Expanding US Highway 54 in New Mexico

Assessing the Economic Effects

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for
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Executive Summary

Regional Economic Models, Inc. (REMI) was retained by Souder, Miller & Associates to forecast the economic and demographic effects of a proposed upgrade to portions of US Highway 54 in New Mexico. Incorporating information from Souder Miller and a HERS-ST simulation, REMI applied the methodology underlying TranSight, its model of transportation economics, to capture the full economic impacts of the highway project in terms of construction spending and improved travel efficiency.

Based on our modeling of the benefits, the construction phase generates over $340 million in gross regional product (GRP) and 1,400 jobs for New Mexico's economy. Over the long run, the enhanced efficiency of transportation on US 54 reduces the production costs of the state's existing industries. As a result, New Mexico produces an annual average of over $24 million in additional GRP above the baseline, which is attributable solely to the US 54 upgrade. By 2023, these indirect effects of the project have stimulated creation of over 500 new jobs above the baseline. The vast majority of these gains are realized by the five counties (Otero, Lincoln, Torrance, Guadalupe, and Quay) through which the highway passes, with the construction, services, and retail trade industries being the biggest beneficiaries.

Total Output in the Five-County Region includes intermediate output. Total Output is almost twice the amount of gross regional product (GRP). The construction boom in 2004 to 2008 generates a total of $554.8 million in Output/Benefit for the region's economy. Improvements to US 54, both construction and maintenance, over the 20-year period requires an investment of $511.2 million.

The indirect benefits of highway construction and maintenance are an increase in Total Output each year after construction. Beginning with the year 2009 and continuing through 2023, the sum of benefits over the 15 years is $602.2 million. During this analysis period, 2002 to 2023, the sum of Total Output for the Five-County Region is $1.157 billion due to the enhanced efficiency of transportation on US 54. Simply, stated the economy of the Five-County Region will receive $2.26 of benefit from each dollar invested in construction and maintenance.

However, we believe that there are additional benefits not included in the modeling. First, we focused exclusively on the highway upgrade's effects on New Mexico businesses, which neglects the substantial benefits to out-of-state firms who can use the improved US 54 as a conduit for transporting goods. In fact, modeling suggests that long-distance commercial trucking will provide a large majority of additional traffic on the upgraded US 54. Furthermore, the improved transportation access along the US 54 corridor might attract businesses to relocate beyond the level predicted in the current modeling, and encourage establishment of a truck warehousing facility. On the whole, this highway improvement project might serve as a good foundation for catalyzing further regional development. US Highway 54 will be maintained over the next 20 years and will have residual value. Residual value of this transportation system infrastructure is not included in the above benefit dollars.

Introduction

Regional Economic Models, Inc. (REMI) was commissioned by Souder, Miller & Associates to perform a corridor study for the New Mexico Department of Transportation (NMDOT). The NMDOT is currently considering a major upgrade to US Highway 54, and asked Souder Miller and REMI to evaluate the potential economic and demographic effects stemming from the highway construction project and the ensuing enhancement of the New Mexico transportation network. To perform this analysis, REMI built a Policy Insight model of New Mexico subdivided into two regions: one representing the five counties through which US 54 passes, and the other representing the state's remaining counties. We then simulated the impact of the proposed highway upgrade by applying the methodology underlying TranSight (REMI's transportation-economics model) to cost/benefit outputs generated by NMDOT's version of the HERS-ST (Highway Economic Requirements System-State Version) travel-demand model. This report summarizes our methodological approach and our predictions of the economic effects of this improvement to New Mexico's transportation infrastructure. It also highlights additional effects of the highway that the NMDOT may wish to explore, contingent upon data availability.

US 54 is a significant carrier of freight traffic in the central United States, stretching from El Paso, Texas in a northeasterly direction toward Chicago, Illinois. While some of its importance has been supplanted by the interstate highway system, it continues to be a major conduit for shipping intermediate inputs and end-use goods in the region. In recent years, many of its segments have been widened to four lanes to accommodate traffic demand, and, as a result of this increased capacity and the diagonal directness of the route relative to nearby interstates, US 54 has diverted a notable share of long-haul traffic from the interstate system. Naturally, the increased traffic has provided economic benefits to the towns through which US 54 passes.

In New Mexico, the first 80 miles of US 54 (north from the state's southern Texas border to the town of Tularosa) have already been expanded to four lanes. A second four-lane stretch exists in the 59 miles between Santa Rosa and Tucumcari, where the highway overlays Interstate 40, the state's major east-west throughway. However, the remaining 235 miles of US 54 only support one lane of traffic in each direction. While congestion is not pervasive, traffic is frequently backed up behind slower-moving vehicles because traffic volumes coupled with the grades and hills on the road discourage passing in the oncoming lane. Because of this potential for delays, drivers of commercial trucks often opt for alternative routes when hauling freight from Mexico and the Southwest US to central and north-central population centers such as Kansas City and Chicago, even though those routes are less geographically direct than US 54. Rather than cutting northeast on US 54 across New Mexico, trucks that reach El Paso typically travel eastward into Texas on Interstates 10 and 20 before connecting with a major north-south corridor.

The NMDOT believes that upgrading the two remaining two-lane segments of US 54 (the first running from Tularosa north to the junction with I-40, and the second from Tucumcari to the eastern Texas border) will induce substantial re-routing of commercial through-traffic from the southerly Texas routes to US 54. The expanded capacity is expected to be sufficient to handle the incremental traffic without creating congestion problems; in fact, by eliminating the possibility of becoming trapped behind slower-moving vehicles, the upgrade should increase average speed. Components of the proposed enhancement for these two segments include adding an additional lane in each direction, broadening the shoulders, improving the road's alignment, and resurfacing. The plan also incorporates a resurfacing of the existing four-lane segments of US 54 between the southern Texas border and Alamogordo. The vast majority of the construction is slated for completion within the first five years of the project's inception; NMDOT intends to budget smaller amounts of construction spending for subsequent funding periods.

Data Sources

The initial stage of analyzing the US 54 upgrade was performed by the NMDOT, which simulated the proposed changes to the highway using a HERS-ST model tailored for New Mexico. This simulation involved a detailed specification of the precise improvements to be made to the road, including the lane additions and resurfacing. Once parameterized and run, the HERS model produced forecasts of vehicle miles traveled (VMTs), delay time, and a variety of vehicle-related costs, broken down by four "funding periods" of five years each. These results provided valuable inputs to the economic impact assessment performed by REMI, as they painted a reasonable picture of the direct costs and benefits attributable to the US 54 project, including expectations of traffic shifts from other routes. Figure 1 below summarizes the results of the HERS "US 54 upgrade" simulation that were utilized in the course of REMI's modeling.

HERS Output Variable	Before project	Period 1	Period 2	Period 3	Period 4
Delay (hrs/1000 VMT)	0.60	0.15	0.14	0.14	0.14
VMT (millions)	296	436	572	705	832
Operating costs ($/1000 VMT)	380	397	418	430	424
Crash costs ($/1000 VMT)	113	93	94	95	97
Fatalities (per 100 million VMT)	1.74	1.43	1.45	1.48	1.5
Injuries (per 100 million VMT)	70.7	57.8	58.3	58.8	59.3
Crashes (per 100 million VMT)	118	96.4	96.5	96.8	97.3
Avg Ann Maint Cost ($/mile)	2667	1395	2497	3241	3545
Avg Pollut. Cost ($/1000 VMT)	42.42	28.15	17.74	11.18	11.29
Construction cost ($ thousands)		428220	2734	15622	64650

Figure 1. HERS-ST output used in US 54 analysis

However, the HERS results were not in themselves sufficient to proceed with the modeling, due to two fundamental limitations. First, the impacts tabulated by HERS applied exclusively to the US 54 corridor in isolation, without consideration to impacts on the surrounding transportation network. Since our assignment was to survey the statewide effects of the US 54 project, we required information concerning traffic on US 54 in relation to other highways in the state. Second, while the HERS output effectively captures highway conditions under the assumption that the upgrade is implemented; it fails to present a control scenario (which we label a "baseline") in which the upgrade is not undertaken. Because macroeconomic analysis using Policy Insight is predicated on comparing a policy scenario to the status quo, we needed to develop a baseline (or control) case to serve as a point of reference for the comparison.

The supplemental information REMI needed was researched and delivered to REMI by Jim Smith of Souder Miller. Using various sources, including data from the Middle Rio Grande Council of Governments and the NMDOT, Souder Miller disaggregated New Mexico's total vehicle miles traveled (VMT) and vehicle hours traveled (VHT) in 2002 into three categories: US 54 by itself (excluding traffic on the overlapping stretch with I-40), the five-county region through which US 54 passes (including the US 54 corridor), and the rest of the state. Souder Miller also produced an analogous breakdown of VMTs and VHTs for the forecast year of 2023, to offer an indication of how highway demand is expected to evolve over the next 20 years. The 2002 and 2023 numbers are presented in Figure 2 below.

Baseline 2002

	Annual VMT	Annual VHT	Implied Speed
US 54 corridor	345,831,660	5,411,855	63.90
Total 5-Cty region (incl US 54)	2,100,575,000	33,098,200	63.46
Rest of New Mexico	18,115,680,000	376,986,600	48.05

Baseline 2023

	Annual VMT	Annual VHT	Implied Speed
US 54 corridor	1,203,813,800	18,463,160	65.20
Total 5-Cty region (incl US 54)	3,309,455,000	52,117,255	63.50
Rest of New Mexico	27,014,927,500	598,495,245	45.14

Figure 2. Baseline highway travel data by region

Along with the quantitative support, Souder Miller lent its local expertise to help us develop modeling assumptions that were reasonable and defensible. In conjunction with the HERS outputs, this information enabled us to commence the economic modeling process.

Modeling Tool

To assess the impact of the US 54 project on the state of New Mexico, REMI decided to apply the conceptual principles of our transportation-economics modeling tool, TranSight, within the framework of our macroeconomic forecasting program, Policy Insight. Direct utilization of TranSight is preferable for analyzing travel demand model outputs. However, due to the format in which data were available for this project, we chose to emulate a TranSight analysis by applying its underlying formulae to generate values for appropriate policy variables in Policy Insight. The TranSight/Policy Insight package was ideally suited to tackle this analysis, because of its unique ability to generate dynamic year-by-year estimates of the total regional economic and demographic effects of a specific policy initiative or government undertaking.

We built a Policy Insight model of New Mexico that was subdivided into two regions: one (the "Five-County Region") consisting of the five counties traversed by the US 54 corridor (Otero, Lincoln, Torrance, Guadalupe, and Quay), and the other ("Rest of State") consisting of the remaining counties. This enabled us to isolate the economic costs and benefits accruing to the counties directly affected by the highway upgrade, while also measuring any offsetting effects on the rest of the state. Ideally, the model would be extended to capture major economic centers along the US 54 route beyond the New Mexico borders. Since the majority of new traffic on US 54 derives from long-distance truck hauling, much of the tangible economic benefit generated by the upgrade will be captured by producers outside the state (in Chicago, Mexico, and elsewhere) who can ship goods more efficiently. However, due to a variety of considerations, NMDOT ultimately narrowed its modeling sphere to the state of New Mexico. Figure 3 below illustrates the two regions as defined for the modeling exercise.

Figure 3. Region definition for US 54 modeling

REMI TranSight integrates leading travel-demand and transportation forecasting models (such as TranPlan, TransCAD, TP Plus, EMME/2, and HERS) with the REMI Economic and Demographic Forecasting and Simulation model for 53 sectors (EDFS-53). While stand-alone transportation models produce forecasts of travel-demand response to a proposed transportation project, TranSight provides a more complete perspective by predicting the full array of economic and demographic effects that will result from completing the project. It translates the key outputs generated by the transportation models into a series of cost and amenity variables that can be incorporated into a single-region or multi-region impact analysis, as driven by the powerful EDFS-53 engine, which is also the core of REMI's Policy Insight model. The output of this process shows such key economic indicators as employment by industry, output and value added by industry, personal income, population, and many more.

TranSight allows the user to specify the financial dimensions of an upgrade to the transportation infrastructure, including expected construction costs, financing, and annual operation/maintenance costs. But in addition, it calculates several *indirect* types of costs and benefits that may ensue from the project, including changes in safety, emissions, fuel costs, and transportation costs. Some of these computations require user input regarding construction, finance, and operations, while others use the output from travel-demand model scenarios. Collectively, this information is transferred into EDFS-53, which produces multi-year forecasts of economic and demographic trends under the transportation upgrade, and compares them with a baseline forecast. In capturing the full effects of the project, TranSight can assist governments in determining whether allocating funds to a particular transportation upgrade is a winning proposition relative to funding other policy initiatives.

The model structure is represented pictorially in Figure 4 below, which reveals both the components of the model and the manner in which information flows between them. Outputs from the transportation model are combined with built-in cost parameters and project-specific information to produce values for policy variables designed to simulate the project's direct impact. These are processed by EDFS-53 to generate comprehensive forecasts of the project's macroeconomic effects. Please see the Appendix for details regarding the specific variables used to simulate the US 54 project.

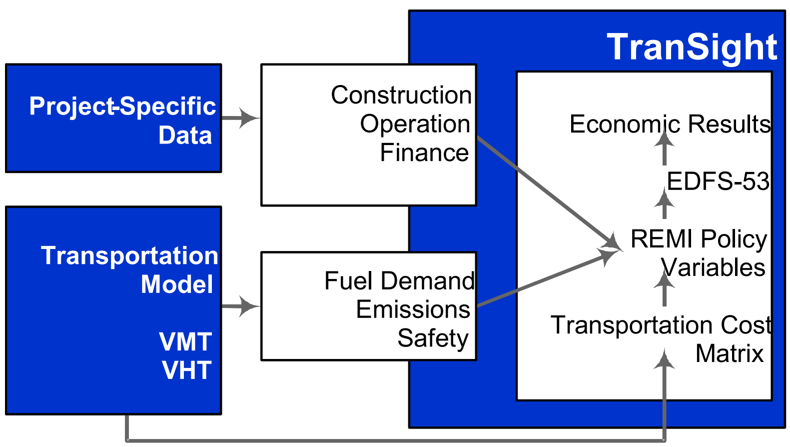

Figure 4. Model structure of TranSight

Methodology

REMI's analytical approach involved incorporating both HERS-ST outputs and information from Souder Miller to derive model inputs that reflect the US 54 upgrade. These inputs were subsequently fed into the two-region Policy Insight model to forecast such macroeconomic indicators as employment, gross regional product (GRP), and personal income. Finally, this forecast was compared to a control forecast, the assumptions of which are identical to the simulation forecast, except that the US 54 project is omitted. The difference between the two forecasts constituted the economic impact of the project itself.

Transportation Costs

Our first step was to calculate parameters indicating how the highway upgrade reduces transportation and accessibility costs. Expanding a road's capacity can improve travel efficiency by increasing the average speed of vehicles. This increased efficiency yields monetary benefits for industries that rely on trucking to transport products to market. But furthermore, the increased speed enhances firms' access to suppliers of intermediate inputs, which can ultimately decrease production costs. These two phenomena are captured in TranSight's transportation cost matrix and accessibility cost matrix, whose conceptual foundations are described in further detail in the Appendix.

To quantify the transportation-efficiency improvements induced by the US 54 project, REMI needed to determine both a baseline average speed (in absence of the highway upgrade) and simulated average speed following the completion of the road improvements. For the baseline average speed, we computed the ratio of annual VMTs to annual VHTs on US 54 alone, based on 2002 road data.

For the simulated average speed, we decided to concentrate on the time benefits to existing traffic caused by diminishing congestion and temporarily set aside the additional VMTs of travel on US 54. HERS-ST generates a measure of vehicle delay hours per 1,000 VMT, which reflects the degree of congestion predicted for the highway, both prior to the project's inception and at the close of each funding period. For each funding period, we calculated the difference between the anticipated delay time per 1,000 VMT and multiplied that difference by the baseline VMT on US 54 to obtain the reduction in annual delay hours caused by the US 54 upgrade. Next, the baseline VHT on US 54 was adjusted downward to capture the proposed increase in the US 54 speed limit to 70 mph. The reduced delay time was then subtracted from this adjusted baseline VHT on US 54 to yield an estimate of total annual VHTs that included the effects of the road improvements. Finally, dividing baseline VMTs by this reduced amount of VHTs gave a simulated average speed that could be compared directly with the baseline speed. Formulaically, this calculation can be represented as follows:

$$SS_t = \frac{VMT_{base}}{VHT_{base} - (VMT_{base} * (D_t - D_{base}))}$$

where…

SS_t = simulated speed in funding period t (t ranging from 1 to 4)

VMT_{base} = vehicle miles traveled in the baseline

VHT_{base} = vehicle hours traveled in the baseline, adjusted for new speed limit of 70 mph

D_t = delay hours per 1,000 VMT in funding period t

D_{base} = delay hours per 1,000 VMT prior to inception of US 54 project

This process yielded an average baseline speed of 63.9 mph and an average simulated speed of 70.0 mph, implying that the upgrade would increase travel velocities on US 54 by over 6 miles per hour. Before entering this speed improvement as a model input, we needed to adjust for the fact that US 54 is only one constituent road within a larger highway network in the Five-County region. Since the majority of incremental traffic on US 54 is caused by diversion of commercial trucks from routes outside the Five-County region, we could make the simplifying assumption that average speeds on other Five-County highways would be unaffected by the upgrade. This assumption allowed us to apply the speed improvement only to the proportion of total Five-County VMTs associated with US 54, which was calculated as 16.5% based on 2002 baseline data. By scaling down the 6.1 mph speed change by this percentage, we computed an overall Five-County speed improvement of roughly 1 mph. This was incorporated in the model as a reduction in both transportation cost and accessibility cost for travel within the Five-County region, in each of the four funding periods.

Construction

In addition to the economic gains due to enhanced transportation efficiency, road projects can also stimulate job growth in the construction sector and in the service and manufacturing industries that support it. Because project-specific construction and maintenance cost estimates for the US 54 upgrade were unavailable, Souder Miller agreed with using the construction figures generated by HERS-ST as a reasonable proxy. As HERS-ST provided both construction and maintenance spending by funding period, we divided each period's spending amounts equally among the period's five constituent years, since REMI modeling is conducted on a year-by-year basis. The vast majority of construction spending (approximately $428 million) occurs in the initial five years of the forecast, while expenditures on maintenance progressively increase over time as the road depreciates, ultimately exceeding $3500 per mile annually. As documented more fully in the Appendix, this spending is reflected in the model as increased exogenous demand for the Construction sector. Since the NMDOT indicated that the federal government would provide the vast majority of construction funds, we made the simplifying assumption that financing the project would be essentially costless from the state's perspective. If we receive information about the state's contribution to funding, we can incorporate it into future modeling runs as government expenditures diverted from other spending objectives.

Disamenities

While the additional traffic induced by a highway upgrade can spur economic activity, it can also bring harmful side effects in the form of increased vehicle emissions and accidents. From a modeling perspective, these effects represent disamenities that diminish the attractiveness of living and working in a particular geographic area. Within the context of REMI's models, disamenities either reduce immigration to or increase out-migration from the affected region. Based on discussions with the NMDOT, we concluded that we should not model disamenities from the US 54 upgrade. The only available parameters for capturing emissions and accidents rates are derived from nationwide studies, and thus would not be appropriate for evaluating highway projects in New Mexico. In the absence of state-specific information on these disamenity effects, we elected to exclude them from the analysis.

Results

We created a simulation scenario for this study which included the benefits from the transportation efficiency improvement and construction. All graphs in this section display changes relative to the baseline forecast—that is, the change in a particular macroeconomic indicator due solely to the US 54 enhancement and its indirect effects. Note that all dollar amounts are presented in 1996 fixed dollars, which is consistent with the Bureau of Economic Analysis's provision of national account data, and which eliminates the effects of inflation.

Figure 5 shows the difference in the Gross Regional Product (GRP) caused by the expansion project for New Mexico as a whole. The construction boom in 2004 to 2008 generates a total of $341.42 million in GRP for New Mexico's economy. The indirect benefit of the expansion project is an increase in GRP each year, from $17.94 million in 2009 to $32.59 million in 2023.

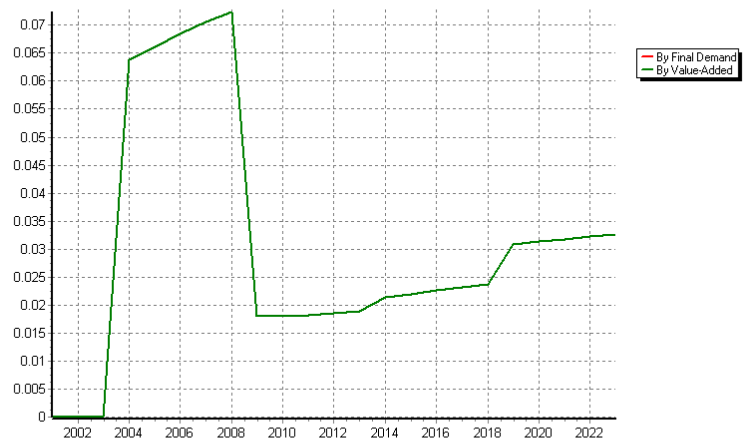

Figure 5. New Mexico: Difference in GRP (Billion 1996 Dollars)

Figure 6 shows the difference in GRP caused by the expansion project for the Five-County region by itself. The construction boom in 2004 to 2008 generates a total of $295.36 million in GRP for the region's economy. The indirect benefit of the expansion project is an increase in GRP each year from $20.68 million in 2009 to $35.55 million in 2023. Thus, comparing with the previous graph, all of the indirect benefits are realized in the Five-County region, but a healthy percentage of the construction-phase benefits accrue to firms in the rest of the state.

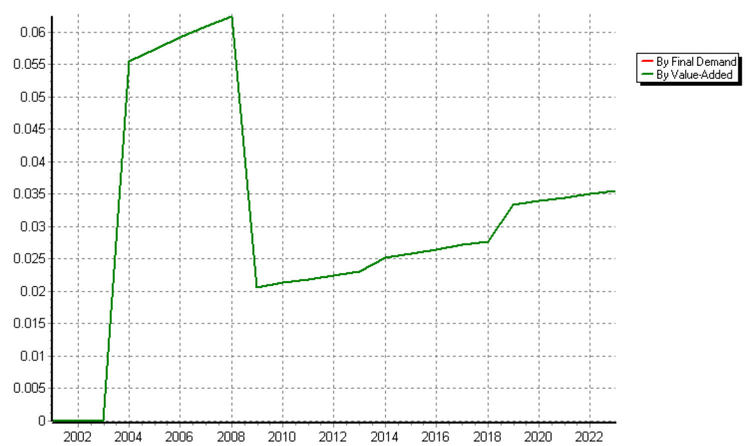

Figure 6. Five-County Region: Difference in GRP (Billion 1996 Dollars)

Figure 7 shows the difference in Total Output caused by the expansion project for New Mexico as a whole. Unlike GRP, Total Output includes the intermediate outputs generated by the project. The construction boom in 2004 to 2008 generates a total of $631 million in Output for New Mexico's economy. The indirect benefit of the expansion project is an increase in total Output each year from $21.87 million in 2009 to $48.98 million in 2023.

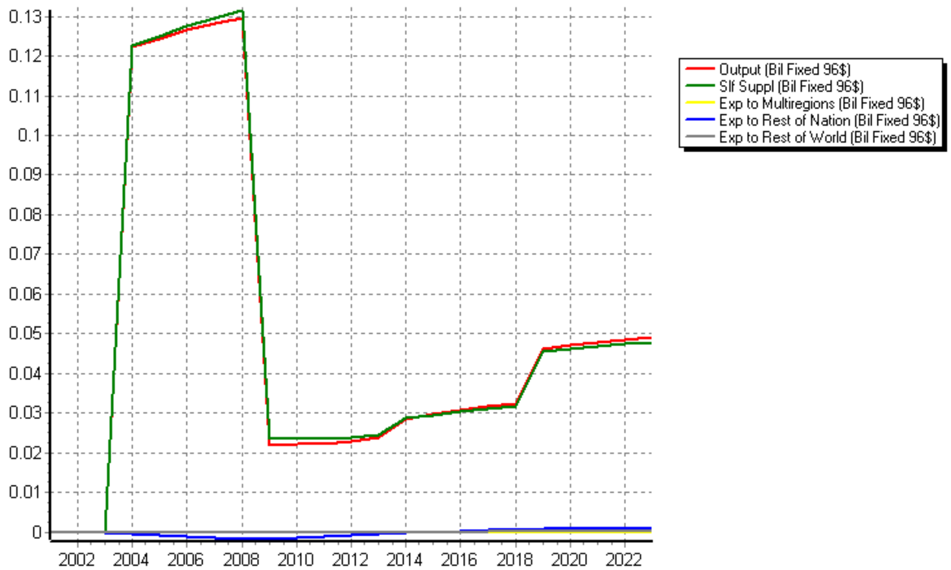

Figure 7. New Mexico: Total Output (Billion 1996 Dollars)

Figure 8 shows the difference in Total Output caused by the expansion project for the Five-County region by itself. The construction boom in 2004 to 2008 generates a total of $554.8 million in Output for the region's economy. The indirect benefit of this expansion project is an increase in total Output each year from $28.27 million in 2009 to $54.10 million in 2023.

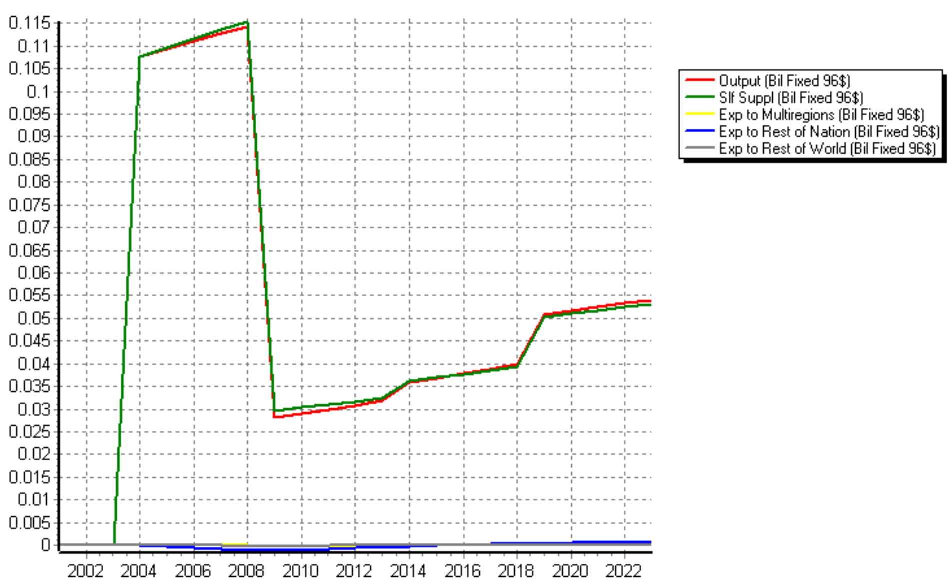

Figure 8. Five-County Region: Total Output (Billion 1996 Dollars)

Figure 9 shows Output by 10 major economic sectors for New Mexico as a whole. During the construction period, the construction sector will generate an output of $405.07 million. After the construction period, the construction sector drops to an increase in output of $4.53 million in 2009 to $16.14 million in 2023. This sector benefits in output because it will have a continuous stream of additional sales due to the construction and maintenance from the project. Services, Retail Trade, Finance, Insurance and Real Estate are the other sectors with substantial impact, totaling $464.58 million in additional output from 2004 to 2023.

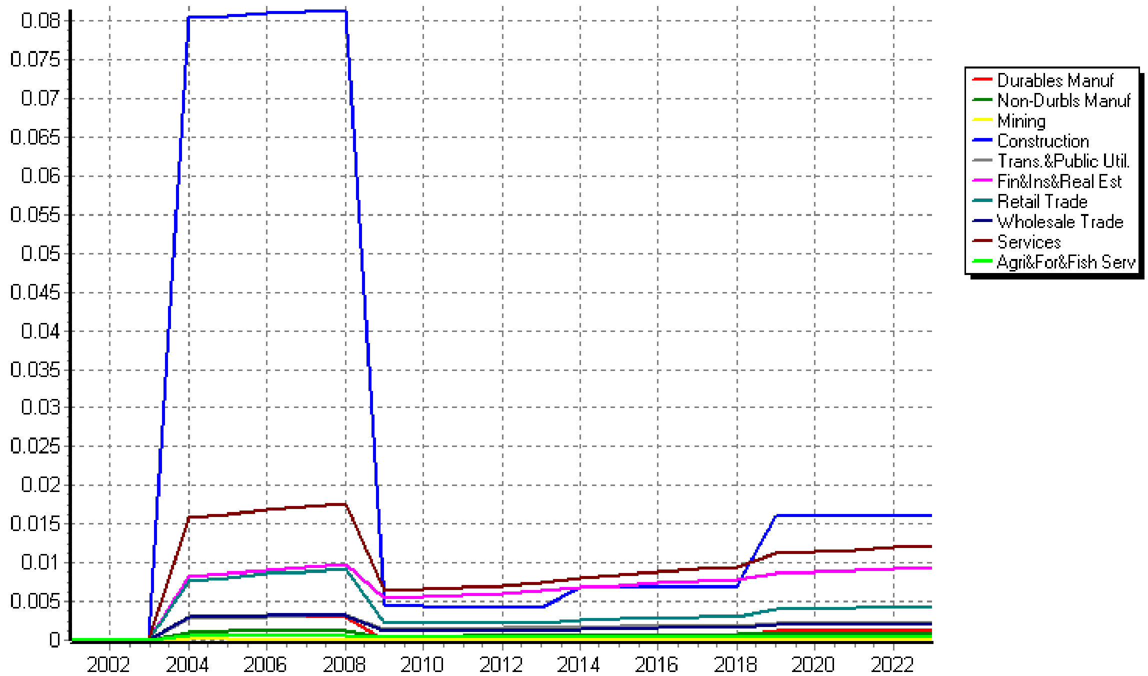

Figure 9. New Mexico: 10-sector Output (Billion 1996 Dollars)

Figure 10 shows the difference in Total Employment caused by the expansion project for New Mexico as a whole. The construction boom creates a total of 1,408 jobs during its peak year of 2008, which includes 742 Construction jobs, 271 Service jobs, and 171 Retail Trade jobs providing the majority of the employment opportunities. Employment quickly drops after the completion of the project but remains above the baseline level for the remainder of the forecast period. The improvement of US 54 creates an additional 321 jobs in 2009, rising to 511 in 2023, with Construction, Services, and Retail Trade providing most of the opportunities.

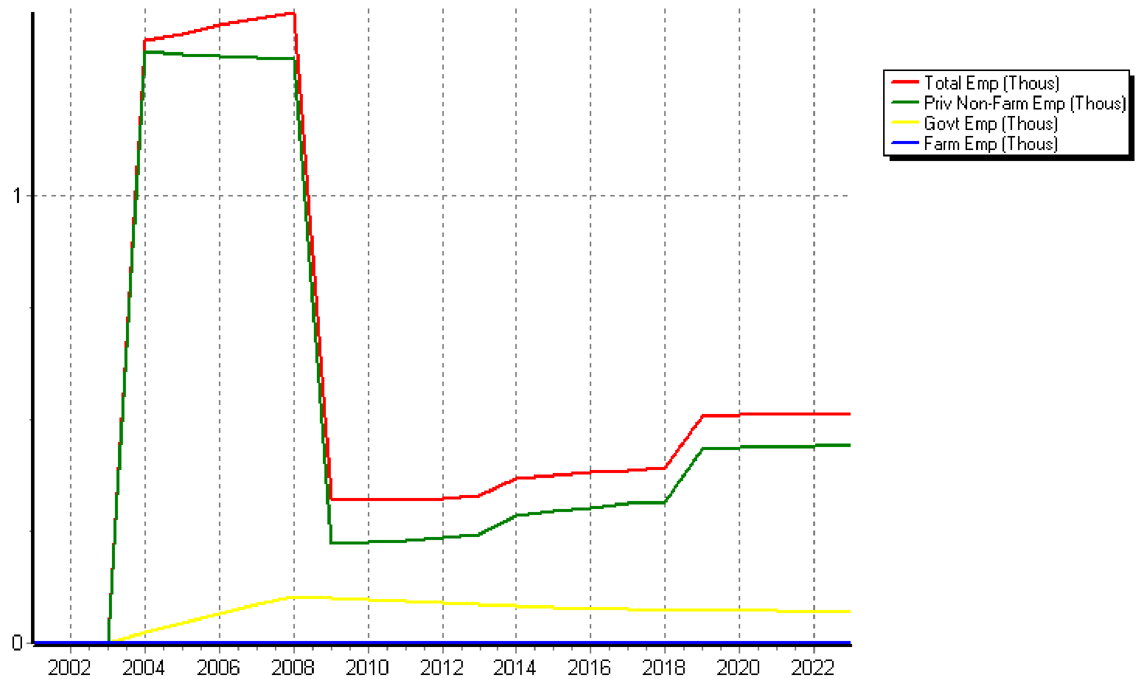

Figure 10. New Mexico: Total Employment (Jobs/Year in Thousands)

Figure 11 shows the percentage change in the Relative Cost of Production (RCP) in New Mexico compared to the rest of the nation. A lower RCP will benefit New Mexico because the state will be able to produce goods at a lower cost compared to the rest of the nation. The RCP will increase during the construction period and have its peak in 2007 but will quickly drop because of transportation improvements on US 54. The improvements reduce Relative Labor Cost and Relative Composite Input Cost due to better access to commodities for both residents and firms. Better access to commodities in the local economy lowers the delivered price of intermediate and final goods in the state, improving the state's attractiveness for the local residents and lowering the cost of production for the firms.

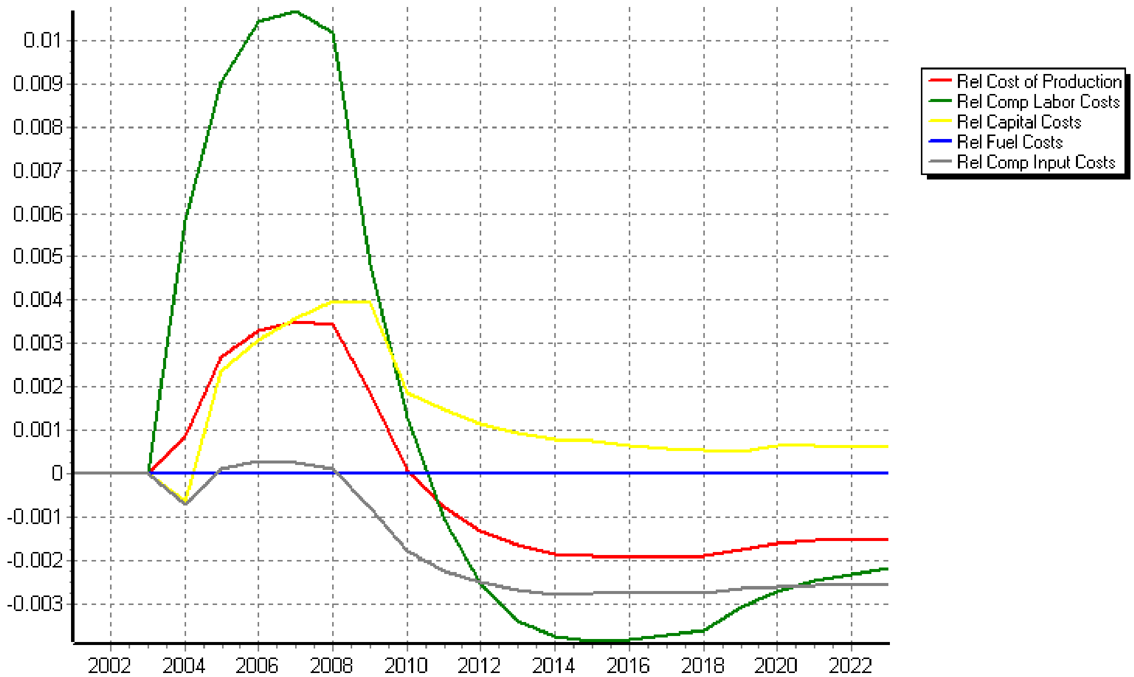

Figure 11. New Mexico: Percentage Change in Relative Cost of Production

Conclusion

As evident in our modeling results, the economic effects of the US 54 upgrade on the state of New Mexico are relatively modest. This is primarily due to the small economic base and population in the Five County region, which means that few economic agents are poised to take advantage of the improved transportation efficiency along the corridor. Other than the construction industry, which benefits directly from the road project during the construction phase, most of the forecasted growth is experienced by the retail trade and service sectors, which have less spillover effect on the local economy than expansion of the manufacturing base would produce. While the Five-County economy does exhibit impressive growth on a percentage basis, its share of the state's baseline economic activity is small, so the growth is minor on an absolute dollar basis.

However, REMI believes that there are additional benefits not captured in the current round of modeling that could be substantial enough to ensure that the US 54 upgrade would be cost-justified. These include the following:

- **Benefits to other states**: As mentioned in the report, tabulating only the benefits accruing to producers within New Mexico's borders neglects the considerable gains to out-of-state firms who can use the upgraded US 54 as a throughway for transporting end-use goods and intermediate inputs to production. In fact, Souder Miller indicates that the majority of additional VMTs on US 54 come from I-10/20 commercial traffic re-routed onto the newly widened US 54 at El Paso. Both the trucking/distribution firms and the industries using the commodities being transported on the trucks are likely to be based outside the state, in such areas as southern California, Mexico, and the industrial belt of the upper Midwest.
- **Benefits to the rest of New Mexico**: It seems reasonable that an improved US 54 would draw away some portion of commercial and private through-traffic on Interstate 25. Rather than driving due north through Albuquerque and onward to Colorado before turning east (a fairly rugged and mountainous route), vehicles could cut diagonally across New Mexico on US 54 (a comparatively flatter route) and pick up east-west roads in Texas or Kansas. Based on a study of vehicle classification numbers, Souder Miller concluded that very little commercial traffic uses the segment of I-25 south of Albuquerque; on the other hand, the Federal Highway Administration's freight traffic maps do indicate such usage. To the extent that US 54 diverts traffic away from I-25 and perhaps from portions of I-40, the project could diminish the degree of road congestion in these heavily traveled portions of New Mexico. This in turn would yield economic benefits (in the form of reduced production costs) for producers in the metropolitan areas of New Mexico.
- **Opening of a truck warehousing/switching facility**: Discussions with Souder Miller implied that locating a new facility for commercial truck repair and storage along the revamped US 54 corridor is a strong possibility. This facility would clearly attract additional truck traffic to the route while generating local economic benefits for those who operate, supply, and work at the facility.
- **Relocation of businesses**: Our modeling may understate business expansion along the US 54 corridor, particularly if firms in Albuquerque and other parts of the state are willing to relocate their operations to the Five-County region. This expansion is made even more likely to occur if the warehousing facility cited above were encouraged by the state in a coordinated economic

development program. In the past, firms have indicated to New Mexico officials that they would locate in a particular town or region if the primary artery is widened or otherwise upgraded.

Appendix: Model Variables

This appendix describes the various costs and benefits that are incorporated into REMI's assessment of the US 54 upgrade, employing the TranSight methodology as a foundation.

Construction Costs

Governments incur the costs of building, financing, and maintaining a transportation upgrade over the lifetime of the project. While the construction process represents an expense from the government's perspective, it also represents demand that stimulates increased employment and production of intermediate inputs by the private sector. Both of these aspects are included in TranSight's modeling framework. In TranSight, the user enters projected construction costs and projected operation and maintenance (O&M) costs in dollar form for each of the forecast years, in accordance with the annual work schedule of the transportation upgrade under consideration. The operation and maintenance costs heavily depend upon the nature of the undertaking. Public transit requires significant operating costs and replacement of depreciated equipment, as contrasted with road improvements that may only require periodic pavement and shoulder maintenance.

TranSight translates these expenditures into demand policy variables within EDFS-53. First, contracts with construction firms to implement the transportation project are reflected in increased exogenous final demand for the construction industry, which naturally flows through into sales, employment, demand for intermediate inputs (based on the IO table), and other variables. TranSight also passes operations and maintenance spending into exogenous final demand for construction, due to the unavailability of input-output coefficients for specialized segments of the construction sector (such as maintenance and repair). The model uses endogenous trade-flow shares (based on a gravity-model approach) to allocate this demand to increased sales by the construction industry in both the specified region and other defined regions, including residual regions comprising the "rest of US" and the "rest of world."

The Transportation Cost Matrices

"Effective distance" is the mechanism through which the theory of economic geography enters the decision-making processes of economic agents in TranSight. It can be imagined as the geographic distance between two centers of economic activity, adjusted for the efficiency of multi-modal transportation between them. Hence, improvements in the transportation infrastructure reduce effective distance between two locations and consequently increase their interaction, in terms of the flows of labor, intermediate inputs, and end-use commodities. In general, as effective distance increases, the costs that deter economic activity rise through an exponential process called "distance decay." The rate of change by economic sector of the distance decay curve (known as the distance decay parameter, β) captures both the increased deterrence and the variable impact on flows by sector.

For businesses involved in transporting goods, shorter travel times for their delivery vehicles translate into savings on fuel, wages, and perhaps vehicle and inventory costs. Furthermore, traveling sales personnel can potentially reach more clients during business hours. Although these savings can stem directly from additional roads, which provide quicker alternative routes between popular destinations, they can also result from widened roads, public transit networks, or enhanced traffic control systems, which can diminish congestion and lower accident rates.

As stipulated by the theory of economic geography (which is integrated into the EDFS-53 model), both firms and households obtain benefits from policies that expand their access to variety in labor, intermediate inputs, and end-use goods. Regarding labor markets, transportation upgrades improve compatibility between employers and employees through two complementary channels: firms can access a broader and more diverse labor pool, while workers can reach additional jobs that may be better suited to their preferences. Even in the absence of job switching, shorter commutes to existing jobs produce time savings valuable to both workers and employers. The commuter-related benefits accruing to firms are captured through the commuter cost matrix, while the gains to suppliers of labor are described above in the "Value of Time" section.

Economic geography also assumes that markets are characterized by monopolistic competition, meaning that goods and services are non-homogeneous. Therefore, all economic agents derive incremental utility from the ability to choose from a wider array of alternatives. By facilitating interactions among a more diverse set of buyers and sellers, transportation upgrades can broaden the scope for market transactions. Businesses can find better matches for their needs in the intermediate input markets, while households can purchase more varied goods and services.

Within the TranSight framework, effective distance implicitly enters the calculation in three distinct forms: commuter costs, transportation costs and accessibility costs. We made the simplifying assumption that US 54 would not be utilized for commuting from home to work, thus allowing us to focus on transportation and accessibility cost impacts.

The transportation cost matrix displays time savings for on-the-clock business travel and transport of goods. Transportation costs can vary among regions as well as across forecast years. Thus, a new or expanded highway connecting two regions may have substantial impacts on transport costs between them, but also smaller secondary effects on costs between other regions as traffic patterns shift in response to the new alternative. The intertemporal differences can capture the cumulative impact of business development that occurs along the new highway or near a new public transit station, which may steadily increase congestion and thereby increase average travel times.

Savings are grounded in the difference between the alternative and baseline scenarios in the ratio of VMT to VHT. This approach captures the offset between shorter travel times and additional miles traveled, both of which are likely consequences of an upgraded transportation infrastructure. TranSight computes the transportation cost savings parameters as follows. Because the baseline values are in the numerator, a cost change parameter greater than 1 implies a cost increase relative to the baseline case, whereas ΔTC_{ij} less than 1 suggests cost savings to the commercial and industrial sectors due to the transportation project. Thus, the value of 1 would indicate that the transportation improvement has a neutral impact on transportation costs, with the degree of deviation from 1 being associated with the magnitude of the cost effect.

$$\Delta TC_{ij} = \frac{(VMT_{ij}^{base} / VHT_{ij}^{base})}{(VMT_{ij}^{alt} / VHT_{ij}^{alt})}$$

where

VMT_{ij}^{base} = Vehicle miles traveled between i and j: base scenario

VHT_{ij}^{base} = Vehicle hours traveled between i and j: base scenario

VMT_{ij}^{alt} = Vehicle miles traveled between i and j: alternative scenario

VHT_{ij}^{alt} = Vehicle hours traveled between i and j: alternative scenario

The final cost matrix bridges business and consumer interests by reflecting the value of increased accessibility to intermediate inputs and consumer goods afforded by the upgraded transportation system. While widened roads may only marginally improve accessibility, other infrastructure upgrades such as new bus routes, highways, or commuter rail lines may yield notable decreases in accessibility costs. As with the preceding two cost matrices, accessibility costs are entered for each pair of modeled regions in each forecast year. TranSight measures the change in these costs by comparing the ratio of VMT to VHT between the alternative and baseline scenarios, through an equation comparable to the transportation cost formula above.

As these three matrices already have counterparts in Policy Insight, TranSight passes them directly into EDFS-53, where they impact economic and demographic trends through different channels. Decreases in transportation costs lower the delivered prices of products, which are computed as the sum of the commodity's cost at its origin and the distance-related cost of transferring the commodity to its destination. These price changes translate into lower input costs for producers and into benefits for consumers. Improved accessibility costs influence the location decisions of households via the economic migration module, and also indirectly diminish production costs due to improved access to well-suited factor inputs.

All of these effects cascade into other macroeconomic variables because of the interlinkages built into the model, as illustrated in Figure 4 below. As a consequence of affecting commodity and labor access indices, transportation projects can have secondary effects on regional wages, employment, delivered prices, and market shares, among other variables. Importantly, an improvement in a region's transportation infrastructure can yield localized benefits in costs and productivity which can increase its competitive position vis-à-vis surrounding regions. But at the same time, the project can create spillover effects in those neighboring regions, particularly on labor and capital inputs that are drawn from those areas.

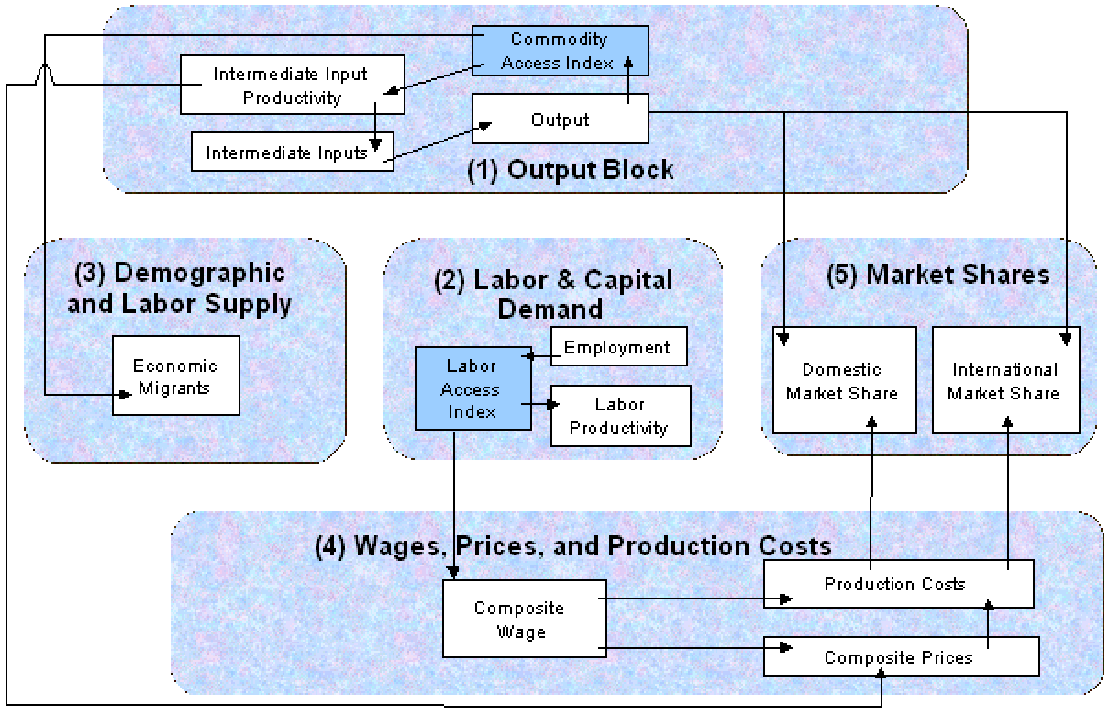

Figure 12. Impact of economic geography within EDFS-53