NEW REMI ENDOGENOUS RESIDENCE ADJUSTMENT EQUATION: TRANSPORTATION, DEVELOPMENT, AND COMMUTING FOR AN EXAMPLE IN THE NY/NJ/CT METRO AREA

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ABSTRACT

This paper describes the new endogenous residence adjustment equation in the REMI model. Economic conditions and transportation improvements have a strong influence over commuting patterns and economic development within a metropolitan area. This equation relates the factors households consider when making location decisions: place-of-residence; place-of-work; distance of commuting; and the relative cost of living amid potential places to live. As labor market conditions, costs of living, and the ease of the commuting change between two areas, the direction and magnitude of commuting flows now change in response. The new residence adjustment equation provides a dynamic forecast of income by place-of-work compared to place-of-residence in terms of New Economic Geography theory. It allows for policy simulations based on relative consumer prices, taxes, labor force availability, and commuting costs. We present the methodology for endogenous residence adjustment, as well as an example simulation for a transit project in the Connecticut, New Jersey, and New York metro area and how it influences the economy and the commuting flows between the local counties.

ACKNOWLEDGEMENTS

The authors would like to thank Colby Brown of Citilabs for generously providing travel-demand data on the network effects of increasing rail capacity in the New York metro area and western Connecticut. The nature of this paper and its realistic policy scenario would not be possible without this external data. For anybody interested in the data and methodologies behind the travel-demand simulations, we encourage you to contact Colby at (415) 337-9029 or <cbrown@citilabs.com>, or at his office in Connecticut.

INTRODUCTION

Labor mobility and improvements in transportation technology over the course of the twentieth-century have given households in the United States the ability to locate at increasingly large distances from their place-of-work. This distinction between place-of-residency and place-of-work has profound implications for transportation planning, economic development, and taxation issues. The flow between work and home creates commuting. Commuting implies the trillions in transportation investments within cities, suburbs, and exurbs to each its flow, save time, improve the quality of life, and to add fluidity to the labor market. The quality and dependability of the access to jobs for households and access to workers for firms helps determine the overall competitiveness of an area and industries' ability to grow. Lastly, the federal system and various state borders make commuting a fiscal issue. Sales taxes are by the point-of-sale, but income taxes are by place-of-residence. A person working in Chicago enjoys a job in Illinois but may commute in on a train from Wisconsin—paying their state taxes to Madison instead of Springfield in the process. All of these factors make commuting an important factor in planning and policy analysis.

To consider these factors in more detail, REMI has added a new endogenous residence adjustment to its models. This equation allows policy simulations to examine the influence of changing commuting patterns on regional economics and demographics. It also allows simulations to see how commuting might change in response to changing labor market conditions, transportation improvements, state or local taxes, and a myriad of other factors. The remainder of this paper presents a background to the REMI model, full detail on the new residence adjustment equation, and an example simulation for a transportation improvement project for the Connecticut, New Jersey, and New York metro area (specifically improving transportation access between New York and southwestern Connecticut). It presents the underlying data estimated by the REMI model on the income flows between the three states as well as the change to the flow when introducing new transportation infrastructure. This all has an impact on jobs, GDP, and commuting dollars, which therefore has implications for transportation planning, taxes, and other factors at the state- or metro-level.

THE REMI MODEL

The REMI model is a computerized, multi-regional, dynamic model of the counties of the United States (or provinces or similar units of foreign nations). These particular simulations used TranSight, REMI's transportation-specific software package that includes integration of travel demand data and effective distance matrices through gravity models. The REMI model relies on four quantitative methodologies to guide its approach to economic modeling. This allows their strengths to come through while compensating for any of their individual weaknesses:

1. **Input/output (IO) tabulation** – At the core of the REMI model is an IO matrix, sometimes called a "social accounting matrix" (SAM) to illustrate the structure of an

economy. This structure includes inter-industry transactions, labor income, capital income, and multipliers. An IO model is strong at showing the induced effects of an additional $1 in an economy, but weaker at showing long-run changes, which the other methodologies add.

2. **Computable general equilibrium (CGE)** – REMI includes some components of equilibrium and CGE modeling. CGE models and their methodology shows the long-run impacts of incentives and prices through market-level concepts for labor, housing, consumer goods, imports, exports, and competitiveness. The CGE parts of REMI show the interactions between all of these levels at the same time.
3. **Econometrics** – REMI uses advanced statistics and historical data to create the parameters and data necessary to build the IO and CGE portions of the model. This includes the strength of responses to shocks, the natural changes to the underlying structure of the economy over time, and the amount of "lag" between the initial change and before the economy returns to balance again.
4. **New Economic Geography** – The geography concepts in the model give it a sense of spatial distance and access between different points for labor, intermediate goods, and final goods ready for sale. This endogenously influences the productivity and competitiveness of regions in the model. For example, an area with a strong cluster in a technology industry like medical research or aerospace engineering (such as Boston for the former or Seattle for the latter) relies on access to a specialized, dedicated labor pool of qualified and experienced workers to staff key positions and drive innovation. Adding new highways or transit to firms and households' access to each other deepens the labor pool, creates more competition, and helps engender a superior employer/employee match, which improves productivity and competitiveness in the model. The New Economic Geography allows for alternatives simulation of improving access and commuting conditions, which now endogenously change.

The REMI model relies on a transparent, explicit structure to relate cause-and-effect together in a regional economy. Its organization includes a five-block structure, as seen in Figure 1. Block 1 represents macroeconomic conditions and final demand for GDP, including consumption, investment, net exports, government spending, and intermediate goods. Block 2 includes firms and their production decisions through a Cobb-Douglas production function, where they maximize profits by minimizing costs when accounting for the real productivity of labor and capital. Block 3 is a full demographic model with households, a cohort/component population forecast, and labor mobility for place-of-residence and place-of-work. Block 3 includes labor market concepts and product market concepts, which come together on Block 5 to measure the competitiveness of an area via endogenous regional purchase coefficients (RPC). The impact of commuting is on the labor access index in Block 2 (and therefore labor productivity, from the business perspective) and an adjustment to regional real disposable income in Block 1. An area with a net inflow of commuting dollars would have more consumer spending than its raw number of jobs would suggest (such as in a suburb compared to an urban core), which means more consumer spending on staples like retail, entertainment, and housing in that area.

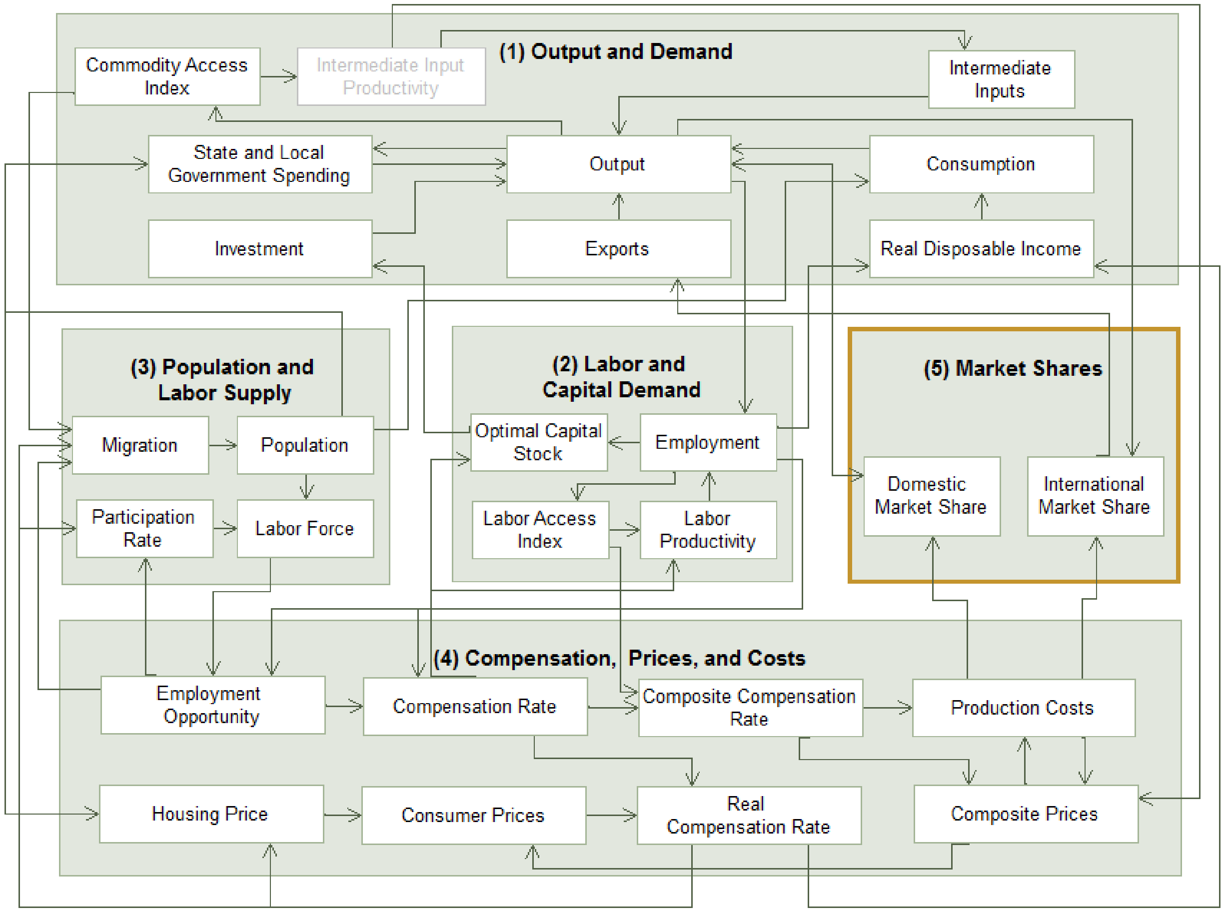


Figure 1 – REMI model structure

NEW RESIDENCE ADJUSTMENT

Traditionally, personal income in a region comes from the residence of the income recipients (BEA 2004). The Bureau of Economic Analysis (BEA) collects data from different sources in order to have a personal income estimate. Some of the data for the components of personal income, mainly property income, are by the place-of-residence. These components of income include personal dividend income, personal interest income, rental income of persons, and proprietors' income.

However, according to BEA, about 60% of personal income data, including wage and salary disbursements, supplements to wages and salaries, and contributions to social insurance, are by place-of-work. Consequently, these initial place-of-work data points need adjustment so they will summarize on a place-of-residence basis so the income of the recipients whose place-of-work is different from place-of-residence adjusts to be a consistent income by place-of-residence for all data.

Residence adjustment, which may be positive or negative, is the net inflow of earnings from inter-regional commuters. For state-level estimates, it is statistically important to do residence adjustment for those individuals who commute to work between states. This is particularly important for states with economically active metropolitan areas that extend over boundaries, such as the Washington-Arlington-Alexandria metropolitan statistical area (MSA) through the District of Columbia, Maryland, Virginia, and West Virginia. Residence adjustment is even important for county-level statistics, because it is more common for an individual to work and live in different counties at that level. There are a high proportion of cross-county commuters in any multi-county metropolitan area. The residence adjustment (RA) is the subtraction of the gross outflow of income (GO) subject to adjustment from the gross inflow of income (GI) subject to adjustment, and it therefore represents a region's net transfer of income. BEA utilizes decennial journey-to-work (JTW) commute data between states and between counties to make the residence adjustment. JTW comes from the U.S. Census.

The phenomenon of commuting, and especially long-distance commuting, is widespread due to significant improvements in information and communication technology (Hincks and Wong, 2003). Commuting has become an important issue for policymakers in the field of regional transit and development. According to the Bureau of Transportation Statistics (BTS) and the Omnibus Household Survey (2003), the average commuter travels approximately fifteen miles to work. More than 11% reported more than thirty miles. The longer the commute the more likely the commuter will cross a state border or a county line. This makes residence adjustment even more important to estimate accurately and scientifically as an economic and social variable.

BEA provides a detailed methodology on how to adjust the income of inter-state and inter-county commuters. The income data compiled on the place-of-residence by BEA has seen extensive use in studying regional evolution, such as by Higgins, Levy, and Young (2006). The existing literature has very limited development in forecasting residence adjustment and inter-regional commuting. Rose and Stevens (1991) have argued that income flows between generations, receipt, and spending should be part of a closed IO model. They presented several methodologies for estimating trans-boundary income flows under the IO framework. The economic forecast for residence adjustment is important for informing policymakers and community planners. The information on the relationship between the residence and workplace can guide transportation planning to improve plans and guide community development stratagems.

METHODOLOGY

Following BEA's adjustment strategy, the inflows from county *l* to county *k* is the inflow ratio multiplied by the corresponding component of income subject to adjustment, which is total compensation in county *l* subtracted by federal military compensation and contribution for government social insurance. In the REMI model, the inflow and outflow ratios, indicated by *rs* and *nrs* respectively, are the earnings shares from the inflow and outflow commuters. The previous versions of the REMI model had these shares fixed at their calculated last history year values. These fixed shares came from JTW and residence adjustment data from U.S. Census and BEA.

Gross Inflows:

$$GI_t^k = \sum_{k \neq l}^{n} rs^{l,k} * \left(COMPT_t^l - COMP_t^{nFM,l} - TWPER_t^l - EGSI_t^l \right) \quad (1)$$

GI_t^k =The income of employees who live in the local region k and work in another (gross inflow of commuter dollars for residents of region k who work in all other areas) in time period t.

$COMPT_t^l$ =Total compensation in region l and time period t.

$COMPT_t^{nFM,l}$ = Federal military compensation in region l and time period t.

$TWPER_t^l$ = Employee and self-employed contributions for government social insurance in region l and time period t.

$EGSI_t^l$ = Employer contributions for government social insurance in region l and time period t.

$rs^{l,k}$=The share of earnings in l that is earned by residents of k who work outside of k (fixed for the forecast period based on the last history year share)

Gross Outflows:

$$GO_t^k = \sum_{k \neq l}^{n} nrs^{k,l} * \left(COMPT_t^k - COMP_t^{nFM,k} - TWPER_t^k - EGSI_t^k \right) \quad (2)$$

GO_t^k =The income of employees who work in the local region k and live in another (gross outflow of commuter dollars for employees of region k who live in all other areas) in time period t.

$nrs^{k.l}$= Share of earnings in region k going to residents of region l (fixed for the forecast period based on the last history year share).

Residence Adjustment:

$$RA_t^k = GI_t^k - GO_t^k \quad (3)$$

Endogenous Approach on Residence Adjustment

The new forecast approach on residence adjustment comes from a commuter flow equation. This makes the earning shares for those commuting across regions an internal calculation. The equation takes into account the spatial distance and relative cost of living between places of residence *k* and work *l*, allowing earnings shares $rs^{k,l}$ to shift endogenously in the forecast in response to both direct and indirect policy variable changes. The commuter flow equation is as such:

$$rs_t^{k,l} = \frac{LF_t^l * (P_t^l)^{(1-\sigma)} * (D^{k,l})^{-\beta}}{\sum_{k\neq l}^{n} LF_t^j * (P_t^j)^{(1-\sigma)} * (D^{j,k})^{-\beta}} \qquad (4)$$

$rs_t^{k,l}$ = the share of commuters who live in region *l* and work in region *k* in time period *t*.
LF_t^l= labor force in region *l* in time period *t*.
P_t^l= the consumer price index including housing price in region *l* in time period *t*.
$D^{k,l}$= the commute distance from region *l* to region *k*.
σ= Sigma value, the estimated parameter for consumer price.
β= Beta value, the estimated parameter for distance decay.

The endogenous residence adjustment approach accounts for cross commuting due to the differentiation of workers. Since labor is a heterogeneous resource, firms and workers looking for job matches may cross borders and travel in patterns other than circular orientations around employment hubs. Endogenous residence adjustment quantifies the strength of this effect through econometric parameters on the responses of consumers to price and distance, which allows them to commute in something other than radial patterns.

Commuter income flow for those who live in region *l* and work in region *k* in period *t*, $CI_t^{k,l}$, is the commuter flow share times the region *k*'s income on the place of work as in equation (1) from previously:

$$CI_t^{k,l} = \sum_{k\neq l}^{n} rs_t^{k,l} * \left(COMPT_t^k - COMP_t^{nFM,k} - TWPER_t^k - EGSI_t^k\right)$$

Gross Inflows and Outflows

Summing commuter income flows yields the relative gross inflow and gross outflow for a region, as in equation (5) and equation (6):

$$GI_t^k = \sum_{k\neq l}^{n} CI_t^{l,k} \qquad (5)$$

$$GO_t^k = \sum_{k\neq l}^{n} CI_t^{k,l} \qquad (6)$$

Residence Adjustment

The net residence adjustment comes from subtracting gross outflow as in equation (3).

Commuters

The number of commuters comes from an estimate based on the average income per commuter:

$$C_t^{l,k} = CI_t^{k,l} * \frac{(EMPT_t^k - EMP_t^{nFM,k})}{(COMPT_t^k - COMP_t^{nFM,k} - TWPER_t^k - EGSI_t^k)} \quad (7)$$

Where

$C_t^{l,k}$ = the commuters who live in region l and work in region k in time period t.

$EMPT_t^k$ = total number of jobs in region k in time period t.

$EMP_t^{nFM,k}$ = number of military jobs in region k in time period t.

Commuter Inflows and Outflows

Summing the commuter flows yields the relative gross inflow and gross outflow for a region:

$$GIE_t^k = \sum_{k \neq l}^{n} C_t^{k,l} \quad (8)$$

$$GOE_t^k = \sum_{k \neq l}^{n} C_t^{l,k} \quad (9)$$

where

GIE_t^k = The commuters who live in the local region k and work in another in time period t.

GOE_t^k = The commuters who work in the local region k and live in another in time period t.

Residence Adjusted Employment

Residence adjusted employment (RAE) involves scaling the total number of non-military jobs by the share of residence adjustment to total labor and propriety's income (YLPT) in equation (10):

$$RAE_t^k = \left(1 + (RA_t^k / YLP_t^k)\right) * (EMPT_t^k - EMP_t^{nFM,k}) \quad (10)$$

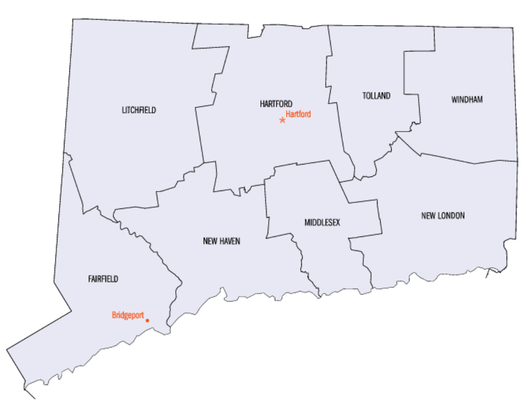
Using the endogenous equation for residence adjustment, the REMI model can simulate how policy changes in terms of commuter earnings respond to other transportation costs or price-related variables as they shift inflow and outflow ratios.

The extreme demonstration of interstate income flow is DC-MD-VA-WV. The residence adjustment for DC was -$43 billion in 2012 (Stawaser 2012). This means that more than half of the earnings generated in DC go towards people living outside of the District, primarily in Maryland and Virginia and a small minority in West Virginia. If the local transportation authorities decided to build a new metro line connecting more suburban areas with downtown DC, the commuting from suburban areas to DC will accordingly grow. The relative housing price will also change for those commuters. The old residence adjustment model cannot model how the flow of income will change in response to the policy change above, because it assumes a fixed ratio of inflow and outflow ratios. In the new residence adjustment methodology, the commuter flow equation will capture the change resulting from consumer price and transportation costs and dynamically feed the model with these changes. Thus, policy simulations and their results will reflect the residence adjustment change, as well as the change of inflow commuters, outflow commuters, and the adjusted employment.

Example Simulation

The example simulation uses an 8-region, 70-sector TranSight model of the New Jersey-New York metro area and counties in Connecticut. Connecticut has eight counties, though this particular model combines Tolland and Windham Counties in the northeast corner of the state into 1-region. The breakout includes:

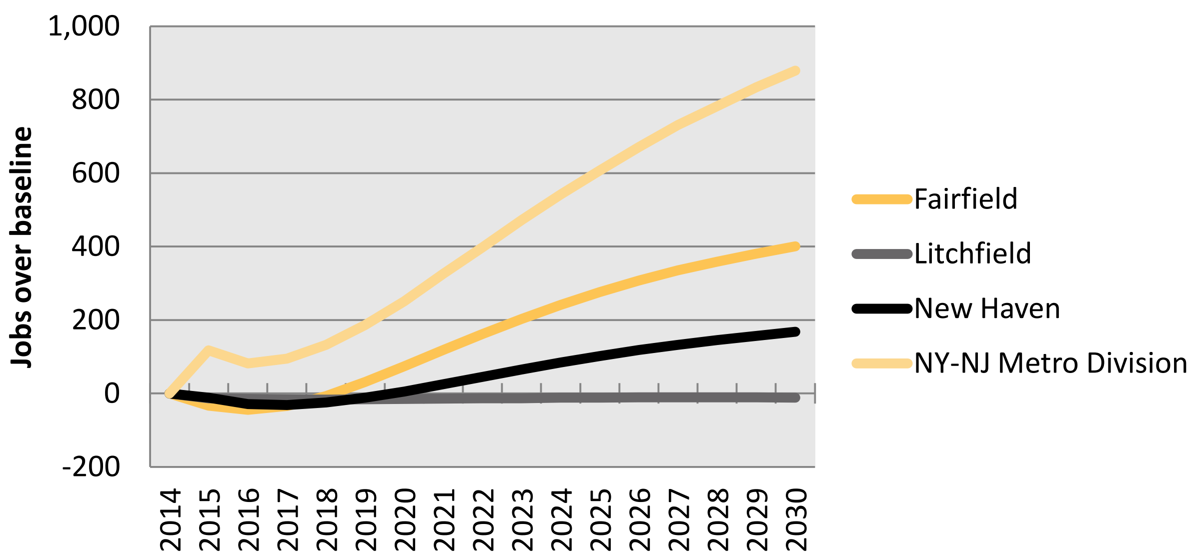
1. Fairfield County, CT
2. Hartford County, CT
3. Litchfield County, CT
4. Middlesex County, CT
5. New Haven County, CT
6. New London County, CT
7. Tolland and Windham, CT
8. NY/NJ Metro Division
    - Bronx, Kings, New York, Putnam, Queens, Richmond, Rockland, and Westchester Counties in NY
    - Bergen, Hudson, and Passaic Counties in NJ



The simulation involves increasing commuting access in and out of Fairfield, Litchfield, and New Haven Counties into the NY/NJ metro. Metro North, a commuter rail service, already links these areas together under the operation of the New York Metropolitan Transportation Authority (MTA). Lines terminate in Harlem and Grand Central Station on Manhattan and begin at New Canaan, CT and Danbury, CT in Fairfield County and at New Haven, CT and Waterbury, CT in New Haven County. There are longstanding plans to extend these lines further northeast to begin in Bristol, CT and New Britain, CT, and even Hartford, CT for transfers to and from Amtrak and Bradley International Airport (BDL). These simulations are not an explicit modeling of any one of these particular options, but rather an exploratory piece of increasing the efficiency of the commuter rail system and infrastructure in Connecticut.

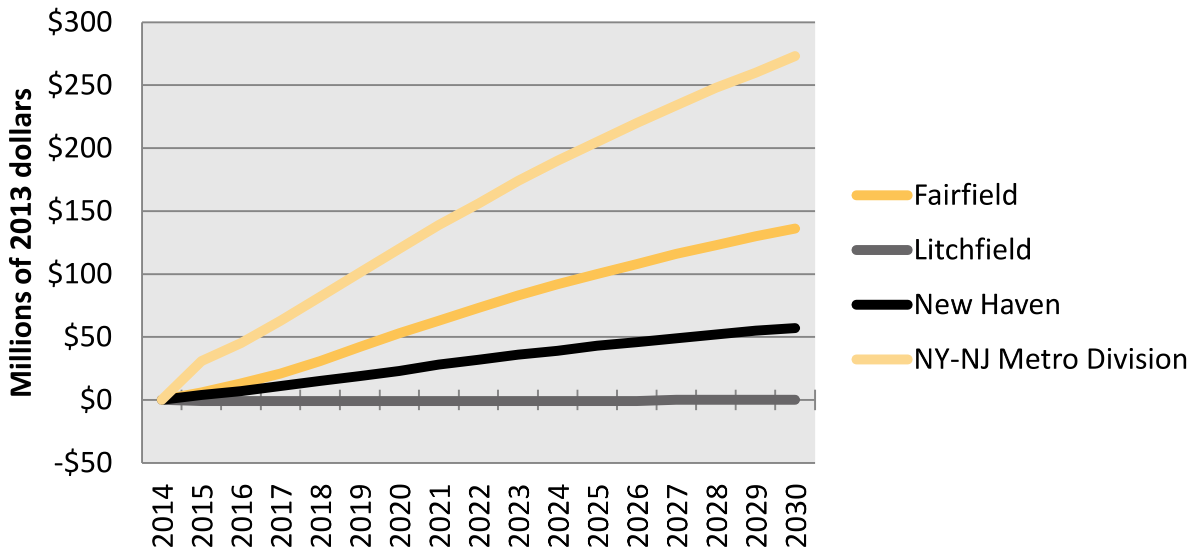
Modeling specific projects in an area requires particular data on the changes in vehicle miles, vehicle hours, and the number of trips by mode and time endangered by adding additional commuter rail lines. This requires inputs from a travel-demand model (TDM), econometric estimations, or survey data on mode switching and saved time. These inputs "drive" input data for TranSight and its effective distance matrices. This study relies on travel-demand simulations performed by Colby Brown of Citilabs (<cbrown@citilabs.com>, (415) 377-9029) and their Cube Voyager model of the NY/NJ/CT metro area. **The simulation implies an improvement in the ability of the existing Metro North to move trains—previously, the travel-demand model presumed an average speed of 45 MPH, and these simulations increase that to 60 MPH.** This spillover helps the general travel network by relieving congested roads because more people will shift to railroad stock as commuting by train becomes more attractive.

FIGURE 2 – TOTAL EMPLOYMENT



The simulation generates a net positive increase in jobs in the CT-NJ-NY region, particularly in the New York metro. This is because the ability for job growth cuts "both ways," and the increase in the ability of Connecticut commuters to seek employment in New York increases the number of jobs there. Another major factor in New York is the decrease in transportation congestion from the heavier use of the rail lines.

FIGURE 3 – GDP



GDP is even more positive. This is because the increase to labor productivity, especially in Fairfield County and NY/NJ, makes firms more competitive in the REMI model, and it allows them to gain more market share, expand, and add more to GDP in the future. This trend influences the total employment numbers above and the gradual increase over time of a slow adjustment from shifts in the labor market.

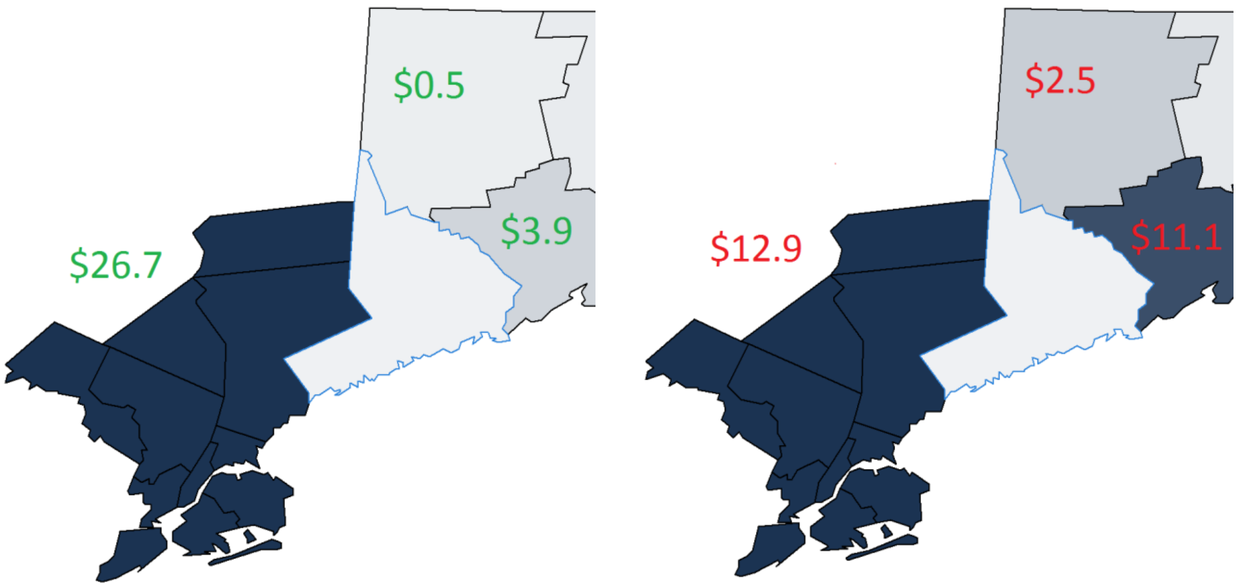
TABLE 1 – RESIDENCE ADJUSTMENT (BASELINE, 2015)

		Place of Work			
Place of Residence	2015	Fairfield	Litchfield	New Haven	NY/NJ Metro Division
	Fairfield		$198.850	$1,703.360	$12,155.580
	Litchfield	$1,150.420		$713.490	$406.980
	New Haven	$4,944.830	$338.660		$298.630
	NY/NJ Metro Division	$5,822.230	$9.340	$130.620	

The units above are in **millions of 2013 dollars**. To read it, for instance, $12 billion ($12,000 million) of personal income in Fairfield County comes from commuters working in New York but living in Connecticut. The REMI model projects Fairfield County to have a total for personal income of about $83 billion in 2015—therefore, the commuter flow from New York represents about 15% of the county's total income. New Haven County is further back from the metro area, and commuter income from New York only accounts for about 3.5% of its income.

Figure 4 – Residence Adjustment (Baseline, 2015)

Living in Fairfield County, commuting out | **Working in Fairfield County, commuting in**



The labels are in **2013 billions of dollars**. These heat maps show the amount of commuting inherent in the REMI model baseline for Fairfield County in 2030. The year 2030 includes national GDP growth over the next fifteen years, which makes these numbers larger than in the table above. Fairfield County has a net inflow of funds from NY/NJ (of about $13.8 billion); though it loses commuter income to New Haven County and the rest of Connecticut. Fairfield County is something of an employment hub on its own, which makes people likely to commute into it, but its own commuters to go “one level up” in seeking employment in New York.

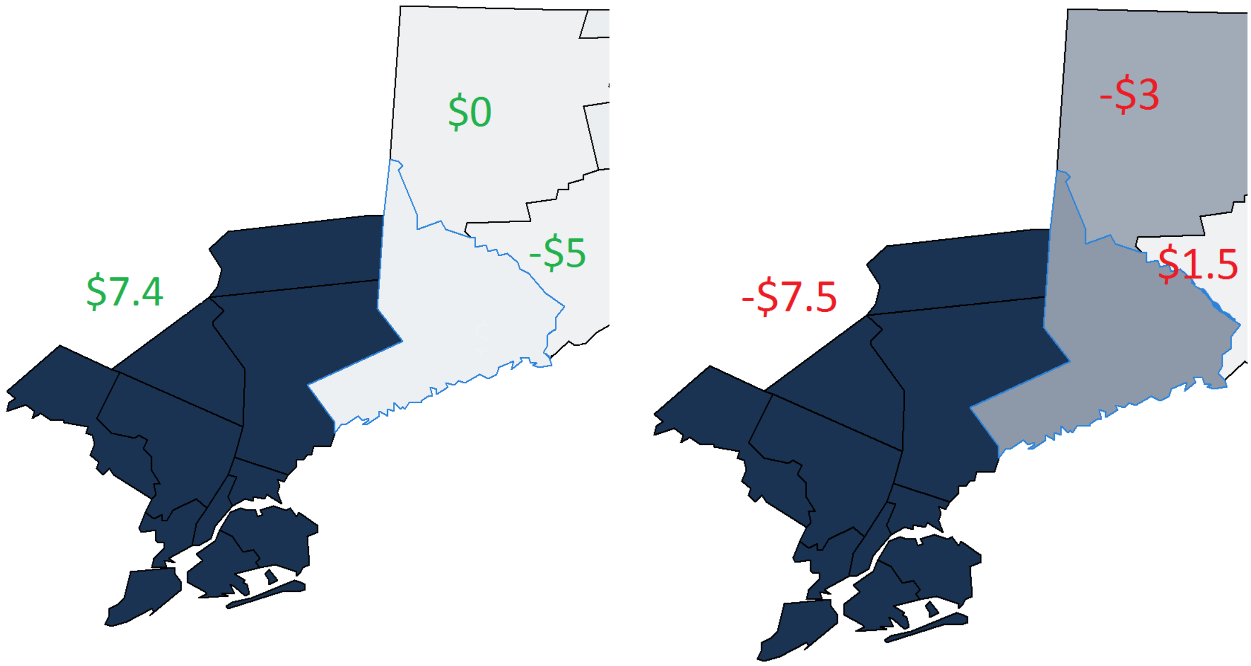
Table 2 – Residence Adjustment (Simulation, 2015)

		Place of Work			
	2015	Fairfield	Litchfield	New Haven	NY/NJ Metro Division
Place of Residence	Fairfield		$0.0	-$4.8	-$6.8
	Litchfield	-$1.8		-$2.2	-$0.4
	New Haven	-$5.9	$0.0		$0.9
	NY/NJ Metro Division	-$7.8	$0.0	$0.1	

The units above are in **millions of 2013 dollars**. The biggest impact is to New Haven County, where the area begins “importing” an additional $0.9 million in 2015 from the New York metro area compared to the baseline. The baseline ratio of inflow to outflow from New York for New Haven County was 2.29 (which is $298.63/$130.62 in millions), though the endogenous adjustment for residence allows a higher concentration of income flow through New Haven County. The same ratio here is 8.67—a huge change from the fixed-share of the previous methodology. This would allow policymakers and planners to see and anticipate a bump in traffic between NY/NJ and New Haven County more than anywhere else and particularly from Fairfield County into NY/NJ at a much greater rate than previous averages. This would work the same for other transportation simulations or those on taxes, energy, and the general cost of living.

FIGURE 5 – RESIDENCE ADJUSTMENT (SIMULATION, 2030)

Living in Fairfield County, commuting out **Working in Fairfield County, commuting in**



The above figures are in **millions of 2013 dollars**. This shows the continued influence of the endogenous residence adjustment. In the baseline, the ratio of flow between NY/NJ and Fairfield County is 2.06, and here it is 16.66. It increases over time as more adjustments take place in the economy to labor and commuting patterns. The ease of movement between these four regions allows more economic activity to concentrate in Fairfield County. This is due to the ease of "drawing" income out of New York because of improved commuting access and relocations out of New York to take advantage of lower costs of living in Connecticut. It also means more people from counties further back into the state "bypassing" Fairfield County and going for the jobs in New York themselves. This gives the centering and the positive economic impacts seen in the county in the earlier results.

CONCLUSIONS

Endogenous residence adjustment adds to the analytical capabilities of any policy analysis model. It allows for the more accurate forecasting of policy impacts in simulations for accounting for commuter adaptations and households' locations decisions in response to policy changes. For example, making it easier to commute in and out of a major metro area will allow some people to relocate to the outlying areas to take advantage of lower costs of doing business (for firms) and a lower cost of living (for households) while maintaining strong economic ties to the engine at the city center. Understanding the propensity of commuter flows to change in response to transportation investments or economic policy is crucial for policymakers. Including it in a consistent analysis framework, such as the REMI model, makes it even more powerful for involving it with all other adjustments.

There are several other potential applications of this capability. For instance, using other REMI policy variables, one could simulate the impact of a higher sales tax (which affects consumer prices and thereby the cost of living) on one state and how that changes commuter flows. For states with strong cross-border effects (such as Missouri with Kansas and Illinois), this may be a strong effect. Consumers would choose to spend more of their own money outside of the state to avoid the higher tax and, over time, may come to settle in other states and commute in, rather than face the higher costs of living in their original location. The general growth in commuting flow would be useful to regional planners and forecasters interested in a forecasted tied to economic growth and demographics. Population forecasts and the economy tie together in the REMI model, and commuting volumes will only increase if there are more jobs open, more of a reason to live at a distance, and more population to house in a constrained space. This report also makes standard economic impacts more accurate for adjusting commuting. This changes consumer spending; this has an induced effect on local industries, supply chains, and housing. This will prevent an "over-concentration" of growth in center areas and allow for more relaxed growth in suburbs and exurbs as commuting becomes more and more important over time.

REFERENCES

1. "Documentation," REMI, Retrieved from http://www.remi.com/resources/documentation on January 23, 2014

2. Bureau of Economic Analysis, 2004. Retrieved from http://www.bea.gov/regional/pdf/spi2005/08%20Residence%20adjustment.pdf on December 23, 2013.

3. Higgins, Matthew John and Levy, Daniel and Young (2006). Andrew T., Growth and Convergence across the U.S.: Evidence from County-Level Data. *Review of Economics and Statistics*, 2006, 88(4), 671-681.

4. Cornelia J. Strawser. 2013, Business Statistics of the United States: Patterns of Economic Change. Bernan Press, 17th edition (November 2, 2012)

5. Rose Z. Rose, and Benjamin H. Stevens (1991) Transboundary income and Expenditure flows in Regional Input-Output Models. *Journal of Regional Science*. 31(3), 253-272

6. Bureau of Transportation Statistics. (2003). Omnibus Survey Household Survey Results Retrieved December 6, 2011, from http://apps.bts.gov/programs/omnibus_surveys/household_survey/2003/april/

7. Hincks, S., & Wong, C. (2010). The Spatial Interaction of Housing and Labour Markets: Commuting Flow Analysis of North West England. *Urban Studies, 47*(3) 620–649