REMI RESEARCH & DEVELOPMENT

what does REMI say? sm

Presented by Jerry Hayes, Vice President

What we've been doing

- Annual Data Updates
- Software Enhancements
- Re-estimating Equation Coefficients
- RSQE Forecast Updates
- Solutions for modelling a changing world
  - New features
  - IQ+

New Features and Changes

An overview of the data changes and new features that are in the latest models

Data Changes

- BLS 2018-2028 Employment Projections
- Incorporated BEA's comprehensive update to Local Area Personal Income 2001-2018.
- Incorporated BEA's GDP data by county and major industry.
  - Expanded from 3 to 21 categories
  - Time series extended from 2012-2015 to 2001-2018

RSQE Updates

- REMI has provided several macroeconomic updates based on the U.S. Economic Outlook from the University of Michigan's Research Seminar in Quantitative Economics (RSQE) due to the rapidly evolving pandemic and response
- The updates can be downloaded from https://www.remi.com/forecast-updates/

New Features Demo

- A quick model demonstration to show off the new features and software interface changes

Input-Output Table

- Added history years
- Color-coded sections
- Added explanatory hints
- Added filtering
- Added ‘Jump To’
- Columns can be viewed as stacked bar graph

Detailed Government Policy Variables

- Added Detailed Government Policy Variables
  - State and local government educational services
  - State and local government hospitals and health services
  - State and local government other services
  - State and local government passenger transit
  - State and local government electric utilities
  - Federal general government (nondefense)
  - Postal service
  - Federal electric utilities
  - Other federal government enterprises

Studies Tool

- This new feature allows users create and run multiple simulations and to compare simulation results to each other.
  - The Forecast Ranking Study can be used to rank simulations based on custom scoring methods.
  - The Multiplier study automates the process for calculating different types of multipliers for different regions and industries.

Automatic Forecast Running

- Multiple forecasts can be added to a queue and run automatically is sequence

Flexible Custom Aggregations

- Custom aggregations now have a flexible option that allows details to be assigned to multiple groups or not be assigned to any group
- Example: Model of all states
  - Massachusetts
  - New England
  - East Coast
  - Total

Custom Results

- Custom Results can be used as a spreading weight for policy variables
- Coefficients from the Input-Output table can be used as constants when defining Constant Factor custom results

Update Interfaces

- The forms have been redesigned to guide users through the process
  - Macroeconomic Update
  - Employment Update
  - Population Update
- Grids can be autofilled using baseline data
- Custom industry and age aggregations can be used

Default Regional Controls

- Each new national control forecast can have a default regional control
- New alternative regional controls can be build off that default regional control
- Fixes issues with ‘Percent Change’ policy variables

Policy Variable Warnings

- Warnings will be generated for policy variables if the policy variable is not expected to have an effect on the model
  - Ex. Adding 10% employment to an industry that has 0 employment in the baseline

Results Enhancements

- Drag and Drop pivoting
- Right-click field options
- Right-click units change
- ‘Current Pivot’ option
- ‘Reload’ option
- Origin and Destination fields can be filtered
- Path option added to Connections Explorer

Documentation

- Organized into several sections
- Added ‘What’s New’
- Customizable tool to display Industries, Occupations, and Commodities
  - Change level of detail and rearrange columns
  - Print, Save to PDF, Save to Excel function
  - Search box
  - No longer in documentation folder

Setting Importer

- Settings and favorites can be imported and exported from a single file for easier sharing

Miscellaneous

- More support for pasting from Excel
  - Cells with Currency, Accounting, Percentage, and other formatting can be copied and pasted directly into inputs
- Search feature added to Policy Variables and Result Variables lists
- Delete buttons added for policy variables on Inputs List
- Private, Government, and Farm Detailed Policy Variable Translator Coefficients show together
- Cancel button added to Save Forecast dialog

Tax-PI

- Major interface changes to Budget Calibration with more guidance
- Separate region aggregations for revenues and expenditures
- Projected budget (without feedbacks)
- Calculate effective rates by averaging over multiple years
- Fixed vs. Marginal revenues and expenditures
- Direct or inversely proportional relationships between budget item and indicator
- Budget item projections with spreadsheet example

End Software Demonstration

Looking into 2021

A preview of what we are working on for the next model release

Data Changes

- Historical Period 2001-2019
- BLS 2019-2029 Employment Projections
  - First time BLS has released projections annually
  - The 2019–29 projections do not include impacts of the COVID-19 pandemic and response efforts.

Consumption Equation Parameters

- REMI periodically re-estimates parameters for model equations
- The consumption equation parameters have been re-estimated for the next version of the model
- Presentation by Xiaochu Ma

Direct, Indirect, and Induced Effects

- REMI has a dynamic model and doesn't neatly fit with concept of Direct, Indirect, and Induced effects however this is the language that many people use to communicate about economic impacts
- Adding new calculations of Direct, Indirect, and Induced Effects to simulation results along with multiplier calculations
- Important that concepts are well-defined
- Presentation by Haozheyi Guan

Demographic Impact of Job Changes

- Job losses due to COVID and other factors may disproportionately affect different genders and races
  - Between January and September, employment losses by women are 618,000 higher than men and 761,000 more women than men have dropped out of the labor force
- IPUMS survey data shows employment by occupation, gender, and race
- We are working on incorporating this information into models to help study demographic impacts of job changes

Women are disproportionately affected by COVID

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IQ+

- Quarterly Analysis model
- Software development and modification of model equations
- The economy is rapidly evolving and decision makers are concerned about how policies will affect the next quarter

Software Improvements

- Focusing on adding helpful features and improving user experience
  - Interface improvements
  - Tax variables working with multiple regions
  - Easier to use custom results calculations
  - More enhancements to data visualizations
  - Adding and improving right-click menus
  - And more!

Conclusion

- REMI has a growing development team
- Making best use of the available data
- Dedicated to improving software interface
- Working to add new results
- Love to hear feedback

HOW TO CALCULATE MULTIPLIERS?

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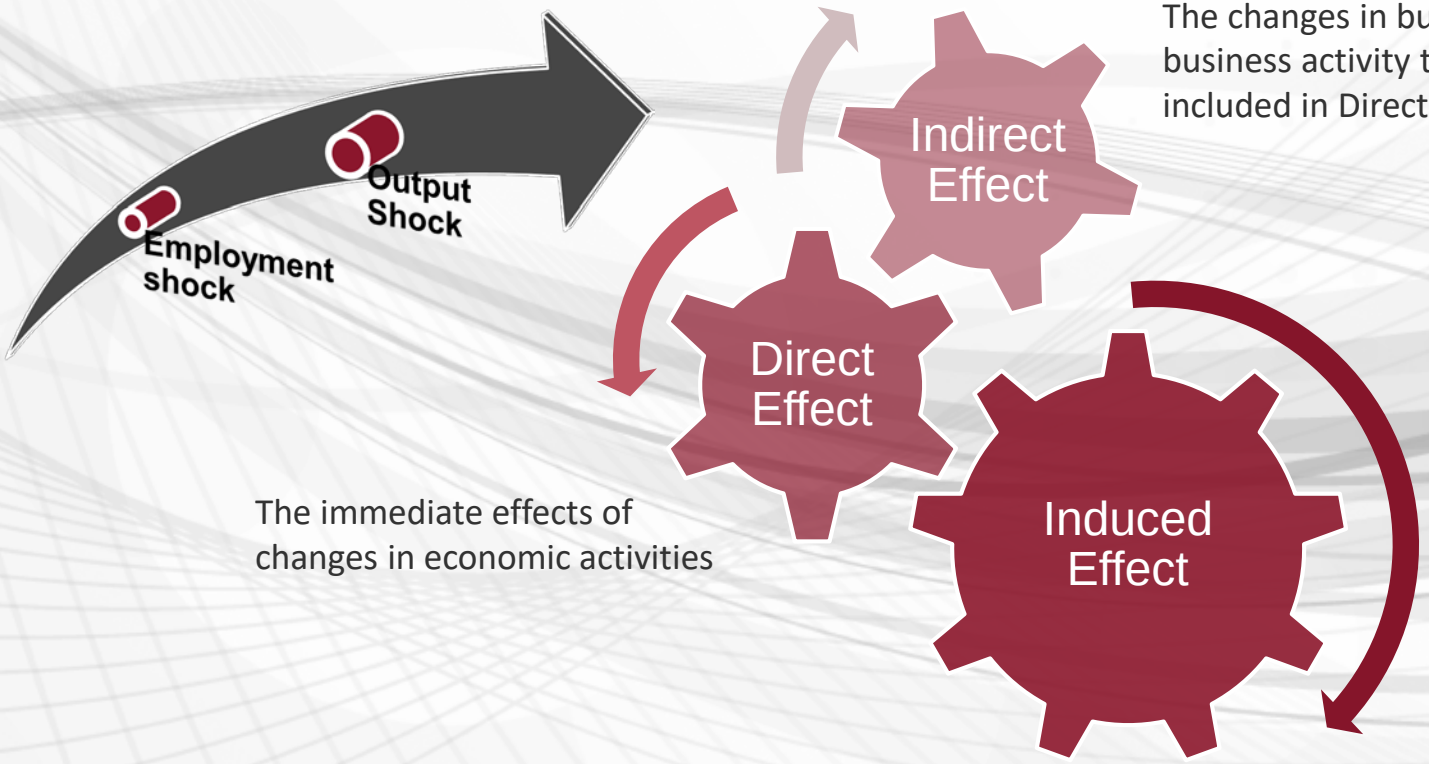
Presented by: Haozheyi Guan, Economic Analyst

Agenda

- Introduction
- Sample Simulation
- Comparison Analysis
- Policy Variable List

Introduction



The changes in business-to-business activity that are not included in Direct Effect

The immediate effects of changes in economic activities

The economic impacts of household spending and other dynamic responses as a result of exogenous shock.

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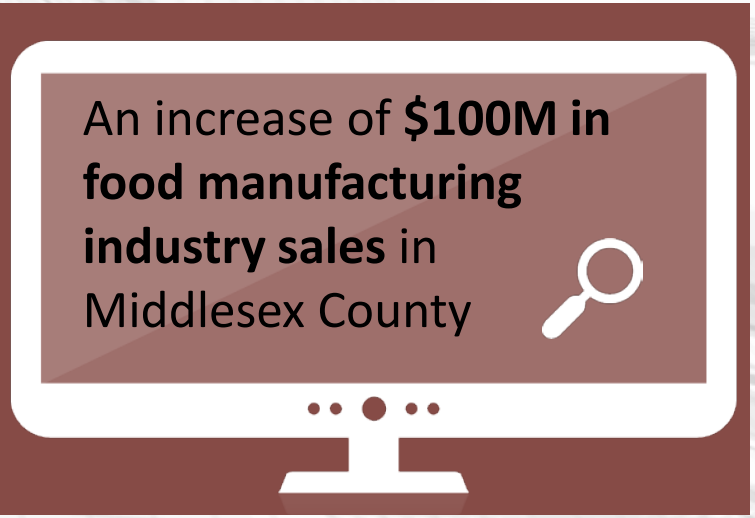
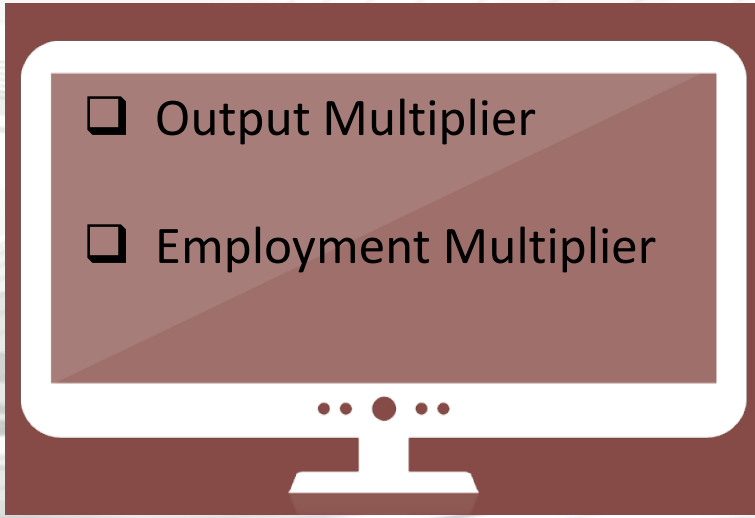
Sample Simulation

An increase of **$100M in food manufacturing industry sales** in Middlesex County



- ❑ Output Multiplier
- ❑ Employment Multiplier



Sample Simulation

Step 1

- *Direct Output = $100M (Exogenous Shock)*

Step 2

- *Indirect Output Coefficient = sum (**IO Coefficient** per industry * **Regional Purchase Coefficient** per industry)*
- *Indirect Output = Indirect Output Coefficient * Direct Output*

Step 3

- *Induced Output = Total Output – Direct Output – Indirect Output*

Sample Simulation

Step 1

- *Direct Employment = Direct Output / Food Manufacturing **Labor Productivity***

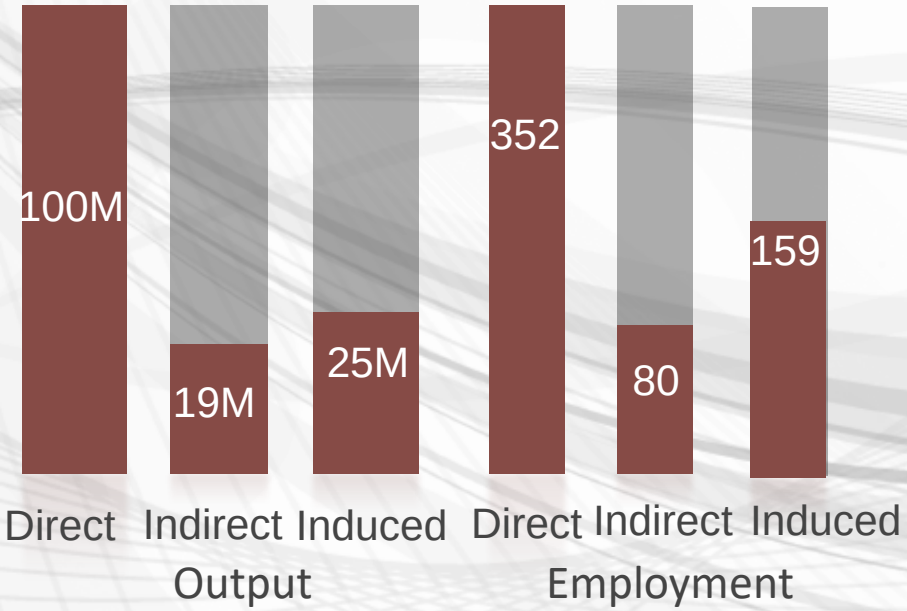
Step 2

- *Indirect Employment Coefficient = sum (**IO Coefficient** per industry * **Regional Purchase Coefficient** per industry / **Labor Productivity** per Industry)*
- *Indirect Employment = Indirect Employment Coefficient * Direct Output*

Step 3

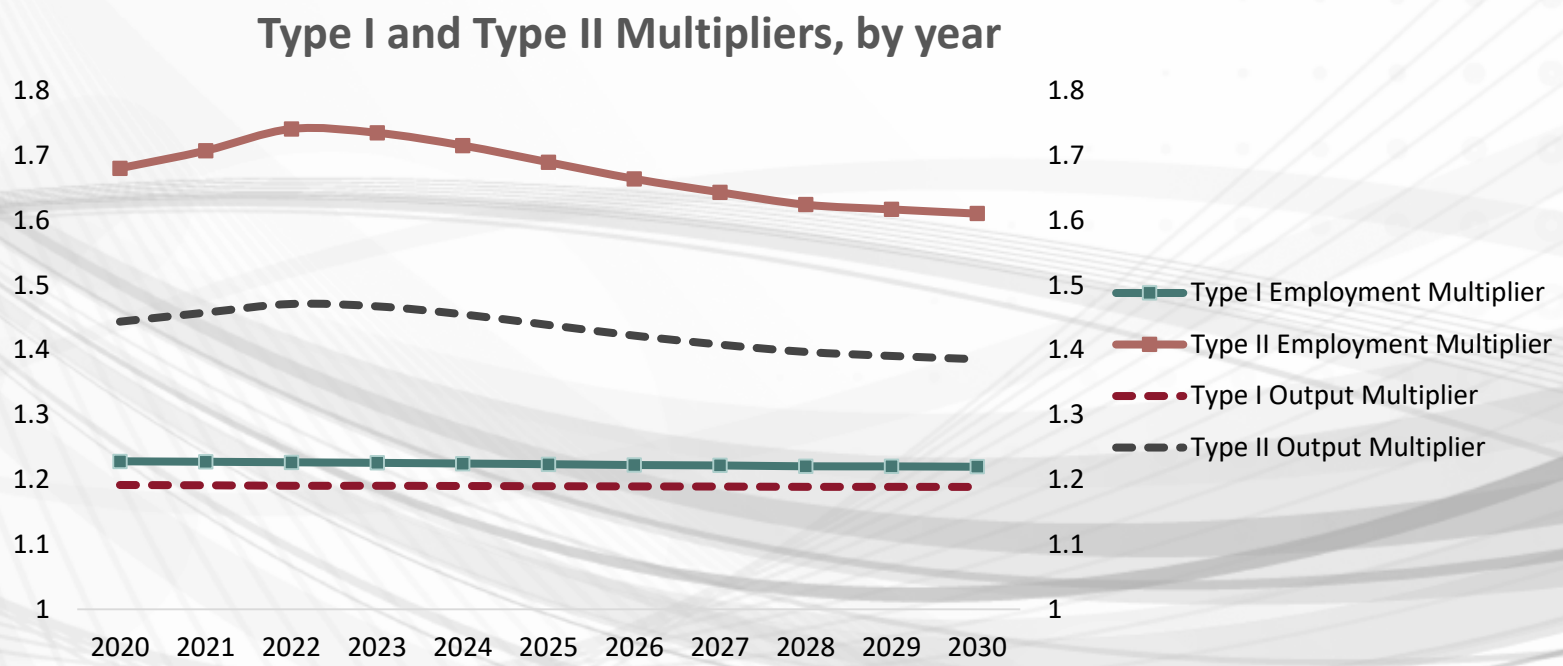
- *Induced Employment = Total Employment – Direct Employment – Indirect Employment*

Sample Simulation



- $19M output and 80 new jobs could be produced in other backward-linked industries due to business spending, as of year 2020.
- Household spending can help further create $25M output and 159 more jobs in industries like real estate, retail trade and health care.

Sample Simulation



- $\textit{Type I Multiplier} = \frac{\textit{Direct Effects} + \textit{Indirect Effects}}{\textit{Direct Effects}}$

- $\textit{Type II Multiplier} = \frac{\textit{Direct Effects} + \textit{Indirect Effects} + \textit{Induced Effects}}{\textit{Direct Effects}}$

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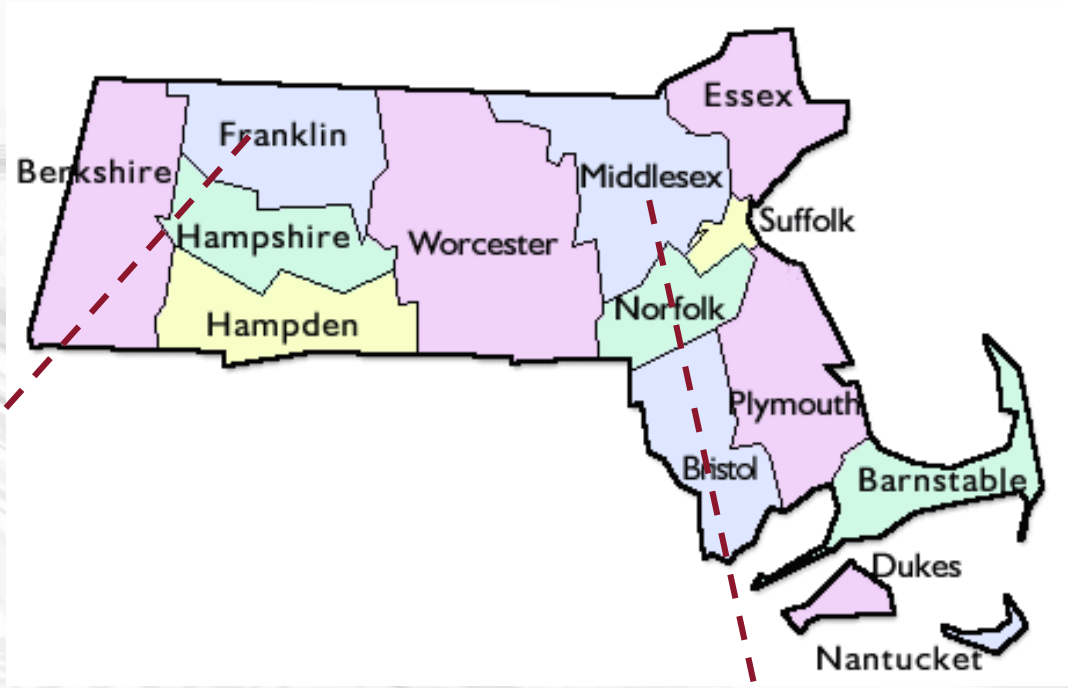
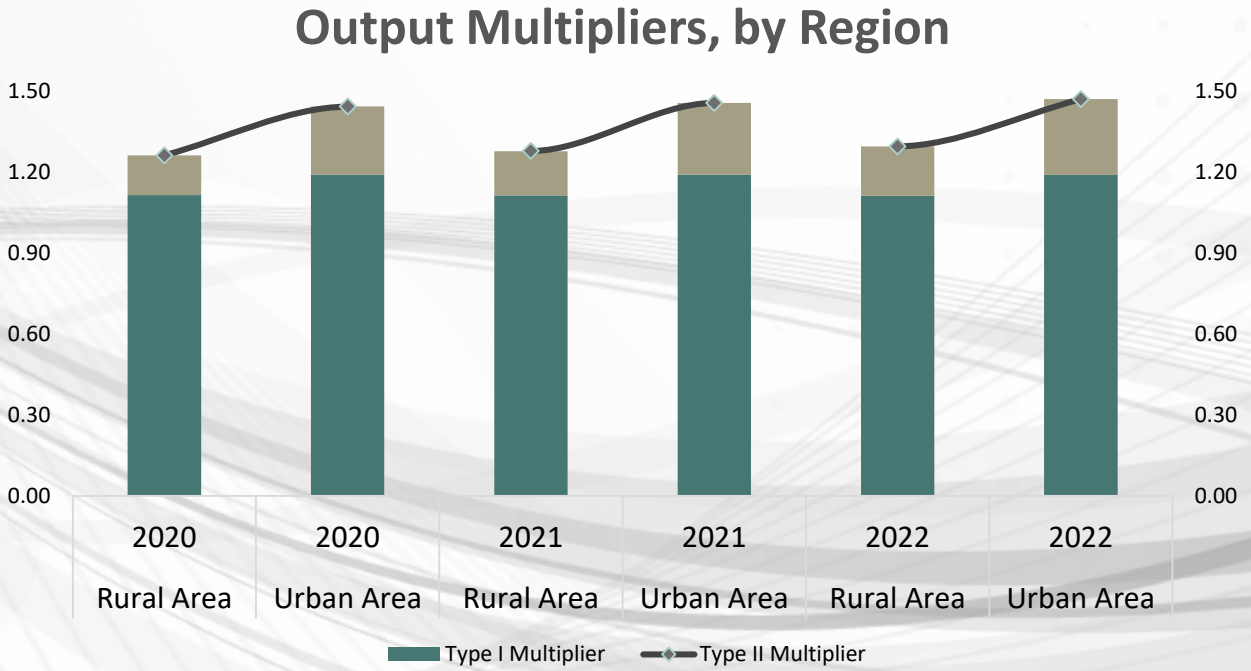
Comparison Analysis by Region



Rural Area

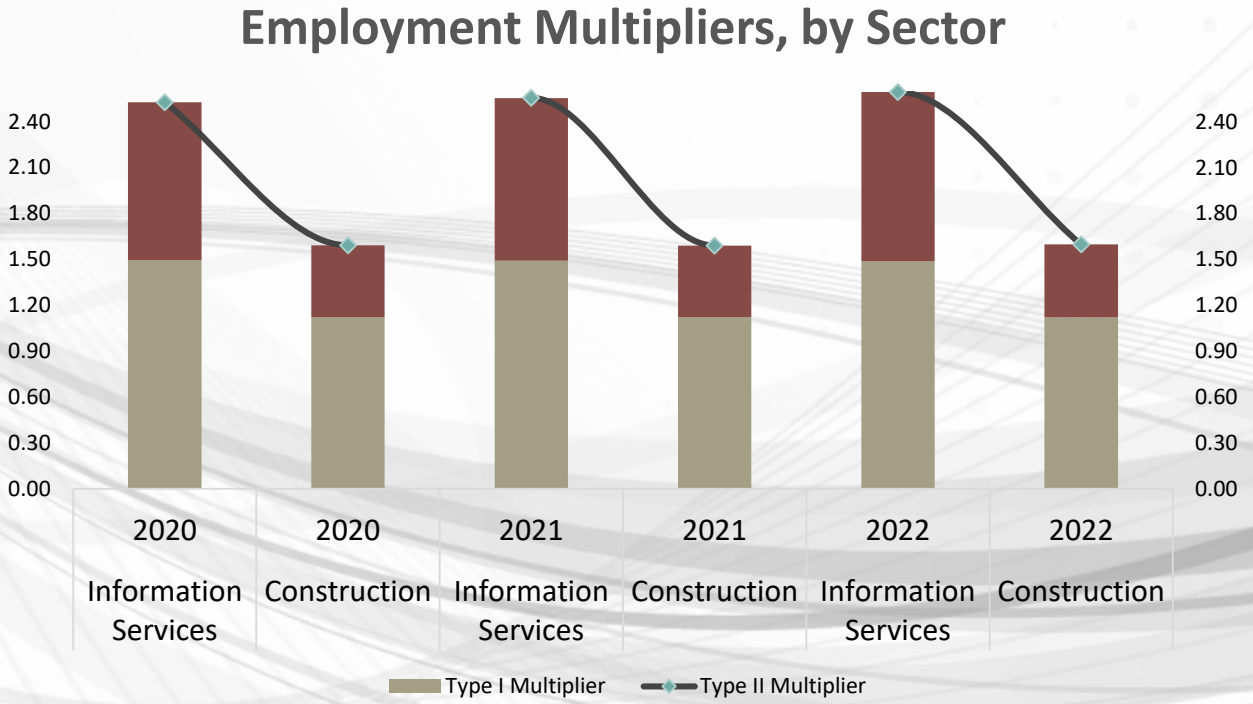
Urban Area

Comparison Analysis by Region



- Multipliers tend to increase from rural area to urban area
  - Businesses are more closely related in urban area, higher spillover effects
  - Different consumer purchase behaviors among different regions

Comparison Analysis by Sector



- Multipliers tend to be stronger in services than in construction sector
  - Depend on characteristic of different industries

Policy Variable List

Policy Variable	Direct Effects	Indirect Effects	Induced Effects
Employment	Immediate Output or Employment Changes within Industry	Output or Employment Changes across Industry through the supply chain in the input-output model.	Output or Employment changes due to changes in consumption, investment, or government spending, etc.
Farm Employment			
Farm Output			
Detailed Farm Output			
Industry Employment (Exogenous Production)			
Industry Employment (International Exports)			
Industry Sales (Exogenous Production)			
Detailed Industry Sales (Exogenous Production)			
Industry Sales (International Exports)			
Output			
State and Local Government Employment			
State and Local Government Output			
Federal Civilian Government Employment			
Federal Civilian Government Output			
Federal Military Government Employment			
Federal Military Government Output			
Detailed Government Output			

Conclusion

- Direct Effects are measured as Output or Employment changes within the directly affected industry.
- To calculate the indirect effects, we will need to identify the suppliers of directly affected industries and to calculate changes in Output or Employment of the supplier industries.
- The induced effects would be the “leftover” that capture broader impacts on entire economy.

CONSUMPTION EQUATION ESTIMATION

Presented by Xiaochu Ma, Economic Analyst

Why is consumption equation important?

- In the U.S., final consumption expenditure accounts for 82.3% of GDP in 2018 (World Bank Data).
- People's consumption behavior is an important factor of consideration for government policy-making, such as tax policies.
- Consumption is also important for economic forecasting, such as output and employment .

Contents

- Equation Overview
- Elasticities Estimation
- Age Effect Estimation
- Regional Effect Estimation

Part 1: Equation Overview

1. Consumption Equation:

(1). Calibration Effect | (2). Age Composition Effect | (3). Regional Effect | (4). Marginal Income Effect | (5). Region-Specific Marginal Price Effect | (6).U.S. Forecast Effect | (7). Local Population

$$C_{j,t}^{k} = \left[\frac{\left(\frac{YD_T^k}{N_T^k}\right)}{\left(\frac{YD_T^u}{N_T^u}\right)}\right] \times \left[\frac{\sum_l^7 (\%DG_{l,t}^R \times PC_{l,j}^u)}{\sum_l^7 (\%DG_{l,t}^u \times PC_{l,j}^u)}\right] \times \left[\frac{\frac{\bar{C}_j^R}{\bar{C}_j^u}}{Age\ Comp\ Effect\ (2)}\right] \times \left[\frac{\frac{\left(\frac{RYD_t^k}{N_t^k}\right)}{\left(\frac{RYD_t^u}{N_t^u}\right)}}{\frac{\left(\frac{RYD_T^k}{N_T^k}\right)}{\left(\frac{RYD_T^u}{N_T^u}\right)}}\right]^{\beta_j} \times \left[\frac{\frac{\left(\frac{CIFP_{j,t}^k}{\bar{P}_t^k}\right)}{\left(\frac{P_{j,t}^u}{\bar{P}_t^u}\right)}}{\frac{\left(\frac{P_{j,T}^k}{\bar{P}_T^k}\right)}{\left(\frac{P_{j,T}^u}{\bar{P}_T^u}\right)}}\right]^{\gamma_j} \times \left[\frac{C_{j,t}^u}{N_t^u}\right] \times N_t^k$$

Part 1: Equation Overview

2. Elements that need to be estimated: age effect(2), regional effect(3), income elasticity(4), and price elasticity(5)

3. Difference from last estimation: data for last estimation is from 1990 to 2012; data for new estimation is from 1990 to 2018

Part 2: Elasticities Estimation

1. Goal: estimate income elasticity β_j for term 4 and price elasticity γ_j for term 5

2. Data source: BEA National Income and Product Accounts from 1990 to 2018

Part 2: Elasticities Estimation

3. Estimation Steps:

- Step 1: run OLS regression by commodity

$$\Delta\left(\frac{C_t}{N_t}\right) = \beta \cdot \Delta\left(\frac{RYD_t}{N_t}\right) + \gamma \cdot \Delta\left(\frac{P_t}{\overline{P}_t}\right) + \varepsilon_t$$

- Step 2: classify 75 commodities into luxuries and necessities according to income elasticities

luxury : β>1; necessity: β<1

Part 2: Elasticities Estimation

3. Estimation Steps:

- Step 3: run regressions separately for luxuries and necessities

$$\Delta\left(\frac{C_{j,t}}{N_t}\right) = \beta_L \cdot \Delta\left(\frac{RYD_t}{N_t}\right) + \gamma_L \cdot \Delta\left(\frac{P_{j,t}}{\bar{P}_t}\right) + \varepsilon_{j,t}$$

$$\Delta\left(\frac{C_{j,t}}{N_t}\right) = \beta_N \cdot \Delta\left(\frac{RYD_t}{N_t}\right) + \gamma_N \cdot \Delta\left(\frac{P_{j,t}}{\bar{P}_t}\right) + \varepsilon_{j,t}$$

Part 2: Elasticities Estimation

3. Estimation Steps:

- Step 4: normalize elasticities based on the following equations

$$\beta_N \times W_N + \beta_L \times W_L = 1$$

$$\gamma_N \times W_N + \gamma_L \times W_L = -1$$

Note: *W* is the proportion of necessities/luxuries as share of total consumption expenditure

Part 2: Elasticities Estimation

4. Results:

β_L = 1.676; β_N = 0.651; γ_L = -1.935; γ_N = -0.517

5. Changes from last estimation:

- For last version:

β_L = 1.729; β_N = 0.614; γ_L = -1.649; γ_N = -0.657

Part 2: Elasticities Estimation

5. Changes from last estimation:

- Six commodities have changed their classification of luxuries/necessities

Table 2. Change in Consumption Commodity Classification

SectorID	Label	New Version Classification	Old Version Classification
21	Women's and girls' clothing	Necessities	Luxuries
42	Paramedical services	Luxuries	Necessities
45	Motor vehicle maintenance and repair	Necessities	Luxuries
47	Ground transportation	Necessities	Luxuries
57	Financial services furnished without payment	Necessities	Luxuries
60	Net household insurance	Necessities	Luxuries

Part 3: Age Effect Estimation

1. Propensity to consume certain commodities differs largely by age group

2. Goal: estimate PC and Age Effect for 2018

$$Age\ Composition\ Effect = \frac{\sum_l^7 (\%DG_{l,t}^R \times PC_{l,j}^u)}{\sum_l^7 (\%DG_{l,t}^u \times PC_{l,j}^u)}$$

3. Data Source: BLS Consumer Expenditure Survey 2018 tables; Census 2018 population estimates

Part 3: Age Effect Estimation

4. Estimation Steps:

- Step 1: calculate PC (propensity to consume) for each age group/commodity

$$PC_{l,j} = \frac{average\ consumption\ by\ age\ group\ l\ on\ commodity\ j}{average\ consumption\ by\ all\ age\ groups\ on\ commodity\ j}$$

Part 3: Age Effect Estimation

4. Estimation Steps:

- Step 2: calculate population proportion by region

Table 3. Population Proportion of the U.S. Total

	20 years and older	20-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75 years and older
Northeast	76.62%	6.54%	13.73%	12.20%	13.29%	13.82%	9.67%	7.37%
Midwest	74.68%	6.72%	13.23%	12.27%	12.51%	13.50%	9.49%	6.96%
South	74.35%	6.58%	13.63%	12.81%	12.76%	12.65%	9.38%	6.54%
West	74.51%	6.73%	14.86%	13.19%	12.42%	12.22%	8.92%	6.15%
US	74.85%	6.64%	13.86%	12.68%	12.72%	12.93%	9.34%	6.68%

Part 3: Age Effect Estimation

4. Estimation Steps:

- Step 3: calculate age effect for four regions in 2018 according to term 2

$$Age\ Composition\ Effect = \frac{\sum_l^7 (\%DG_{l,t}^R \times PC_{l,j}^u)}{\sum_l^7 (\%DG_{l,t}^u \times PC_{l,j}^u)}$$

Part 4: Regional Effect Estimation

1. Families from different regions have different consumption patterns

2. Goal: estimate regional effect using 2018's data

$$Regional\ Effect = \frac{\frac{\bar{C}_j^R}{\bar{C}_j^u}}{Age\ Comp\ Effect\ (2)}$$

3. Data Source: BLS Consumer Expenditure Survey 2018 tables

Part 4: Regional Effect Estimation

4. Estimation Steps:

- Step 1: calculate the regional average consumption on commodity j relative to the national average expenditure on commodity j

$$\frac{\bar{C}_j^R}{\bar{C}_j^u}$$

- Step 2: divide step 1 by age effect to avoid double-counting the age effect

THANK YOU !