The Replacement of the Brent Spence Bridge: Tolls, Commuting Patterns and Economic Activity in Northern Kentucky

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Executive Summary

In this report, we investigate the impact of proposed tolls levied on users of the replacement for the Brent Spence Bridge, including impacts on commuting patterns and overall economic activity in Northern Kentucky. Overall, consistent with economic literature, the economic impact of the improved bridge will be positive and the toll, while slightly mitigating that impact, is likely to have only small effects on commuting patterns, trucking and retail and food service industries.

- We estimate that the net impact of the new bridge and the toll under our estimated likely scenarios would reduce commuter traffic by less than 2%, and possibly increase traffic by 1%.
- We estimate that the net impact of the new bridge and the toll under our likely scenarios would decrease trucking by less than 3% for trips made over the bridge: only a portion of overall trucking in the region.
- Our results suggest that while there may be some over-river shopping in Northern Kentucky, there are also consumers in Northern Kentucky shopping in Cincinnati: while the toll may reduce trips, it is unlikely to have an impact on retail or accommodation and food service in the region.
- We were also asked to investigate the impact of the Davis-Bacon act on the overall cost of the bridge. We find that the construction costs may be 10 to 15% higher due to Davis-Bacon wage requirements.

Introduction

The Ohio Department of Transportation and the Kentucky Transportation cabinet have announced plans to rebuild the Brent Spence Bridge and approaches. The Brent Spence Bridge spans the Ohio River connecting carrying traffic on I-75 and I-71 between Northern Kentucky and Cincinnati in Southern Ohio. The Cincinnati Metropolitan Area consists of five counties in Ohio, seven counties in Kentucky and three counties in Indiana for a total of fifteen counties spanning three states (see Figure 1). The two freeways, I-75 and I-71, which cross the Brent Spence Bridge pass through seven of these fifteen counties including Boone, Gallatin, Grant and Kenton counties in Kentucky and Butler, Hamilton and Warren counties in Ohio. Three other bridges (see Figure 2) carry interstate traffic across the Ohio river between Kentucky and counties in the Cincinnati Metropolitan Area: the Carol C. Cropper Bridge (I-275) between Boone County Kentucky and Dearborn County Indiana on the West side of the MSA; the Daniel Carter Beard Bridge (Big Mac Bridge, I-471) between Campbell County and Hamilton County just east of the Spence Bridge; and the Combs-Hehl Bridge (I-275) between Campbell County in Kentucky and Hamilton County in Ohio on the East side of the MSA. Three other bridges (the Clay Wade Bailey Bridge carrying U.S. 42 and 127, the John A. Roebling Bridge; and the Taylor-Southgate Bridge carrying U.S 27), span the Ohio River between Kenton and Campbell counties in Kentucky and Hamilton County in Ohio. Five of these seven bridges (the exception being the two I-275 bridges) connect downtown Cincinnati with Covington and Newport in Kentucky. Covington is on the west side of the Licking River in Kenton County, while Newport is on the east side in Campbell County.

Figure 1: Cincinnati MSA

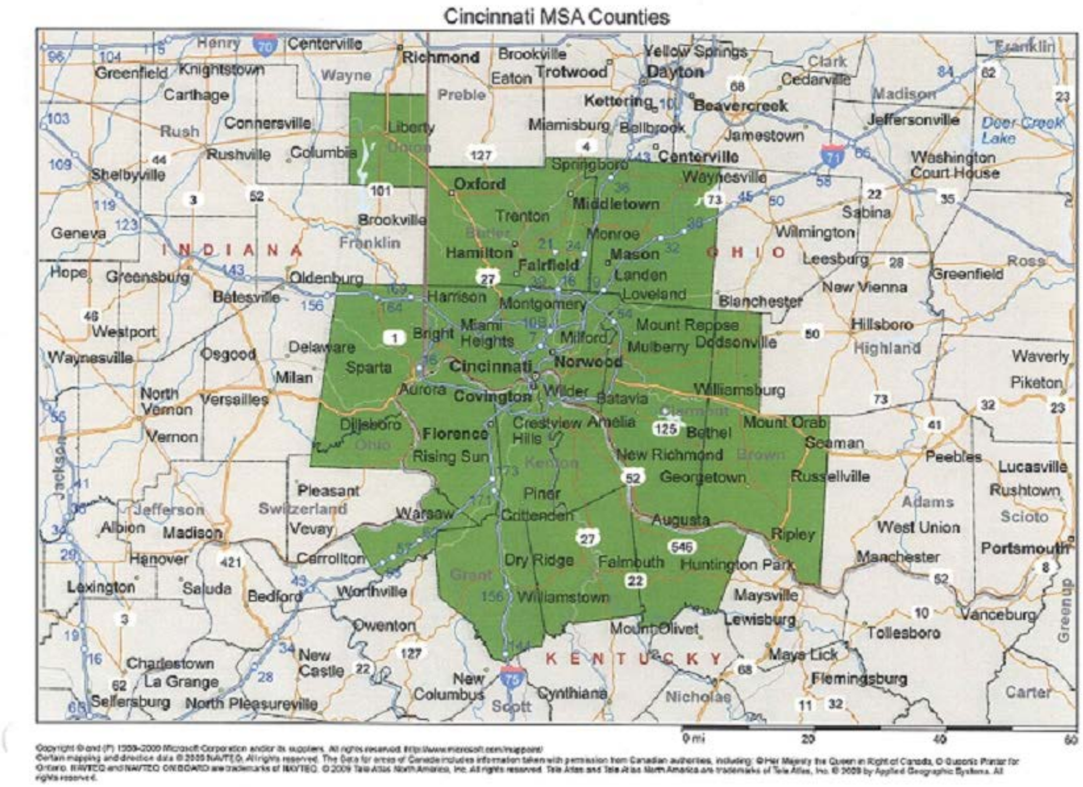
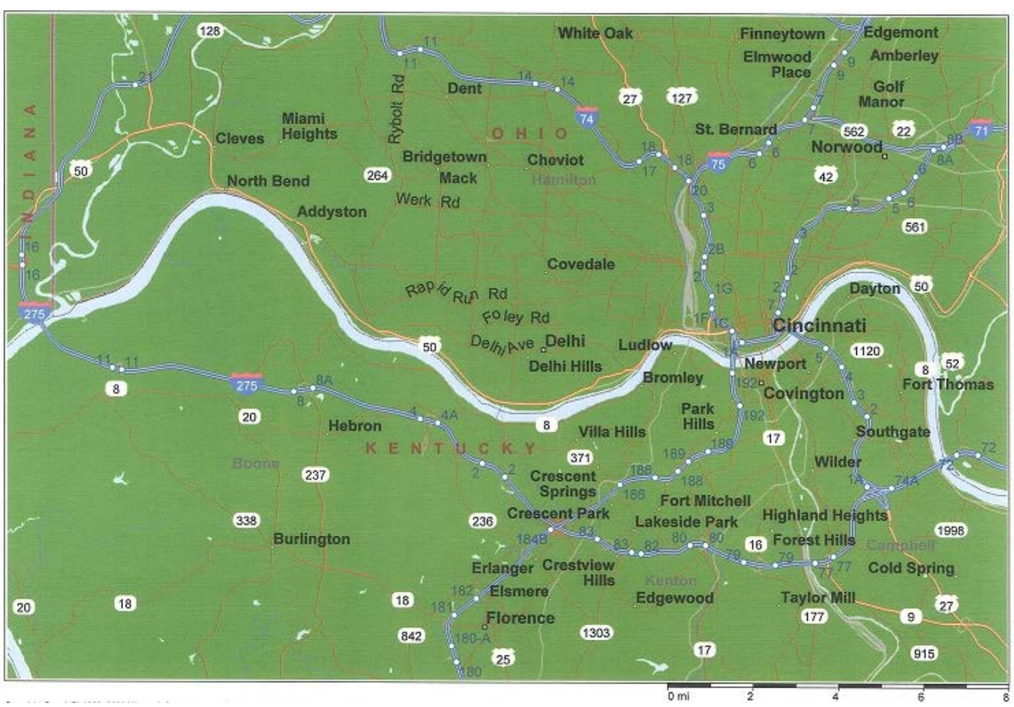


Figure 2: Cincinnati MSA Bridges



The proposed renovation of the Brent Spence Bridge and its approaches is clearly a needed improvement in infrastructure. The Federal Highway Administration lists the Brent Spence Bridge as functionally obsolete. The structure was originally designed to carry approximately 80,000 vehicles per day and in 2005 it carried 172,000 vehicles per day (National Bridge Inventory Data Base). The proposed project will improve traffic flow and safety along this important corridor.

The Center for Business and Economic Research was asked to examine the impact of a toll on this bridge on economic activity in Northern Kentucky. In particular concern arises about the impact of the toll on residents living in Northern Kentucky who commute into Cincinnati for work as well the impact to potential customers from Ohio for retail shopping and entertainment venues in Northern Kentucky. The trucking industry is also of importance to Northern Kentucky, as it constitutes a large employment category and interacts with manufacturing and wholesale goods industries.

In Component 1, we review the economic literature on highway improvements and tolls. The literature on tolls is not well developed, but does find that consumers and workers do not appear to be sensitive to tolls. We also review literature on the overall economic impact of bridge and road improvements and any interactions with tolls. We find little literature specifically on tolls, however, the general finding of the literature is that highway and bridge improvements have a net positive impact on economic activity that is not mitigated by toll roads. Component 2 of this report addresses the likely impact of a toll on commuting patterns and Component 3 addresses the broader economic impacts on the region.

Finally, in Component 4, we were asked to investigate the potential costs of the Davis-Bacon prevailing wage requirements on the cost of the Bridge itself. The economic literature is remarkably wide in its estimates, ranging from no effects to effects as large as 25% or more. Our calculations suggest between 10 and 15% higher costs due to the higher wages. However it is possible that this is an overstatement if firms respond by making different hiring decisions or by using fewer workers and more technology.

Component 1: Review of Literature and Background

Component 1 is composed of a literature review of Components 2 and 3 including the impact of the toll on commuting patterns and the broader economic impacts of the toll. We divide this literature review into two parts: in Part 1 we focus on the impact of tolls on commuting, other trips in automobiles (typically privately owned), and general traffic patterns and flows. In the Part 2 we summarize the small literature on the broader economic impacts of tolls.

Part 1: Impact of Tolls on Private Automobile Trips and Traffic.

Perhaps surprisingly, a trip or drive is easily thought of like any other economic good. An individual chooses to make a particular trip when the cost of the trip is lower than the overall benefit of making that trip. Economists capture this idea in a demand curve, where the amount of the good consumed depends on the price or cost of that good. Typically, as the price rises, the consumption of a good falls.

In the case of simple goods, like candy bars, the price of the good is easily measured as the dollar figure one must pay the merchant to purchase that item. In the case of a trip, the cost has a number of more complicated components. We focus on three, although some authors (see for example Burris, 2003) identify as many as seven. An obvious first component is the fuel cost necessary for the trip itself. In many ways, this is one of the most obvious costs of any trip made in a private automobile. Fuel costs are relatively simple to estimate based upon average fuel efficiency and travel times.

The second component is the time spent in the automobile during the trip. This is an example of what economists refer to as an opportunity cost. While driving an automobile, the consumer is able to do very little else and so “gives up” whatever they would have done were the trip not undertaken. Economists use a variety of approaches to applying a dollar figure to time. Many are based upon the wage or earning potential of the individual. In the case of transportation, economists have arrived at a number of estimates, most of which are based upon hourly earnings estimates. These estimates can be further refined by examining commuting patterns by income.

The third component is tolls paid for travel on the roads, and of course this is the primary component we will examine in the study below. A number of studies have examined this component specifically (some of these are detailed below). There are a number of general points about this component. The elasticity (or sensitivity) of travel to road tolls is not markedly different than any other cost component. Trips appear to be slightly more sensitive to changes in tolls than changes in fuel prices. However, trips appear to be more sensitive to time costs than tolls: increases or decreases in time costs due to traffic and other consideration have a larger impact on travel choice than tolls. This is understandable as time costs in general are a larger component of the overall trip.

Burris (2003) provides a nice summary of the literature on estimated trip price elasticity by each of the components outlined above. We reproduce components of Burris' Tables one and two in our Table 1. Additionally, we report estimates from more recent literature focusing on the elasticity of tolls. The elasticity estimates reported in Table 1 measure the percentage change in the number of trips made for a 1% change in the price of the trip. For example, an elasticity of -0.25 implies that a 10% increase in costs results in a 2.5% decrease in the number of trips made. Estimates in Table 1 for elasticity for toll costs range from very small negative numbers (even a few positive numbers) to as high as –0.78. Most range from around -0.15 to -0.33 with a cross study average of -0.21. As also can be seen, the estimates focusing on toll roads are not markedly dissimilar to estimates using other costs. Travel time elasticities do appear to be somewhat higher, although this difference may be due to the difficulty of estimating the value of time, rather than actual differences in sensitivities. In general these are "inelastic" values over the entire range. Elasticities between 0 and -1 represent cases where a 1% change in price yields less than a 1% change in consumption. For the case of travel, in general the literature has found that consumers are not very responsive to changes in the price of travel, even in the long run.

Table 1.1: Elasticity Estimates

Study	Type of Estimate	Elasticity
Toll Elasticities		
(Burris, Review)		
Wuestefeld and Regan (1981)	Toll Road Toll	-0.03 to -0.31
Wuestefeld and Regan (1981)	Toll Bridges	-0.15 to -0.31
Gifford and Talkington (1996)	Golden Gate Bridge	-0.15
Harvey, G.W. (1994)	San Fran Bay Bridge	-0.05
Wildur Smith Associates	Various	-0.1 to -0.35
(Our review)		
Hirschman et al (1995)	New York City Bridge and Tunnel	-0.03 to -.26
McArthur et al (2013)	Norway Bridges and Ferries	-0.24
Loo (2003)	Hong Kong Tunnels	0.054 to -0.309
Odeck and Brathen (2008)	Norway Trunc Roads and Motorways	-0.14 to -0.78
Other Elasticities		
(Burris Review)		
Johansson and Schipper (1997)	Fuel	-0.05 to -0.55
Goodwin (1992)	Fuel	-0.16 to -0.33
Luk and Hepburn (1993)	Fuel	-0.1
De Jong and Gunn (2001)	Fuel	-0.16 to -0.26
Ingram and Liu (1999)	Fuel	-0.05 to -0.55
Lee, D.B. (2000)	Travel Time	-0.38 to -0.68
Goodwin (1996)	Travel Time	-0.27 to -1.33
(Our review)		
McArthur et al (2013)	Travel Time	-0.24
Hirschman et al (1995)	Light Trucks	-0.07 to -0.54
Hirschman et al (1995)	Heavy Trucks	-0.0 to -0.6

A number of studies are worth highlighting. The Wuestefeld and Regan (1981) study specifically examines a broad sample of toll bridges and roads across the U.S. while the Hirschman et al (1995) study examines traffic patterns into and out of Manhattan across the bridges and through tunnels. These two studies, in many ways, are most comparable to the proposed toll here. The Hirschman et al (1995) study also has advantages in that certain bridges and tunnels had less expensive or free close substitutes (as does the Brent Spence Bridge), while other bridges had fewer substitutes. This allows us to examine how the presence of alternative routes would impact the traffic.

The Odeck and Brathen (2008) study is particular relevant in that it focuses on cases in which a new toll was implemented. The average was somewhat higher than found in other studies, and also represents a longer run estimate than many other studies. While a drawback of this study is that it derives from Norwegian data, as can been seen in our table, estimates are remarkably stable around the world and the variation is most likely from differences specific to the bridge rather than cultural or economic differences between countries.

The Hirschman et al (1995) study is one of the few studies which examines the impact on trucking. In many ways it may be less than ideal in this case in that trucking into and out of Manhattan is likely to be different – and less sensitive to price changes - than trucking in and around Cincinnati. They find a range from very small to around -0.6.

Part 2: Broader Economic Impact Studies

As Cherrington (2006) notes, "the body of literature specifically examining toll road impacts is still relatively small." Cherington (2006) provides a relatively comprehensive review of this literature. In general, the literature finds that the imposition of tolls is generally coupled with expansion of the road system infrastructure or is designed to reduce traffic in high volume areas. In both of these cases, the overall economic benefit on the region is typically positive: commute times are reduced either through the toll itself or through the combination of the toll and the expanded infrastructure. However, as noted by Cherrington et al. (2006), the broad economic impacts of tolls are often highly case specific and situation dependent.

There is a larger literature on the impact of transportation development infrastructure. In general studies find that highway infrastructure (either new or improvements) lead to enhanced economic growth (both employment and population) near the development (Weiss, 2005; Rychnowsky et al, 2003; Chandra and Thompson, 1998; Bollinger and Ihlanfeldt, 1997 & 2003). Boarnet and Chalermpong (2001) find that road improvements in general increase the willingness to pay, and hence the use of the roads, by consumers. Tolls offset the increased demand induced by the improvement and thus the economic impact is relatively small. Vadali (2008) finds that improved access from road improvements and expansions, even when tolls are imposed, generally increases residential property values near the corridors.

Pugh and Fairburn (2008) examine the impact of a new toll road on employment and economic activity. Like Boarnet and Chalermpong (2001) and Vadali (2008) they find that the access benefits outweigh the toll cost substantially. Also, in agreement with previous literature, they find that the development impacts are highly localized near the development.

Unfortunately these studies are small and clearly findings are highly specific to the situation. However, the general finding is that tolls have very little broader economic impact, and what impact they may have is lost in the overall impact from improved access. Many authors hypothesize that the tolls reduce congestion and separate high value users (who use the toll road) from low value users (who may shift to other trips). In so far as businesses (transportation and warehousing) and commuters are likely to be high value users of the improved bridge, there are reasons to believe that the economic impact of the toll will be minimal.

Component 2: Commuting Patterns and the Likely Impact of a Toll.

Current Commuting Patterns

The Brent Spence Bridge typically carries over 95,000 automobiles across the Ohio River on any given day. The weekday average is 128,832 automobiles while the weekend average is still over 113,959 automobiles (based on bridge traffic counts provided by the Ohio-Kentucky-

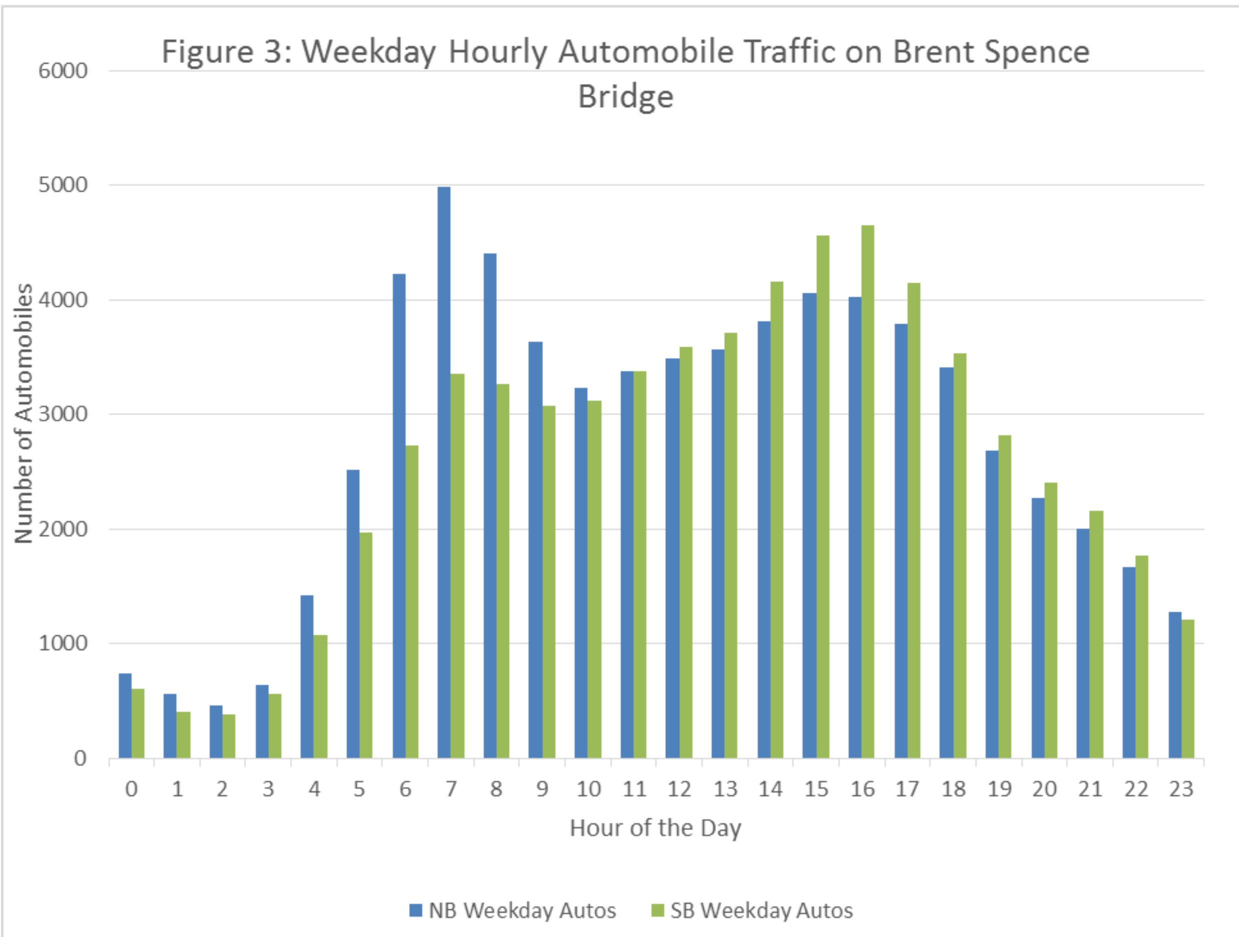
Indiana Regional Council of Governments). These counts represent a variety of types of travelers likely dominated by commuter travel during the work-week.

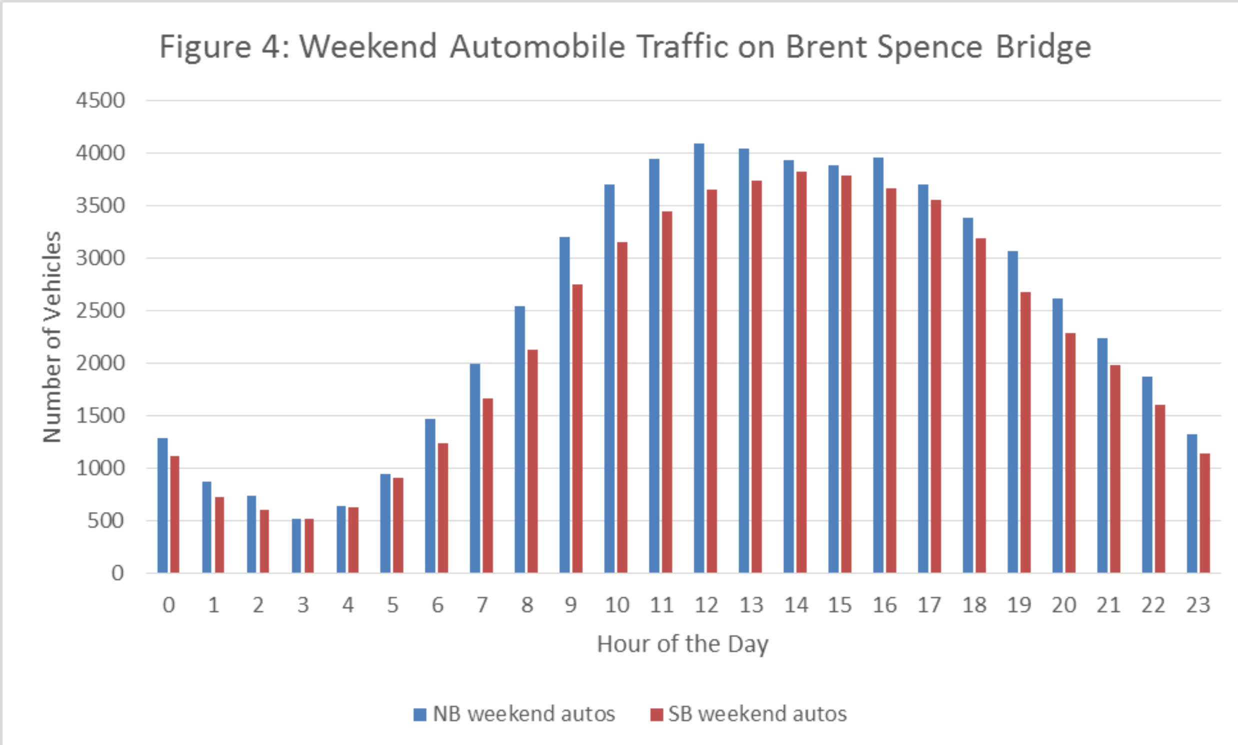
Table 2.1 presents summary statistics from count data collected for the Ohio-Kentucky-Indiana Regional Council of Governments (OKI) on the Brent Spence Bridge from April 19, 2013 through May 19, 2013. The data were collected using radar and hose (pneumatic tube traffic counter) methods and provide reliable estimates of traffic over time, across days, type of vehicle, and direction of travel. We summarize these data by considering the distribution across weekdays and weekends and during morning (6am-10am) and evening (2pm-6pm) peak periods. Forty-eight percent of weekday traffic on the bridge is concentrated during the two rush hour periods (which represent 33% of the total day). As one would expect weekend totals are 20% lower, but still represent robust traffic. During morning rush hour, more traffic is northbound, while during evening hours more traffic is southbound. Approximately 17,240 autos head northbound during the morning commute and a nearly symmetric 17,510 cross southbound in the evening. Similarly approximately 12,427 cross southbound in the morning while over 15,000 cross northbound in the evening. We note in general a northbound bias in all types of traffic. This may be due to physical data collection problems, or to something structural such as diversion to other bridges for southbound traffic or returning snowbirds (referring to travel that may be seasonal in nature) during the time of data collection.

Table 2.1: Traffic Counts on Brent Spence Bridge

		Weekdays	Weekends	Weekday Morning Rush	Weekday Afternoon Rush
NorthBound	Autos	66,225	59,959	17,240	15,691
	Trucks	17,716	10,390	3,740	3,663
	Total	83,941	70,349	20,980	19,354
Southbound	Autos	62,607	54,001	12,427	17,510
	Trucks	14,488	6,558	2,400	3,938
	Total	77,094	60,558	14,827	21,448
Total					
	Autos	128,832	113,960	29,667	33,201
	Trucks	32,204	16,948	6,140	7,601
	Total	161,036	130,908	35,807	40,802

Figure 3 presents hourly automobile traffic by direction for weekdays. The northbound peaks during the 6am-10am period, while the southbound peaks during the 2pm – 6pm period. The southbound traffic shows a secondary peak period between 7am and 9am, while the northbound traffic shows a secondary peak period from 3pm to 6pm. Figure 4 presents weekend traffic for automobiles. While there is a slight northbound peak early in the day (9am to 1pm), the southbound peak (roughly noon to 5pm) is less pronounced. The weekend pattern clearly has fewer commuters than the weekday pattern.





Commuters clearly represent a significant portion of traffic on the Brent Spence Bridge. The patterns apparent in the traffic counts suggest that roughly 17,000 Kentuckians cross the bridge twice each weekday to work in Ohio and over 12,000 Ohioans cross the bridge twice each weekday to work in Kentucky. This is clearly an underestimate as it ignores individuals who shift their commute time away from these peak periods.

In order to obtain commuting estimates that capture individuals using the bridge off peak, we used data from the American Community Survey (ACS). The ACS is collected every year on an on-going basis by the United States Census Bureau. Survey respondents are asked a variety of questions, including the county of residence, the county of work and their average commute time. The U.S. Census compiles county to county commuting patterns and provides them on the Census Bureau web page. Using these data we compiled a matrix of commuting patterns for the Cincinnati Metropolitan area. While these data identify the residence and work locations of commuters, we do not have knowledge of the specific route traveled.

Table 2.2 presents the residence to work counts available by county for the Cincinnati MSA. Table 2.3 summarizes these into northbound and southbound commuters who are likely to be Brent Spence Bridge users. Approximately 53,900 commuters make their way from counties in Kentucky to counties in Ohio or Indiana each day and approximately 29,200 commuters travel from counties in Ohio or Indiana to counties in Kentucky. As noted above, we do not know the specific route taken by commuters but we estimate that as many as 35,000 Kentuckians may commute into Ohio and Indiana across the bridge and as many as 22,700 may commute from Ohio or Indiana across the bridge to Kentucky. The somewhat higher numbers obtained via the ACS as compared to the "rush hour" estimates from the traffic count data may be due to two likely factors. First, and most likely, are commuters who follow a different schedule than the typical 9 to 5 weekday workday. Individuals with flexible work hours, those who work late or early shifts and those who work weekends would not be captured by the "rush hour" counts we compiled in Table 2.1. It is quite obvious that the counts in Table 2.1 are likely to be undercounts for exactly these reasons. We expect that this is the highest portion and point to the fact that the hourly counts during nearly all times are higher on weekdays than weekends, but that weekend traffic is still robust. A second possibility is that we are attributing too much traffic to the Brent Spence Bridge. Our estimates are based on crude assumptions that essentially amount to having all commuters with jobs in certain counties cross the Brent Spence Bridge. For example, we assume that all commuters from Boone County, Kentucky to Hamilton County, Ohio cross the bridge. Clearly many commuters may cross alternative bridges. Traffic patterns from other bridges suggest that at least some of these commuters do so. Hence the counts from the ACS are likely too high.

Table 2.2: Commuting Patterns from the American Community Survey

		Work															
		Indiana			Kentucky							Ohio					
Residence		Dearborn	Franklin	Ohio	Boone	Bracken	Campbell	Gallatin	Grant	Kenton	Pendleton	Brown	Butler	Clermont	Hamilton	Warren	Total Commuters
Indiana	Dearborn	10,030	155	363	1,688		135		7	665			761	156	8,330	152	22,442
	Franklin	476	3,736		101					25		10	692	15	1,615	45	6,715
	Ohio	1,042	8	896	300			9		29			18	48	451	28	2,829
Kentucky	Boone	614			30,444	13	1,391	159	464	10,879	19	26	860	597	10,662	490	56,618
	Bracken	13			181	1,310	433			255	127	63	28		231		2,641
	Campbell	99	47		3,878	16	16,028	62	68	6,506	234	16	735	841	14,183	460	43,173
	Gallatin				1,043		7	1,083	72	361			33		123		2,722
	Grant	21			3,027		150	121	4,135	1,409	59		106	15	739	11	9,793
	Kenton	262		6	16,743	14	5,148	46	295	31,736	110		754	937	19,752	467	76,270
	Pendleton				809	73	888		391	604	2,323		38	23	719	15	5,883
Ohio	Brown				105	28	133		14	240	7	6,682	373	4,948	3,036	370	15,936
	Butler	164	58	10	732		245			1,087			96,977	1,314	45,965	14,201	160,753
	Clermont	50			1,699		851		47	1,694		522	3,529	37,767	40,247	4,131	90,537
	Hamilton	1,312	60	46	6,736		3,333	16	86	8,260	9	25	20,856	8,176	310,370	11,619	370,904
	Warren	49		7	253		206		3	509		52	10,577	1,857	25,797	40,972	80,282
Total Commuters		14,132	4,064	1,328	67,739	1,454	28,948	1,496	5,582	64,259	2,888	7,396	136,337	56,694	482,220	72,961	

Table 2.3: Commuting Patterns for Northbound and Southbound Travelers that are Possible Brent Spence Bridge Users.

	All Commuters	Possible Brent Spence Bridge Users
Northern Kentucky to Ohio & Indiana	53,986	29,252
Ohio & Indiana to Northern Kentucky	35,002	22,740

Table 2.4 provides estimates of commute times between counties in the Cincinnati area. These times were obtained based upon the geographic centroid of the county and using MapQuest and taking the fastest trip time. Commute times within counties are not available using this methodology, but are not relevant to the study here (we are concerned primarily with commute times between Kentucky and Ohio or Indiana, and particularly those possibly crossing the Brent Spence Bridge). The range is quite high, but the highest numbers are associated with low or zero commuters based on Table 2.2 ACS data. Table 2.5 presents estimates of commuting travel time using these data and using the ACS data directly. The ACS data ask respondents the amount of time on their typical commute. Using the two sources of time (MapQuest time and respondent time), we compute estimates of commute times for all workers, workers who have an inter-county commute and workers who are likely to commute across the Brent Spence Bridge. The results are quite similar using either the employee weighted MapQuest times based on centroids or the actual survey data. All workers have an average commute time just over 20 minutes (21.3 or 22.3). Those workers making an inter-county commute have higher times of either 31.9 or 29.5 minutes, while those likely to be using the Brent Spence bridge have times very similar to those of other inter-county commuters of 30.1 min and 32.2 minutes. We will use an average commute time of 30 minutes for Brent Spence Bridge commuters.

Table 2.4: Travel Time (in Minutes) between Population Centroids of Counties (using MapQuest and Longitude/Latitude Data from Left)

		Indiana			Kentucky						Ohio				
		Dearborn	Franklin	Ohio	Boone	Bracken	Campbell	Gallatin	Grant	Kenton	Pendleton	Brown	Butler	Clermont	Hamilton	Warren
Indiana	Dearborn		49	34	37	83	48	63	58	40	76	88	57	61	47	66
	Franklin	49		75	64	109	69	90	85	67	100	109	55	82	56	74
	Ohio	34	75		51	97	62	55	72	54	90	102	71	75	61	80
Kentucky	Boone	37	64	51		62	27	31	26	19	50	67	56	40	31	59
	Bracken	83	109	97	62		46	82	73	53	43	62	90	65	65	89
	Campbell	48	69	62	27	46		47	42	17	37	52	50	26	25	49
	Gallatin	63	90	55	31	82	47		30	38	57	86	75	60	51	79
	Grant	58	85	72	26	73	42	30		33	35	81	70	55	46	74
	Kenton	40	67	54	19	53	17	38	33		44	56	49	30	24	51
	Pendleton	76	100	90	50	43	37	57	35	44		84	81	57	56	80
Ohio	Brown	88	109	102	67	62	52	86	81	56	84		70	34	66	67
	Butler	57	55	71	56	90	50	75	70	49	81	70		44	32	20
	Clermont	61	82	75	40	65	26	60	55	30	57	34	44		39	40
	Hamilton	47	56	61	31	65	25	51	46	24	56	66	32	39		33
	Warren	66	74	80	59	89	49	79	74	51	80	67	20	40	33	

Table 2.5: Estimates of Commuting Travel Time using MapQuest and ACS Time

		Work														
		Indiana			Kentucky							Ohio				
		Dearborn	Franklin	Ohio	Boone	Bracken	Campbell	Gallatin	Grant	Kenton	Pendleton	Brown	Butler	Clermont	Hamilton	Warren
	Dearborn	10,030	155	363	1,688		135		7	665			761	156	8,330	152
Indiana	Franklin	476	3,736		101					25		10	692	15	1,615	45
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	Bracken	13			181	1,310	433			255	127	63	28		231	
	Campbell	99	47		3,878	16	16,028	62	68	6,506	234	16	735	841	14,183	460
Kentucky	Gallatin				1,043		7	1,083	72	361			33		123	
	Grant	21			3,027		150	121	4,135	1,409	59		106	15	739	11
	Kenton	262		6	16,743	14	5,148	46	295	31,736	110		754	937	19,752	467
	Pendleton				809	73	888		391	604	2,323		38	23	719	15
	Brown				105	28	133		14	240	7	6,682	373	4,948	3,036	370
	Butler	164	58	10	732		245			1,087			96,977	1,314	45,965	14,201
Ohio	Clermont	50			1,699		851		47	1,694		522	3,529	37,767	40,247	4,131
	Hamilton	1,312	60	46	6,736		3,333	16	86	8,260	9	25	20,856	8,176	310,370	11,619
	Warren	49		7	253		206		3	509		52	10,577	1,857	25,797	40,972

Trip Costs

We next turn to obtaining estimates of the value of time. As noted in the literature review, various authors have estimated the time costs for commuting at between $12 and $20 per hour. Economists often use earnings income to estimate the opportunity cost of time. This is particularly appropriate here since we are focusing on commuter traffic. The ACS data also provide information on annual income. Table 2.6 presents the average income for commuters likely to cross the Brent Spence Bridge as well as frequencies by income categories. We also present income summaries for commuters of all types in the Cincinnati area. Overall, workers in the Cincinnati area who drive to work have an average annual income level of $46,020. Individuals who are likely to be using the Brent Spence Bridge have an average annual income of $58,407, this is 27% higher than all workers in the region. One approach to estimation is to use hourly incomes based on these averages. Average hourly earnings for all Cincinnati workers is approximately $22, while for those likely to be using the Brent Spence Bridge we find an average of $28 per hour. We will compute travel time costs using $14 per hour, $18 per hour (a common value from the literature), $22 per hour, the overall Cincinnati average wage and $28 per hour, the higher Brent Spence Bridge commuter average.

Table 2.6: Earnings for Commuters

	All commuting workers in Cincinnati	Likely Brent Spence Bridge Users	N.KY Brent Spence
Average Income	$46,020	$58,407	$60,409
Income Distribution			
0-$49,999	69.0%	54.5%	51.6%
$50,000-$99,999	23.6%	35.1%	37.8%
$100,000-$149,999	4.3%	6.2%	6.7%
$150,000-$199,999	1.3%	1.6%	1.4%
$200,000 and up	1.9%	2.6%	2.6%

The final calculation necessary for constructing trip costs are average gasoline costs. Gasoline costs vary over time and we use $3.34 per gallon as an estimate based on an internet survey of Cincinnati gas prices. Again using MapQuest, we construct centroid to centroid distances for commutes between counties. Averaging these distances weighted by employment for likely Brent Spence Bridge users results in an average commute distance of 21 miles. If average fuel economy is 20 miles per gallon, this would imply an average trip gas cost of $3.51. We also use the gas cost from MapQuest. It is not clear what fuel economy or prices these calculations are based on, however, the employment weighted average for these calculations is $2.50. As with our opportunity cost calculation we will use both in order to achieve a range. (Tables for miles and gasoline expenditure are in the Appendix Tables 1 and 2 respectively).

Table 2.7 presents estimated trip costs for a number of scenarios. Along the left hand column we have three "cost structures." In all cases we are using a typical 30 minute commute time. Below we discuss implications for longer and shorter times. The low cost structure represents a case where we assume the value of an hour of a commuter's time is $14. This is one of the lowest estimates of commuter time available in the literature. We also use the lowest gas price estimate (derived from the MapQuest estimates) at $2.50. The Medium 1 and Medium 2 rows both use an average gas cost of $3, slightly higher than the $2.50 cost. Medium 1 uses a $16 per hour value of time. This was chosen based upon results from the 2012 Texas A&M Transportation Institute (TTI) Urban Mobility Study for the Brent Spence Bridge to be comparable. It is also an estimate deriving from the literature. We also examine two higher opportunity costs: $22 and $28 both derived from our estimates of the hourly earnings. Medium 2 uses $22 an hour with a $3 cost for gas. The row with high cost uses $3.50 for gas and the $28 time cost.

Table 2.7: Trip Cost

	No Travel time change			No Toll		$1 toll		$2 toll	
Trip cost	No Toll: Base Cost	$1 Toll	$2 Toll	With 3 min time gain	With 6 min time gain	With 3 min time gain	With 6 min time gain	With 3 min time gain	With 6 min time gain
Low	9.50	10.50	11.50	8.80	8.10	9.80	9.10	10.80	10.10
Medium 1	10.50	11.50	12.50	9.70	8.90	10.70	9.90	11.70	10.90
Medium 2	14.00	15.00	16.00	12.90	11.80	13.90	12.80	14.90	13.80
High	17.50	18.50	19.50	16.10	14.70	17.10	15.70	18.10	16.70

Table 2.8: Percent Change in Trips

		No Travel time change		No Toll		$1 toll		$2 toll	
Elasticity	Trip cost	$1 Toll	$2 Toll	With 3 min time gain	With 6 min time gain	With 3 min time gain	With 6 min time gain	With 3 min time gain	With 6 min time gain
	Low	-1.6%	-3.2%	1.1%	2.2%	-0.5%	0.7%	-2.1%	-0.9%
-0.15	Medium 1	-1.4%	-2.9%	1.1%	2.3%	-0.3%	0.9%	-1.7%	-0.6%
	Medium 2	-1.1%	-2.1%	1.2%	2.4%	0.1%	1.4%	-1.0%	0.2%
	High	-0.9%	-1.7%	1.2%	2.4%	0.4%	1.7%	-0.5%	0.7%
	Low	-2.6%	-5.3%	1.8%	3.7%	-0.8%	1.1%	-3.4%	-1.6%
-0.25	Medium 1	-2.4%	-4.8%	1.9%	3.8%	-0.5%	1.4%	-2.9%	-1.0%
	Medium 2	-1.8%	-3.6%	2.0%	3.9%	0.2%	2.1%	-1.6%	0.4%
	High	-1.4%	-2.9%	2.0%	4.0%	0.6%	2.6%	-0.9%	1.1%
	Low	-5.3%	-10.5%	3.7%	7.4%	-1.6%	2.1%	-6.8%	-3.2%
-0.5	Medium 1	-4.8%	-9.5%	3.8%	7.6%	-1.0%	2.9%	-5.7%	-1.9%
	Medium 2	-3.6%	-7.1%	3.9%	7.9%	0.4%	4.3%	-3.2%	0.7%
	High	-2.9%	-5.7%	4.0%	8.0%	1.1%	5.1%	-1.7%	2.3%

The first panel of table 2.7 presents the various trip costs when there is no change in the length of the trip due to the improved infrastructure. The first column: no travel time change and no toll, represents the base cost of a commute over the Brent Spence Bridge as it stands now. For a person who values their time at $14 an hour and spends $2.50 on gas for their commute, the 30 min commute represents a cost of $9.50. This implies that a person desiring to make that trip would pay up to $9.50 to be instantly transported: avoiding the gas and time costs. Some might argue that this is too low, as it fails to capture other relevant costs such as parking, other costs associated with driving an automobile (e.g. insurance, and maintenance costs), and perhaps particularly stress and aggravation from the drive itself. We do not address insurance and maintenance type costs as they are in many ways "fixed" costs. In the context here, the worker is likely to make some kind of commute, the question is which one. We attempt to focus upon costs specific to the Brent Spence Bridge. Aggravation costs can be captured using higher value of time, as we do in rows two through four. As can be seen, the primary component of the trip cost is the time.

The second and third columns of the first panel in Table 2.7 represent two toll costs: $1 and $2. There is no adjustment in time cost, and this represents the direct cost change in the trip from inducing a toll. This would represent the impact if the new bridge did nothing to reduce the travel times (congestion) but the toll was imposed upon commuters (travelers in general). A $2 toll for the lowest cost row results in approximately a 21% increase in the cost of the trip. At the other extreme, a $1 toll for the highest cost trip represents a 5.7% increase in the costs. It is clear that the estimated impact of a toll is highly dependent on the assumptions about commuters' cost of time that are used.

The second panel examines a case where there is no toll, but commuters gain from reduced congestion and hence shorter commutes. According to the TTI Urban Mobility Study, the current Brent Spence Bridge has a travel time factor of 1.2. This implies that congestion at the bridge causes a 20% increase in travel time for typical trips. We use this as an upper bound for the gain in time and explore two values of a time gain. First, a 3 minute time gain (representing a 10% improvement) and a 6 minute time gain (representing the full 20%

improvement). Costs go down for each type of trip cost because the commuters reduce their travel time. We also present, in this panel, a trip cost with a 3 minute increase in travel time. This represents a case where an individual diverts from the Brent Spence Bridge to one of the other bridges. Here we can see that the slightly higher time costs increase the cost of the trip. The reduction in time represents a monetary gain of between $0.70 (for the 3 minute gain at the lowest cost trip) and $2.80 (for the 6 minute gain for the highest cost trip).

The third and fourth panel combine the first and second panels and explore trip costs for 3 and 6 minute time gains with $1 and $2 tolls. The $1 toll is offset by the time gain for all the two lowest time values for the 3 minute time gain. The $2 toll is only fully offset for the two highest time values when there is a 6 minute time gain. The largest increase in trip cost would be experienced if time value was only $14 per hour, the gain from improved infrastructure was only 3 min, and a $2 toll was imposed, resulting in an increased cost of $1.30 or 13.7%. The largest decrease in trip cost would be experienced if time value were $28 per hour, a 6 minute time gain on the commute occurred, and a $1 toll was imposed, resulting in a decreased cost of $1.80 or 10.3%.

Estimated Impact on Commuting

Table 2.8 presents estimates of the reduction in commuter traffic (and potentially other types of traffic, see Component 3), using the changes in cost from table 2.7 along with different assumptions about the elasticity (price responsiveness) of commuters. The four vertical panels compare to the four panels in the Table 2.7, while the four horizontal panels represent different assumptions about the responsiveness of commuters to changes in trip cost (elasticities). The lowest elasticity (responsiveness to cost) is 15% which represents a low estimate from the literature. While this is certainly a very unresponsive trip consumer, this may be the best estimate for understanding overall commuter behavior. Most elasticity estimates represent the responsiveness of consumers of the particular bridge, road or tunnel. In this analysis, we are less interested in the use of the Bridge as we are in the how the new bridge will impact commuter behavior: if they divert from the bridge to another bridge but still make the commute it is treated the same for this analysis as if the consumer continued to commute across the bridge. For parties interested in estimating toll revenue from the bridge, this low estimate is likely too optimistic. The -0.25 elasticity represents an average for commuter traffic in the literature. This may be the best estimate for our purposes for a number of reasons. First it is roughly in the middle for the estimates found in the literature. There are a number of secondary issues here though. We would like to have a long run estimate, which captures not only the immediate response by consumers, but also long run patterns of worker and firm location decisions. Long run elasticities are always higher than in the short run, yet most of the estimates from the literature are essentially short run estimates. We are, however, more interested in overall commuting, rather than simply commuting on the specific Brent Spence Bridge. In cases where there were no other alternatives to the bridge or tunnel being studies, estimates of consumer responsiveness were lower. Also, most estimates in the literature derive for total bridge traffic, rather than specifically commuter traffic. It has been noted, however, that commuters have lower responsiveness to changes in price due to the high value of getting to work. In thinking about "all commuters" crossing the Ohio River between Northern Kentucky and the rest of the Cincinnati MSA, we would expect to use a lower (potentially much lower) elasticity to represent the overall impact of changes in the Brent Spence Bridge on commuting. The -0.25 value represents these two offsetting effects (long run vs overall commuter impact) well. The two higher elasticities are estimates for more leisure-oriented trips. The literature finds that individuals who are traveling for leisure (such as shopping or entertainment) have higher responsiveness to changes in the trip price.

Focusing on the -0.25 elasticity rows we begin by looking at the first vertical panel representing no travel time change but the imposition of a $1 or $2 toll. For the lowest cost trip estimate with no travel time change, a $2 toll would result in a 5.2% decrease in commuter traffic. This is unlikely to be the true net impact of the Brent Spence Bridge project, but does represent an important case: what is the impact of the toll after we net out changes in travel time. The thought experiment would be "after building the new bridge and operating it for some period of time, if a $2 toll was imposed, what would happen to commuter traffic." This is the "direct effect" of the toll. However, the 5.2% reduction is the highest estimate in this panel. As time value increases (even without a gain from improved access) the toll becomes a smaller part of the total trip cost, and thus reduces the impact.

The second vertical panel of Table 2.8 examines how the potential time gain from the improved road impacts commuters. We certainly expect, and the literature has generally found, that reduced time will induce more commutes. People who before chose jobs or housing locations to avoid commutes will change their decision. Again, focusing on the -0.25 elasticity, we see that the shorter commute will induce between 1.8% and 4% more commuters depending upon the trip cost assumptions and the improvement in time. For the lowest trip cost assumption with the 3 minute time gain, we will see only a 1.8% increase in commuters. If the time gain is 6 full minutes, and the typical commuter has a base trip cost of $17.50 (the high cost trip), we would see a 4% increase in commuting. Using the Medium 1 row, we expect that we would see an increase of 1.9% to 3.8% depending upon the gain from less congestion.

The third and fourth vertical panels of Table 2.8 provide a combination of the two offsetting effects: the higher price induced by the toll and the decrease in commute times provided by the improved bridge. Estimates range from a decrease of as much as 3.4% in commuting to an increase in commuting by as much as 2.6%. For a $1 toll, using the Medium 1 row, we would expect a decrease in commuting of 0.5 percent if the time gain is only 3 minutes, and an increase in commuters of 1.4% if the time gain is the full 6 minutes. We note that here, in order to have a zero impact on commuting for a $1 toll the time gain is 3.7 minutes.

For a $2 toll, commuting may decline by as much as 3.4% or increase by as much as 1.1% again depending on the base value of time and the amount of time gain from reduced congestion. Focusing on the Medium 1 costs, we note that here the decline in commuters is between 1% and 2.9%. The time gain necessary to offset a $2 toll would be 7.5 minutes which seems highly unlikely

Another approach to consider is what toll would result in no change in commuting for different time gains. This simply compares the dollar value of the trips (see table 2.7). Again focusing on the Medium 1 row and the -0.25 elasticity, a three minute time gain would be exactly offset by an $ .80 cent toll. A six minute time gain would be exactly offset by a $1.60 toll.

We have focused on the Medium 1 case in our discussion, but we argue that this is likely too low a cost for commuters in Cincinnati. Overall, our estimates place the hourly earnings for typical workers in Cincinnati at $22 per hour. Further, when we limit our sample to individuals who are potential Brent Spence Bridge users, the average earnings rise and we find a value of time of as high as $28 (on average). Again focusing on the -0.25 elasticity, those two rows show increases in commuters for the $1 toll and somewhere between a 1.6% decrease and a 1.1% increase for the $2 toll. We also note that these estimates do not account well for the psychic costs from "bad traffic." Congestion and challenging driving raise the costs of commuting by more than simply the time difference (3 minutes in bad traffic is worse than 3 minutes when traffic flows smoothly and uneventfully). Since commuting is more likely to occur in poor traffic, and the improved bridge is likely to significantly reduce traffic congestion, this argues for either using higher values of time (to capture the aggravation of bad traffic) or using larger time gains (to account for higher prices for gains from reduced congestion). In either case, the likely net impact would shift toward increases in commuters rather than decreases.

We draw three specific conclusions from Tables 2.7 and 2.8. The first is that while tolls have an impact, that impact is relatively small compared to the overall cost of a trip. The largest component of the cost is the time value, but the gasoline value itself is larger than even a $2 toll. The second is that time gains from decreased congestion on the bridge are likely to offset the tolls, if not completely, to an amount resulting in relatively small changes in commuting patterns: typically less than 3%. Finally, the toll itself could be chosen to offset the gain from reduced congestion and this toll would likely be over $1 but less than $2. This is not necessarily the optimal toll. The optimal toll would also include the overall costs of congestion and would typically be higher than the toll computed to just balance the gain in time.

It is important to put the changes into perspective here. We estimate total commuting across the Ohio River via the Brent Spence Bridge to be approximately 57,700 people each day (see tables 2.2 and 2.3). A total of 35,000 are "northbound" while 22,700 are "southbound." If 3% of these from each direction decide to avoid the cross river commute (a seemingly worst case scenario), that would reduce commuting by about 1,732 workers: 1,050 northbound and 682 southbound. Given that the overall population of the Northern Kentucky counties in the Cincinnati MSA is over 431,000, and the total number of employed in this region is nearly 200,000, this would seem to have a small impact on Northern Kentucky and in general on the Cincinnati Metropolitan Area which has over 2 million in population. Moreover, three additional changes would likely occur: "job swapping", relocation of residence and finally relocation by employers. Some of the workers will choose to find employment on their side of the river. Since this will occur with both groups, there will be some "job swapping" where former northbound commuters take the jobs of former southbound commuters and vice versa. There will also be some residential relocations: people who want to keep their jobs, but don't want to commute will move (this is significantly less likely). Here the "swapping" can be thought of as well. On net however, 368 individuals will need to move north. There is also a net force to have firms who employ many northbound commuters to move south of the river (and also vice versa, but the net result will be movement of firms into Northern Kentucky). This reduces the costs of employees and makes it possible to hire them at slightly lower wages. This is likely to be a small effect, but it will reduce the net north migration some. The value of 368 is tiny. It is likely that it will be impossible to even measure this amount were we to do a full study. The overall impact of the toll on commuting, employment and workers is simply very small.

Component 3: Broader Economic Impacts of the Bridge and Tolls.

Economic Climate in Northern Kentucky

There is very little research on how a toll on a bridge or roadway impacts other economic activities besides commuting and general use of the bridge or road. This lack of research is somewhat surprising in that one might suspect that this would be a major concern. However, as noted in the literature review, tolls are often associated with improvements in infrastructure and the overall economic impact is typically positive.

In this section we first outline the major economic activities in Northern Kentucky and the Cincinnati Metropolitan area. The focus in this section is on the impacts on Northern

Kentucky specifically, and hence our focus is on the six counties in Northern Kentucky which are part of the Cincinnati Metropolitan Area. We focus our attention on four specific industries of concern: Transportation and Warehousing, Retail Trade, Accommodation and Food Service, and Arts and Recreation. Transportation and Warehousing may be impacted by the toll in that the costs of tolls to the trucking industry may change that industries' location choices in the long run. There is concern that retail trade may be hampered by costs of using the bridge. If significant portions of the retail trade industry are due to Ohio residents travelling to Kentucky to shop, the increased costs of these trips may reduce their number and hence have an impact on the retail trade industry. Similarly, Northern Kentucky attractions (such as the Aquarium) may draw patrons from Ohio and Indiana. These patrons are also likely to eat at Northern Kentucky restaurants and to utilize other accommodation firms. Again, concern arises that the toll may decrease this activity and thus have an impact on this industry.

Table 3.1 presents total employment by two-digit North American Industrial Classification System (NAICS) industries from establishment data (our source for this was the Bureau for Economic Analysis (BEA) presentation of U.S. Census Bureau estimates). The first column aggregates employment for the entire Cincinnati MSA. The second column presents employment for all Northern Kentucky counties in the Cincinnati MSA, the third column focuses on the three "close in" counties (Boone, Kenton and Campbell), while the fourth column isolates Kenton County. Cincinnati has total employment of 868,014 and a population of 2.1 million. Table 3.2 examines which industries are large percentages of employment in the four geographic regions. Overall, the three largest industries in the Cincinnati MSA are Health Care (15% of all employment), Manufacturing (12.1%), and Retail Trade (11.8%). Transportation and Warehousing is 3.7% of total MSA employment, Accommodation and Food Service is 9.9% of MSA employment, while Arts and Recreation is 2.5%. For Northern Kentucky, Manufacturing (12.7%), Retail Trade (12.5%) and Health Care (12.1%) are again the three largest. Transportation and Warehousing in Northern Kentucky is 7.4% of employment, Accommodation and Food Service is 11.2%, while Arts and Recreation is 1.5%.

Table 3.1: Employment Estimates by Industry

Industry	Cincinnati MSA	N. Kentucky	Close In	Boone	Kenton	Campbell
Agriculture	439	0	0	0	0	0
Mining	280	0	0	0	0	0
Utilities	2340	157	157	157	0	0
Construction	34927	4391	4186	1817	2369	0
Manufacturing	104752	19361	18469	11465	4580	2424
Wholesale Trade	50686	10551	10432	7315	2056	1061
Retail Trade	102214	19095	17697	8395	5386	3916
Transportation & Warehousing	32469	11364	11131	11131	0	0
Information	13327	1416	1416	746	441	229
Finance	48535	7846	7633	3243	3784	606
Real Estate	11340	2040	1969	728	751	490
Professional Services	53457	6839	6692	1882	3442	1368
Management	41060	5274	5274	2036	2971	267
Waste Services	58744	9594	9473	5318	3287	868
Education	15253	1465	1465	537	780	148
Health Care	130548	18485	18184	4781	9936	3467
Arts and Recreation	18280	2253	2253	842	796	615
Accommodation & Food Service	86101	17141	17082	6374	6130	4578
Other Services	29327	5420	5134	2396	1721	1017
Government (Fed, State, Local)	33661	10066	9334	2457	5854	1032
NEC	274	43	43	21	15	7
Total	868,014	153,074	148,024	71,641	54,299	22,093
Population	2,128,603	431,997	375,935	123,316	161,711	90,908

Table 3.2: Industry Percent of Total Employment

Industry	Cincinnati MSA	N. Kentucky	Close In	Boone	Kenton	Campbell
Agriculture	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Mining	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Utilities	0.3%	0.1%	0.1%	0.2%	0.0%	0.0%
Construction	4.0%	2.9%	2.8%	2.5%	4.4%	0.0%
Manufacturing	12.1%	12.7%	12.5%	16.0%	8.4%	11.0%
Wholesale Trade	5.8%	6.9%	7.0%	10.2%	3.8%	4.8%
Retail Trade	11.8%	12.5%	12.0%	11.7%	9.9%	17.7%
Transportation & Warehousing	3.7%	7.4%	7.5%	15.5%	0.0%	0.0%
Information	1.5%	0.9%	1.0%	1.0%	0.8%	1.0%
Finance	5.6%	5.1%	5.2%	4.5%	7.0%	2.7%
Real Estate	1.3%	1.3%	1.3%	1.0%	1.4%	2.2%
Professional Services	6.2%	4.5%	4.5%	2.6%	6.3%	6.2%
Management	4.7%	3.5%	3.6%	2.8%	5.5%	1.2%
Waste Services	6.8%	6.3%	6.4%	7.4%	6.1%	3.9%
Education	1.8%	1.0%	1.0%	0.7%	1.4%	0.7%
Health Care	15.0%	12.1%	12.3%	6.7%	18.3%	15.7%
Arts and Recreation	2.1%	1.5%	1.5%	1.2%	1.5%	2.8%
Accommodation & Food Service	9.9%	11.2%	11.5%	8.9%	11.3%	20.7%
Other Services	3.4%	3.5%	3.5%	3.3%	3.2%	4.6%
Government (Fed, State, Local)	3.9%	6.6%	6.3%	3.4%	10.8%	4.7%
NEC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.3 provides percentages of the total MSA employment in each industry for the three geographic sub-regions of the MSA in Northern Kentucky. For example, Northern Kentucky employment in Transportation and Warehousing is 35% of the entire Cincinnati MSA employment in that industry. Overall, 17.6% of employment in the MSA is in Northern Kentucky, while 20.3% of the MSA population resides there. Clearly, Northern Kentucky disproportionately commutes into Ohio for employment. In addition to Transportation and Warehousing, Manufacturing (18.5%), Wholesale Trade (20.8%), Retail Trade (18.7%) and Real Estate (18.0%), Accommodation and Food Service (19.9%), Other Services (18.5%) and Government (29.9%) each have a higher percentage of the MSA employment in Northern Kentucky than the overall employment percentage represented in Northern Kentucky. Focusing on the four industries of concern, we do note that three of them are disproportionately represented in Northern Kentucky (Transportation and Warehousing, Retail Trade and Accommodation and Food Service). Arts and Entertainment in Northern Kentucky is 12.3% of the overall MSA employment in that industry. However, it should be noted that except for

Wholesale Trade and Transportation and Warehousing, the percentage is lower than the 20% of population.

Table 3.3: Region Percent of MSA Employment

Industry	N.Kentucky	Close In	Boone	Kenton	Campbell
Agriculture	0.0%	0.0%	0.0%	0.0%	0.0%
Mining	0.0%	0.0%	0.0%	0.0%	0.0%
Utilities	6.7%	6.7%	6.7%	0.0%	0.0%
Construction	12.6%	12.0%	5.2%	6.8%	0.0%
Manufacturing	18.5%	17.6%	10.9%	4.4%	2.3%
Wholesale Trade	20.8%	20.6%	14.4%	4.1%	2.1%
Retail Trade	18.7%	17.3%	8.2%	5.3%	3.8%
Transportation & Warehousing	35.0%	34.3%	34.3%	0.0%	0.0%
Information	10.6%	10.6%	5.6%	3.3%	1.7%
Finance	16.2%	15.7%	6.7%	7.8%	1.2%
Real Estate	18.0%	17.4%	6.4%	6.6%	4.3%
Professional Services	12.8%	12.5%	3.5%	6.4%	2.6%
Management	12.8%	12.8%	5.0%	7.2%	0.7%
Waste Services	16.3%	16.1%	9.1%	5.6%	1.5%
Education	9.6%	9.6%	3.5%	5.1%	1.0%
Health Care	14.2%	13.9%	3.7%	7.6%	2.7%
Arts and Recreation	12.3%	12.3%	4.6%	4.4%	3.4%
Accommodation & Food Service	19.9%	19.8%	7.4%	7.1%	5.3%
Other Services	18.5%	17.5%	8.2%	5.9%	3.5%
Government (Fed, State, Local)	29.9%	27.7%	7.3%	17.4%	3.1%
NEC	15.7%	15.7%	7.7%	5.5%	2.6%
Total	17.6%	17.1%	8.3%	6.3%	2.5%
Population	20.3%	17.7%	5.8%	7.6%	4.3%

In the three close-in counties we see a nearly identical pattern in Table 3.3. Approximately 17.1% of MSA employment is in these three counties, while 17.7% of population is concentrated here. For the three close-in counties, we note that Transportation and Warehousing again is 34.3% of total MSA employment. The data reveal that nearly all employment in this industry is concentrated in Boone County. Within the three close in counties, Manufacturing (17.6%), Wholesale Trade (20.6%), Retail Trade (17.3%), Accommodation and Food Services (19.8%), Other Services (17.5%) and Government (27.7%) all remain above the region employment percent. However, Retail Trade is now only slightly above the region employment. Arts and Recreation remains at approximately 12.3% for these counties.

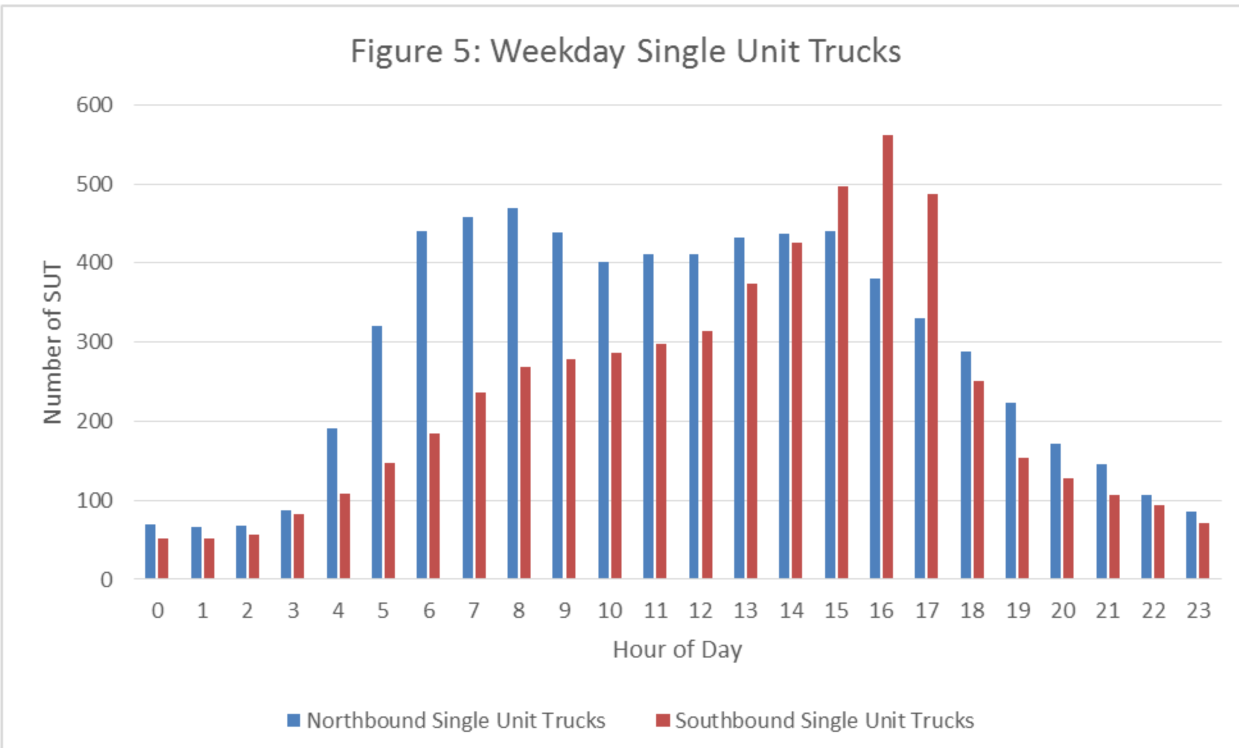
Examining each county specifically, Boone County stands out as having a higher percentage of employment in the county than population. Boone also stands out for having employment in Manufacturing, Transportation and Warehousing and Wholesale Trade as being concentrated in that county.

<u>Transportation and Warehousing</u>

Transportation and Warehousing is clearly an important industry to Northern Kentucky and Boone County particularly. The clear concentration of this industry in Boone County is related to a number of factors: first, the high concentration of Manufacturing and Wholesale Trade employment; second the transportation access provided by both the Airport and the access to I-75 and I-71. The I-275 bypass also provides access to I-74.

Very few estimates for elasticity of heavy trucks to tolls exist in the literature. The Hirschman et al. (1995) paper provides some estimates, however I am skeptical that they apply well to the situation here. The Hirschman et al. (1995) paper studied tunnels and bridges into Manhattan. This is a markedly different situation than a toll on a major through highway used by the Transportation and Warehousing industry. The results in that paper varied from an elasticity of zero to an elasticity of -0.60. The highest elasticity was associated with a bridge which had nearby “free” substitutes. This does demonstrate that trucking will substitute for different bridges. In the case of Cincinnati, this would most likely be the I-471 Bridge and the two bridges for the I-275 bypass.

Figures 5 through 7 plot Class Single Unit, Class C and Class D truck traffic by time for weekdays. Weekend patterns are much smoother over time. Single unit trucks are likely making short trips associated with local deliveries. As is apparent in Figure 5 these have a “commuter” pattern where there is high northbound usage in the morning and high southbound usage in the late afternoon. This appears to represent deliveries out of Northern Kentucky into Cincinnati. Class C (multi units with a single trailer) traffic has a surprisingly southbound bias throughout the day, with traffic peaking near late morning. While Class C (single trailer) traffic has a very flat time distribution. Class D traffic seems to be a mixture of the two. It has a northbound bias in general, but peaks in mid-morning for northbound and peaks in late afternoon for southbound, although there is a secondary northbound peak in the early evening. These patterns may represent large Less than Truckload (LTL) firms moving material to various hubs within the Cincinnati area. Boone county industries may be relying upon the Brent Spence Bridge for transportation of goods into Cincinnati and likely to northern destinations such as Dayton and Columbus and possibly further. The Cincinnati area is highlighted as a major trucking and transportation hub with firms located in Ohio and Indiana as well.



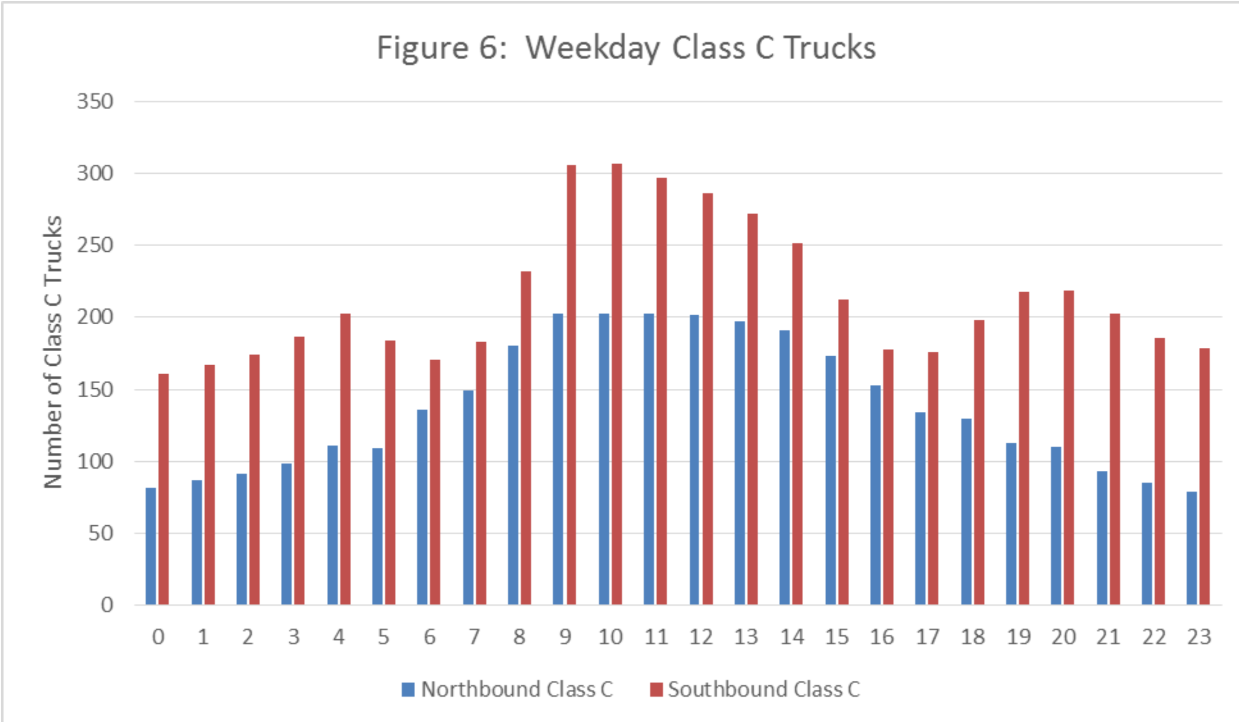


Figure 6: Weekday Class C Trucks
Number of Class C Trucks
0
50
100
150
200
250
300
350
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Northbound Class C
Southbound Class C

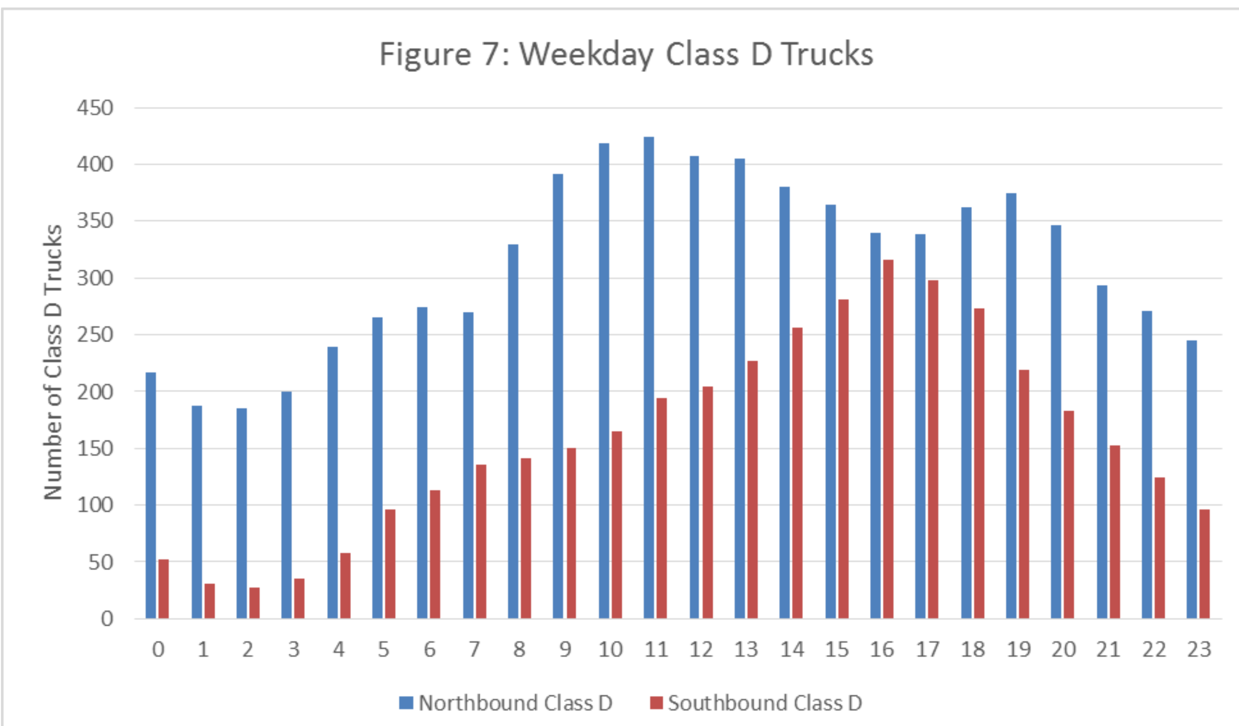


Figure 7: Weekday Class D Trucks
Number of Class D Trucks
0
50
100
150
200
250
300
350
400
450
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Northbound Class D
Southbound Class D

According to The Truckers Report, the largest cost of trucking operations is fuel cost (accounting for 39% of operating costs and about $0.54 per mile). The second largest operating expense was driver salary accounting for 26% of total operating costs and estimated at $0.36 per mile. According to the Bureau of Labor Statistics, truck drivers have an average hourly wage of $19.40 and a median hourly wage of $18.37. Estimates of the hourly cost of operating a truck range from $40 to $60 per hour depending on the type of truck and the type of load. The truck report places all tolls, permits and licenses as 2% of overall expenses and estimates $0.02 per mile. Based on these numbers we construct three “trips” associated with the Brent Spence Bridge: a short trip of approximately 20 miles (this would be comparable to driving from Boone county to locations within the Cincinnati MSA in Ohio and Indiana), a medium trip of 75 miles (comparable to a drive to Dayton from Boone County), and a trip of 175 miles (which would be a round trip of 350 miles, taking most of a day). Using the data above, Table 3.4 presents our estimates of costs from the labor and gasoline components for each of these type trips. Toll costs vary by type of truck. Current proposals are for $3 to $6 for light trucks and $5 to $10 for heavy trucks. It is likely that light trucks will be more likely to take shorter trips, while heavier trucks are more likely to take the longer trips. However, we present our estimates for trip type in all cases.

Table 3.4: Trucking Cost Estimates by Length of Trip

	No time change					No Toll		$3 Toll		$6 Toll		$5 Toll		$10 Toll	
Trip Length	No Toll	$3 Toll	$6 Toll	$5 toll	$10 toll	3 min gain	6 min gain	3 min gain	6 min gain	3 min gain	6 min gain	3 min gain	6 min gain	3 min gain	6 min gain
Short	$18.00	$21.00	$24.00	$23.00	$28.00	$16.00	$14.00	$19.00	$17.00	$22.00	$20.00	$21.00	$19.00	$26.00	$24.00
Medium	$67.50	$70.50	$73.50	$72.50	$77.50	$65.50	$63.50	$68.50	$66.50	$71.50	$69.50	$70.50	$68.50	$75.50	$73.50
Long	$157.50	$160.50	$163.50	$162.50	$167.50	$155.50	$153.50	$158.50	$156.50	$161.50	$159.50	$160.50	$158.50	$165.50	$163.50

Table 3.5: Percent Change in Truck Traffic

		No time Gain				No Toll		$3 Toll		$6 Toll		$5 Toll		$10 Toll	
Elasticity	Trip Length	$3 Toll	$6 Toll	$5 toll	$10 toll	3 min gain	6 min gain	3 min gain	6 min gain	3 min gain	6 min gain	3 min gain	6 min gain	3 min gain	6 min gain
	Short	-1.7%	-3.3%	-2.8%	-5.6%	1.1%	2.2%	-0.6%	0.6%	-2.2%	-1.1%	-1.7%	-0.6%	-4.4%	-3.3%
-0.1	Medium	-0.4%	-0.9%	-0.7%	-1.5%	0.3%	0.6%	-0.1%	0.1%	-0.6%	-0.3%	-0.4%	-0.1%	-1.2%	-0.9%
	Long	-0.2%	-0.4%	-0.3%	-0.6%	0.1%	0.3%	-0.1%	0.1%	-0.3%	-0.1%	-0.2%	-0.1%	-0.5%	-0.4%
	Short	-5.0%	-10.0%	-8.3%	-16.7%	3.3%	6.7%	-1.7%	1.7%	-6.7%	-3.3%	-5.0%	-1.7%	-13.3%	-10.0%
-0.3	Medium	-1.3%	-2.7%	-2.2%	-4.4%	0.9%	1.8%	-0.4%	0.4%	-1.8%	-0.9%	-1.3%	-0.4%	-3.6%	-2.7%
	Long	-0.6%	-1.1%	-1.0%	-1.9%	0.4%	0.8%	-0.2%	0.2%	-0.8%	-0.4%	-0.6%	-0.2%	-1.5%	-1.1%
	Short	-8.3%	-16.7%	-13.9%	-27.8%	5.6%	11.1%	-2.8%	2.8%	-11.1%	-5.6%	-8.3%	-2.8%	-22.2%	-16.7%
-0.5	Medium	-2.2%	-4.4%	-3.7%	-7.4%	1.5%	3.0%	-0.7%	0.7%	-3.0%	-1.5%	-2.2%	-0.7%	-5.9%	-4.4%
	Long	-1.0%	-1.9%	-1.6%	-3.2%	0.6%	1.3%	-0.3%	0.3%	-1.3%	-0.6%	-1.0%	-0.3%	-2.5%	-1.9%

We have very little data available on trucking costs. Data of this nature is generally closely held by the firm for competitive reasons. However, similar to the commute data, we can consider three factors: time cost for drivers and travel time, fuel costs plus the toll. This likely understates the typical cost of a delivery run, but provides some context for the likely impact. The choice of elasticity is complicated. Like the commuter discussion above, we care less about the use of the specific bridge rather than whether the toll will cause a decrease in traffic. Similarly though, we also care about a long run effect where firms may choose to relocate. Here though, this seems unlikely: the high concentration of manufacturing, the location of the major airport, and the fact that Cincinnati is a major city make it unlikely that firms will choose to relocate to other places. The location of Cincinnati serves wide markets in Kentucky, Tennessee, West Virginia, Ohio, and Indiana. The nearest airport of comparable size is in the Detroit area. While one might be concerned about relocation to Louisville, given similar access to highways, the airport serves as an important anchor. While the elasticities in the Hirschman 1995 paper are questionable, we use a variety of values within the range. The lower elasticities are most likely accurate for the impact that the toll and new bridge will have on trucking, and it should be noted that this only applies to trips that are likely to use the Brent Spence Bridge. Since most trucking firms in Boone County ship south and west as well (to destinations like Lexington, Knoxville, and Louisville), the overall impact on any firm will be even lower.

Table 3.4 presents the cost structure while Table 3.5 presents the percentage impact on trips involving the bridge. As is quite clear, the highest impact of the toll will be for the shorter trips (where it is a larger percentage of the total trip cost) and of course for the highest elasticity. Even so, the overall impact is modest. The worst-case scenario, where there is no time gain, using the highest elasticity and the $10 toll on short trips, we expect a reduction of 28% in trips. However, as noted above, it is much more reasonable to expect that there is some time gain. We price this using a low estimate of the hourly cost of a trip: $45. Hourly wages are $19, hourly gas costs are backed out from per mile costs and an assumed speed of 55 miles per hour. As can be seen, if there was no toll, this would result in a net increase of as much as 11% in trips (six minute time gain for short trips). As we consider the likely mix of time gain and toll cost, the worst case scenario would be a decrease of 22% if we use the highest toll cost, the 3 minute time gain and the highest elasticity (-.5).

Most trucking companies would have a mix of trips. Based on the counts used, Single Unit Trucks are approximately 38% of trucking usage on the bridge. These most likely represent the shorter trips. While Class C trucks are approximately 20% and Class D are approximately 42%. Class C and D trucks are more likely to be making the longer trips. Because a number of alternative routes exist and because demand for these good will remain strong and transportation costs are a small percentage of the overall price of the goods, we expect that the -.1 elasticity is a far more reasonable expectation. We find that in this case, estimates are quite small, typically less than 2%.

Overall, the impact on trucking will clearly be small. Given the concentration of Manufacturing and Wholesale employment in the region, and the proximity of the airport, it is unlikely that firms will relocate. This suggests that actually using the smallest elasticity is perhaps the most accurate. As can be seen in that row, only the short trips with a $6 toll and no time gain have an impact over 1%.

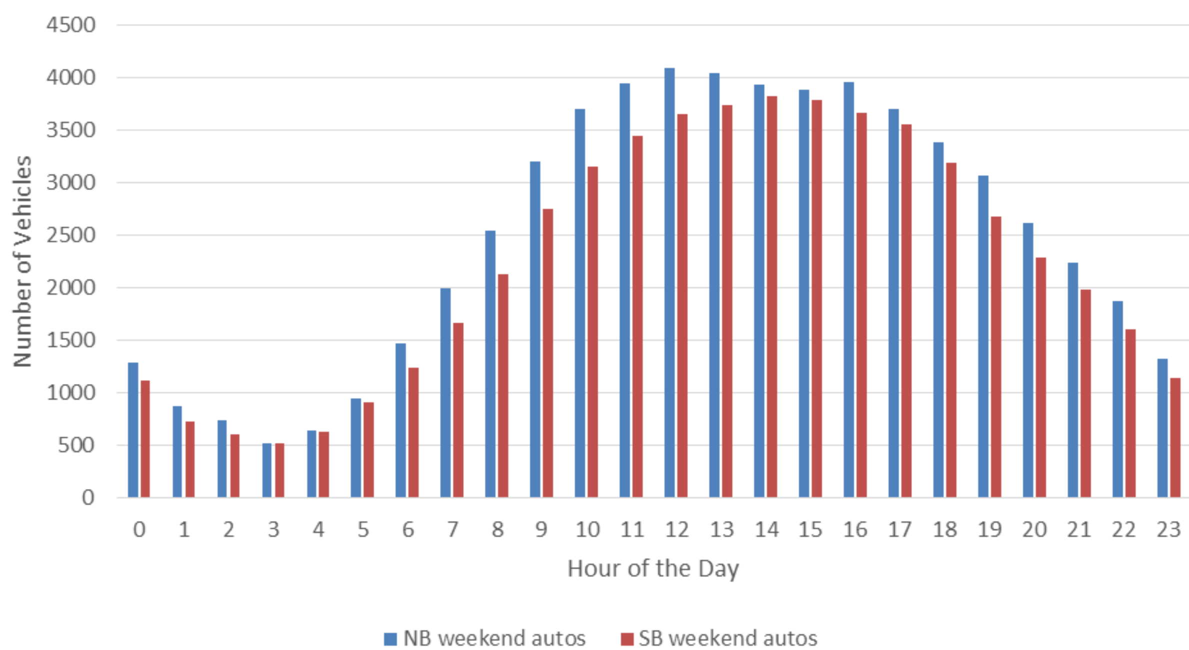
As with commuting, the largest cost of any trucking trip is the time cost. The likely gain in travel times, while very small even for long trips, significantly offsets the toll price. Further we are using a very low cost of time (other studies have used $50 to $60). Recalling that in general, the combination of tolls and licenses are approximately 2% of trip costs for truck shipping, it is highly unlikely that the toll will have any significant impact on this important industry.

<u>Shopping and Recreational Trips</u>

As noted above, Northern Kentucky in general has a slightly higher concentration of Retail Trade and Accommodation and Food Service than the Cincinnati region. While it is important to recognize this fact, and it is important to discuss it, the difference between Northern Kentucky and the rest of the Cincinnati region is not particularly remarkable. Indeed, with 20% of the population residing in Northern Kentucky, we would expect roughly 20% of the Retail Trade and 20% of the Food Service employment to be in Northern Kentucky if consumers shop and eat close to home. We note that 18.7% of the region's Retail Trade and 19.9% of the Food and Accommodation employment is in Northern Kentucky suggesting that – if anything – residents in Northern Kentucky drive elsewhere to purchase retail goods but likely eat out near home. Perhaps, since a large portion of residents commute into the city center, they make their retail purchases there rather than near home.

As further evidence of this we consider traffic flows on the bridge for the weekends. The weekend traffic flows are more likely to be representative of trips made for shopping and other recreational purposes. Returning to Figure 4 below, we show that the commuting pattern is muted but still present. Certainly some of this pattern is due to individuals who work weekends, but another component are individuals traveling into the city. More importantly, we note the relatively symmetric traffic flows all day (as compared to weekdays). If large numbers of consumers were driving from Ohio into Northern Kentucky via the bridge we would expect to see a complete reversal of the pattern.

Figure 4: Weekend Automobile Traffic on Brent Spence Bridge



Returning to Table 3.3 we note that the percentage of Retail Trade employment in the three close-in counties (Boone, Kenton and Campbell) is 17.3% of the Cincinnati total, while population is 17.1%. Finally, we note that for Boone County, Retail Trade is somewhat higher at 8.2% as compared to 5.8% of population. However for the remaining counties (including those not specifically listed) Retail Trade is a significantly smaller portion of employment than the population. Certainly it is again Boone County that we would expect to see the largest impact on retail sales. However, much of the Boone County shopping will derive from the other Northern Kentucky counties (as evidenced by the balance). The large outlet shopping malls certainly bring in some customers from Ohio and Indiana, but they also draw customers from further south, west and east in Kentucky.

Accommodation and Food Service appears to be slightly more concentrated in the three close-in counties, accounting for 19.8% of the MSA employment in this industry. Again, the concentration is primarily in Boone County as one might expect. Again, we point to the fact that the 8.2% of employment in Accommodation and Food is nearly identical to the 8.3% of overall MSA employment in Boone County. We also note that the other counties in the region have lower employment in this industry than their population or employment shares would suggest. This suggests that much of the concentration is due to customers from within Northern Kentucky, who clearly would not use the Brent Spence Bridge.

There are three possible scenarios which would account for the fact that the percentage of employment in Retail and Accommodation and Food in Northern Kentucky is nearly identical to the percentage of population. The first is that no one travels across the river for shopping (or food). Thus the numbers align closely because there is always a proportionate amount of employment for population. The second is that while people travel across the river, the flow is completely symmetric with roughly equal numbers traveling into Northern Kentucky as travel out of it. The third is that consumers largely travel “north” to shop: that is consumers in Northern Kentucky shop in Ohio, while consumers in Kentucky drive north to Northern Kentucky to shop and that somehow these numbers serendipitously balance.

In the first two scenarios, the new bridge and the toll will have no impact on retail shopping. In the first case, with no crossings, the bridge plays no roll. We acknowledge that this is highly unlikely given the traffic patterns, but it serves to begin the discussion. In the second case – which is much more likely – the impact of the toll would be symmetric: while customers coming south over the river from Ohio and Indiana may decrease because of the toll, so too will consumers who travel North over the river from Northern Kentucky now remain in northern Kentucky to shop.

In the third scenario – which we argue is highly unlikely – the impact of the toll (assuming it reduces trips) would actually benefit Northern Kentucky shopping. While the travel from points south (from other counties in Kentucky) would be completely unaffected by the toll, any reduction in those who travel into Ohio to shop would be induced to shop in Northern Kentucky (presumably closer to home).

Returning to Table 2.7 we point out that even at high elasticities, and worst case scenarios, the impact of the bridge toll on trips is small. This is not surprising since even a $2 toll is a relatively small price and the likely gain from improved traffic flow offsets at least some if not all of this cost. This fact is no less true for individuals traveling for shopping or other recreational activities. Indeed, as we can see in the table, the impact of the toll is lower when the overall cost of the trip in question is higher. It is actually quite reasonable to include the expenditure on shopping, food and entertainment associated with the trip into the base. Clearly this would further reduce the impact of the toll (and the impact of the time gains). Simply put, an individual who is driving from Cincinnati to Northern Ohio to shop at outlet malls is spending a great deal of money on this trip: the imposition of a $2 toll is going to have a very small marginal effect.

The economic literature on highways is quite clear that improvements in highways have a strong positive local impact on the economy. While little literature specifically examines how a toll will mitigate this impact, the conclusion of that literature is that tolls do not significantly offset that impact. Overall, improvements in highway infrastructure are typically found to have a positive impact on the local economy.

Implications of Sales Tax Financing

An alternative to financing the Bridge with tolls is to increase the state sales tax. Here we consider two possible scenarios: in the first, and most likely, both Ohio and Kentucky increase their sales tax keep the relative rates the same. In the second, Kentucky raises its sales tax, while Ohio's tax remains constant. While we recognize the second case is rather unlikely, the remaining likely cases would be where both Ohio and Kentucky raise their sales tax, but Kentucky raises the tax by larger amount. These middle cases can be understood to have aspects of both cases considered here.

Retail sales, in general are rather price elastic: in contrast to the trip elasticities. In general a 1% increase in prices leads to more than a 1% decrease in sales. Estimates range from 1% to 4% (see for example Fox, 1986; Walsh and Jones, 1988; Tosun and Skidmore, 2007). In the first case, the sales taxes in both states are raised by the same proportion. Transportation and warehousing is derived demand. As retail sales in both regions fall, demand for the products shipped by trucking companies (and the manufacturing of these products would fall as well). Unlike the toll, however, the tax does not directly affect the trucking and other similar enterprises.

Retail sales both north and south of the river would fall. An increase in sales would reduce retail sales both from local consumers (those on the same side of the bridge) and from bridge crossers at the same rate. This is in sharp contrast to the case of the toll which only impacts cross bridge consumers. Clearly the increase would have a larger impact upon retail sales in northern Kentucky by the sheer volume of the consumers affected. As noted above, it is unlikely that bridge crossing consumers make up a large part of retail sales in Northern Kentucky. It is important to recognize here that the proportionate increase in both states would have no impact on the ratio of cross bridge shopping. That is consumers traveling south across the Ohio River would decrease at the same rate as consumers traveling north: the impact is symmetric.

In the second case, where only Kentucky would increase the sales tax, the impact on Transportation and Warehousing in Kentucky would generally be smaller and indeed would most likely result in the lowest impact on Transportation and Warehousing in Northern Kentucky. The fact that the trucking in regional, serving Kentucky, Ohio, Indiana and Tennessee is the main reason for the low impact. While certainly the tax in Kentucky would reduce retail sales in Kentucky, as Fox (1986) shows, Kentucky populations living near other states would increase shopping in those states to take advantage of lower prices. Since large parts of the Kentucky population live near borders (Louisville, Paducah, Bowling Green), and the retail outlets on both sides of the border are served by the same trucking industry, the net impact on trucking would actually be smaller in this case.

The net impact on Retail Sales in Northern Kentucky would be larger. We get both the direct effect of a raise in prices, but we also would experience a larger decrease in consumers traveling to Northern Kentucky and an increase in consumers traveling to Ohio to shop. This is in sharp contrast to the case where there is a general increase in both states. In that case, only the direct effect occurs.

An important question is whether the impact of an increase in sales tax would have a larger impact overall is difficult. The toll would generally be spread over many years, while a sales tax option might be designed to pay for the improvements in a shorter period of time. Were the sales tax option spread over the same period of time, the amount would likely be very small. However, this seems unlikely and policy makers tend to raise sales taxes in increments of at least 0.25% (more likely .5% or a full 1%). It is also likely that Kentucky would raise its rate, more than Ohio since Kentucky's economy is smaller. In order to raise the same nominal dollar amount, the tax rate in Kentucky would likely need to go up more. Hence something closer to the second scenario, is most likely.

<u>Component 4: The Impact of the "Davis-Bacon" Prevailing Wage on the Cost of the Brent Spence Bridge Replacement.</u>

The Davis Bacon Act requires workers to be paid a "prevailing" wage set by the Federal Government when Federal money is used in a project. Some states, such as Kentucky and Ohio have a state specific "prevailing wage" rule which applies in the case when the Federal rule would not be in effect, but state funds are being used in the project. In the case of the Brent Spence Bridge Federal and state highway money is being used, in part, and so prevailing wage rules apply. Typically, these wages are higher than wages that would be obtained in the absence of such a requirement. A variety of studies have examined the impact of the Davis-Bacon prevailing wage on the costs of public projects. The results of these studies are far from conclusive.

Some authors find a very high impact (Dean, 2009; Vitullo-Martin, 2012) while others find little or no significant impact on construction costs (Kessler and Katz, 2001; Azari-Rad, 2003, Philips and Prus, 2003). In general, it is certainly true that Davis-Bacon wages are higher than average wages for similar positions in most markets. This appears to be true of Kentucky and Ohio in general (see below). However, there may be employer responses which significantly dampen the impact as compared to the raw percentage differences in base wage rates. One such possibility is for the firm to hire higher quality workers. Certainly the union wage literature has found evidence of this practice when firms face unions. A second possibility is to use workers more efficiently and hire fewer workers for the same type of project. Substitution toward technology is well recognized as a general response to higher wages. Again, the union wage literature has demonstrated this approach as well. Finally, it may be that firms absorb higher costs in lower profits. This is more difficult to measure and has been suggested but not well documented in the union wage literature. However, it seems unlikely that the Davis-Bacon act would have no impact on the costs of construction.

We examined documents which suggest that the Prevailing Wage Laws in Kentucky results in wage differentials ranging from 10% to 40% (see, Kentucky Labor Cabinet, 2013, and

Bureau of Labor Statistics (BLS) hourly wage estimates). For example, according to the BLS wage data, Operating Engineers for highway and street construction in the Cincinnati Metropolitan area earn $25.11 per hour. The Kenton County requirements for Operating Engineers range from $28.45 to $30.79 per hour, depending on the position (13% to 23%). Similarly, the average wage for construction laborers in Cincinnati is approximately $19.25 per hour, while the prevailing wage requirement would be between $26.72 and $27.22 per hour (38% to 41%). It would be nearly impossible to get an accurate estimate of the increase in costs without knowing the specific mix of workers used for the project, which is well beyond the scope of this study. However, based on other literature, it would seem that a 25% increase in hourly wage costs is not unreasonable.

Labor costs on construction projects range from 40% to 60% of total construction costs. At 40%, a 25% higher wage bill means the construction costs will be about 10% higher, while at 60% we would find 15% higher costs. Perhaps interestingly, a number of research studies appear to find roughly 10 to 15% higher overall costs associated with the Davis – Bacon act. This does not really appear to have any firm level response, although it is likely that firms will have some response. We expect that the overall costs of the project are between 10 and 15% higher due to the Davis Bacon act.

Current estimates of the project place total construction costs at $1.8 billion with an overall cost of approximately $2.6 billion. If the construction phase were 10% lower, the total costs would be $1.62 billion for construction and $2.42 billion for the total project. At 15% the difference would be $1.53 billion for construction costs and $2.33 billion for the overall project. These estimates are neither worst case nor best case estimates. We suspect that in truth the savings would be slightly lower than we estimate, allowing for firm response.

Conclusions

Economic literature has long shown that highway improvement generally results in economic gains in the region. We expect that overall, the Brent Spence Bridge project will not be remarkably different. While certainly a toll will mitigate the impact of the project compared to what might occur in the absence of the toll, both economic studies and our calculations indicate that the impact of the toll will be relatively small.

Overall, we expect that commuter patterns will change very little in response to the toll, largely because they are offset by time gains from the project and because they are a relatively small portion of the trip costs. A crucial assumption in estimating this effect is how value of time is assessed. While some studies associated with the Brent Spence Bridge project have used $14 to $16 per hour (and we present estimates based upon this as well), we find this figure to be remarkably low. Average wages among commuters in the region and especially for likely Brent Spence Bridge users are in the range of $22 to $26 per hour. For the higher wage workers, the gain in time from reduced congestion far outweighs the toll cost even for a $2 toll.

We examine the industry structure and discuss the likely impact of tolls on the economy of Northern Kentucky. Northern Kentucky is home to a remarkably high concentration of transportation and warehousing employment. Tolls on trucks will clearly impact this industry. We find the impact will be highest on short trip type deliveries. Overall, the decrease in truck trips is likely to be small, around 2%, which implies a very small impact on trucking companies and the industry as a whole.

While Northern Kentucky does have high employment in both Retail and Food Service industries, the employment is proportional to population in general. While certainly some customer base is travelling over the Bridge, it is symmetrically likely that some consumers local to Northern Kentucky shop in Cincinnati either for convenience or for the "excursion" value. While trips for shopping and other recreation are somewhat more sensitive to changes in prices, these trips too are inelastic. The value of time is still the single largest component. We estimate that the impact on retail sales will be relatively small and that some of it will be made up by local customers choosing to shop closer to home. This is consistent with the finding that overall, road improvement improves employment and other economic activities, even in the presence of a toll.

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APPENDIX

Appendix Table 1: Travel Time in Minutes between population centroids of Counties (MapQuest)

		Indiana			Kentucky							Ohio				
		Dearborn	Franklin	Ohio	Boone	Bracken	Campbell	Gallatin	Grant	Kenton	Pendleton	Brown	Butler	Clermont	Hamilton	Warren
	Dearborn		49	34	37	83	48	63	58	40	76	88	57	61	47	66
Indiana	Franklin	49		75	64	109	69	90	85	67	100	109	55	82	56	74
	Ohio	34	75		51	97	62	55	72	54	90	102	71	75	61	80
	Boone	37	64	51		62	27	31	26	19	50	67	56	40	31	59
	Bracken	83	109	97	62		46	82	73	53	43	62	90	65	65	89
	Campbell	48	69	62	27	46		47	42	17	37	52	50	26	25	49
Kentucky	Gallatin	63	90	55	31	82	47		30	38	57	86	75	60	51	79
	Grant	58	85	72	26	73	42	30		33	35	81	70	55	46	74
	Kenton	40	67	54	19	53	17	38	33		44	56	49	30	24	51
	Pendleton	76	100	90	50	43	37	57	35	44		84	81	57	56	80
	Brown	88	109	102	67	62	52	86	81	56	84		70	34	66	67
	Butler	57	55	71	56	90	50	75	70	49	81	70		44	32	20
Ohio	Clermont	61	82	75	40	65	26	60	55	30	57	34	44		39	40
	Hamilton	47	56	61	31	65	25	51	46	24	56	66	32	39		33
	Warren	66	74	80	59	89	49	79	74	51	80	67	20	40	33	

Appendix Table 2: Distance in Miles between population Centroids of Counties (MapQuest)

		Indiana			Kentucky							Ohio				
		Dearborn	Franklin	Ohio	Boone	Bracken	Campbell	Gallatin	Grant	Kenton	Pendleton	Brown	Butler	Clermont	Hamilton	Warren
	Dearborn		28.6	19.9	25.3	66.5	36.2	54.1	51.0	30.0	57.5	72.6	43.9	50.3	35.7	55.8
Indiana	Franklin	28.6		48.8	51.3	86.3	53.3	80.1	77.0	56.0	76.7	89.6	33.7	68.1	43.6	49.0
	Ohio	19.9	48.8		34.8	76.1	45.8	28.5	60.6	39.5	67.0	82.2	53.5	59.9	45.2	65.3
	Boone	25.3	51.3	34.8		49.5	18.2	26.8	23.7	13.0	33.3	55.6	42.7	33.3	22.6	47.3
	Bracken	66.5	86.3	76.1	49.5		34.8	72.0	46.0	40.8	28.8	46.2	69.8	51.9	49.6	71.9
	Campbell	36.2	53.3	45.8	18.2	34.8		41.6	38.5	10.3	25.6	41.7	37.2	19.4	17.1	39.3
Kentucky	Gallatin	54.1	80.1	28.5	26.8	72.0	41.6		19.4	35.2	41.4	77.9	65.0	55.6	44.9	71.7
	Grant	51.0	77.0	60.6	23.7	46.0	38.5	19.4		32.0	19.1	74.6	61.8	52.4	41.6	68.5
	Kenton	30.0	56.0	39.5	13.0	40.8	10.3	35.2	32.0		31.1	46.2	35.2	24.0	15.0	39.8
	Pendleton	57.5	76.7	67.0	33.3	28.8	25.6	41.4	19.1	31.1		65.0	60.6	42.7	40.4	62.7
	Brown	72.6	89.6	82.2	55.6	46.2	41.7	77.9	74.6	46.2	65.0		58.1	25.6	53.7	56.6
	Butler	43.9	33.7	53.5	42.7	69.8	37.2	65.0	61.8	35.2	60.6	58.1		34.4	22.3	15.7
Ohio	Clermont	50.3	68.1	59.9	33.3	51.9	19.4	55.6	52.4	24.0	42.7	25.6	34.4		31.3	32.0
	Hamilton	35.7	43.6	45.2	22.6	49.6	17.1	44.9	41.6	15.0	40.4	53.7	22.3	31.3		27.9
	Warren	55.8	49.0	65.3	47.3	71.9	39.3	71.7	68.5	39.8	62.7	56.6	15.7	32.0	27.9	