Demographic Challenges to Metropolitan Development: Aging, Migration and Investment in Human Capital

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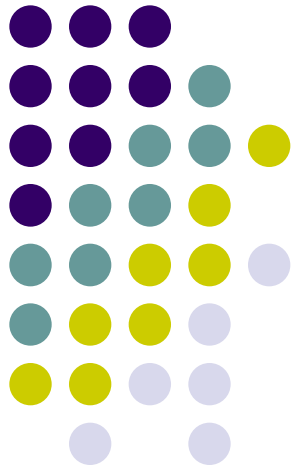

Demographic Challenges to Development

- This summary is based on the following papers available on the Regional Economics Applications Laboratory website:
  - Sang Gyoo Yoon and Geoffrey J.D. Hewings, "Impacts of Demographic Changes in the Chicago Region," *Discussion Paper* 06-T-7
  - Seryoung Park and Geoffrey J.D. Hewings, "Aging and the Regional Economy: Simulation Results from the Chicago CGE Model," *Discussion Paper* 07-T-4
  - Seryoung Park and Geoffrey J.D. Hewings, "Immigration, Aging and the Regional Economy," *Discussion Paper* 07-T-5,
  - Seryoung Park and Geoffrey J.D. Hewings, "Does a Change in Retirement Age Affect a Regional Economy? Evidence from the Chicago Economy," *Discussion Paper* 07-T-6
  - Tae-Jeong Kim and Geoffrey J.D. Hewings, "Inter-Regional Endogenous Growth under the Impacts of Demographic Changes" *Discussion Paper* 10-T-3 (forthcoming, *Applied Economics*)

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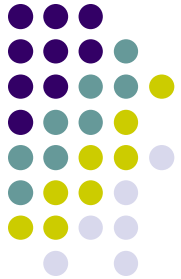
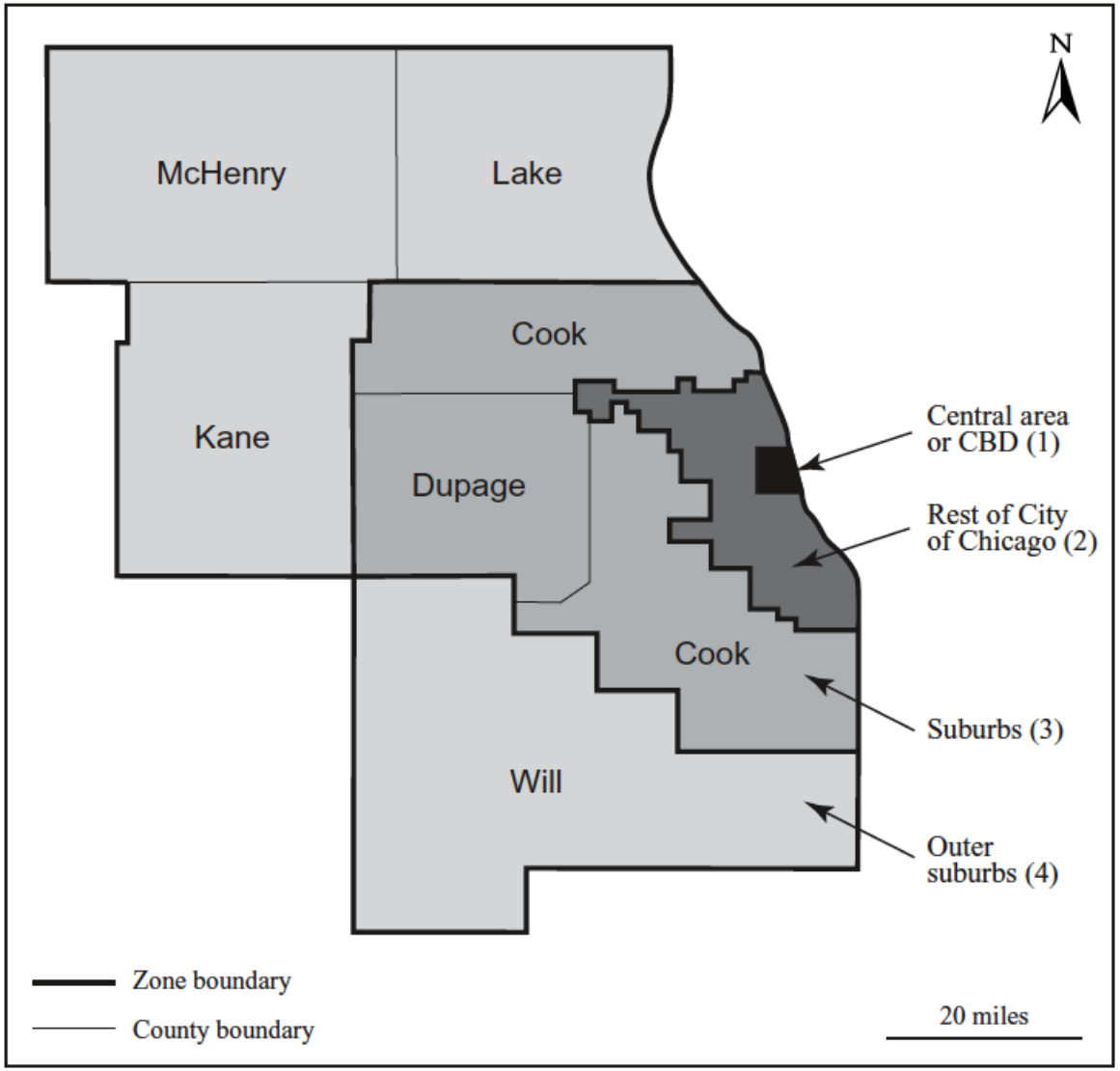
Demographic Implications for Transportation



- Changes in the composition of population
  - Changes in the demand and location of housing
    - Smaller household size
    - Central locations more attractive
  - Changes in the demand for transportation
    - Decrease in demand for journey-to-work trips
    - Increase in demand for journey-to-medical, journey-to-shop and recreation/social trip-making
    - Change in modal choice - more public transportation demand?
  - Macro-micro-macro modeling – top-down/bottom-up interaction of population and employment forecasts and ability of region to absorb new growth given land use constraints (paper by Kim & Hewings, *ARS*, 2012)

Spatial Divisions of the Chicago Region: Meso-Level Approach



Chicago Intra Metropolitan Flows

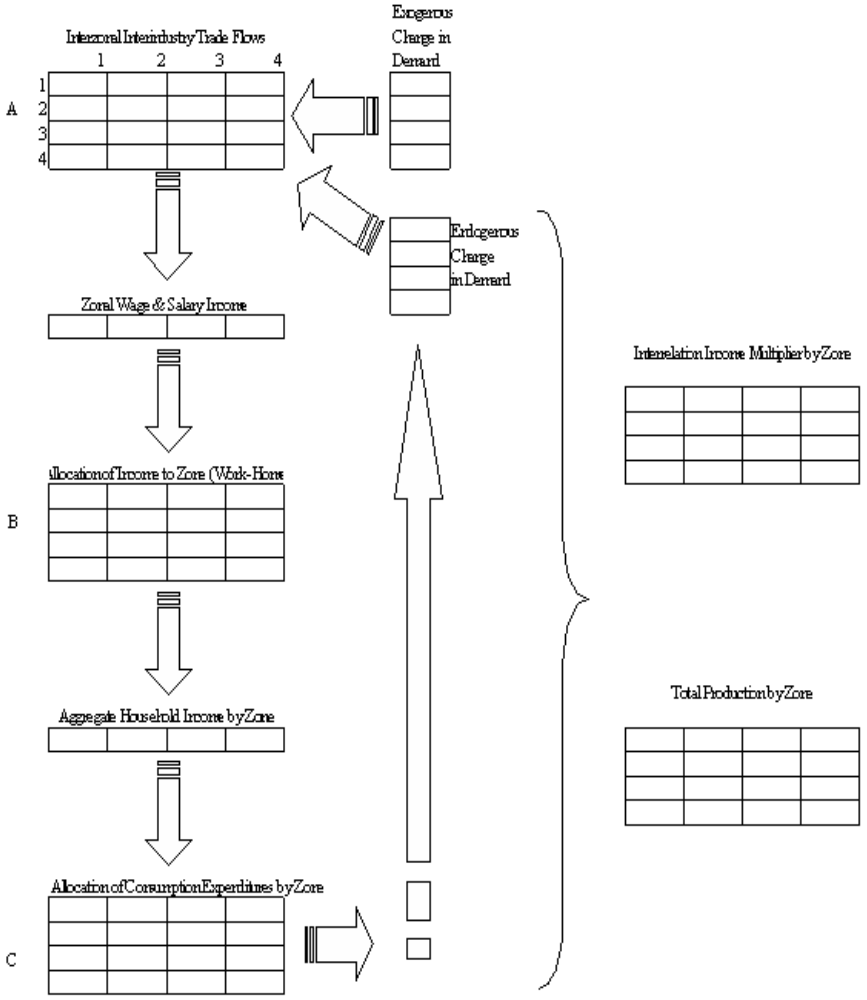
Goods and Services Flows

Wages and salaries

Flows of commuters and their incomes by zone

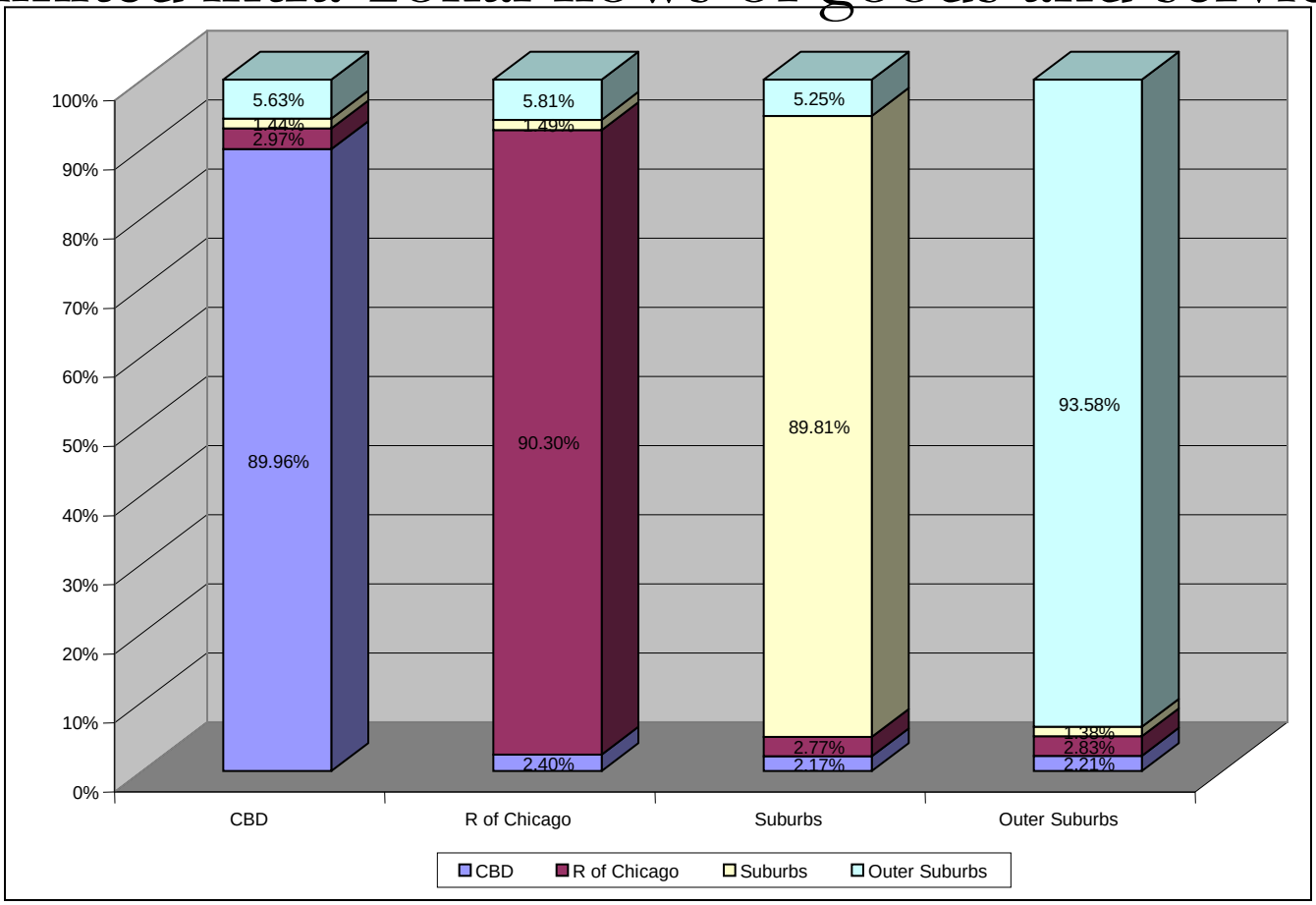
Household expenditures

Flows of expenditures by zone



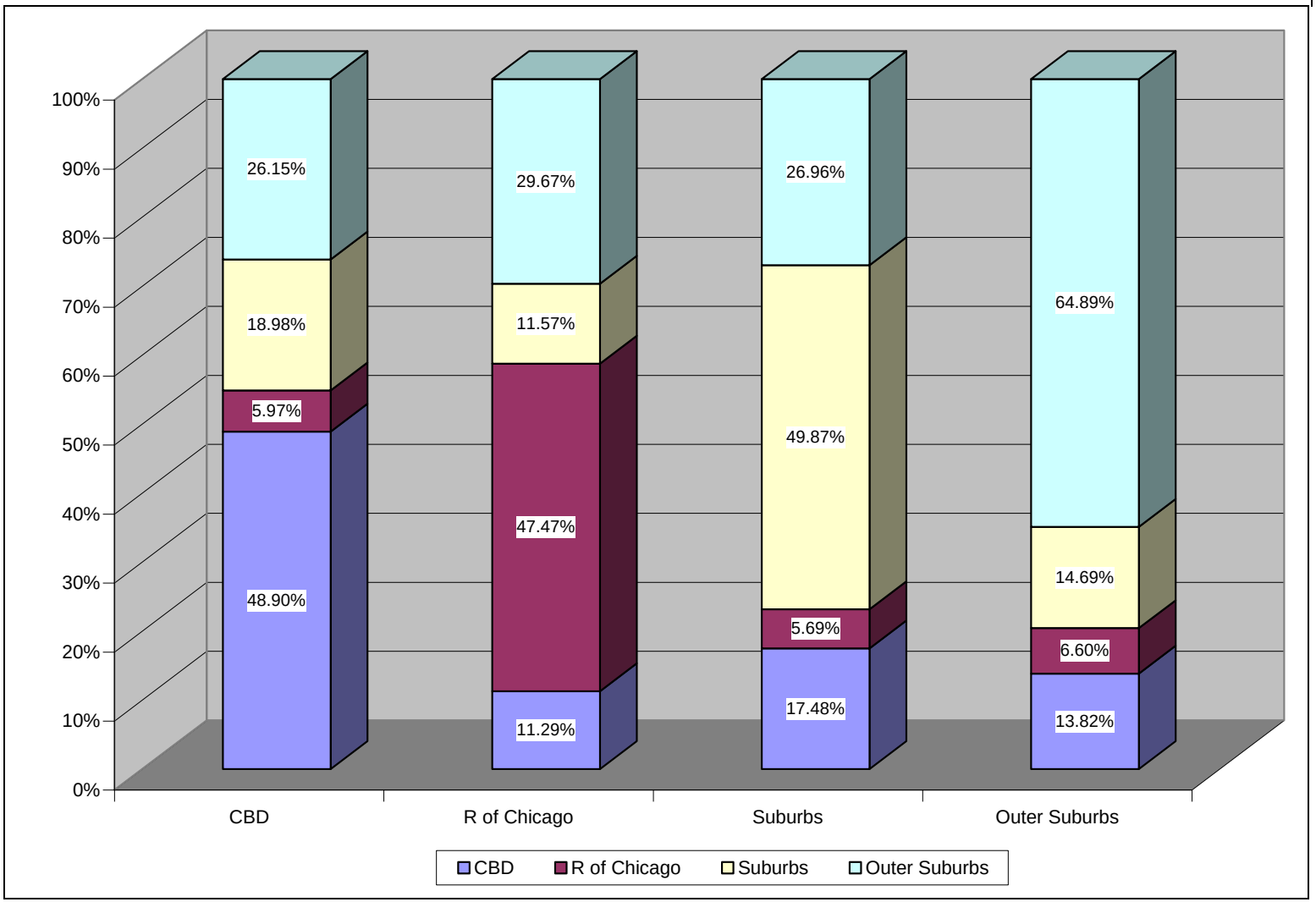
Interindustry interdependence

- Limited intra-zonal flows of goods and services



Total interdependence

- Substantial interdependence when all interactions considered:
- Trade, journey-to-work, income flows, spatial consumption patterns and their direct and indirect impacts



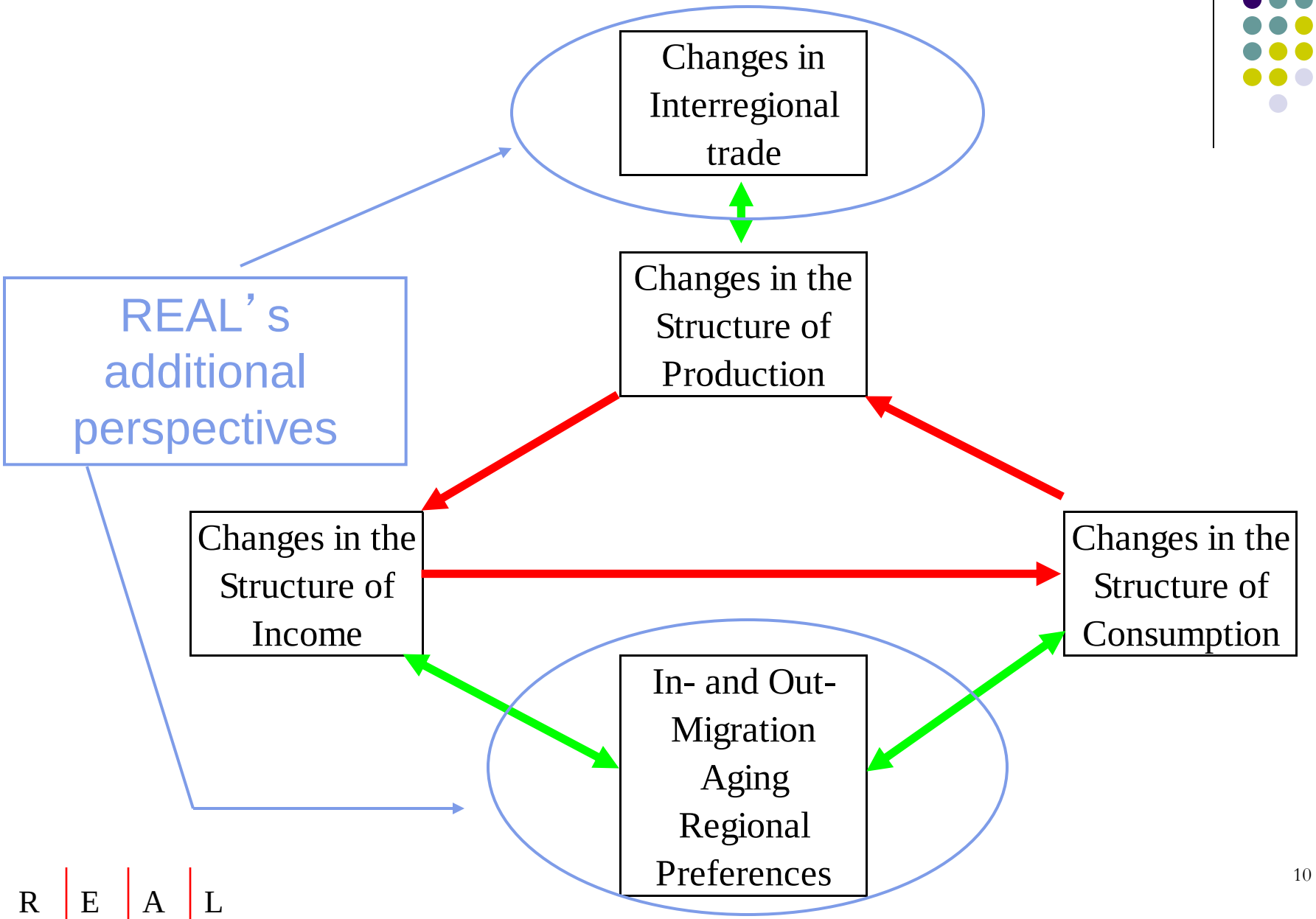
Initial Explorations

Results using an Econometric-Input-Output Model linked with Modified AIDS

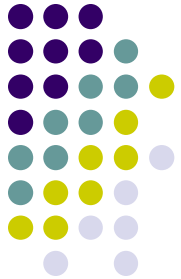
Demographic Challenges to Urban Development

- Presentation explores of the role of households on the Chicago and Midwest economies, tracing impacts of
  - aging
  - income distribution
  - consumption expenditure patterns and change with age/income
  - in- and out-migration
  - Retirement location decisions
  - Investment in human capital - when, how many times over a lifetime?
- Consumption by households accounts for 70% of gross domestic product in both the national and regional economies
- Any change in the composition of this consumption could have important direct and indirect (ripple) effects on the economy

Demographic Challenges to Development



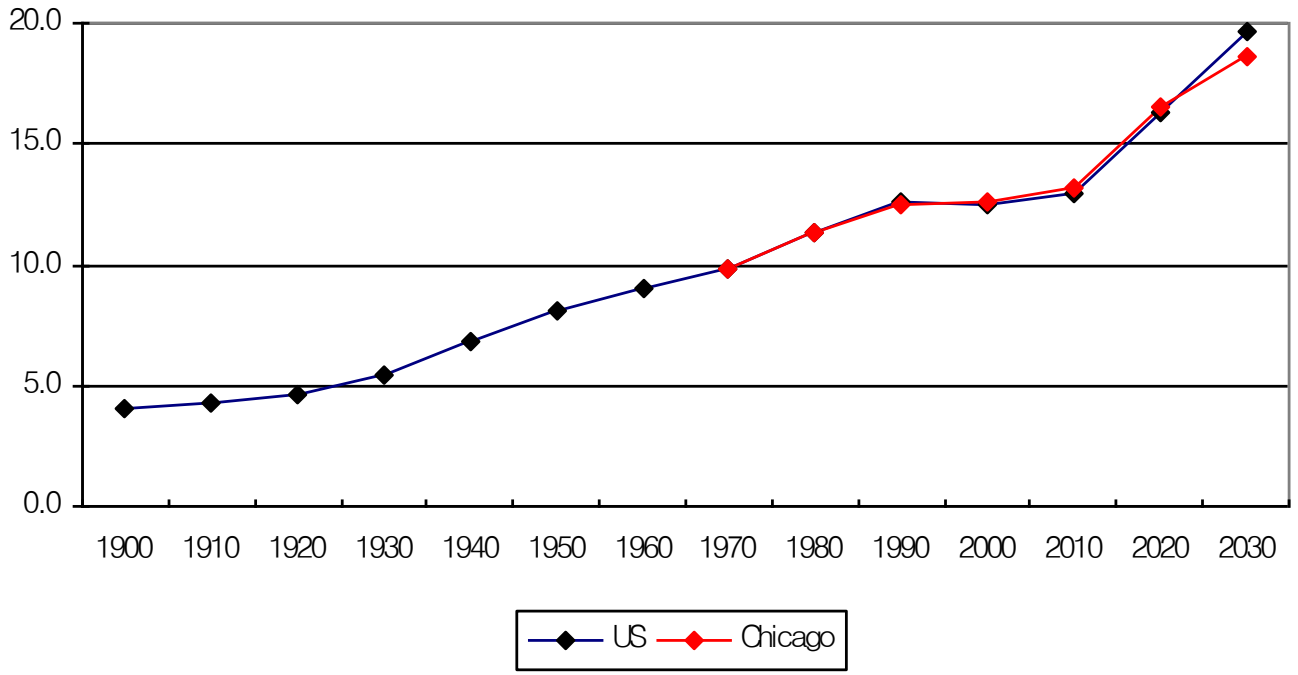
Demographic Challenges to Development



- A region's demographic structure is determined by the combination of:
  - LONG-TERM IMPACT
    - natural increase (births – deaths)
  - SHORT-TERM/INSTANTANEOUS IMPACT
    - two types of migration:
      - International and
      - Interregional

Demographic Challenges to Development

- Percentage of population in US and Chicago > 65 will grow to 20% by 2040 (30% in Japan)



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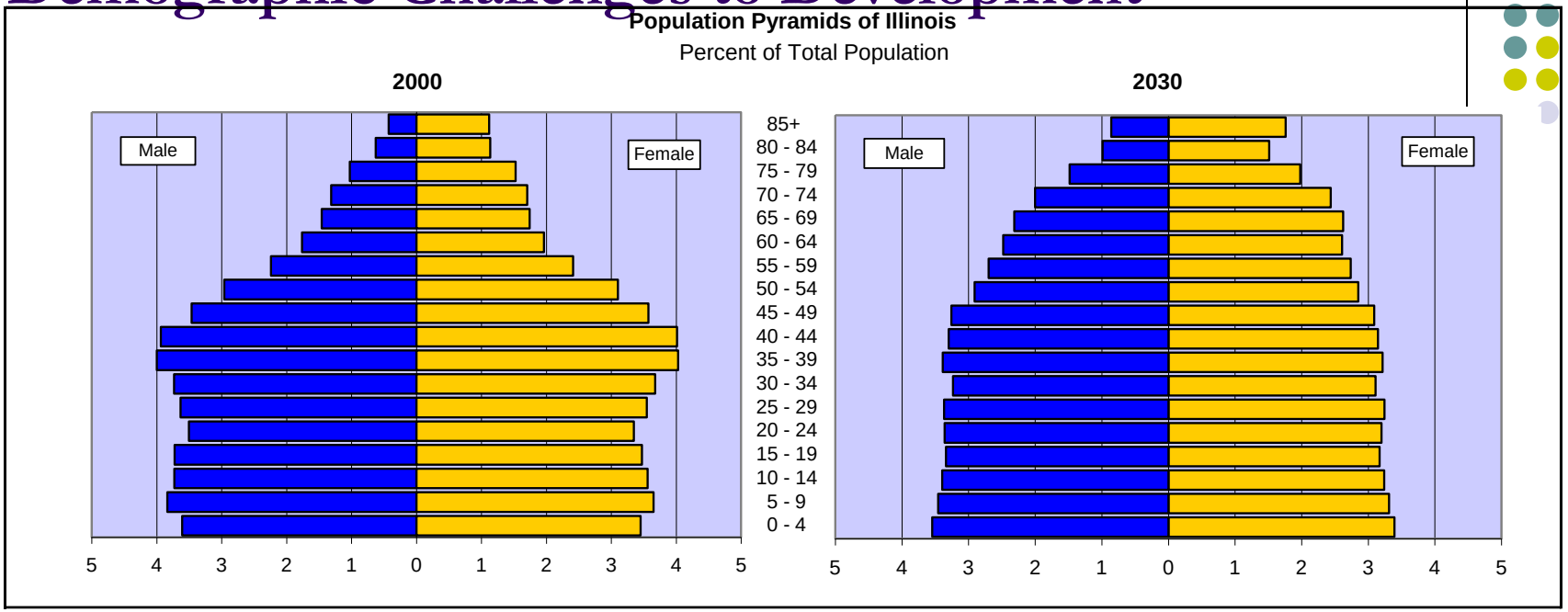
Demographic Challenges to Development



Illinois Population **2000** **2030**

Cohort	Change 2000-2030 Number	%
Under 18	13,662	0.4
5-17	-41,976	-1.8
18-24	17,468	1.4
25-44	-302,690	-8.0
45-64	373,007	14.0
65+	912,152	60.8

Note:
Significant decline in 25-44 age cohort

Significant increase in >45

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Demographic Challenges to Development

- To analyze the demographic changes in the Chicago region, this research employs AIDS (Almost Ideal Demand System), which was proposed by Deaton and Muellbauer (1980).
- This system is derived from the PIGLOG (price-independent log)-class expenditure function defined as follows which defines the minimum expenditure necessary to attain a specific utility at given prices:

$$\ln C(U,P) = (1- U)\ln A(P) + U \ln B(P)$$

- where U lies between 0 (subsistence) and 1 (bliss) and $A(p)$ and $B(p)$ are the costs of subsistence and bliss respectively

Demographic Challenges to Development

For a (utility maximizing) consumer, total expenditure, x, is equal to $C(U,P)$: this be be inverted to give U as a function of P and x, the indirect utility function.

Thus, we can generate budget shares as a function of P and x, providing AIDS demand functions in budget share form:

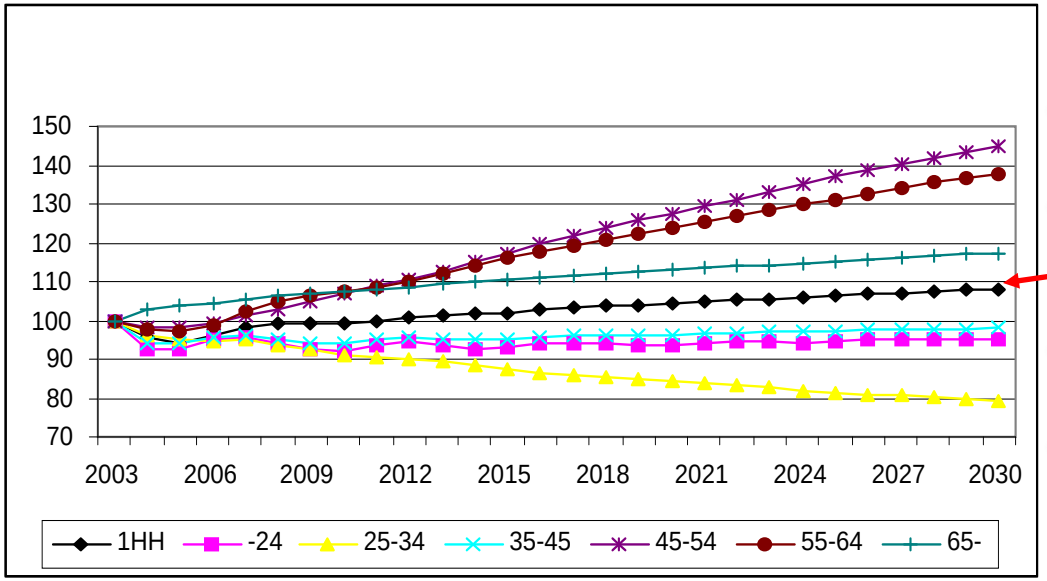
$$w_i = \alpha_1 + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln(x / P)$$

where P is a price index

Further considerations of (1) income levels, (2) household size and (3) age generate *non homotheticity* in consumption function

Demographic Challenges to Development

- Expected consumption by six age groups in Chicago in comparison to aggregating the effects into a single household type.
  - Rate of growth by age are very different
  - Allocation typical $ across goods varies significantly by age for some goods (food, housing, clothing, transportation, health care)



Older households

Representative Household

Younger households

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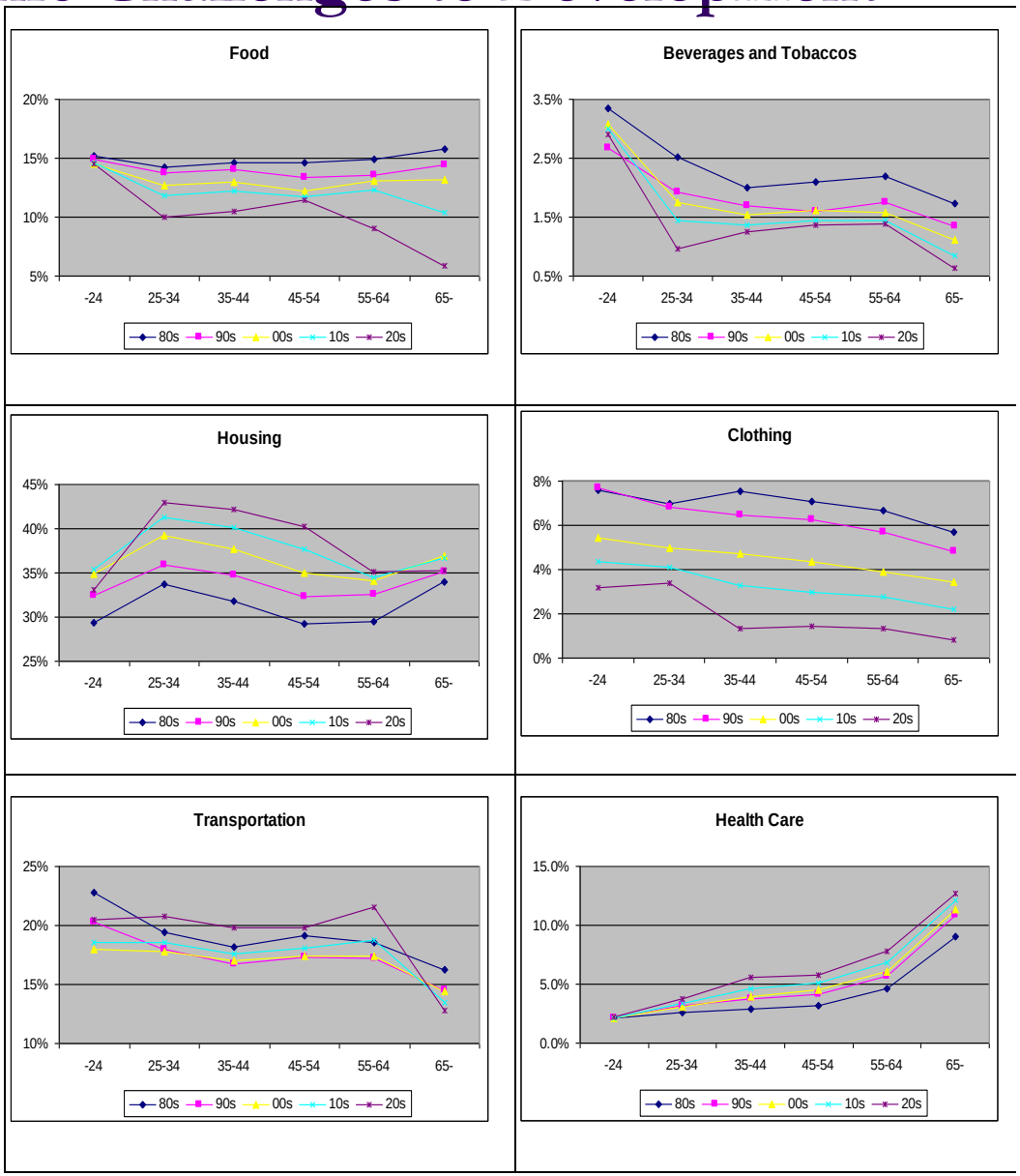

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Demographic Challenges to Development

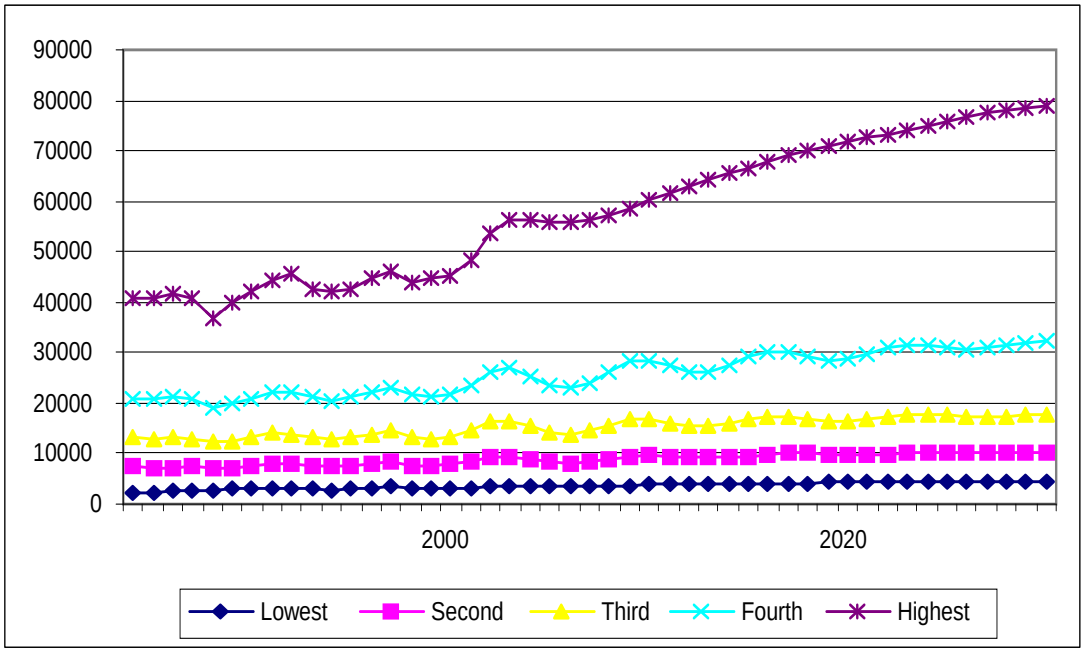
Evidence of non homotheticity by age

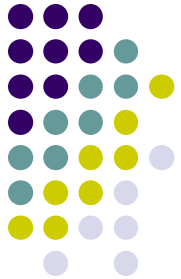
Consumption Types		Total	Under 25	25 - 34	35 - 44	45 – 54	55 – 64	Over 64
Food	2003	12.8	14.5	12.7	13.0	12.4	12.3	13.0
	2010	12.9	14.7	12.8	13.1	12.1	13.4	12.7
	2020	10.7	14.8	11.3	11.7	11.5	11.3	8.7
	2030	8.5	14.8	9.3	9.9	11.3	7.8	4.6
Housing	2003	36.3	34.1	39.0	37.6	34.4	34.4	36.7
	2010	37.0	36.0	40.2	38.6	35.9	34.3	37.1
	2020	37.4	34.4	41.9	40.7	38.7	34.6	36.1
	2030	36.7	32.3	43.4	43.3	41.2	35.3	35.3
Clothing	2003	4.3	5.2	4.8	4.7	4.2	3.8	3.3
	2010	3.5	5.1	4.5	4.2	3.8	3.5	3.0
	2020	2.3	4.2	3.9	2.9	2.7	2.6	1.9
	2030	0.3	2.7	3.1	0.5	0.9	0.8	0.4
Transportation	2003	16.9	18.1	17.7	16.7	17.3	17.6	14.7
	2010	16.5	17.9	17.6	16.8	17.4	17.7	14.0
	2020	17.0	18.9	19.2	18.2	18.6	19.7	13.1
	2030	17.7	20.4	21.4	20.2	20.1	22.3	12.6
Health care	2003	5.2	2.1	3.2	3.9	4.4	6.2	11.3
	2010	5.6	2.2	3.1	4.2	4.8	6.4	11.8
	2020	6.0	2.2	3.5	5.0	5.3	7.1	12.3
	2030	6.4	2.3	3.7	5.9	5.9	8.1	12.9
Others	2003	13.7	8.2	12.3	13.7	15.7	14.9	12.3
	2010	13.6	7.8	12.1	12.8	14.9	15.5	13.3
	2020	13.2	8.0	11.1	10.8	12.8	15.0	19.8
	2030	13.0	8.4	10.1	8.7	10.2	14.5	25.8

Age groups with strong demand declining in size

Demographic Challenges to Development

- Income growth by quintiles reveals an increase in the Gini coefficient
  - Effects of hollowing out, retiree out-migration and loss of high paying manufacturing jobs





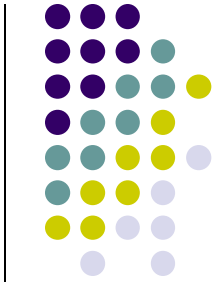
Aging and the Macroeconomy

Results using a Two-Region CGE Model Integrated within an Overlapping Generations Framework

Demographic Challenges to Development

- Earlier results developed with an econometric-input-output model (Marshallian CGE)
- Used same data base to generate two-region (Chicago-Rest of the US) Walrasian CGE
- Considered behavior by households of different ages 21-85

Demographic Challenges to Development

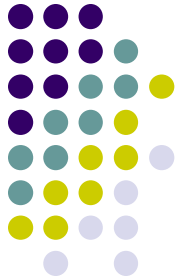


- Two regions, Chicago and rest of the US (ROUS), but the basic structure of this regional model is closely related to its national counterparts
- Households maximize their utility by choosing a profile of consumption (from income and assets) over the lifecycle:
  - individuals were forward looking (i.e., they considered the future in making decisions about whether to spend or save);
  - they had some uncertainty about how long they would live;
  - income consisted of wage and salary (and dividends) while they were working and only dividends and pensions in retirement;
  - all individuals retired at age 65 and died at or before 85.
- Firms demand factors following from profit maximization, responding to differences in goods and factor prices
- Prices adjust in both goods and factor markets to clear the excess demand

Demographic Challenges to Development

- Differences from standard models:
  - Labor partially mobile between regions – use a wage elasticity of migration
  - 2-step hierarchical nesting structure is necessary to complete the household's decision process, since both regions trade in goods and each individual considers products from different regions as imperfect substitutes (Armington assumption)
    - **1.st step: spend now or save for later**
      - Time separability allows a distinction between intertemporal and intraperiod decision-making in the nesting structure.
    - **2.nd step: chose between Chicago and US goods**
      - substitution elasticities play an important role in determining each agent's optimal choice: values of elasticities between two regions influence the magnitude of the regional effects

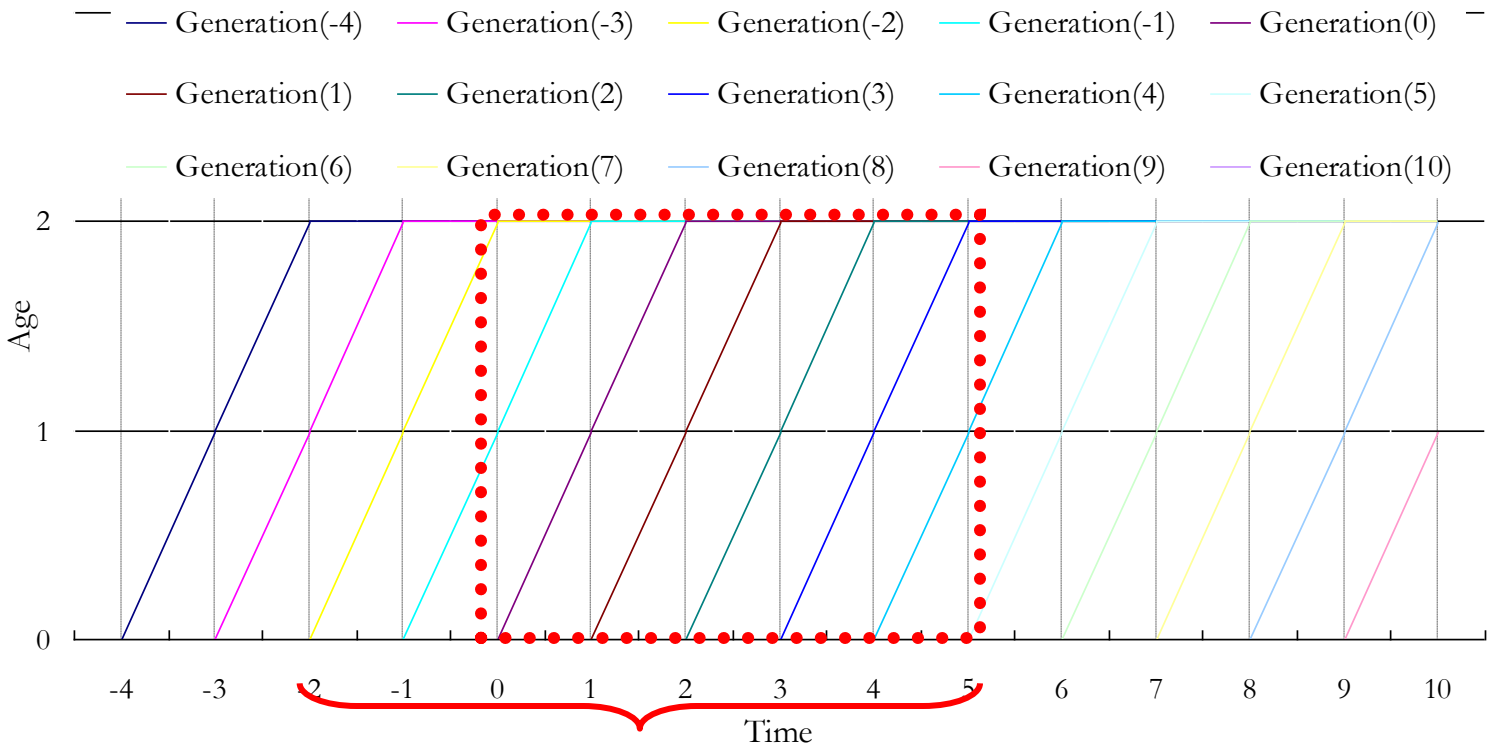
Demographic Challenges to Development



- Model is disaggregated by age cohort
- Dynamic processes, describing the path of consumption and savings behavior of each age cohort over time
- Each region is populated by individual agents who live to age 85
- The individual agent enters the labor market at the age of 21 and retires (no option) at the age of 65
- Since all the individuals between ages 0 and 20 are considered not to perform economic activities, reflecting they are supported by their parents, this model deals with only the individual agents > age 21

Overlapping Generations

The Scope of Consideration: *If we are interested in Time 0~5, consideration needs to be given to Generation -2 ~ 5.*



Demographic Challenges to Development

Mortality risk represented by the conditional probability (s):

$\prod_{k=1}^{j} s_k$ is then the unconditional probability of being alive at age k. Expected lifetime utility is:

$$U_i = \sum_{j=1}^{65} \left(\frac{1}{1+\rho}\right)^{j-1} \left[\prod_{k=1}^{j} s_k\right] \frac{(C_{i,j})^{1-\gamma}}{1-\gamma}$$

where $C_{i,j}$ is the aggregate consumption of an individual of age in i^{th} generation, ϱ is the subjective discount rate, γ is the inverse of the intertemporal elasticity of substitution

Thus, the effective discount rate is expressed as:

$$\left(\frac{1}{1+\rho}\right)^{j-1} \prod_{k=1}^{j} s_k \frac{1}{1-\gamma}$$

meaning that with mortality risk, the utility of future consumption is more heavily discounted

Demographic Challenges to Development

- At every period, each individual faces the budget constraints described as follows:

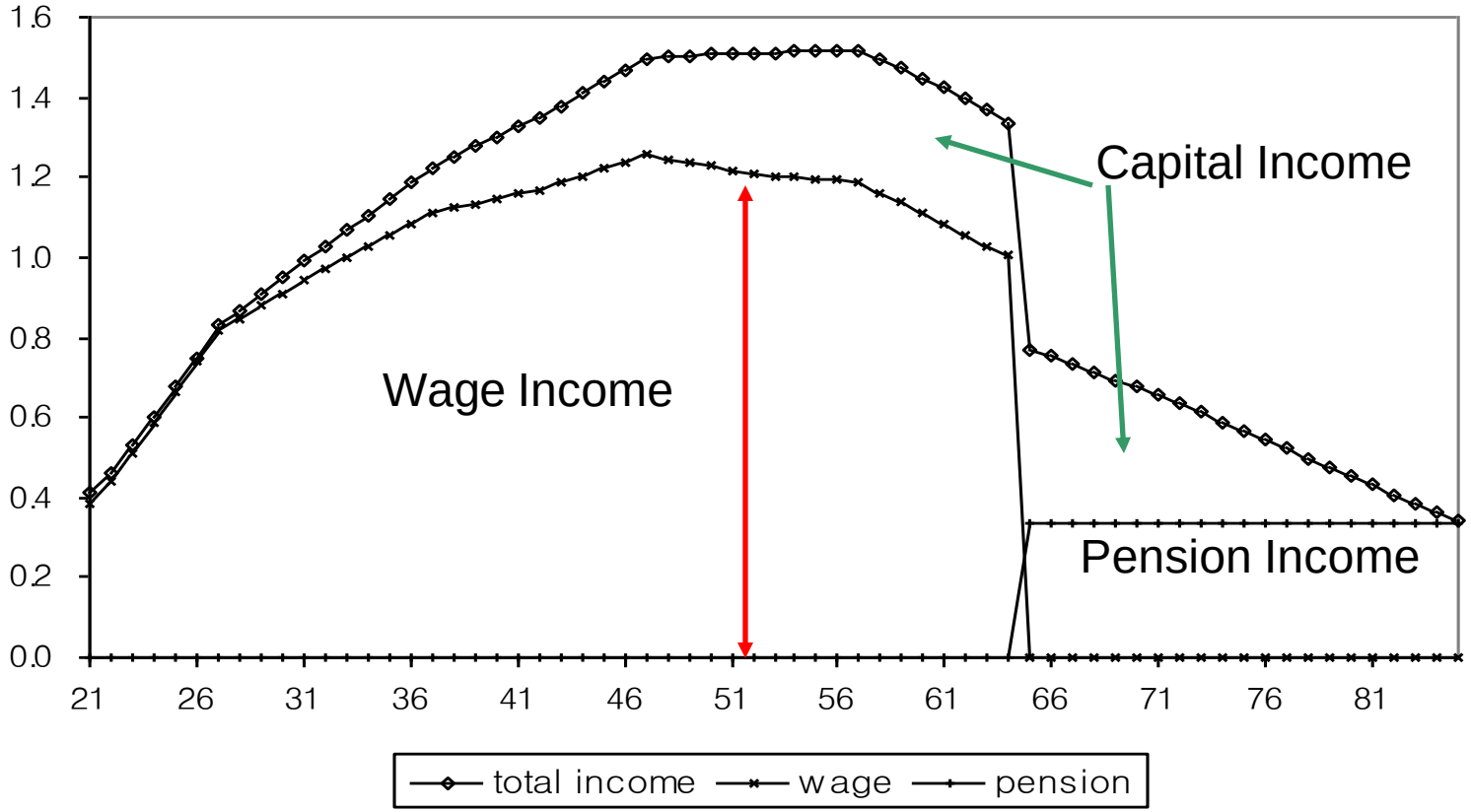
$$(1+\tau_c)P^C C_{i,j} + a_{i,j} = (1-\tau_w-\tau_p)w\,e_j + (1+(1-\tau_r)r)a_{i,j-1} + pen_{i,j} + \Phi$$

consumption + assets = wage income + asset income + pensions + bequests

- where $a_{i,j}$ is the asset of generation i at age j,
- τ_w, τ_c and τ_r are tax rates on labor income, consumption, and capital income respectively,
- τ_p is the social security tax rate, i.e. pension contribution rate, w is the wage, r is the interest rate, and P^C is the price of aggregate consumption good.
- $pen_{i,j}$ stands for the pension benefit of generation i at age j, and Φ is the transfer from accidental bequests

Demographic Challenges to Development

Contributions to income over a lifetime (no change in population structure)



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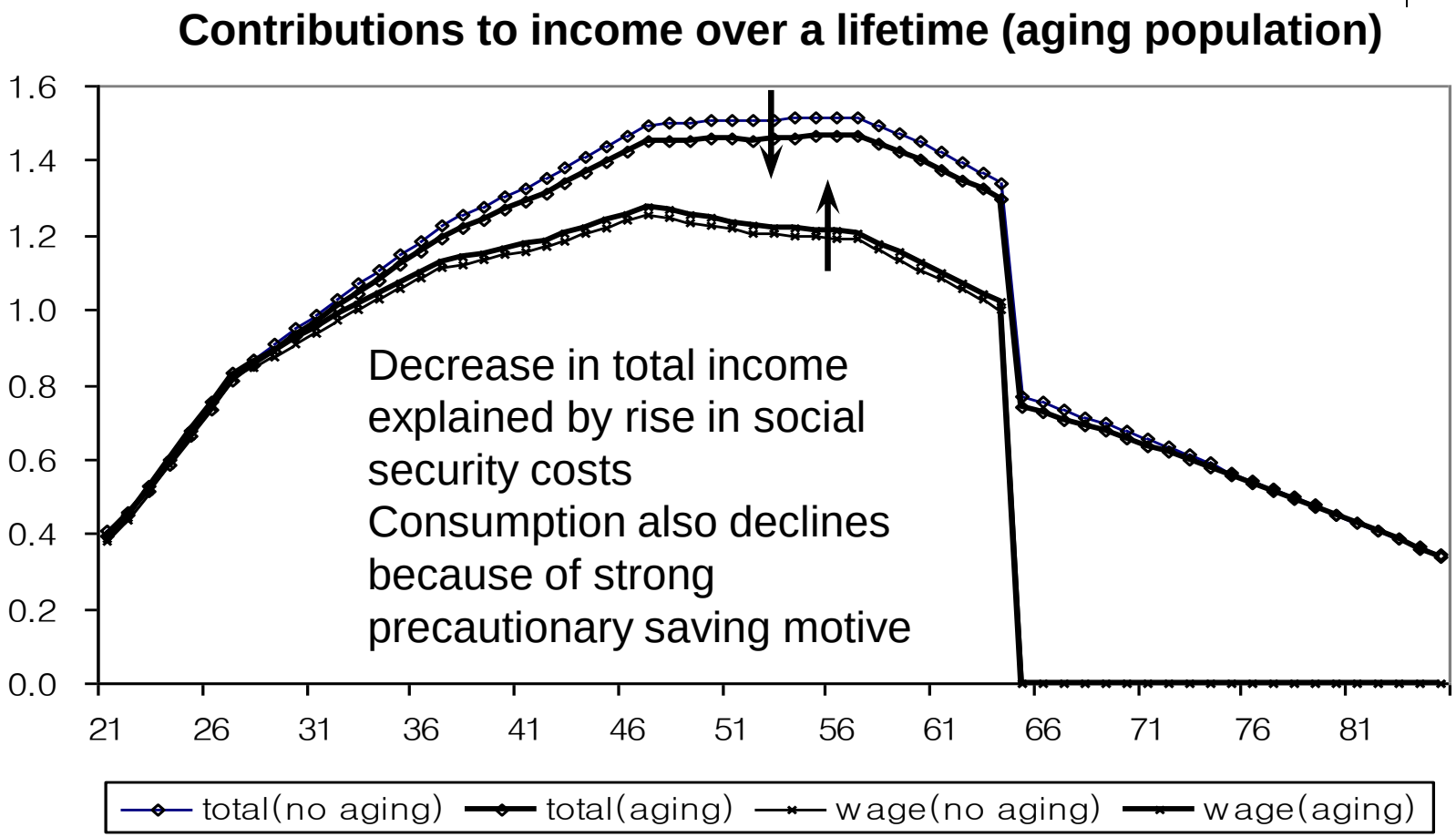

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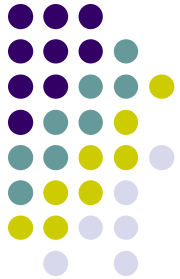


- As a consequence
  - Decline in Gross Regional Product
  - In contrast to the earlier findings, when an aging population is considered in this more behavioral manner, the **income inequality declines** rather than increases because:
    - Changes in social security payments by wealthier workers;
    - Increased returns from assets and
    - More forward-looking behavior, retirees will have more assets from which to draw income in retirement.
  - Earlier analysis failed to include the effect of assets (non wage and salary income) and, increasingly, these will form a major part of the income base for retirees.

Immigration, Aging and the Regional Economy

Demographic Challenges to Development

- Will immigration create adverse/positive effects on the local labor market?
  - **By crowding out;**
  - **Reduction of wages and exhaust employment opportunities for native workers, especially for those who are young and have low skills.**
  - **Higher income disparity could be generated due to the large decline in the income of low-skilled workers.**
  - **Immigration may change the age structure, and imbalance caused by aging population.**
  - **Impact on solvency problem of the social security program because immigrants pay social security tax, and usually have no parents who are currently drawing on the system.**
- Of course this assumes that the immigrants participate in the formal economy (whether legal or not) and thus contribute through direct and indirect taxes.

Demographic Challenges to Development

- Three scenarios, which are differentiated by the size of immigrants for both regions; Chicago and rest of the U.S. compared with baseline that assumed aging and no immigration
  - **Scenario 1: Historic immigration level**
    - Chicago admits to 0.6 percent of the regional population every year,.
  - **Scenario 2**: **Twice Historic level**
    - Chicago region admits 1.2% (0.1 million/year) while US as a whole fixed at 0.6 percent.
  - **Scenario 3: 2.5 times Historic Level**
    - Chicago adopts even more favorable immigration policy where the number of annual immigrants admitted in Chicago region increase to 1.5 percent of its population, or about 0.12 million.

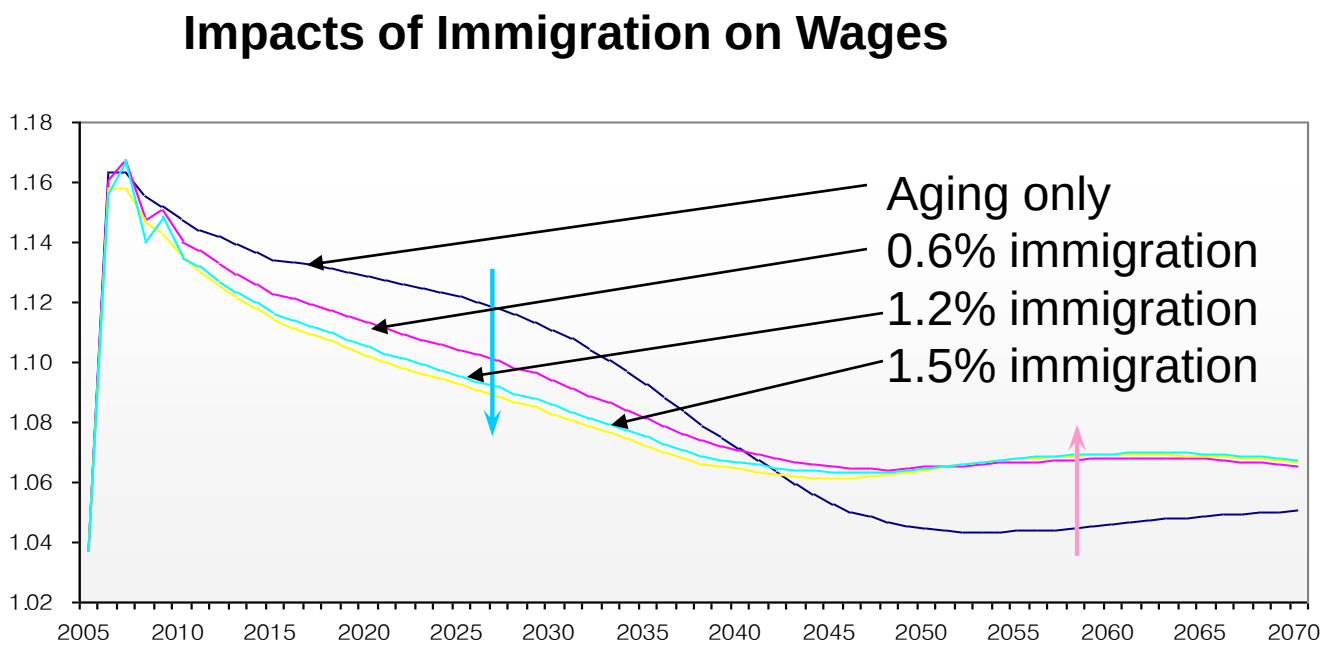
Demographic Challenges to Development

- Dependency ratio [the percentage of the dependent old age populations (those ≥65) to the population in the working age groups (between 15 and 64)] in the Chicago region is expected to be substantially reduced over the next several decades. Impacts 2030:

Aging	**32%**
Scenario 3	**19%**
2005 Level	**19%**

- Newly admitted immigrants are assumed to be equally distributed between the ages of 21 and 35, and whose average productivity is about 60 percent of the peak at 47 years of age. The baseline Scenario, whose results are compared with Scenario 1 through 3, assumes an aging population with no immigration. This is the scenario that was introduced in the previous section.

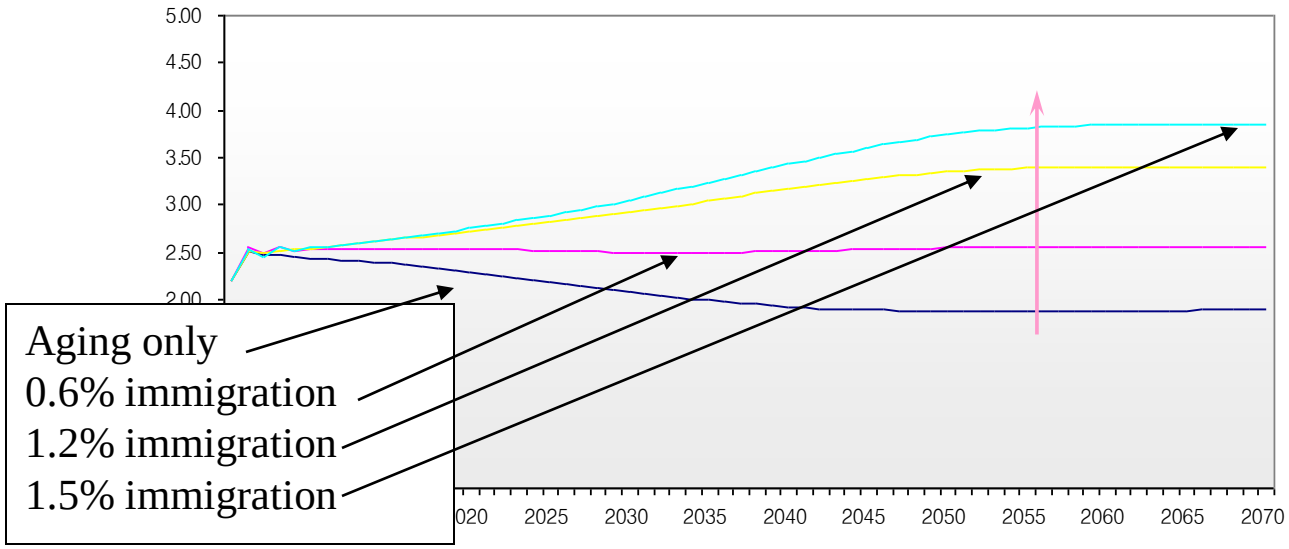
Demographic Challenges to Development



Inflow of young immigrants, initially, lowers the capital/labor ratio,
→ contributes to a decrease in wages

Demographic Challenges to Development

Impact of Immigration on Chicago Gross Regional Product



An increase in immigrants has more positive impacts on regional output growth.

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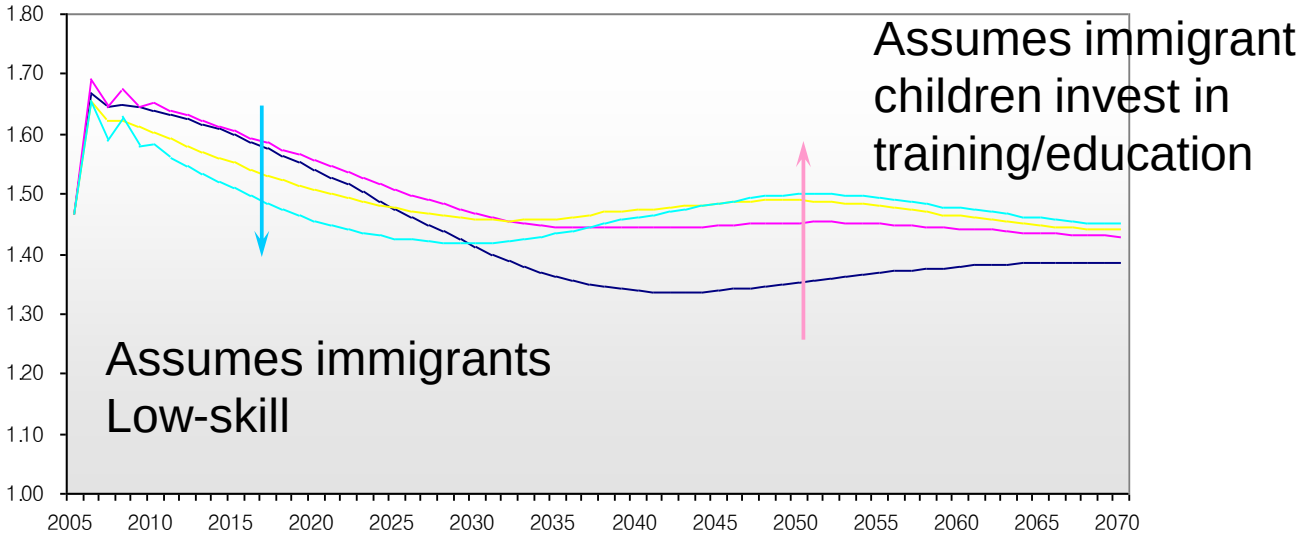
Per Capita Chicago Gross Regional Product



- Transitional profile of per capita GRP is different from aggregate GRP
- The national GRP share of the Chicago region noticeably increases from 3.0 percent to around 3.5~4.0 percent in Scenario 2 and 3 because both scenarios assume relatively higher share of immigrants are admitted only in the Chicago region.

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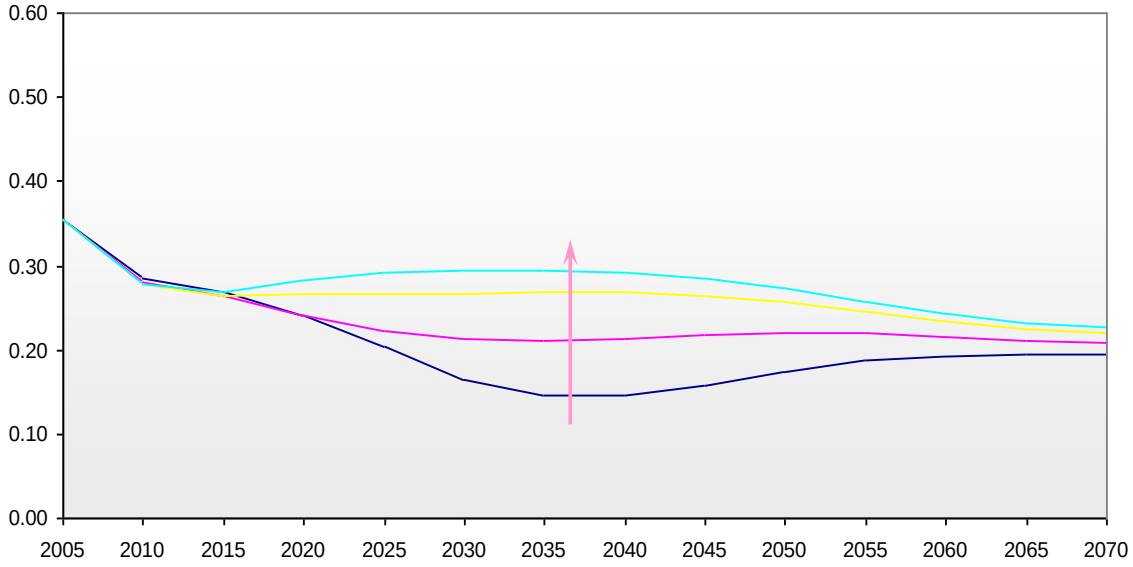
Demographic Challenges to Development

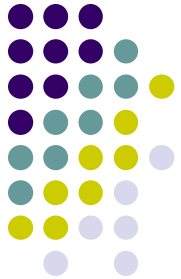
Immigration Impacts on Income Distribution: Gini Coefficients for Chicago



immigration turns out to have a **negative impact** on equality in terms of income distribution:

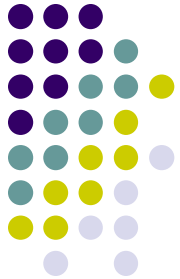
- younger populations relying on labor income become relatively poorer as more immigrants decrease wage income,
- whereas rich middle-aged populations are not much affected by the immigration because they earn large capital income thanks to the increases in the interest rate.

Demographic Challenges to Development



Does a Change in Retirement Age Affect a Regional Economy?

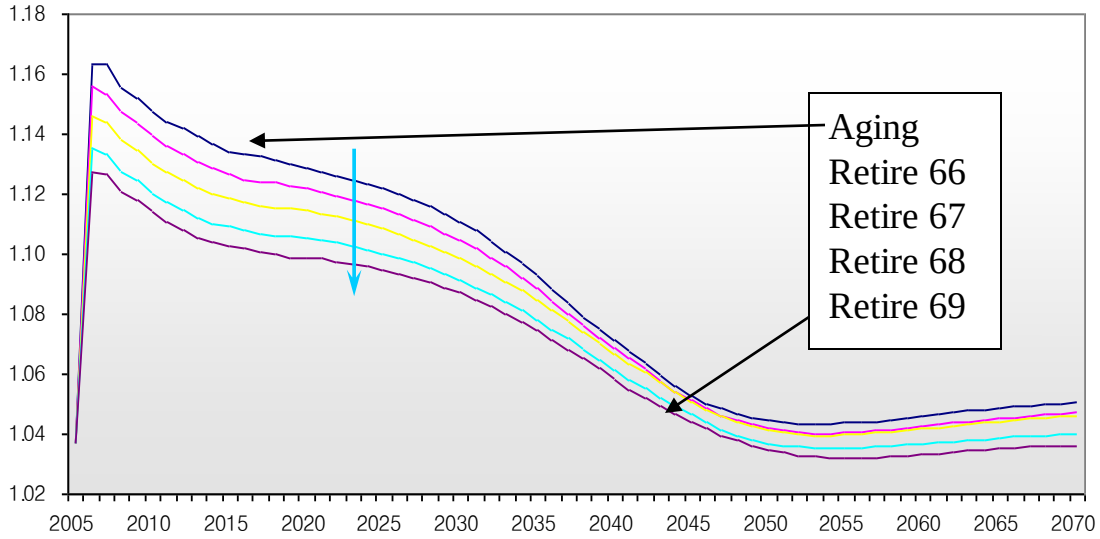
Demographic Challenges to Development



- Assumed that the retirement age is delayed by one year for each Scenario, i.e., for Scenario 1 through 4, individual is supposed to retire at 66, 67, 68, and 69, respectively.
- Baseline scenario is one in which the population ages as before.
- Increasing the retirement age generates a smaller capital/labor ratio compared to Baseline Scenario since the labor force increases as much as the working age is expanded.

Demographic Challenges to Development

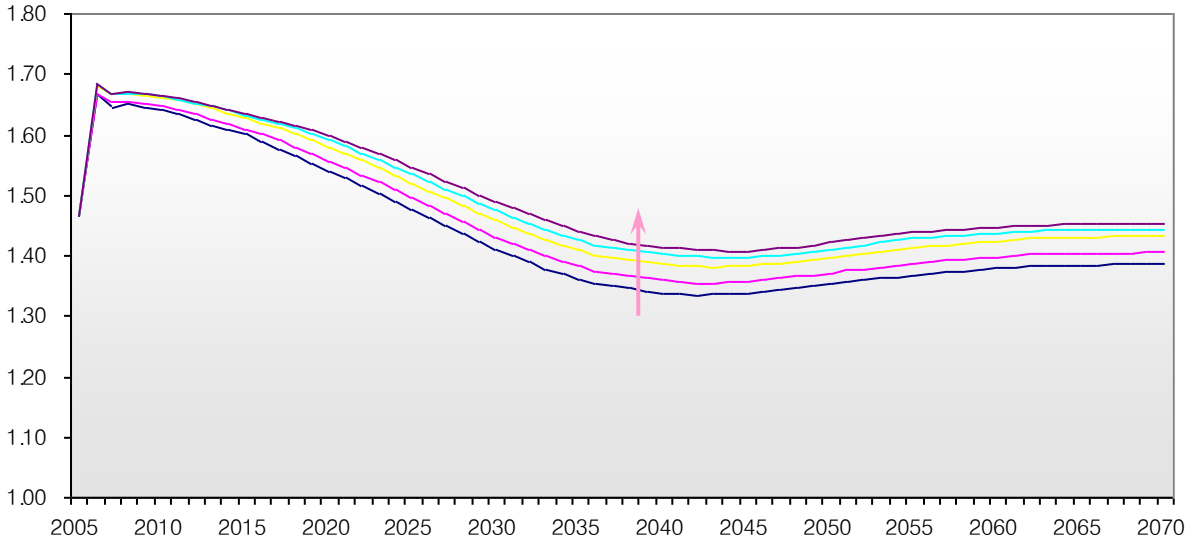
Extending retirement age and the impact on wages



- The lower capital/labor ratio leads to a fall in wages as shown
- If the retirement age is delayed by 4 years (to age 69) then wages fall by 7~8 percent until 2030s compared to the baseline
- Most recover after this time

Demographic Challenges to Development

Retirement age and Chicago Per Capita Gross Regional Product



- Increasing the retirement age contributes to an increase the output, and thus the per capita GRP also increases since there is no change in the size of population.
- If individuals could continue working beyond the age 65 by at least 2 or 3 years longer, then the per capita GRP around 2050s starts to rise above the level before the aging population occurs.
- However, the additional gain in per capita GRP corresponding to a one-year increase in retirement age becomes smaller, reflecting the fact that the productivity of population decreases dramatically from age 65

Demographic Challenges to Development

- The policy implications become complicated when consider all combinations:
  - Immigration and **out-migration retirees** (results not presented but loss of income from retirees significant**)**
  - pension reform,
  - changing retirement age and
  - skill acquisitions of the immigrant children – key issue in consideration of the welfare effects
- In progress: development of an optimization module to address multiple objectives

Inter-Regional Endogenous Growth under the Impact of Demographic Changes

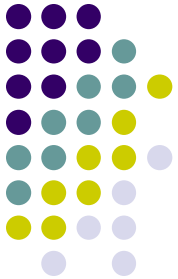
Introduction

- **Educational investment in developing workers' human capital improves the overall productivity in the corresponding economy and thus significantly attenuate the negative impacts generated by a shrinking labor force**
- Work of Sadahiro and Shimasawa (2002) and Ludwig *et al. (2007*) influential in motivating this paper – intergenerational transfer of knowledge
- Significant regional differences and even more differentiation by ethnic groups – concern about Latino population – especially as will account for 37% Chicago metro population by 2035

The Model: Overview

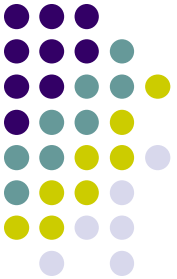
- 6 regions- Illinois (IL=1), Indiana (IN=2), Michigan (MI=3), Ohio (OH=4), Wisconsin (WI=5) and the rest of US (ROUS=6)
- The economy is closed to the rest of the world; no foreign imports or exports in the model.
- There are two types of economic agents in each region: a representative firm and households
- Each year, there are 65 overlapped generations in the household sector
- A federal government operates a social security system in each region

The Model (2)



- The economy produces physical goods as well as human capital
- Physical goods are tradable across regions; and the firm can purchase intermediate goods from each region
- Consumers and investors purchase goods from all the regions for consumption and investment purposes respectively
- Households now have 3 decisions:
  - Allocation between consumption and saving (inter-temporal)
  - Allocation between goods produced in any region (inter-regional)
  - **Allocation between education and working (human capital)**

Additions to CGE/OLG Model: Human Capital Investment



- Draw on ideas of Sadahiro and Shimasawa (2002):

$$h_{j,g+1,t+1}=(1-d_h)h_{j,g,t}+B(mk_{j,t})^{f}(h_{j,g,t}e_{j,g,t})^{1-f}$$

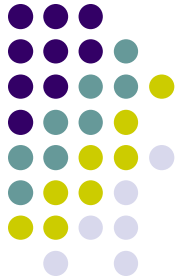
where k_t is the physical capital/labor ratio while B is the parameter for the accumulation efficiency of human capital, m is the portion of physical capital stock used for producing the human capital stock, δ_h is the parameter of depreciation rate of human capital stock and ϕ is the parameter of the elasticity of human capital formation function

- Human capital is transmitted between generations according to following rule:

$$h_{j,1,t}=p^{hc}\left(\left(\sum_{g=1}^{45}h_{j,g,t-1}N_{j,g,t-1}\right)/\sum_{g=1}^{45}N_{j,g,t-1}\right)$$

where π^{hc} is the parameter of human capital transmission factor

The Model – Human Capital



- This parameter can be interpreted as the degree of quality or efficiency to pass the available stock of knowledge from generation to generation in the workplace.
- If a society can provide the individual a successful educational environment (either formally or in-formally) in childhood and youth so that the individual learns the cognitive ability and creativeness well in these periods, this parameter value should be high since the human ability acquired early will make post-secondary school learning easier
- **Significant differences across ethnic groups** (another paper)
- Significant evidence from Head-Start education programs in US that this works

Steady-State Results

- Since it was unlikely that US was in steady state in 2007, likely that the steady-state simulation and actual data should not be entirely consistent
- Differences in investment in physical and human capital play a key role in generating different levels of per capita output in the simulation model

	IL	IN	MI	OH	WI	ROUS
Physical Investment (A)	1.2911	0.3982	0.6625	0.8502	0.3876	28.2210
Output (B)	7.9929	3.2557	4.8748	6.0022	2.9510	165.0061
Investment-Output ratio (A / B)	0.1615	0.1223	0.1359	0.1416	0.1313	0.1710

- ROUS and IL have higher investment ratios – may reflect differences in rental rates across states

Steady-State Results

- Could educational attainment be a factor in determining economic performance through its impact on productivity?

	IL	IN	MI	OH	WI	ROUS
Time share in education (%)	**13.18**	10.42	10.55	11.42	10.97	**13.55**
Avg. human capital stock	2.27	1.77	1.78	1.94	1.85	2.39
Gross State Product / Annual Employment: 1998 thru 2007[1)]	80.52	67.77	74.88	68.94	65.06	78.66

Measure of labor productivity

- Age profile of human capital stock reveals **high skilled region** (ROUS, IL) and **less skilled region** (IN, MI, OH, WI)

Steady-State Results

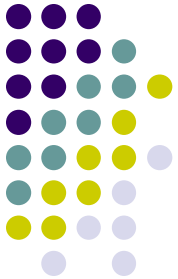
- Average worker at retirement age is almost 37% more productive in high skilled regions – result that is consistent with differences in labor productivity
- In turn, gaps may also reflect differences in time spent on educational investments (see earlier table)
- Steady state prices reflect observed values

Steady-State Results

Age	IL	IN	MI	OH	WI	ROUS
15-64	0.9665	0.9873	0.9474	0.9105	0.9750	1.1163
65+	1.5595	1.5774	1.6320	1.5261	1.7803	1.9415
15+	1.0571	1.0796	1.0535	1.0136	1.1057	1.2464
Dependency ratio	18.04% → 29.10% (+11.1%p)	18.54% → 29.63% (+11.1%p)	18.33% → 31.57% (+13.2%p)	20.11% → 33.70% (+13.6%p)	19.39% → 35.40% (+16.1%p)	18.70% → 32.53% (+13.8%p)

- Per capita output declines in all regions
- OH: declines not as pronounced but number of people in working age (15-64) declines faster than other regions as a result of slow (1.4%) population growth (compared to 24.6% in ROUS)
- Has one positive outcome – growing population and limited supply in OH (due to drop in labor force) improves terms of trade for OH (invoking Armington again)

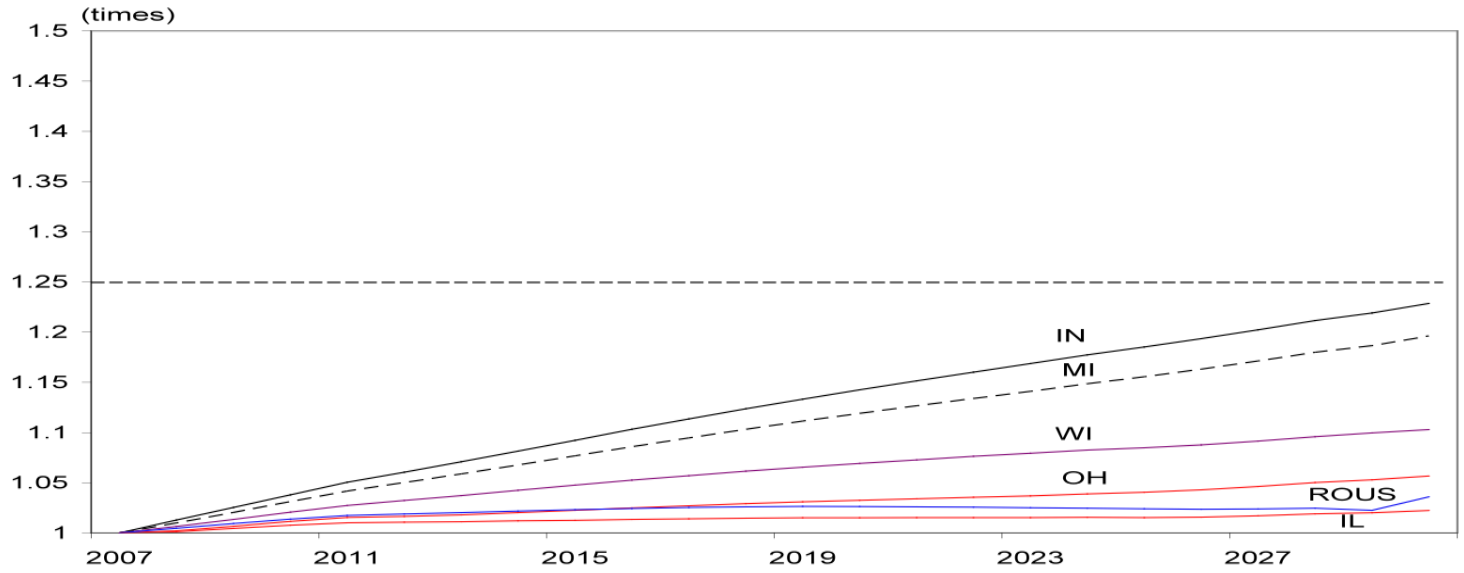
Dynamic Simulation



		IL	IN	MI	OH	WI	ROUS
Per-capita output	2007: A	7.6775	5.7624	5.3164	6.1117	5.9618	7.9339
	2030: B	7.8491	7.0798	6.3597	6.4586	6.5759	8.2189
	B/A	1.0224	1.2286	1.1962	1.0568	1.1030	1.0359

- Results reveal that per capita growth will be positive even with ageing population
- Contradicts earlier work (Park and Hewings, 2007)
- Now, individual's endogenous choice of educational investment mitigates negative effects of ageing
- Result: declining labor force but increasing productivity with highest levels in IN and MI

Dynamic Simulation

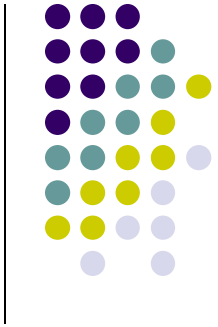


- Growth of per capita output while apparently large for IN and MI still amounts to only 0.9% per year
- IL and ROUS still produce most per worker and MI least in 2030

Conclusions

- However, there are some important limitations
  - Investment decisions imply perfect rationality and foresight
  - In reality, some incentives may be needed to encourage workers to invest (and continue to invest) in their human capital
  - The dynamics of the economy have not been considered in terms of
    - Introduction of new goods and services
    - Location of the production of these outputs

Conclusions

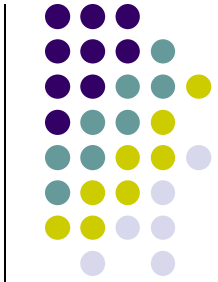


- Model's limitation in mobility of labor needs to be addressed since interstate migration is significant
  - Consider role of job re-locations
  - Increasing impact of retiree out-migration (for Midwest, net out-migration for people 65-75 but net in-migration for those >75)
- A companion paper

Tae-Jeong Kim and Geoffrey J.D. Hewings (REAL 10-T-2) *Endogenous Growth of the Ageing Economy with Intra-Generational Heterogeneity over Race and Migration Status*

explores the role of ethnic composition and the increasing concern for underinvestment in human capital in minority/immigrant populations

Conclusions



- More recent work:
  - Application to National Institute for Ageing: Focus on:
    - Re-attachment to labor force after initial retirement:
      - Motivation – extended life expectancy generating need for larger assets
      - optimal re-training strategy
      - If relocated – do they return to previous location to re-enter labor force?
      - Do they attempt to reclaim prior profession?
    - Role of single women
      - 2-3 times more likely to live in poverty after retirement
      - Tend to outlive spouse – optimal planning