MEGAREGIONS – THE ECONOMIC TIES:

A CASE STUDY OF THE CHESAPEAKE MEGAREGION

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ABSTRACT

Megaregions, large agglomerations of urban areas, are emerging as a geographic unit across the world. This paper examines the economy of the Chesapeake megaregion, showing how economic and freight flows link the megaregion together. We first provide background on the megaregion concept then identify and describe the Chesapeake Megaregion. Using data from IMPLAN on economic flows between counties in the megaregion, we illustrate the internal economic and freight linkages. This includes an analysis of the economic self-sufficiency, the dollar value of freight flows into and out of Baltimore and Richmond, an analysis of the economic impact of growth in the economies of Baltimore and Richmond on other parts of the megaregion and a supply chain analysis of freight flows interlinked across the megaregion. Finally, conclusions are drawn about internal economic and freight linkages and the role transportation plays in the economy.

Key Words: The Chesapeake Megaregion, Economy, Highway Freight Flow

INTRODUCTION

Megaregions are clusters of metropolitan areas and their surrounding but interactive areas linked by shared environmental, economic, and social interests. As estimated by America 2050, a national infrastructure planning and policy program led by Regional Plan Association (RPA), more than 70 percent of the nation's population and employment growth will take place in megaregions by 2050 *(1)*. The future of the American economy largely hinges on the prosperity and sustainability of its megaregions, a new geographic and planning unit.

Multiple studies have been done of megaregions. Megaregion were originally conceptualized as "megalopolis" by French geographer Jean Gottmann in the mid twentieth century to describe the continuous urbanized area between New York and Washington, D.C. *(2)*. In 2005, RPA started the America 2050 research program, and identified 11 megaregions in the U.S. *(3)*. Dr. Catherine Ross of Georgia Tech suggesting further research on increasing mobility of megaregion interstate highway corridors *(4, 5)*.

The majority of existing empirical studies of megaregions have used data from the Commodity Flow Survey (CFS), or the Freight Analysis Framework (FAF) dataset *(6, 7)*. CFS data is collected every five year through a partnership between the Census Bureau and the Bureau of Transportation Statistics (BTS) *(8)*. It contains shipment information (in terms of value, weight, mode, origin, destination and the distance shipped) of raw materials and finished goods. CFS includes shipment in industries of manufacturing, wholesale trade, but excludes most retail and service industries *(8, 9)*. CFS provides national and state level data. FAF is a compiled dataset with collected data from a variety of sources, such as the CFS *(10)*. It includes estimates for tonnage and value by origin and destination, commodity type, and mode. FAF data are divided into 123 domestic regions and 8 foreign regions. A domestic FAF region can be one Metropolitan Statistical Area (MSA) or a Consolidated Statistical Areas (CSA) as defined by the Office of Management and Budget, part of one MSA/CSA, or the portion of a state that is not included in a MSA or CSA. With their relatively large geographic scales, CFS and FAF are most appropriate for national freight movements and movements into and out of megaregions. However, they have limited capability to analyze detailed freight flows within a megaregion. Therefore, an alternate data source is needed. The data we used for analyzing economic ties of the Chesapeake Megaregion is from IMPLAN. We will discuss this data in details in the next section.

DATA AND METHODOLOGY

The data we used for this paper is IMPLAN county-pair trade data. IMPLAN data is collected and maintained by MIG Inc., a private company. The data is gathered from various data sources, including but not limited to, Census of Employment and Wages (CEW) from Bureau of Labor Statistics (BLS), Regional Economic Accounts (REA) from the Bureau of Economic Analysis (BEA), County Business Pattern (CBP) from the U.S. Census Bureau, and National Income and Product Accounts (NIPA). Relationships among different data are established to estimate missing data. IMPLAN contains trade information on dollar flows between counties by 440 IMPLAN sectors. These flows are between each county pair, thus between two counties there are 440x440 flows or 193,600 flows. With that detail level, IMPLAN is an useful tool to quantify economic interactions within a megaregion *(11)*.

As said, the IMPLAN data are in dollar values. Since commodities vary by their weight and bulk per unit, to convert dollar values into tonnage is needed for highway freight analysis. Therefore, HaulChoice, a proprietary model developed by ECONorthwest, was used. HaulChoice is a freight mode-choice model which uses characteristics of zonal endpoints, the haul distance and cost, and certain megaregional controls to parameterize the mode choice model. It uses proprietary mathematical and statistical procedures, as well as its own crosswalks between NAICS and IMPLAN commodity categories. The result of the HaulChoice model is truck tonnage by county pair and the dollar value of truck tonnage by county pair.

108 counties within the Chesapeake megaregion are our research objects. Due to budget limitations, IMPLAN data was purchased for Delaware, Maryland, Virginia, and the Washington DC but not for adjacent states. The IMPLAN data thus represents dollar flows within the megaregion but does not represent flows to or from external counties.

This paper demonstrates how the megaregion is tied together through the economy and freight flows. The study contains (1) a description of the Chesapeake Megaregion, (2) an analysis of economic interdependencies, and (3) economic interactions among megaregion components. In the economic interactions portion, we first use maps to describe highway freight linkages for Baltimore and Richmond with the remainder of the Megaregion. We then conduct an economic impact analysis showing how a one percent output change in Baltimore and Richmond will affect the other counties' economies. Finally, a supply chain analysis illustrates flows into Richmond, from Richmond to Baltimore and then to surrounding areas. Our study shows that places are within the megaregion are woven together, based on their specialties, supporting and complementing each other to achieve an overall prosperity and vitality.

THE CHESAPEAKE MEGAREGION

The Chesapeake region, anchored by Washington D.C., Baltimore, and Richmond metropolitan areas, has been long taken as a part of the Northeast Megaregion (or Megalopolis in Gottmann's term) which stretches from Boston to Washington, D.C. *(2, 12)*. Lang and Nelson (2007) proposed the concept of "megapolitan area" as a cluster of two or more metropolitan areas, and as a composition element of megaregions *(13)*. According to their definition, the Chesapeake region is one of three megapolitan areas in the Northeast Megaregion (the other two megapolitans are: New England with Boston/Providence the anchor metros and Mid-Atlantic with New York/Philadelphia the anchor). Lang and Nelson predicted that this Chesapeake megapolitan area will see the fastest growth in the Northeast, with a growth of 32 million residents in 2040.

Ross (2012) later redefined Northeast Megaregion into three megaregions*(4)*. Using available data from multiple sources including the Highway Performance Monitoring System (HPMS), FAF, and private data sources, she first identified three tiers of areas: megaregion core areas, areas of influence, and clusters of metropolitan regions. Through applying analytic techniques including graph theory, Markov chains, and factor analysis, she then delineated 10 megaregions. More importantly, Ross finds that interactions within the Buffalo-Boston-New York-Philadelphia megaregion and the Washington DC-Virginia megaregion are stronger than the connection between these two megaregions. This smaller geography also makes policy implementation more feasible, given that collaborative policy solutions require cooperation among a smaller number of states and local governments.

The two studies above led us to focus on the Chesapeake Megaregion as one entity rather than part of the Northeast. Based on our research interest in economic ties, we defined the Chesapeake Megaregion as the continuous urban clusters on the Western side of the Chesapeake Bay, including major cities such as Washington D.C., Baltimore, and Richmond (Figure 1). In addition it includes the Delmarva Peninsula, the area east of the Chesapeake Bay. It stretches from Southern Pennsylvania to Northern North Carolina, and from West Virginia to Delaware. According to the Census 2010, the Chesapeake Megaregion had a population of 15 million and employment of 9 million. The largest population and employment centers are located along Interstate 95 and Interstate 64, with the Washington DC area having the most high-income households. Similarly, most jobs are located along the Interstate 95 and Interstate 64 arc. In terms of industry, service and government/military employment dominate. GDP for the Chesapeake Megaregion was $880 billion in 2010, or 6 percent of the nation's GDP, according to 2010 BEA. The Chesapeake Megaregion is projected to grow faster than other areas of the northeast corridor and by 2030 will contain more than 7 million households with employment above 12 million.

The Chesapeake Megaregion contains an advanced system of rail, ports, and highways that facilitate commodity flows and link labor markets that depend heavily on the transportation and government sectors. It includes three major airports: Baltimore Washington International, Washington Dulles and Washington Reagan. Major ports include the Norfolk-Hampton Roads areas, Baltimore, and the Wilmington area. The surface transportation linkages include 13,000 lane miles of Interstate highways, with significant north-south routes of Interstate 95 and Interstate 81, and east-west routes Interstate 270 and Interstate 64. Particularly, the Interstate 95/Interstate 64 crescent from Wilmington Delaware through Baltimore, Washington, Richmond and terminating in the Hampton Roads-Norfolk area is the main highway link. Rail linkages major north-south and east-west rail routes provided by the Norfolk Southern, the Chessie System and AMTRAK.

Existing political linkages also support the concept of the Chesapeake Megaregion. Examples of these linkages include the I-95 Corridor Coalition that tackles freight movement and the Chesapeake Bay Commission which addresses stewardship of the Bay, the unifying economic and environmental heart of the megaregion.

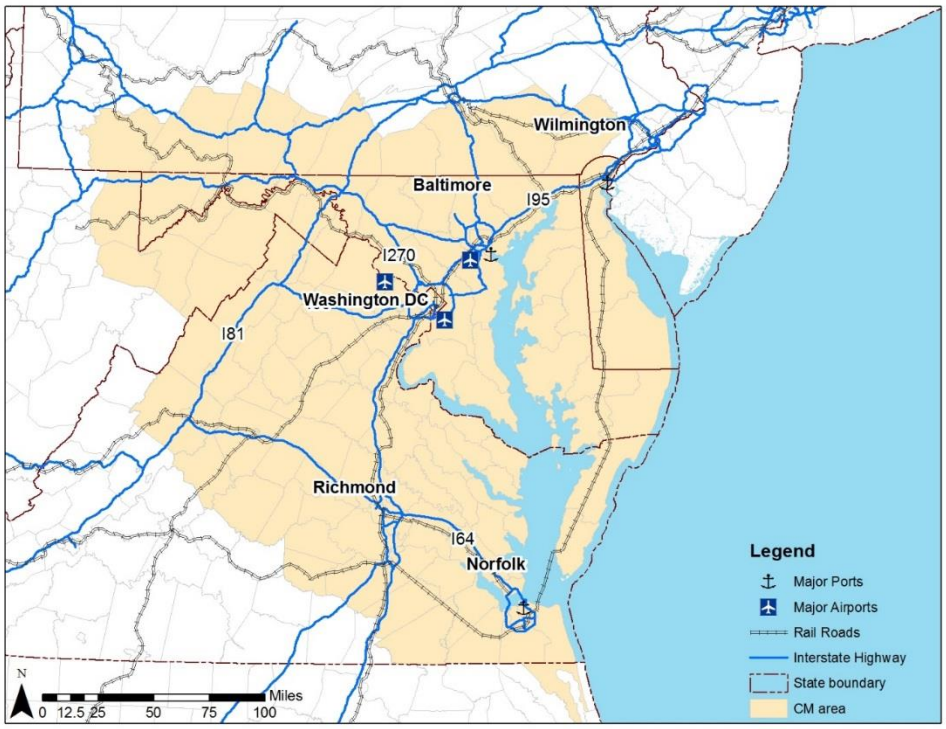

FIGURE 1 The Chesapeake Megaregion.

ECONOMIC SELF SUFFICIENCY

To understand to what degree the Chesapeake Megaregion is economically self-sufficient, we examined production in 19 major categories, identifying whether the origins were inside or outside the Chesapeake Megaregion (Figure 2). Then we calculated the percentages of the input coming from counties within the same megaregion. This percentage is defined as "internal demand." Results have shown that out of 19 industries, demands of 16 industries are more than 50% satisfied within the megaregion, ranging from 54% (Government and unclassified sectors) to 96% (management of companies and enterprises). For example, about 95% input of professional and technical services are provided by counties within the Megaregion. The only three industries that have a lower-than-50% internal demand satisfaction are manufacturing (20%), mining (10%), and agriculture, forestry, fishing, and hunting (33%) all of which are resource-based industries. They reflect that the Chesapeake Megaregion's concentration of knowledge and service production, and the dependence on external areas for industrial and agricultural material supplies.

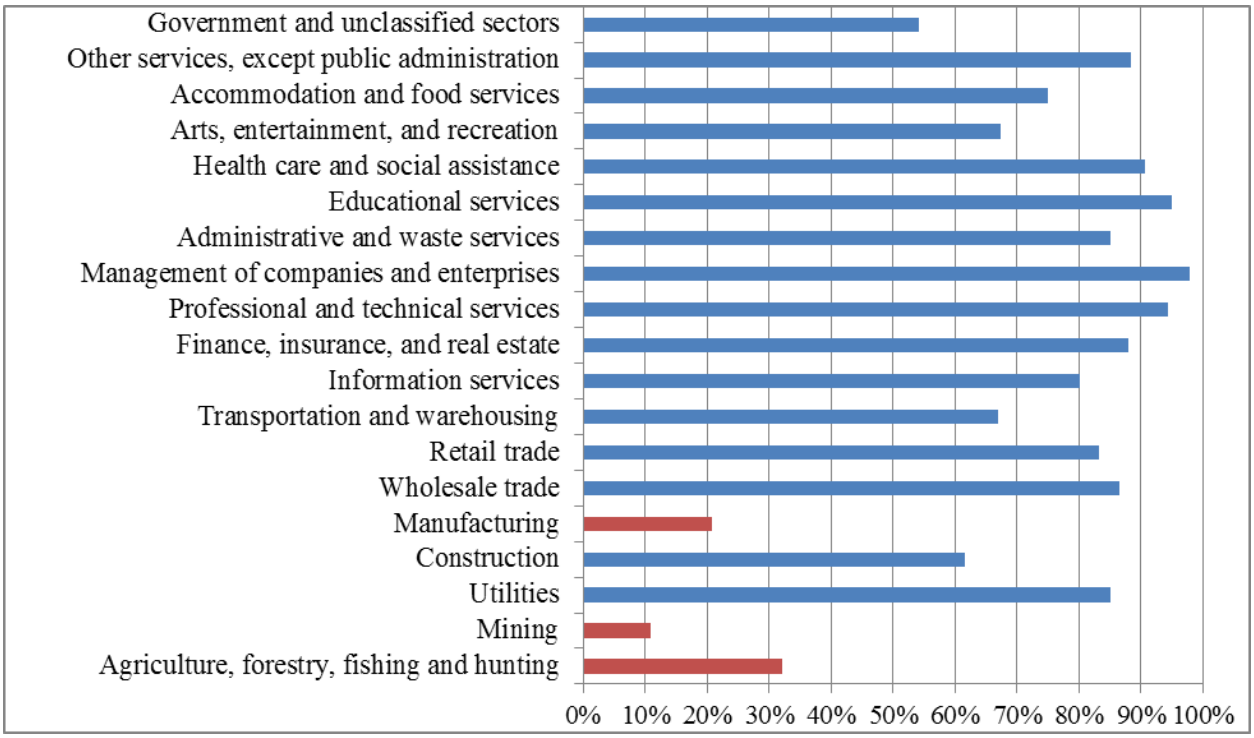

Figure 2 Economic self-sufficiency within the Chesapeake Megaregion.

HIGHWAY FREIGHT LINKAGES

Highway freight linkages are indicators for economic interactions between counties. In this section, we illustrate highway freight flows in dollar value and tonnage both into and from two major cities: the City of Baltimore and the City of Richmond, to map out economic ties within the Chesapeake Megaregion.

Baltimore

The Baltimore freight flows include both flows into and out of Baltimore itself and flows to and from the port of Baltimore. The Baltimore freight flows are captured in Figure 3. Baltimore imports from across the Chesapeake Megaregion, such as Hampton Roads to the south and the Interstate 81 corridor to the west. Particularly, the Northern Delaware, likely due to shipments into the Port of Wilmington, provides a large dollar value of freight flows to the City of Baltimore. The County of Baltimore also provides a high value of freight into the City of Baltimore. Nearly all counties with high value freight flows into or out of the City of Baltimore are located on interstate highways. Wilmington, Delaware, Washington, D.C., and Hampton Roads, Virginia are on Interstate 95 and Interstate 60, Frederick is on Interstate 70, and counties along Interstate 81.

Figure 4 shows that the City of Baltimore generates freight flows to an area which encompasses Washington D.C. and extends east into northern Delaware and south to Richmond. Similarly, a high share of freight flow goes from the City of Baltimore to the County of Baltimore. This finding demonstrates that Baltimore City and Baltimore County are tightly linked. However, a high volume of freight flows go beyond the immediate surrounding areas and into the remainder of the Megaregion. Washington D.C. is another major city in the area that has significant amount of freight flow from the City of Baltimore.

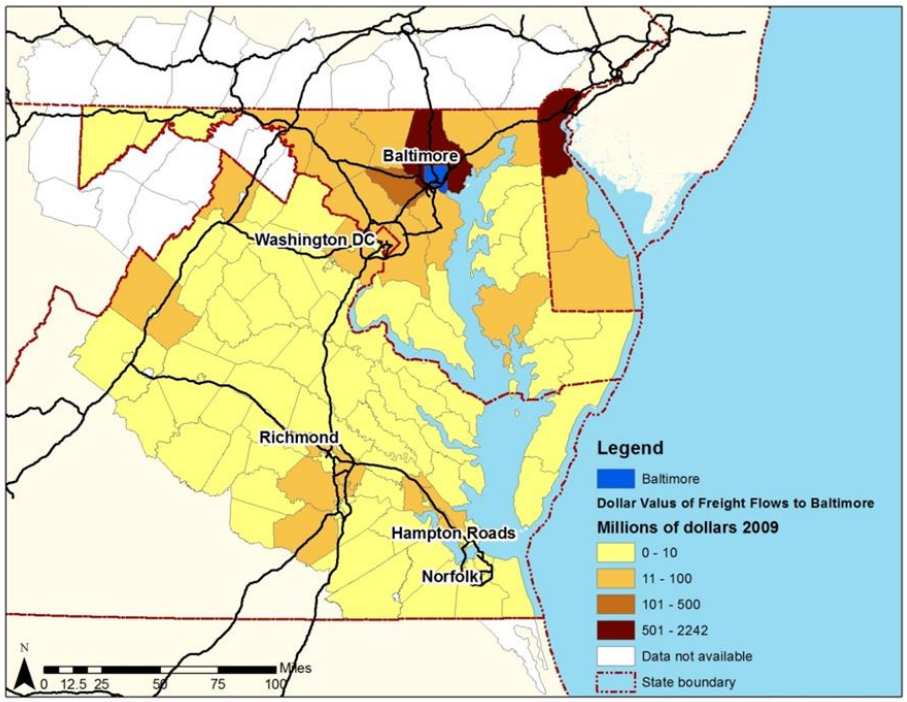

Figure 3 Dollar value of highway freight flows to the City of Baltimore from the Chesapeake Megaregion Counties in 2009.

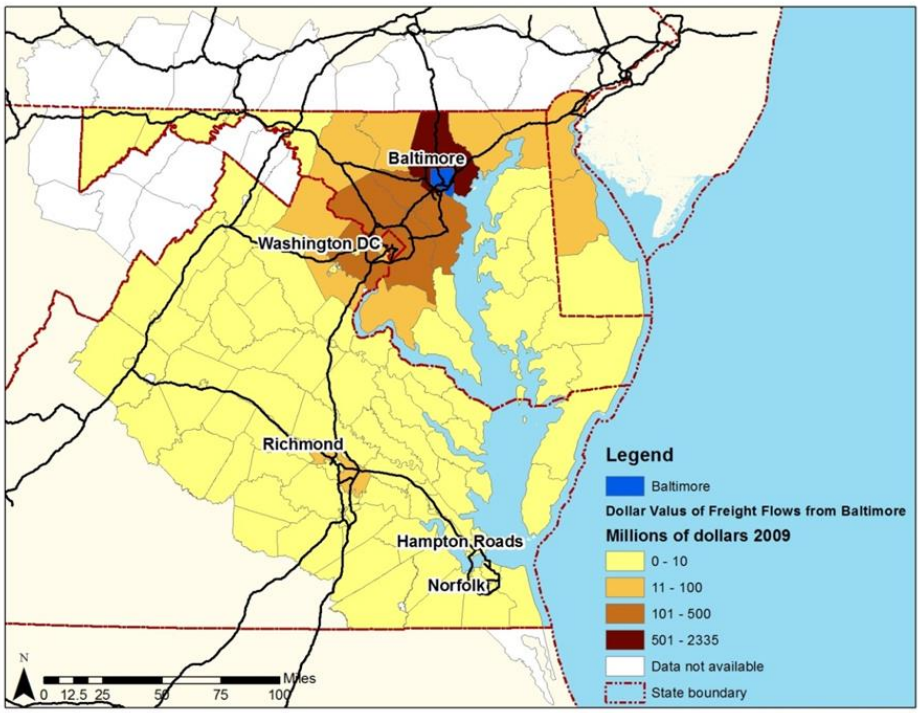

Figure 4 Dollar value of highway freight flows from the City of Baltimore to the Chesapeake Megaregion counties in 2009.

Richmond

The city of Richmond is located near the southern end of the megaregion, at the intersection of the Interstate 95 and Interstate 64 corridors, thus it has excellent north–south and east–west access and is well connected to the entire megaregion. The imports to the City of Richmond are of low dollar value, and have origins across the megaregion, from Baltimore and Washington in the North to Hampton Roads in the southeast. Most of the counties exporting to Richmond are located along Interstate 95 and Interstate 64.

Compared to imports, the exports from Richmond have a higher dollar value. The destinations of these exports also span the entire megaregion including Baltimore and Washington to the north, other counties along Interstate 95 and Norfolk to the southeast. The higher dollar value or exports suggests that Richmond, through manufacturing and other activities, adds value to imported goods then exports them to others.

Two findings result from the analysis of the City of Baltimore and the City of Richmond. First of all, in terms of import and export, freight flows of major cities go far beyond the MPO boundaries, crossing the entire Megaregion. What's more, the shipments largely rely on the Interstate 95 and Interstate 64 corridors. It is reasonable to estimate that delays or closures in these corridors will greatly impede quick and safe freight movements and likely impact the megaregion economy.

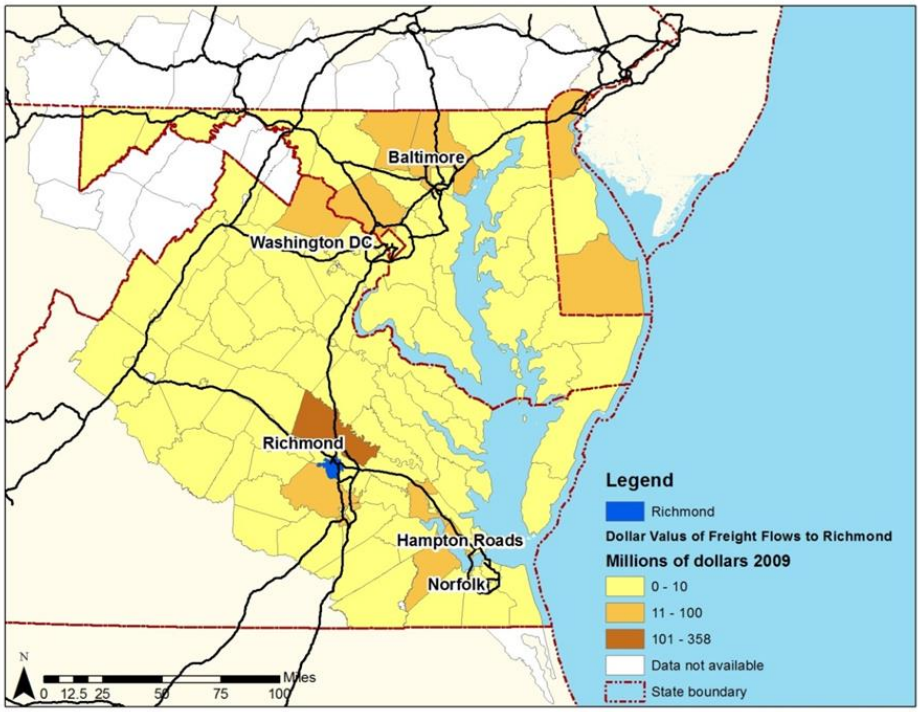

FIGURE 5 Dollar value of highway freight flows to Richmond from the Chesapeake Megaregion counties in 2009.

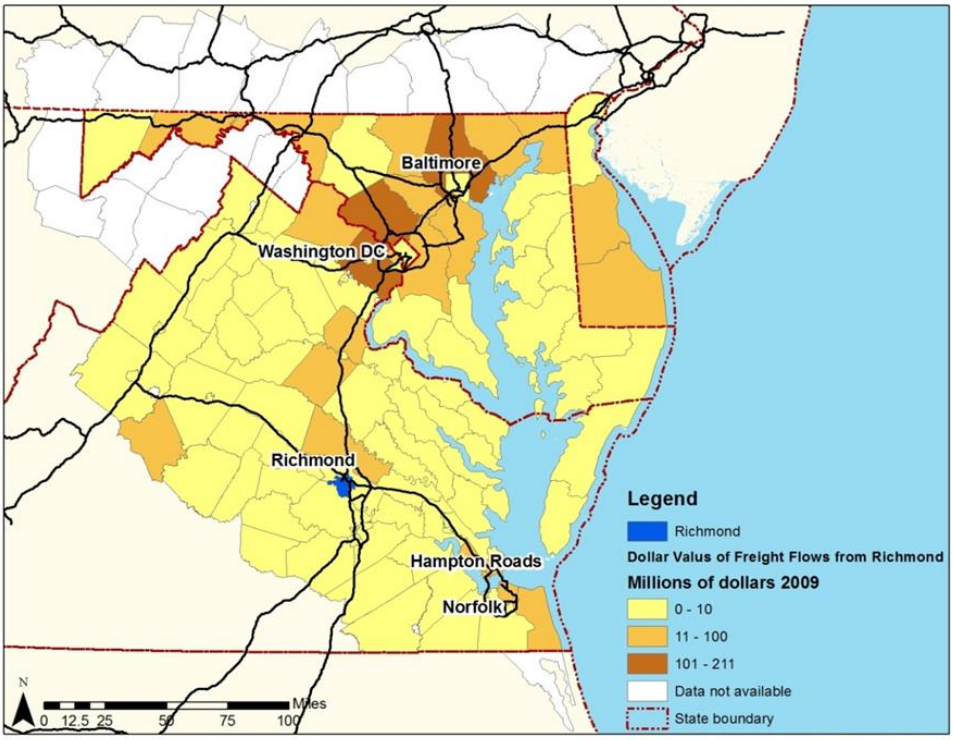

FIGURE 6 Dollar value of highway freight flows from Richmond City to the Chesapeake Megaregion counties in 2009.

ECONOMIC IMPACT ANALYSIS

Another way to view the economic linkages is analyzing the impact of an economic change in one county on other counties within the megaregion. These impacts are examined in both magnitude and industry mix. The economic impact analysis is conducted using IMPLAN Trade Flow Estimation. The estimation model uses econometric equations, derived from a multi-regional input-output (MRIO) model, to estimate regional purchase coefficients (RPCs) for each commodity, and then to estimate trade of commodity between counties/regions *(14)*.

To stimulate economic impact, we first artificially increased Baltimore's output by one percent (in terms of dollar value). Since the city analysis reveals that Baltimore County and Baltimore City are closely tied together, we included both of them for this impact analysis. As Figure 7 and Figure 8 shows, one percent increase of the City of Baltimore's output will impact areas as far away as Southern Virginia and Wilmington, Delaware. However, the impacts are not uniform. In terms of magnitude, counties surrounding Baltimore, particularly New Castle, Anne Arundel, and Frederick have been impacted the most. In terms of industry mix, some areas, such as Anne Arundel County and Howard County, show the greatest impact on the service sector while others, such as New Castle, James City, and the Isle of Wight in southern Virginia, show the greatest impact on manufacturing.

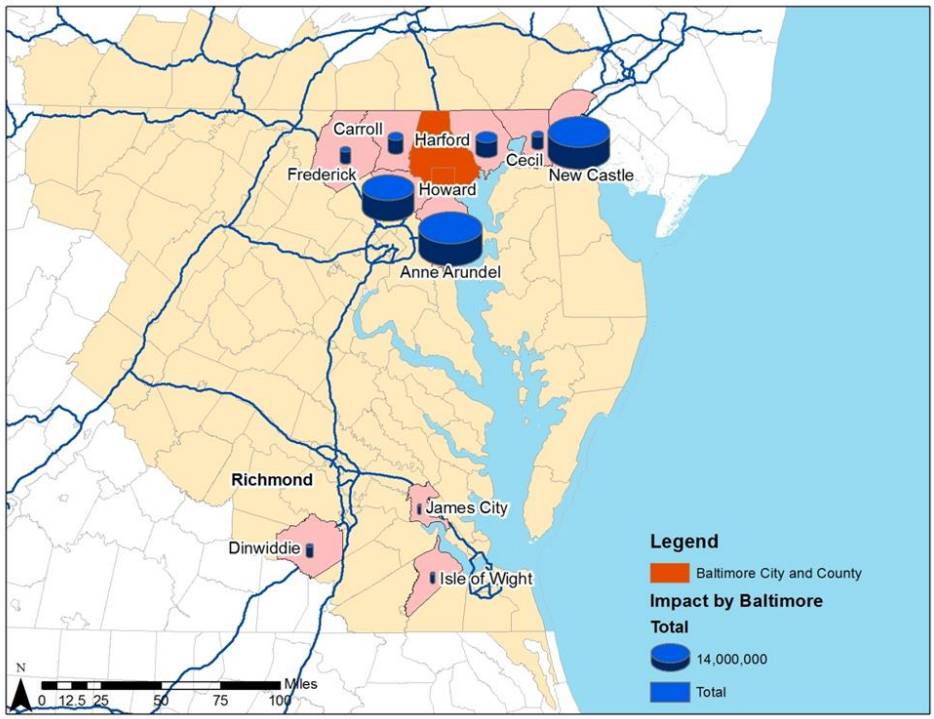

FIGURE 7 The impact of one percent change in Baltimore City and County production on the selected counties in 2009 dollar value.

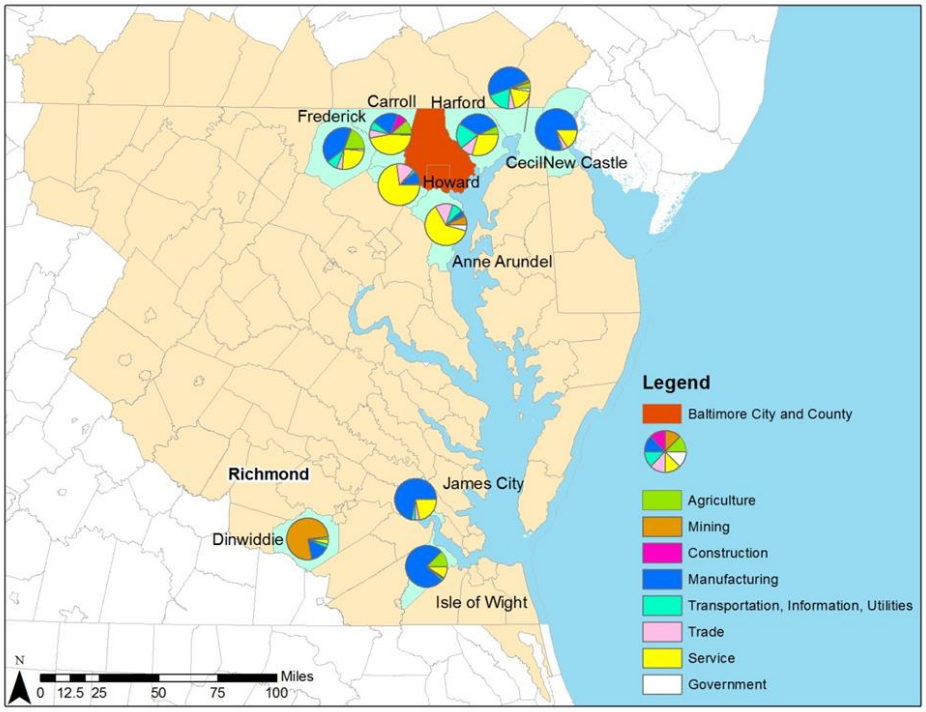

FIGURE 8 The impact of one percent change in Baltimore City and County production on the selected counties in industry share.

Similarly, we increased Richmond's output by one percent. As Figure 9 and Figure 10 illustrates, its impact, again, was found across the Chesapeake Megaregion, with significant impacts up to Baltimore and down to areas near Newport News and Norfolk. As with Baltimore, the sector impacts are not uniform. In some areas such as Loudon County and James City the greatest impact is on services while in other areas like Washington County the greatest impact is on manufacturing *(14)*.

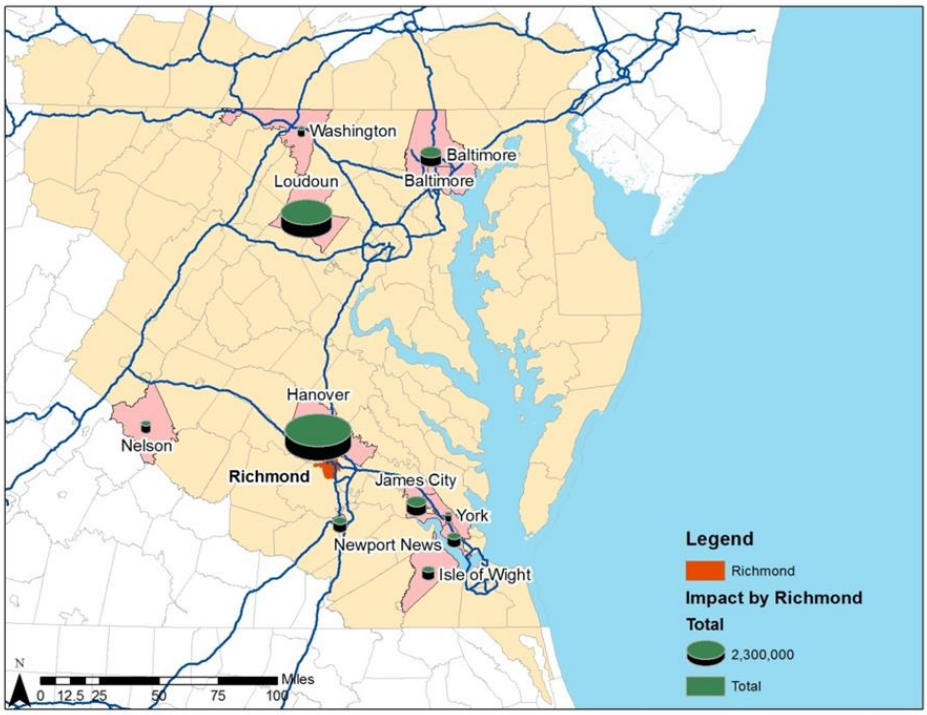

FIGURE 9 The impact of one percent change in Richmond production on the selected counties in 2009 dollar value.

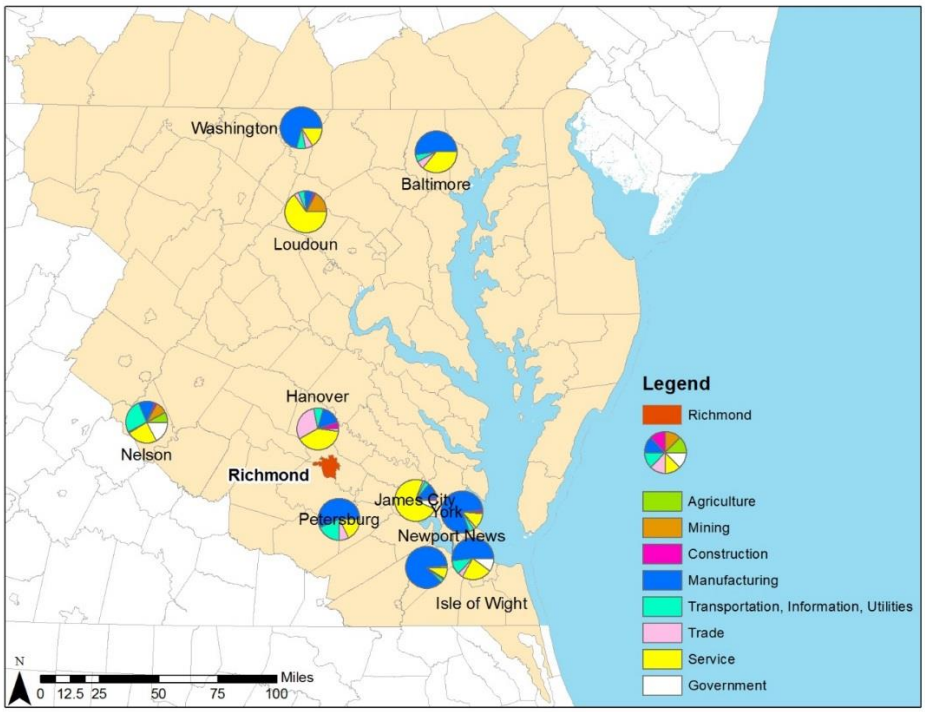

FIGURE 10 The impact of one percent change in Richmond production on the selected counties in industry share.

SUPPLY CHAIN ANALYSIS *(15)*

Supply chain analysis is another way to capture economic ties with the megaregion. Figure 11 shows the top seven counties shipping into Richmond in terms of freight tonnage. Richmond imports a diverse range of commodities from the surrounding region, primarily counties clustered near the Hampton Roads port area, but some as far away as Loudoun County, VA. Materials are processed in Richmond and shipped to Baltimore for further processing, as Figure 12 illustrates. This is an example of the specialization in production for individual counties that has been made possible by a reliable transportation network and a highly connected region.

Richmond has become a major center for paper product recycling and production. This specialization means that Richmond imports from surrounding counties a significant amount of paper related commodities. Trade in this industry makes up nearly 10 percent of all freight entering Richmond from other counties in the megaregion. Another important set of commodities for Richmond is concrete and stone-related materials. The shipment of these commodities represents over 16 percent of all incoming freight, and in addition the shipments are bulky and expensive to transport.

Figure 12 shows the freight movement from Richmond to Baltimore, and the Baltimore exports to other counties directly related to the incoming flows from Richmond. Major commodities moving from Richmond to Baltimore, include paper mill products (taking up to 37.66%), aluminum products, and pharmaceutical preparation manufacturing products. Outputs related to these commodities are then mapped as shipments to other counties. Major consumers of commodities dependent on trade between Richmond and Baltimore include the surrounding counties of Howard, Montgomery, Prince Georges County, Maryland, and Fairfax, Virginia. These

related shipments include stationary products, cardboard and boxes, aluminum alloys, pesticide and fertilizer, and medicinal and botanical manufactured goods. Importantly, this map shows the commodity flow that is dependent on trade between Richmond and Baltimore and subsequently dependent on Interstate 95, the major interstate connection between the two areas.

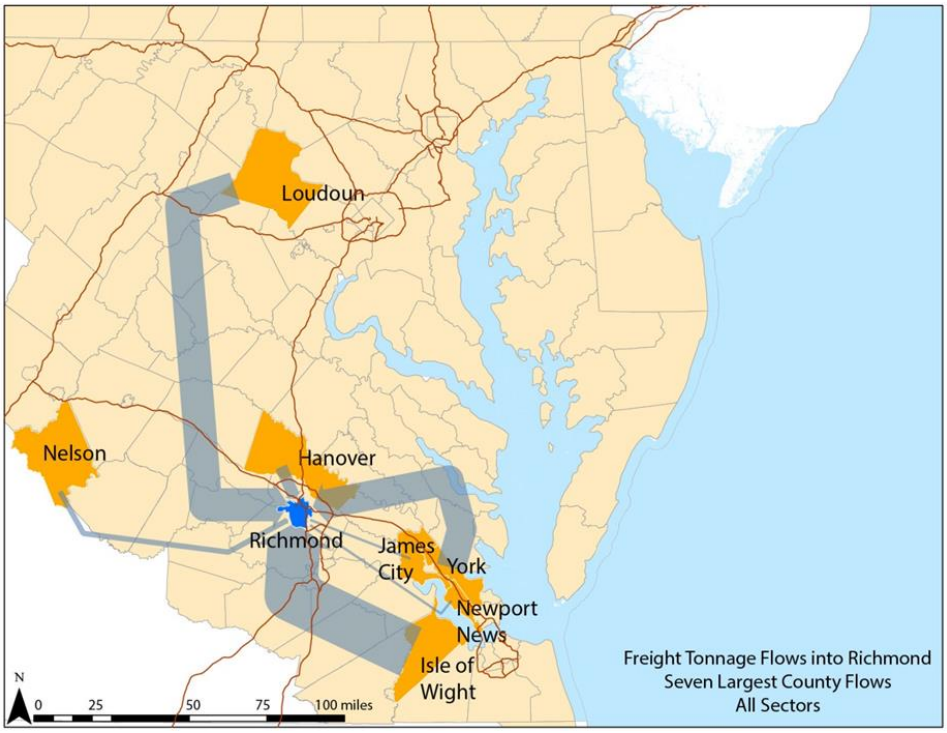

FIGURE 11 The seven largest county-pair highway freight flows in tonnage to Richmond.

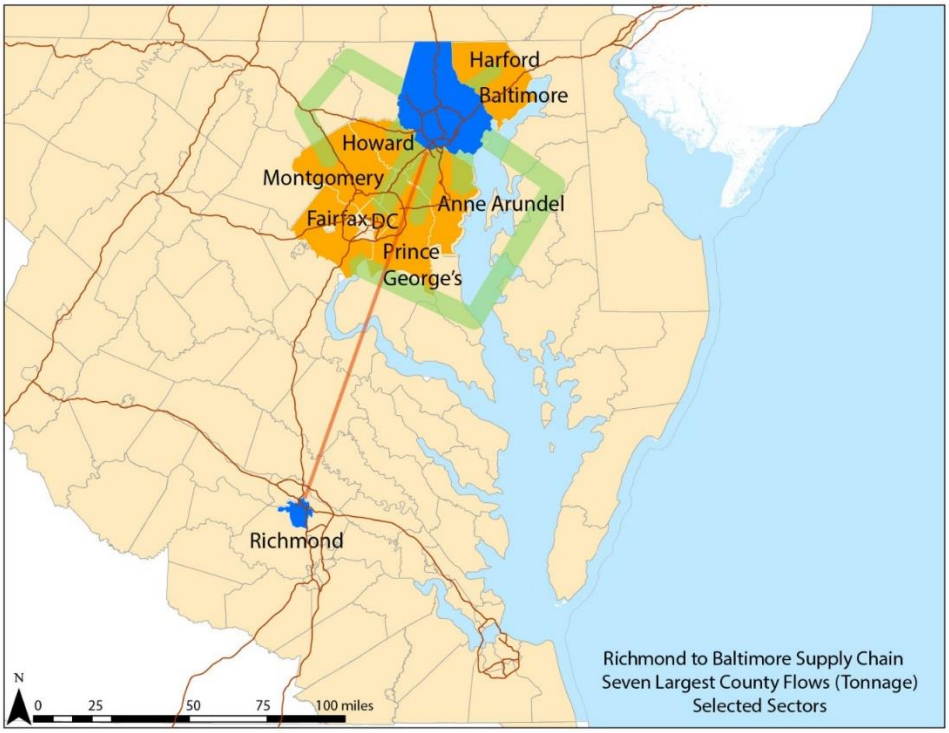

FIGURE 12 The seven largest county-pair highway freight flows in tonnage from Richmond to Baltimore.

CONCLUSION AND DISCUSSION

The Chesapeake Megaregion is an area of strong, interdependent economic relationships. Much is known about the overall importance to the megaregion, but little research has been conducted with regard to its inner workings. The finer grain research of the megaregion economic functions is vital in developing plans for the future of the region. However, to conduct such analysis a rich data source is required. IMPLAN data enables detailed analysis of economic flows among the counties that compose the megaregion. With this data set, we conduct freight flow analysis on an unprecedented scope to better understand the megaregional economic structure. In our case study, using the IMPLAN county-to-county economic flows, we find the Chesapeake Megaregion is in fact tightly linked and these linkages stretch beyond areas traditionally covered by MPOs.

We build on the network of linkages by converting economic flows to highway freight movements. This reveals not only that freight linkages play a critical role in the Chesapeake Megaregion economy, but also provides data on specific commodities, highway links and county pairs that are critical to the wellbeing of the regional economy. The City of Baltimore, for example, imports from sources throughout the Megaregion, from Wilmington in the Northeast to Hampton Roads in the south. At the same time Baltimore exports freight in a much more constrained area, primarily to surrounding counties. The relation of Richmond's freight shipments to the entire Megaregion can also be seen and is even more pronounced than Baltimore's. Richmond imports from across the Chesapeake Megaregion, with major import sources as far away as Wilmington. It exports to many areas in the north, Baltimore and Washington in particular. By dollar values Richmond appears to export more than it imports. This indicates that through manufacturing or other processes Richmond adds dollar value to its imports before exporting.

An economic impact analysis further illustrates the importance of freight flow relationships in the Chesapeake Megaregion. A simple one percent increase or decrease (across all commodities) of exports Richmond has a significant impact on economic activity across the entire Megaregion. The impact is particularly pronounced in such diverse locations as Loudon County Virginia, Baltimore Maryland and counties to the west and southeast of Richmond. Further, a prospective increase in Richmond's exports has varying effects on multiple counties. For some counties, the change has a strong effect on the manufacturing sector while for other counties the greatest impact is on service employment.

An analysis of supply chains shows that a one-dimensional county-to-county flow only begins to scratch the surface of the complicated economic relationships that exist within the megaregion. There exists is a complex web of commodity flows among the counties in the Chesapeake Megaregion. Each county relies on multiple intra-regional trading partners to both supply raw goods and purchase intermediary finished goods. Much of the economic activity in the megaregion may capitalize on county specific competitive advantages, without the need to import/export commodities, dollars or jobs outside of the megaregion.

The results of this analysis also have major implications for transportation. To maintain the function and prosperity of counties within the Megaregion, it is important to control traffic congestion and to ensure efficient highway freight movements. Particularly, in our Chesapeake Megaregion, Interstates 95 and 64 play a critical role as major freight corridors; linking economic hubs like as Baltimore to the North, Washington, D.C., and Richmond to the South. Megaregional transportation coordination will be a critical future planning endeavors to address congestion problems and ensure economic prosperity. (For more detailed congestion analysis, the interested audience may want to read the full report of this megaregion project for FHWA).

The megaregion is emerging as an important unit of analysis in planning. Though research has been somewhat limited in describing the inner-workings of the megaregion; it is clear from our analysis that there is significant economic activity within the megaregion. The megaregion is the sole location of many economic actives across a diverse array of activities. In the future, it will be critical to address issues of economic well-being and transportation infrastructure at a scale much greater than traditionally considered. Addressing issues at this scale will ensure the future strength of broad swatches of the US economy.

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