	-94	-93	-95	-73	-11
Healthcare Support Occupations	-39	-39	-48	-38	-6
Protective Service Occupations	-72	-52	-46	-56	-6
Food Preparation and Serving Related Occupations	-189	-199	-220	-146	-28
Building and Grounds Cleaning and Maintenance Occupations	-173	-107	-120	-77	-15
Personal Care and Service Occupations	-97	-63	-71	-45	-11
Sales and Related Occupations	-459	-302	-390	-207	-44
Office and Administrative Support Occupations	-1045	-576	-733	-453	-88
Farming, Fishing, and Forestry Occupations	-4	-4	-6	-2	-1
Construction and Extraction Occupations	-260	-212	-240	-121	-29
Installation, Maintenance, and Repair Occupations	-330	-201	-238	-131	-23
Production Occupations	-3478	-1026	-1531	-711	-147
Transportation and Material Moving Occupations	-548	-354	-399	-245	-51

Tracing the Value Chain

Primary Metal and metal product manufacturing

- Table shows the percentage of indirect effects from a change in production in the state at the top of the column

	IL	IN	OH	WI	MI	RUS
IL	32.0%	7.3%	4.8%	3.9%	6.5%	4.5%
IN	5.9%	30.9%	5.3%	6.7%	3.5%	3.5%
OH	3.4%	4.5%	28.9%	6.2%	6.5%	2.9%
WI	4.2%	9.2%	9.6%	26.4%	3.7%	5.3%
MI	2.9%	1.8%	4.1%	1.5%	27.2%	2.1%
Total MW	16.5%	22.8%	23.8%	18.4%	20.2%	18.3%
RUS	51.5%	46.3%	47.3%	55.2%	52.7%	81.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Multiplier	2.192	2.288	2.184	2.215	2.165	2.074

Tracing the Value Chain

Transportation, Logistics and Warehousing

- Table shows the percentage of indirect effects from a change in production in the state at the top of the column

	IL	IN	OH	WI	MI	RUS
IL	59.8%	5.8%	3.7%	2.4%	4.7%	1.8%
IN	2.2%	56.2%	2.4%	2.6%	1.4%	0.6%
OH	1.8%	2.4%	53.0%	3.6%	3.4%	0.9%
WI	1.8%	4.7%	5.5%	55.0%	1.6%	1.3%
MI	1.1%	0.7%	1.8%	0.6%	54.5%	0.5%
Total MW	6.9%	13.5%	13.5%	9.2%	11.0%	5.2%
RUS	33.4%	30.3%	33.5%	35.8%	34.4%	94.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Multiplier	1.865	1.859	1.817	1.815	1.848	1.753

The Costs and Benefits of Interdependence

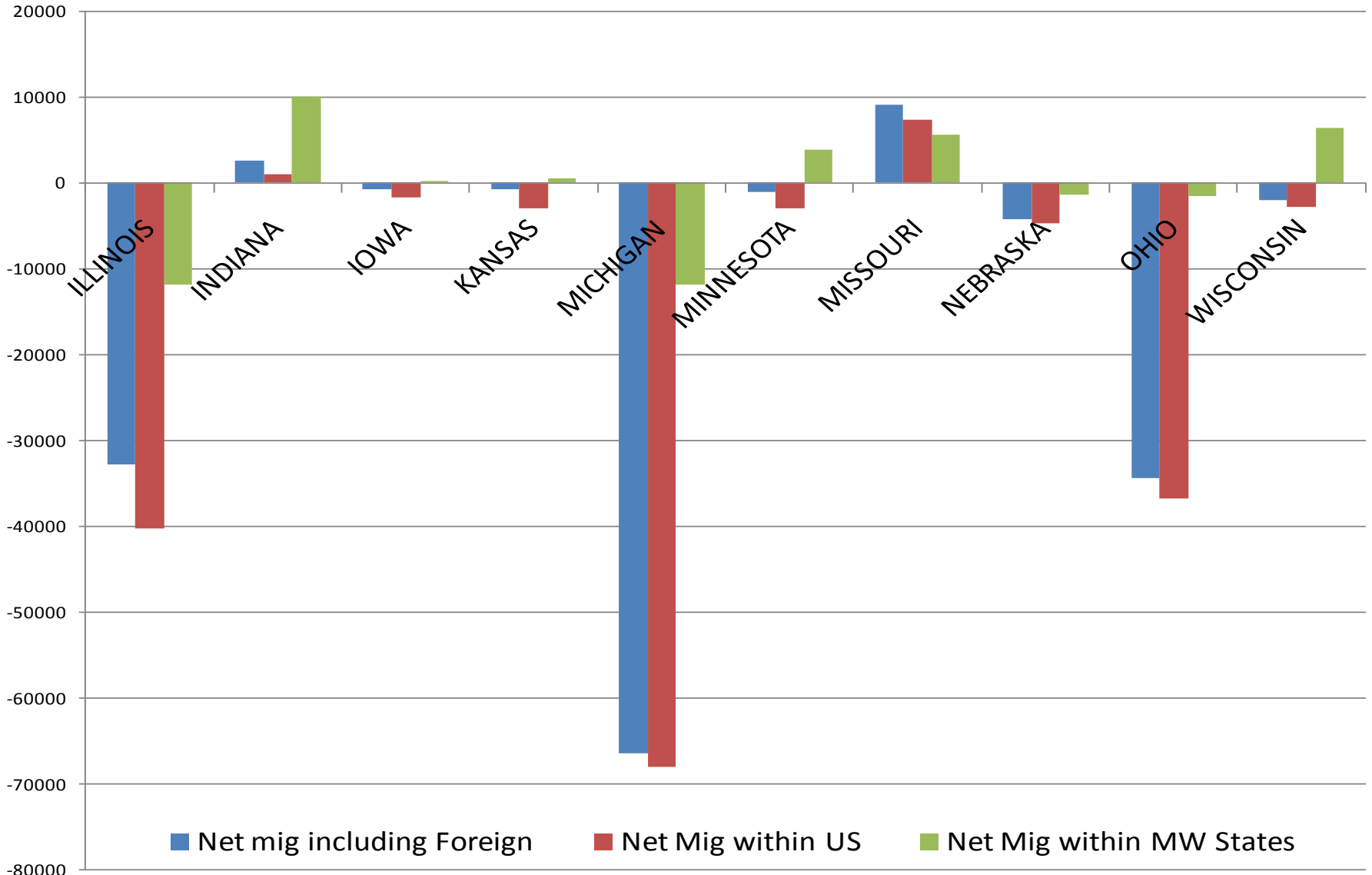
- While the existence of strongly-linked value chains can create positive benefits to the Midwest economy, during downturns, the reverse will be the case.
- During current recession, five Midwest states have lost 1.78 million jobs – 20% of the US total of lost jobs
- The results presented here provide compelling evidence of the need to view the region as an economic unit in considering strategic investment
- Movement of goods and services complemented by significant movements of people.....

Migration Analysis

Net Migration from State of Origin 2006-2007

	ILLINOIS	INDIANA	IOWA	KANSAS	MICHIGAN	MINNESOTA	MISSOURI	NEBRASKA	OHIO	WISCONSIN
ILLINOIS	-40,155	7,912	1,516	156	-4,278	912	1,315	-50	-983	5,280
INDIANA	-7,912	1,076	76	54	-1,667	384	543	-14	-1,584	79
IOWA	-1,516	-76	-1,694	266	-248	640	801	-31	-31	-19
KANSAS	-156	-54	-266	-2,958	-412	38	715	-314	-38	-19
MICHIGAN	4,278	1,667	248	412	-68,000	1,193	860	144	1,698	1,345
MINNESOTA	-912	-384	-640	-38	-1,193	-2,872	125	-236	-327	-205
MISSOURI	-1,315	-543	-801	-715	-860	-125	7,420	-767	-238	-234
NEBRASKA	50	14	31	314	-144	236	767	-4,652	97	30
OHIO	983	1,584	31	38	-1,698	327	238	-97	-36,701	124
WISCONSIN	-5,280	-79	19	19	-1,345	205	234	-30	-124	-2,794
RUS	-28,375	-8,965	-1,908	-3,464	-56,155	-6,682	1,822	-3,257	-35,171	-9,175
Immigrants	7,336	1,518	967	2,284	1,643	1,770	1,670	477	2,405	829
Non-Migrants	10,179,103	5,130,931	2,407,895	2,158,019	7,936,285	4,219,403	4,493,584	1,435,806	9,053,131	4,636,062

Migration Analysis



Migration Analysis

- Michigan, Illinois, and Ohio are the biggest losers in terms of net migration within US
 - they lost 68,000, 40,155, and 36,701 people, respectively.
 - However, only 4.2% of Ohio's out migration move to Midwest States, the number for Illinois and Michigan is 29.3% and 17.4%.
- Within ten Midwest States, only Missouri and Indiana gained net migration from US with 7,420 and 1,076 people, respectively.
- All ten states gained population from foreign countries

Future Research [1]

- Impact Analyses
 - Labor market shocks (e.g. Aging population, inter-state migration, and demand-supply mismatch in labor markets)
 - Optimal allocation of investment in human capital
 - The American Recovery and Reinvestment Act of 2009
 - Environmental & Energy policies (e.g. Renewable energy requirements)
- Inter-State Freight Demand Estimation – how will increased interstate trade affect the Midwest economies?
- Multi-level Modeling & Forecasting
 - Allocation of impacts below state level

Future Research [2]

- Develop demographic linkage (age, sex, race, educational attainment, and etc.) to the current occupation groups in Midwestern states.
- Analyze the potential of occupation supplies for different Midwestern state, and its subsequent demand and policy initiatives to promote key human capital. Investment initiatives
- Connect wage information with occupational groups, and identify the possible income gap and social welfare concerns generated by the change of occupation composition dynamics.
- Ascertain the possible relationship between regional economic development and the clusters of certain occupations.
- Extend occupation analysis to current migration researches to answer – who are migrating? What are the occupations of these migrants? What places become more attractive to migrants with certain occupations?