Revisiting the Impact of the Appalachian Development Highway System

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Abstract

We revisit estimates for the impact of the Appalachian Regional Development Highway System (ADHS) presented in Jaworski and Kitchens (2019) using the quantitative framework developed by Jaworski, Kitchens and Nigai (2023). We present revised estimates that range from $35.1 to $44.8 billion. We also present new results for the relative role of the ADHS in providing domestic versus international market access as well as estimates for the value of the ADHS within versus outside the territory of the Appalachian Regional Commission. Finally, we briefly discuss the implications of these results for understanding the efficacy of the ADHS in addressing poor economic performance in the Appalachian region.

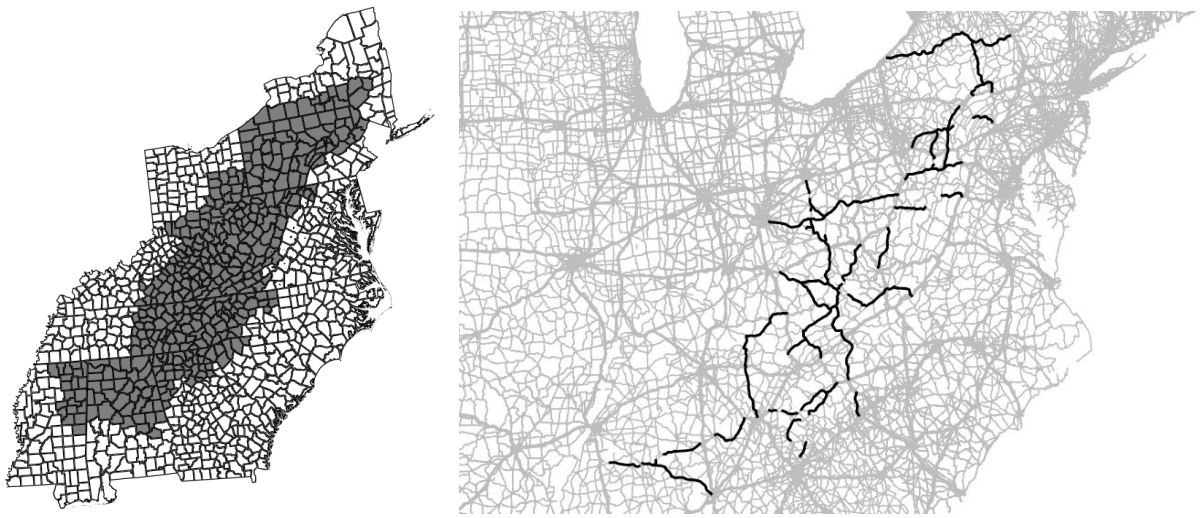
In this note we revisit the results of Jaworski and Kitchens (2019) regarding the impact and value of the Appalachian Regional Development Highway System through the lens of the model presented in Jaworski, Kitchens and Nigai (2023). The model in Jaworski, Kitchens and Nigai (2023) builds on the standard economic geography model of Eaton and Kortum (2002) and extensions, e.g., by Donaldson and Hornbeck (2016) and Caliendo, Dvorkin and Parro (2019). The motivation is to ensure that an approach to quantifying the value of transportation infrastructure with a richer set of mechanisms confirms the main conclusions reached in Jaworski and Kitchens (2019).

The Appalachian Regional Development Highway System (ADHS) was created as part of the Appalachian Regional Commission (ARC) and was intended as one part of a larger strategy to facilitate economic development by addressing the region's lack of market integration. Figure 1 shows the region of the ARC – including counties in Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia – and the placement of the road network associated with the ADHS. Ultimately, the ADHS included roughly 2,500 miles of high-quality graded roads allowing travel speeds exceeding 65 miles per hour.

The model of Jaworski, Kitchens and Nigai (2023) improves on the framework utilized by Jaworski and Kitchens (2019) in several ways. Most importantly, Jaworski, Kitchens and Nigai (2023) include (i) locations from outside the United States, (ii) traffic congestion on highways, (iii) many sectors with input-output linkages, (iv) the opportunity for goods to use alternative transportation modes including highways, rail and inland waterways, (v) imperfectly mobile labor, and (vi) agglomeration. These features are not novel to Jaworski, Kitchens and Nigai (2023), however, their approach incorporates these into a single framework. In addition, the way in which foreign locations and congestion are included have broad applicability to other settings. The results presented in Jaworski, Kitchens and Nigai (2023) indicate that the entire Interstate Highway System (IHS) is valued at between $421 and $578 billion. This is higher than previous estimates and so it is reasonable to ask whether applying this framework in other settings revises other estimates in the literature.

Revisiting the impact of the ADHS is useful because it presents an opportunity to carry out replication in a setting where many of the specific model features in Jaworski, Kitchens

Figure 1: The Territory of the ARC and Placement of the ADHS



A. ARC B. ADHS

Notes: Panel A shows the territory of the Appalachian Regional Commission (ARC) in gray. Panel B shows the placement of the Appalachian Regional Development Highway System (ADHS) as black lines and other US highways as gray lines.

and Nigai (2023) may be important, and were not captured well or were entirely absent from Jaworski and Kitchens (2019). In addition, because the framework allows for a decomposition into the value of a highway (or highway system like the ADHS) attributable to domestic versus international market access, there is also an opportunity to produce new results that may be of interest and contribute (modestly) to the literature. More generally, this is an attempt to show the value of replication as well as highlight some principles that are useful to follow in carrying out replication.

Data. The data used to revisit the value of the ADHS are identical to the the data discussed in Section 4 of Jaworski, Kitchens and Nigai (2023). This includes information on domestic and international trade flows (including within the United States and between US states and the rest of the world), production and consumption shares, transportation modes, and county-level employment and output, and county-to-county migration. Most importantly, Jaworski, Kitchens and Nigai (2023) show how to construct domestic and international trade costs from information on domestic highway travel times, international shipping distances, and other sources. Jaworski, Kitchens and Nigai (2023) also estimate the sectoral trade and travel time elasticities that are used to

calibrate the model.

Model. The theoretical framework is described in Section 3 of Jaworski, Kitchens and Nigai (2023). A novel feature of their approach is to accomodate the model to the idiosyncrasies of data availability for the United States from a variety of sources. As an example, trade cost data are available for the most detailed level of geography in the model (i.e., either county-county or country-county pairs), while trade flows are only available at the state-state and state-country levels. This means researchers cannot simply use a model that only works at the most detailed level of geography, while substantial information would be lost on the variation of trade costs within states if a model was just applied to state and country level data. Jaworski, Kitchens and Nigai (2023) overcome this issue by writing down a model with a two-tier spatial structure that allows for intra- and inter-state movement of goods while ensuring that aggregation is consistent across the different levels of geography. Simply put, this allows for using county-level data when it is available and still incorporating state- or country-level information.

In addition, the model also incorporates the other features: (i) trade between US and non-US locations, (ii) congestion, (iii) input-output linkages between many sectors, (iv) several transportation modes including highways, rail and inland waterways, (v) imperfect labor mobility, and (vi) agglomeration.

Results. To revisit the impact of the ADHS, we consider counterfactuals very similar in spirit to those originally conducted by Jaworski and Kitchens (2019). We compare the change in welfare and other economic outcomes that occurs when moving from a scenario that includes all of the highways as they existed in 2010 with a scenario in which all fundamentals are held constant and only trade costs are altered by removing the ADHS as it appears in Panel B of Figure 1.

The results from this exercise are reported in Table 1. The two rows show results that allow for alternative specifications of the production technology, which is attended to capture the time horizon over which adjustment may occur. The two values reported in column 1 are $44.8 billion (row 1) and $35.1 billion (row 2) as compared with $53.7 billion reported in Jaworski and Kitchens (2019). This difference may reflect the fact that the model of Jaworski, Kitchens and Nigai (2023) allows for more general equilibrium adjustment in response to changes in the highway network from removing the

Table 1: Losses from Removing the ADHS

	Horizon	Total (1)	Domestic (2)	International (3)
1.	Short	44.8	23.0	21.8
2.	Medium	35.1	17.1	18.0

Notes: The table shows results from counterfactual exercises removing the Appalachian Regional Development Highway System (ADHS). Column 1 shows the total reduction in real GDP (in billions) from removing the ADHS, column 2 shows the reduction in real GDP (in billions) from removing the ADHS for domestic components of trade costs, column 3 captures the reduction in real GDP (in billions) from removing the ADHS for foreign components of trade costs by taking the difference between columns 1 and 2. The rows present results for alternative specifications that capture short-run (row 1) and medium-run (row 2) horizons for adjustments of the production technology.

ADHS. Although, the difference is relatively small and does not alter the main conclusions reached by Jaworski and Kitchens (2019), it is noteworthy. The results in columns 2 and 3 decompose the total losses into portion attributable to domestic versus international market access. The contribution of domestic market access is larger in the short run. However, in both the short-run and medium-run scenarios the contribution of the ADHS to international market access is substantial.

The difference in the change in welfare for counties in the ARC versus counties outside of the ARC was large ($5.5 billion versus $39.3 billion), which implies substantial leakage of the welfare gains associated with the ADHS outside of the targeted region.[1] This issue warrants further study in the context of this and other place-based policies. Finally, across counties within the ARC region, the range for the change in welfare from removing the ADHS is between -0.6 percent and 8.4 percent.

Conclusion. This note reports results from revisiting the findings of Jaworski and Kitchens (2019) through the lens of the model presented in Jaworski, Kitchens and Nigai (2023). The exercise revised downward the estimated value of the ADHS from $53.7 billion to a range of between $35.1 and $44.8 billion. In addition, this exercise produced a decomposition of the benefits into the domestic and international components. Finally, welfare gains can also be decomposed regionally for counties in the ARC and counties

[1]This was a calculation that Jaworski and Kitchens (2019) could not do for spatially disaggregated units since the assumption of perfect mobility also has the implication that agents in the model are indifferent and therefore welfare is the same across space.

outside the ARC.

Overall, the results are consistent with the conclusions reached by Jaworski and Kitchens (2019, p. 789): "Ultimately, the gains stemming from the [Appalachian Regional Development Highway System] were not enough to overcome more fundamental changes in Appalachia." If anything, the new results suggest more pessimism regarding the potential for spatially-targeted transportation infrastructure to improve market integration and, thereby, increase welfare in the intended region.[2]

The poor efficacy of the ADHS may reflect a mis-assessment during the 1960s regarding the importance of the lack of market integration versus other types of infrastructure, investments in human capital, out-migration, etc., for economic development in the region. As an alternative, Gauthier (1973, p. 108) writes,

> "In the six years since the passage of the Appalachian Regional Development Act there appears to be a serious contradiction between the original objectives of the Appalachian Highway Development System and the results achieved to date. The Appalachian Development Commission has failed to design and execute a coordinated regional plan."

In the end, the challenge of public infrastructure provision and regional economic development may reflect the difficulties of coordination across different levels of government as they respond to the concerns of voters, politicians, or other interests.

[2]As a caveat to too much pessimism, the exercise reported in Jaworski and Kitchens (2019) and the new analysis in this note based on Jaworski, Kitchens and Nigai (2023) does not incorporate the benefits associated with lower commuting costs. This is an avenue for potential future research to pursue.

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