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## The "highway effect" on public finance: Case of the STAR highway in the Philippines

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**ADB Working Paper Series**

**The “Highway Effect” on Public Finance:  
Case of the STAR Highway in the Philippines**



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**Abstract**

In this study, we examine the impact of the STAR highway located in Batangas province, Philippines, on the public finance of the cities and municipalities through which it directly passes. Specifically, we exploit a unique, disaggregated dataset on tax (property and business taxes) as well as non-tax revenues (regulatory fees and user charges) of the cities and municipalities in the Batangas province. We find, based on our two specifications of a modified difference-in-difference model, that the STAR highway had a robust, statistically significant, and economically growing impact on business taxes. We also find that this so-called “highway effect” also extends to municipalities located in a neighboring province to Batangas. Furthermore, based on more careful inspection and robustness checks, it appears that the STAR highway had a significant impact not only on business taxes, but also on property taxes and regulatory fees. These findings support the widely held belief that infrastructure investments matter; further, our micro-case study suggests that infrastructure investments can indirectly boost tax and non-tax revenues through their power to reduce transportation costs and enhance the activity of firms and workers located along the highway.

**JEL Classification:** H54; H71; O22; R11

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## 1. INTRODUCTION

Transportation infrastructure is widely deemed to have critical development impacts. For one, public investment on transportation infrastructure constitutes a major portion of spending during sluggish economic activity. The IMF estimates that the Asia and Pacific region spends about \$360 billion per year on transport. However, this amount masks the uneven distribution of spending on infrastructure, in general, and on transportation, in particular. Specifically, in some countries, transportation infrastructure has seen a dramatic expansion, while others have seen only modest increases, or even contracted (UNESCAP 2013). Improving and expanding transportation infrastructure is also believed to be synonymous with economic development, particularly in terms of reducing poverty, which explains the Asian Development Bank's (ADB) support for it. For instance, transport has accounted for 27% of ADB's lending during 2005–2009 (ADB 2010).

The need to assess whether development outcomes are being achieved and met, for instance, on the side of multilateral donors, has placed new demands on evaluations that can accurately measure the impact of assistance. The need to evaluate lending in transportation projects is no exception. This, then, explains the recent proliferation of various impact evaluation tools. From the earlier wide application of the macroeconomic approach in the assessment of public infrastructure investment to the recent gain in popularity of micro-econometric tools to evaluate particular infrastructure projects, including transport, the interest on impact evaluation methodologies will remain with us for some years to come.

In this paper, we provide a microeconomic case study that examines the impact of the STAR highway located in Batangas province, Philippines, on the public finance of the cities and municipalities through which the STAR highway directly passes. Specifically, we employ a modified version of the difference-in-difference approach, which is typically used in quasi-experimental impact evaluation studies. We then in turn exploit a unique, disaggregated dataset on the tax and non-tax revenues of the cities and municipalities in the Batangas province. These revenues comprise property taxes and business taxes as well as regulatory fees and user charges.

The paper is structured as follows: The next section reviews previous studies that use micro-econometric impact evaluation tools. The third section discusses the difference-in-difference approach and its modification in the present study. The fourth section briefly introduces the STAR tollway and discusses the public finance data used in this study. The fifth section discusses the empirical results. The last section concludes.

## 2. LITERATURE REVIEW

Empirical macroeconomic studies that assess the aggregate impact of infrastructure investments have been popular for many years. Recently, micro-econometric studies have also gained popularity and essentially use the idea of comparing the factual and the counterfactual. That is, a comparison between what happened to individuals or cities in the presence of the infrastructure project compared with how they would have fared without it (Hansen, Anderson and White 2011). However, micro-economic studies that employed experimental evaluation such as randomized control trials (RCTs), which have been widely adopted in the impact evaluation of education and health policies, is difficult to implement in the context of large-scale infrastructure projects (Sawada 2015). One obstacle to RCT-based evaluation is that the infrastructure project's

technical nature prevents randomization since, for instance, the engineering design of the project requires determining the beneficiary villages for an irrigation project (Hansen, Anderson and White 2011). One such exception is the study by Gonzalez-Navarro and Quintana-Domeque (2012), who conducted a randomized street asphaltting experiment to measure the impact of infrastructure on poverty.

Nonetheless, the majority of micro-econometric evaluation studies have used quasi-experimental approaches that employed different means to match the beneficiaries and non-beneficiaries groups (Hansen, Anderson and White 2011). Some of these recent studies are the following: Duflo and Pande (2007) studied the productivity and distributional effects of large irrigation dams in India, using river gradient as an instrumental variable based on the evidence that, in districts located downstream from a dam, agricultural production increases, and vulnerability to rainfall shocks declines. In contrast, agricultural production shows an insignificant increase in the district where the dam is located, but its volatility increases. Rural poverty declines in downstream districts, but increases where the dam is built, suggesting that neither markets nor state institutions have alleviated the adverse distributional impacts of dam construction.

Dinkelman (2011) used a similar identification strategy by using this time land gradient to estimate the impact of electrification on employment growth by analyzing South Africa's mass roll-out of electricity to rural households. The study found that electrification significantly raises female employment within five years. Electrification also appears to increase work hours for men and women, while reducing female wages and increasing male earnings. The study also found evidence that suggests that household electrification raises employment by releasing women from home production and enabling microenterprises. Jensen (2007) studied the introduction of mobile phone service throughout Kerala, an Indian state with a large fishing industry. Using micro-level survey data, the study showed that mobile phone adoption by fishermen and wholesalers was associated with a dramatic reduction in price dispersion for sardines, as well as the complete elimination of waste, and near-perfect adherence to the Law of One Price; further, both consumer and producer welfare increased.

Donaldson (2014) collected colonial-era data to estimate the impact of India's vast railroad network using a general equilibrium trade model. The results showed that railroads decreased trade costs and inter-regional price gaps; increased inter-regional and international trade; eliminated the responsiveness of prices to local productivity shocks (but increased the transmission of these shocks between regions); increased the level of real income (but harmed neighboring regions without railroad access); and decreased real income volatility.

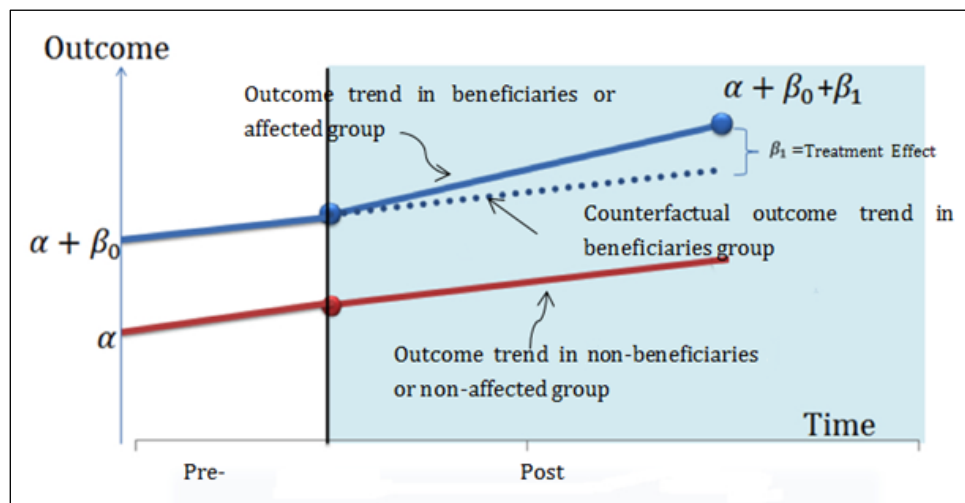
### **3. THE DIFFERENCE-IN-DIFFERENCE METHOD**

The difference-in-difference (DiD) method does what its name suggests. The impact of a policy or a project on a certain outcome can be estimated by computing a double difference, i.e., one over time (before and after) and one across individuals or entities (between beneficiaries, or an affected group, and the non-beneficiaries, or a non-affected group). Specifically, in its simplest form, when data are available for the beneficiaries and non-beneficiaries for two time periods (before and after the operation of an infrastructure project such as the opening of a highway), the method produces impact estimates in the following way: the first difference—the difference in the before-and-after outcomes for the beneficiaries or affected group—is measured to control for factors that are time-invariant. However, the need to control for time-varying factors remains. These factors are then captured in two ways: first, the second difference in

the before-and-after outcomes for the non-beneficiaries or non-affected group is obtained; finally, the second difference is then subtracted from the first difference to further purge other time-varying factors. This final result is interpreted as the impact of the policy or the project.

The key DiD method assumption is that without the policy or the project, the changes in outcomes (i.e., trends) between the beneficiaries, or affected group, and the non-beneficiaries, or non-affected group, are the same over time. In effect, it is the policy or the project as the only factor that creates a trend deviation between these two groups. As can be seen in Figure 1 below, the dotted blue line represents what would have happened in the beneficiaries group in the absence of the policy or the project (unobservable or counterfactual). Notice that this same dotted blue line trends parallel to the red line, which represents the outcome trend for the non-beneficiaries group. Whereas, the anomaly in that part of the solid blue line, i.e., the trend of the beneficiaries group, represents the deviation between the beneficiaries and non-beneficiaries group that was assumed to be exclusively caused by the policy or the project. In practice, however, one can never test this assumption of the same trend between the beneficiaries group and the non-beneficiaries group in the absence of the policy or the project.

**Figure 1: Difference-in-Difference Method**



Source: Authors.

To measure the impact of a policy or project, one can also easily use the DiD method to estimate the following regression equation:

$$Y_{i,t} = \alpha + \beta_0 A_i + \beta_1 P_t \times A_i + \varepsilon_{i,t} \tag{1}$$

Let  $Y_{i,t}$  be the outcome variable of interest such as GDP, GDP per capita, etc.;  $A_i$  is a binary variable that takes a value of 1 for an entity (e.g., household, city, municipality, etc.) belonging to the affected or beneficiaries group, and a value of 0 for an entity belonging to the non-affected or non-beneficiaries group.  $P_t$  is also a binary variable that takes a value of 1 for the period in which the policy was implemented or, in the case of an infrastructure project, the period it was made operational; it takes a value of 0 for the period prior to the implementation of the policy or the operation of the infrastructure project.  $P_t \times A_i$  is an interaction term, i.e., the product of the two binary variables, which then takes a value of 1 only during the period of the implementation of the policy or the operation of the infrastructure project if the entity (e.g., household, city,



municipality, etc.) belongs to the affected or beneficiaries group. This interaction term represents the actual treatment variable.  $\varepsilon_{i,t}$  is the usual error term of the regression with variance  $\sigma^2$ .  $\alpha$ ,  $\beta_0$ ,  $\beta_1$  are the regression parameters to be estimated, and the parameter  $\beta_1$  represents the impact of the policy or the project. The model can be enriched by including entity and time dummies. The main advantage of working with a regression-based approach to the DiD is that other variables can be added to the right-hand side of equation (1), which allows controlling for a possible violation of the assumption of the same trends between the beneficiaries and non-beneficiaries group.

### 3.1 Our Modified Difference-in-Difference Model

Equation (1) above is a discrete specification and thus offers no sense of the dynamics between the infrastructure project and our outcome variable of interest (logarithm of the respective tax and non-tax categories): how quickly the outcome variable grows from the time that an infrastructure project is constructed, completed and made operational, and whether this effect accelerates, stabilizes, mean reverts, or shows no effect. To account for these dynamics, equation (1) can be modified by incorporating leads and lags into the specification and can be expressed as:

$$Y_{i,t} = \alpha + \beta_0 A_i + \sum_{t+4}^{t-2} \beta_1 P_t \times A_i + \varepsilon_{i,t} \quad (2)$$

The variables are similarly defined as above as well as the regression parameters to be estimated. The only difference between equations (1) and (2) is that, in the latter specification, we include the role of leads and lags of the binary variable  $P_t$ , prior to forming its interaction with the other binary variable,  $A_i$ . This is to determine whether the infrastructure project caused a significant difference between our beneficiaries and non-beneficiaries groups in terms of the outcome variable, one and two years before the project's completion, during the year of its completion, and in the next few years right after its completion. Similar to equation (1), this modified model can be enriched by including entity and time dummies.

## 4. PHILLIPINE HIGHWAY AND PHILLIPINE PUBLIC FINANCE DATA

### 4.1 The Philippine STAR Highway

In an effort to expand the flow of people and goods between the Manila Metropolitan area and Batangas City, and thereby contribute to the industrial development of the province of Batangas and surrounding provinces, the Southern Tagalog Arterial Road (STAR) tollway was built with Japan Official Development Assistance. The tollway was constructed in two stages. The STAR Tollway I is the government-constructed portion of a four-lane highway that runs from Santo Tomas, Batangas to Lipa City, Batangas (22.16 km). This was opened to traffic in 2001. Its extension, the STAR Tollway II, is a Build-Operate-Transfer project of a two-lane highway from Lipa City to Batangas City (19.74 km), which was opened to traffic in 2008. Then, in June 2013, STAR Tollway II was upgraded from a two-lane to a four-lane asphalt road, which at the time of writing was nearing full completion. Figure 2 below shows a map of the entire Batangas province<sup>1</sup> and the location of the STAR tollway within it (highlighted in grey). In the

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<sup>1</sup> Batangas province is located in Southern Luzon, one of the three main islands in the Philippines.



natural yet still arbitrary selection of this group is those cities and municipalities that lie adjacent to the west and east of our affected or beneficiaries group. We decided to work with four non-affected or non-beneficiaries groups, as shown in Table 1.

**Table 1: Municipalities in Batangas Province that Constitute the Four Non-affected or Non-beneficiaries Groups**

Non-beneficiaries Group 1	Non-beneficiaries Group 2	Non-beneficiaries Group 3	Non-beneficiaries Group 4
San Jose	Cuenca	Agoncillo	Nasugbu
San Pascual	Alitagtag	Lemery	Lian
Padre Garcia	Bauan	San Nicolas	Tuy
Rosario	Lobo	Taal	Balayan
Taysan	San Juan	San Luis	Calaca
		Mabini	Calatagan

Source: Authors.

Based on the same map shown in Figure 2, the municipalities constituting the non-beneficiaries group 1 and 2 are combinations that lie to the west and east of the affected or beneficiaries group. Non-beneficiaries groups 3 and 4 consist entirely of municipalities that are located on the western side of our affected or beneficiaries group, in particular at the very western edge of Batangas province in the case of non-beneficiaries group 4.

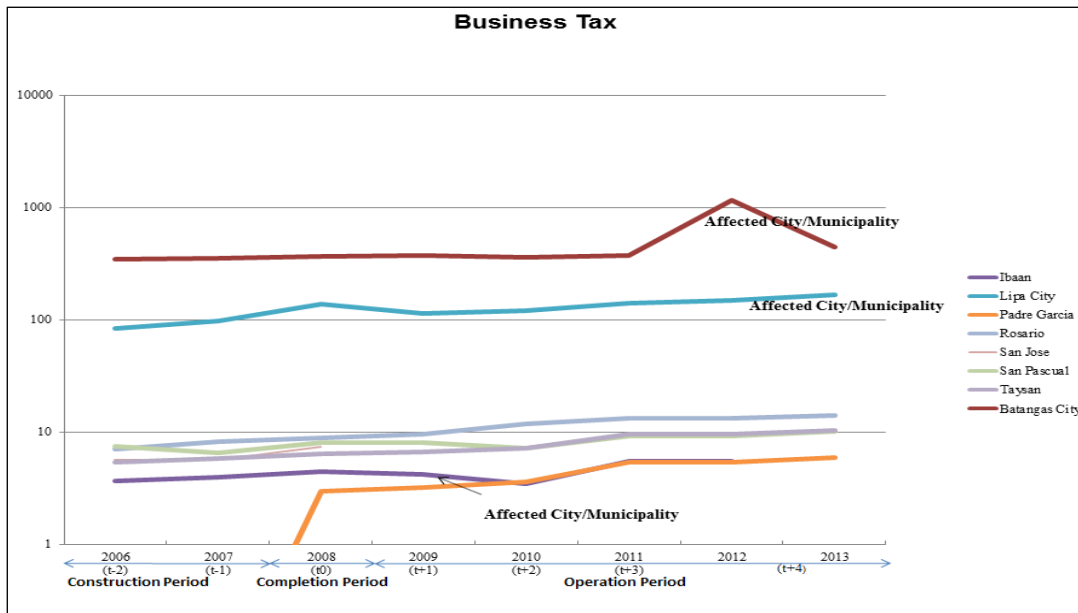
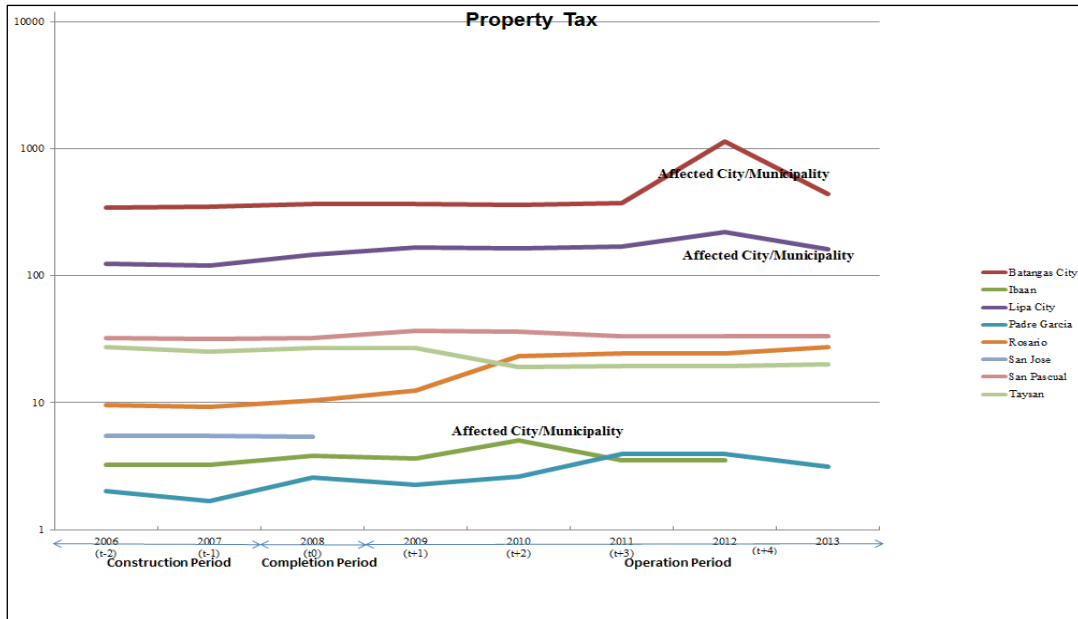
In terms of our public finance data, Figure 3 presents the trend on the property tax, business tax, regulatory fees and user charges from the time construction of STAR tollway II began in 2006 using the data for our affected or beneficiaries group vis-à-vis our non-beneficiaries group 1.

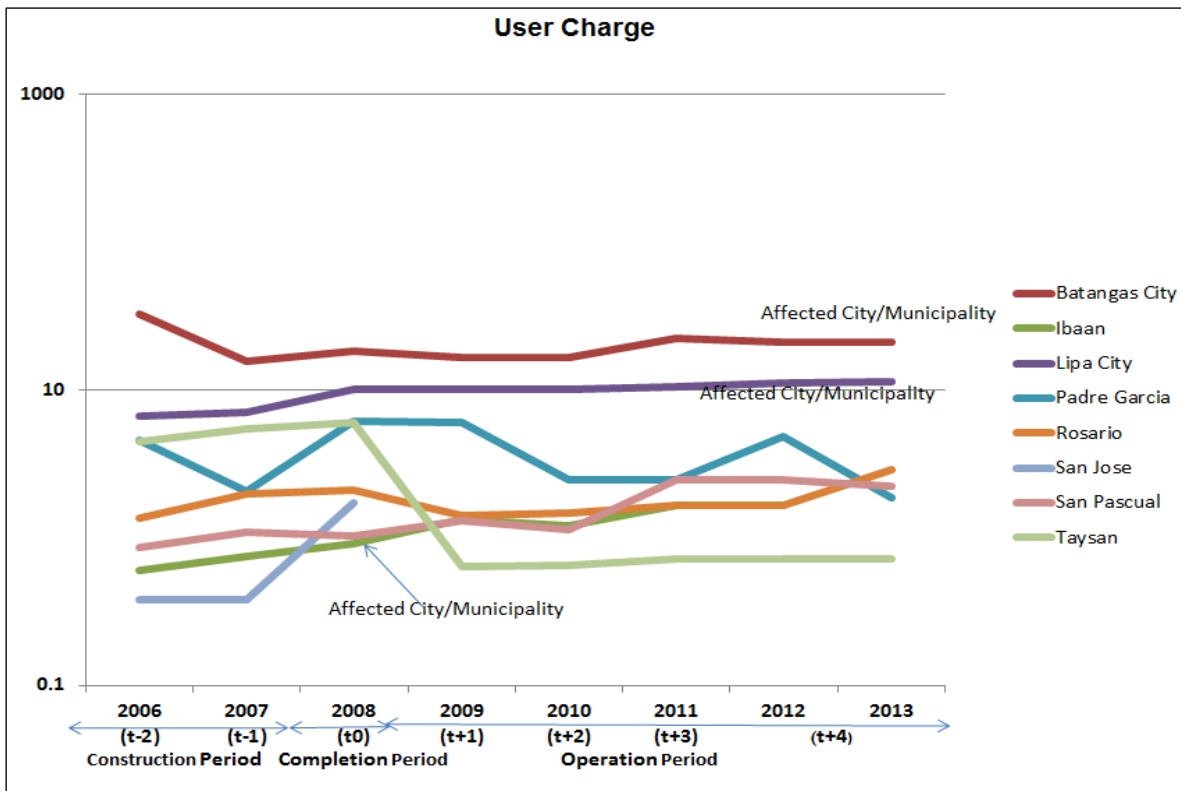
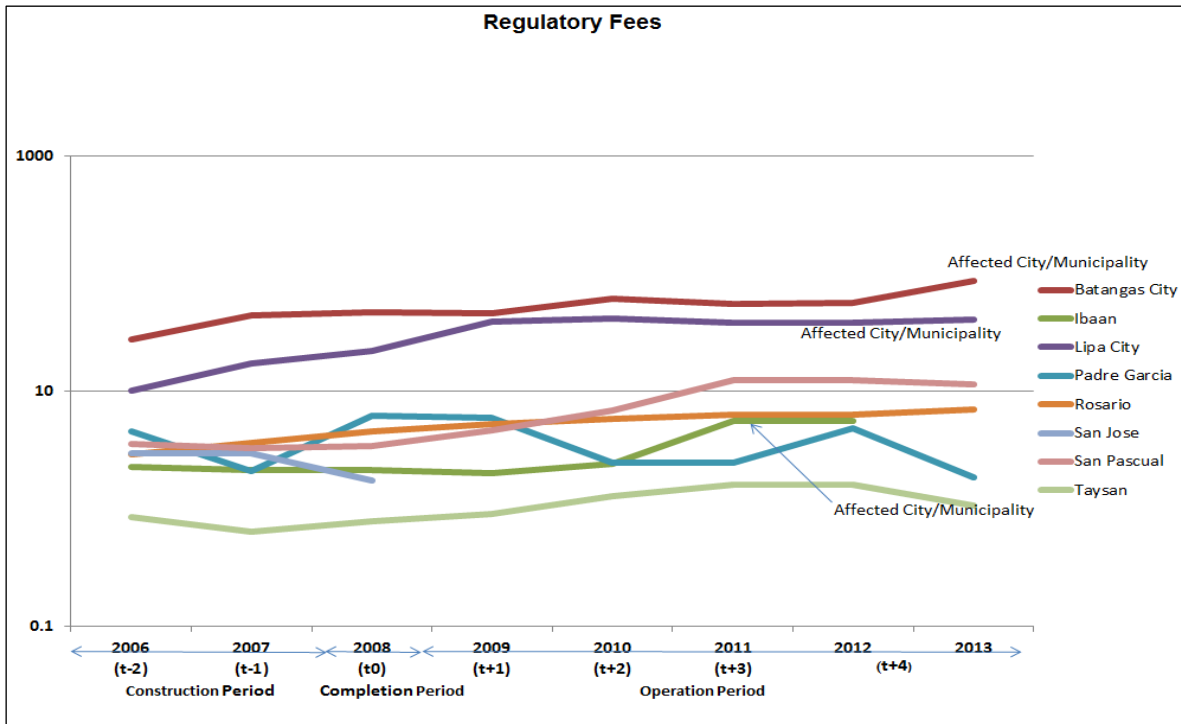
Figure 3 shows that the two major cities in Batangas province, i.e., Lipa City and Batangas City, account for a large share of the different categories of tax and non-tax revenues from 2006 to 2013. This is true even when we compare the revenues of these two cities with the revenues of the other Batangas municipalities (chart not shown). However, the trend that is not clear is whether there is a deviation between our three cities/municipalities of our beneficiaries group as opposed to the municipalities of non-beneficiaries group 1, which is based on our discussion of Section 3, where the marked deviation in trend in the various categories of tax and non-tax data can be assumed to be exclusively caused by the STAR tollway II. This latter observation holds even when we plot the data on our various categories of tax and non-tax revenues for our beneficiaries group vis-à-vis the other municipalities that form the three remaining non-beneficiaries groups. We thus need to resort to an evaluation method such as DiD to indicate whether STAR tollway II indeed had a significant impact on our beneficiaries group as opposed to our four comparison groups, i.e., the non-affected or non-beneficiaries groups across the various categories of tax and non-tax revenues.

Tables 2a to 2d present the estimation results of our modified DiD model (equation 2). Table 2a presents the modified DiD model estimation results between our beneficiaries group and non-beneficiaries group 1; Table 2b for our beneficiaries group and non-beneficiaries group 2; Table 2c for our beneficiaries group and non-beneficiaries group 3; and, Table 2d for our beneficiaries group and non-beneficiaries group 4. In each of these tables, columns (1), (2), (3) and (4) present the estimation results for property tax, business tax, regulatory fees and user charge, respectively. Finally, in each table and for the respective categories of tax and non-tax categories, we augment the baseline specification presented in equation (2) above by controlling for the level of economic activity in Batangas province (denoted as *Construction*), i.e., the number of residential and non-residential constructions.

**Figure 3: Tax and Non-tax Revenues of Beneficiaries Group versus Non-beneficiaries Group 1**

(P million)





Source: Authors.

We can see from Tables 2a–2d that regardless of which non-beneficiaries group we consider, the majority of the interaction terms that incorporate the leads and lags of the  $P_t$  binary variable are significant for only one category of tax revenue, i.e., business taxes.<sup>4</sup> This implies that STAR tollway II, from one and two years before its completion until the next few years following, had an impact on our beneficiaries group as opposed to the non-beneficiaries under this category of tax revenues. Specifically, the estimates suggest that the impact of STAR tollway II on business tax revenues gradually grew from the time of its construction in 2006, reached a peak upon completion in 2008, subsequently slowed down, and, in the last two years of our period of observation, achieved a larger effect.

**Table 2a: Modified DiD Regression Results: Beneficiaries versus Non-beneficiaries Group 1**

	(1) Property Tax	(2) Business Tax	(3) Regulatory Fees	(4) User Charge
Impact D	1.466 (1.478)	0.776 (0.885)	0.929 (0.779)	0.612 (1.125)
Impact D × Period <sub>t-2</sub>	0.095 (0.100)	1.616** (0.626)	0.162 (0.118)	0.453*** (0.105)
Impact D × Period <sub>t-1</sub>	0.254** (0.104)	1.978*** (0.585)	0.610*** (0.191)	0.330 (0.277)
Impact D × Period <sub>t0</sub>	0.293** (0.126)	1.995*** (0.616)	0.637** (0.253)	0.553 (0.292)
Impact D × Period <sub>t+1</sub>	0.060 (0.161)	1.541** (0.803)	0.591 (0.458)	0.604 (0.470)
Impact D × Period <sub>t+2</sub>	0.183 (0.210)	1.520* (0.831)	0.786* (0.412)	0.576 (0.442)
Impact D × Period <sub>t+3</sub>	0.136 (0.144)	1.821** (0.692)	1.037*** (0.282)	0.804* (0.424)
Impact D × Period <sub>t+4, forward</sub>	0.939*** (0.348)	2.360*** (0.556)	1.369*** (0.272)	1.090* (0.603)
Construction	0.709** (0.278)	1.085 (0.920)	0.567 (0.399)	0.118 (0.580)
Constant	10.34*** (2.45)	6.290 (8.038)	10.19*** (3.13)	13.39*** (4.85)
<i>N</i>	90	90	90	90
<i>R</i> <sup>2</sup>	0.25	0.37	0.42	0.21

Notes: Clustered standard errors, corrected for small number of clusters.

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Source: Authors.

<sup>4</sup> This finding also holds even when we use alternative measures of economic activity such as GDP, and even a liquidity measure, for instance, the money supply.

**Table 2b: Modified DiD Regression Results: Beneficiaries versus Non-beneficiaries Group 2**

	(1) Property Tax	(2) Business Tax	(3) Regulatory Fees	(4) User Charge
Impact D	2.383 (1.486)	1.078 (0.889)	1.508* (0.863)	1.084 (1.30)
Impact D × Period <sub>t-2</sub>	0.109 (0.095)	1.686*** (0.614)	0.101 (0.111)	0.319*** (0.076)
Impact D × Period <sub>t-1</sub>	0.248** (0.102)	1.930*** (0.580)	0.652*** (0.188)	0.422 (0.272)
Impact D × Period <sub>t0</sub>	0.297** (0.126)	2.017*** (0.614)	0.619** (0.252)	0.513 (0.291)
Impact D × Period <sub>t+1</sub>	0.101 (0.129)	1.760** (0.722)	0.404 (0.440)	0.191 (0.411)
Impact D × Period <sub>t+2</sub>	0.221 (0.191)	1.720** (0.766)	0.615 (0.396)	0.199 (0.390)
Impact D × Period <sub>t+3</sub>	0.168 (0.125)	1.986*** (0.638)	0.896*** (0.266)	0.493 (0.388)
Impact D × Period <sub>t+4, forward</sub>	0.980*** (0.334)	2.575*** (0.445)	1.185*** (0.246)	0.683 (0.572)
Construction	0.608** (0.145)	0.554 (0.409)	1.021*** (0.258)	1.120*** (0.192)
Constant	10.25*** (1.380)	10.30*** (3.596)	5.92*** (1.952)	4.78** (1.89)
<i>N</i>	94	94	94	94
<i>R</i> <sup>2</sup>	0.42	0.45	0.47	0.21

Notes: Clustered standard errors, corrected for small number of clusters.

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Source: Authors.

**Table 2c: Modified DiD Regression Results: Beneficiaries versus Non-beneficiaries Group 3**

	(1) Property Tax	(2) Business Tax	(3) Regulatory Fees	(4) User Charge
Impact D	2.941** (1.425)	1.528* (0.787)	1.947** (0.805)	1.879* (1.148)
Impact D × Period <sub>t-2</sub>	0.118 (0.095)	1.634*** (0.591)	0.058 (0.117)	0.290*** (0.082)
Impact D × Period <sub>t-1</sub>	0.238** (0.098)	1.966*** (0.571)	0.681*** (0.185)	0.442* (0.266)
Impact D × Period <sub>t0</sub>	0.30** (0.123)	2.0*** (0.596)	0.606** (0.246)	0.504* (0.283)
Impact D × Period <sub>t+1</sub>	0.131 (0.135)	1.597** (0.684)	0.271 (0.449)	0.099 (0.409)
Impact D × Period <sub>t+2</sub>	0.248 (0.195)	1.571** (0.728)	0.495 (0.404)	0.115 (0.387)
Impact D × Period <sub>t+3</sub>	0.190 (0.128)	1.864*** (0.607)	0.797*** (0.280)	0.424 (0.385)
Impact D × Period <sub>t+4, forward</sub>	1.009*** (0.331)	2.415*** (0.412)	1.055*** (0.277)	0.593 (0.569)
Construction	0.537** (0.167)	0.949** (0.387)	1.342*** (0.388)	1.342*** (0.260)
Constant	10.27*** (1.359)	6.64** (3.378)	2.88 (3.416)	2.18 (2.30)
<i>N</i>	118	118	118	118
<i>R</i> <sup>2</sup>	0.50	0.48	0.57	0.42

Notes: Clustered standard errors, corrected for small number of clusters.

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Source: Authors.

**Table 2d: Modified DiD Regression Results: Beneficiaries versus Non-beneficiaries Group 4**

	(1) Property Tax	(2) Business Tax	(3) Regulatory Fees	(4) User Charge
Impact D	1.491 (1.326)	0.896 (0.765)	1.353** (0.692)	1.789* (0.992)
Impact D × Period <sub>t-2</sub>	0.061 (0.092)	1.593** (0.625)	0.210 (0.137)	0.397*** (0.144)
Impact D × Period <sub>t-1</sub>	0.201*** (0.069)	1.775*** (0.607)	0.610*** (0.191)	0.474** (0.194)
Impact D × Period <sub>t0</sub>	0.052** (0.155)	1.808*** (0.651)	0.554** (0.223)	0.260 (0.233)
Impact D × Period <sub>t+1</sub>	-0.230 (0.203)	1.617** (0.777)	0.543 (0.481)	-0.150 (0.401)
Impact D × Period <sub>t+2</sub>	-0.071 (0.171)	1.584** (0.807)	0.752* (0.447)	-0.084 (0.383)
Impact D × Period <sub>t+3</sub>	-0.129 (0.164)	1.829*** (0.688)	0.985*** (0.240)	0.193 (0.343)
Impact D × Period <sub>t+4, forward</sub>	0.595 (0.386)	2.354*** (0.776)	1.258*** (0.107)	0.266 (0.425)
Construction	1.327** (0.497)	0.60 (0.619)	0.745*** (0.270)	2.137*** (0.641)
Constant	5.359 (3.959)	10.24** (4.911)	8.308*** (2.239)	-4.235 (5.14)
<i>N</i>	104	104	104	103
<i>R</i> <sup>2</sup>	0.23	0.36	0.55	0.44

Notes: Clustered standard errors, corrected for small number of clusters.

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Source: Authors.

Finally, as an illustration of the dynamic effects of STAR tollway II on the business tax revenues of Lipa City, Ibaan and Batangas City, we calculate the counterfactual increase in business tax revenues for these three beneficiaries' areas. This is carried out by using the estimated impact coefficients, i.e., the estimated coefficients of the various interaction terms between the leads/lags of the  $P_t$  binary variable and the  $A_i$  binary variable, reported in column 2 of Table 2d, as well as the actual business tax revenues for each of the beneficiaries' areas in a particular period. These calculations are shown in Table 3 below. As we emphasized above, the calculated increase in business tax revenues for the three beneficiaries' areas indeed suggests that the impact of STAR tollway II grew from the time of its construction in 2006, reached a peak at the time of its completion in 2008, subsequently slowed down, and, in the last two years of our period of observation, achieved a larger effect.

**Table 3: Calculated Increase in Business Tax Revenues for the Beneficiaries Group relative to the Non-beneficiaries Group 4**

(P million)

	t <sub>2</sub>	t <sub>1</sub>	t <sub>0</sub>	t <sub>+1</sub>	t <sub>+2</sub>	t <sub>+3</sub>	t <sub>+4, forward</sub>
Lipa City	134.36	173.50	249.70	184.47	191.81	257.35	371.93
Ibaan	5.84	7.04	7.97	6.80	5.46	10.05	12.94
Batangas City	490.90	622.65	652.83	637.89	599.49	742.28	1208.61

Note: For the period t+4, forward in the case of Lipa City and Batangas City is the average increase in business tax revenues in each province.

Source: Authors.



Given that the government support for the Build-Operate-Transfer portion, i.e., STAR tollway II, amounted to P0.5 billion, the estimated annual average of the accumulated increase in business tax revenues for the three beneficiaries' areas is roughly P1 billion. Thus, according to these calculations, STAR tollway provided a net benefit for the government.

## 5.1 Spillover Effect

The next interesting question is whether the same STAR tollway II had a significant impact on the various categories of tax and non-tax revenues of the municipalities located at a neighboring province of Batangas (the so-called spillover effect in the impact evaluation literature). Figure 3 shows these neighboring municipalities, which are located on the eastern part of Batangas province and the STAR tollway, in hollow white with boundaries marked in blue.<sup>5</sup>

**Figure 3: Map of Batangas Province, the Location of the STAR Tollway, and the Municipalities in the Neighboring Province of Quezon**



Source: <http://en.wikipedia.org/wiki/Batangas>

Using these municipalities that are specifically found on the neighboring province of Quezon as a test case, we present in Table 4 our modified DiD estimation results that examine the spillover effect of STAR tollway II. This table should be read in the same manner as Table 2 above, that is, column (1) presents the estimation results for property tax; column (2) the estimation results for business tax; column (3) the estimation results for regulatory fees; and, column (4) the estimation results for user charge. This time, the level of economic activity both in the provinces of Batangas and Quezon were used to augment the baseline specification presented in equation (2) above. As before, economic activity is measured by the number of residential and non-residential constructions, i.e., the variable,  $Construction_t$ .

<sup>5</sup> These municipalities in the province of Quezon are Candalaria, Dolores, San Antonio and Tiaong.

Interestingly, similar to the findings we obtain from Tables 2a to 2d, we again find that under the category of business tax revenues, all the interaction terms remain economically and statistically significant. Unlike, however, the economic significance of the interaction terms in the estimation results on business tax revenues presented in Tables 2a to 2d, here we observe in Table 4 that the impact of the STAR tollway II accelerated from the time of construction and up to the last two years of our period of analysis.

**Table 4: Modified DiD Regression Results: Spillover Effect**

	(1) Property Tax	(2) Business Tax	(3) Regulatory Fees	(4) User Charge
Impact D	0.736 (0.874)	0.438 (1.407)	0.924 (1.046)	0.364 (1.028)
Impact D × Period <sub>t-2</sub>	-0.083 (0.301)	0.991** (0.450)	-0.019 (0.248)	-0.010 (0.250)
Impact D × Period <sub>t-1</sub>	0.574*** (0.118)	1.502*** (0.542)	0.515*** (0.169)	0.434** (0.167)
Impact D × Period <sub>t0</sub>	0.570** (0.223)	1.641*** (0.482)	0.642*** (0.181)	0.422 (0.158)
Impact D × Period <sub>t+1</sub>	0.387 (0.728)	1.779** (0.470)	0.838* (0.448)	0.197 (0.560)
Impact D × Period <sub>t+2</sub>	0.336 (0.594)	1.804** (0.531)	1.044** (0.413)	0.247 (0.531)
Impact D × Period <sub>t+3</sub>	0.450 (0.578)	2.070*** (0.544)	1.238*** (0.369)	0.676 (0.515)
Impact D × Period <sub>t+4, forward</sub>	1.100 (0.758)	2.560*** (0.350)	1.509*** (0.452)	0.787 (0.745)
Construction	2.283** (1.172)	1.577 (1.196)	1.207 (0.855)	1.942* (1.028)
Constant	-2.499 (8.839)	2.230 (9.094)	4.597 (6.566)	-1.612 (7.84)
N	73	73	73	73
R <sup>2</sup>	0.41	0.44	0.50	0.39

Notes: Clustered standard errors, corrected for small number of clusters.

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Source: Authors.

## 5.2 Robustness Test: Using Continuous Distance

The limitation of our previous non-affected or non-beneficiaries group selection strategy is that there is no way for us to determine whether adjacency to those cities and municipalities through which the highway directly passes can give us the suitable comparison group. An alternative approach is to omit a comparison group in terms of the arbitrary selection of the non-affected or non-beneficiaries group, and use instead the calculated continuous distance from the primary urban center of a municipality to its nearest STAR tollway II entry point. By using the calculated continuous distance, our earlier baseline specification (equation 2) can now be expressed as:

$$Y_{i,t} = \alpha + \beta_0 \text{Distance}_t + \sum_{t+4}^{t-2} \beta_1 P_t \times \text{Distance}_t + \varepsilon_{i,t} \quad (3)$$

In this equation (3), the binary variable,  $P_t$ , is defined as before, including the regression parameters to be estimated. However, we now replace the binary variable  $A_i$  with the continuous distance variable,  $\text{Distance}_t$ . As such, the relevant interaction term is between this continuous distance variable,  $\text{Distance}_t$  and the binary variable,  $P_t$ . Nonetheless, similar to equation (2), we still take into account the dynamics of STAR

tollway II and its impact on the various categories of tax and non-tax revenues with the incorporation of leads and lags into the specification of equation (3) via the binary variable,  $P_t$ . In doing so, just as before, we are able to know how quickly our different categories of tax and non-tax revenues grew from the time that the STAR tollway II was constructed, completed and made operational, and whether this effect accelerated, stabilized, mean reverted, or showed no effect. Finally, similar to equations (1) and (2), the model above can be enriched by including entity and time dummies.

Table 5 presents our estimation results of equation (3), and should be read in the same manner as before: column (1) presents the estimation results for property tax; column (2) for business tax; column (3) for regulatory fees; and, column (4) for user charge. Once we control for  $Construction_t$ , we find that the interaction terms in three of the four categories of tax and non-tax revenues are economically and statistically significant. Specifically, these are for the two categories of tax revenues, i.e., property and business taxes, and the non-tax category, regulatory fees. Furthermore, the economic significance of the interaction terms across these three categories does gradually grow over time.

**Table 5: Regression Results: Using Continuous Distance from the STAR Tollway**

	(1) Property Tax	(2) Business Tax	(3) Regulatory Fees	(4) User Charge
Distance	-0.683*** (0.224)	-0.718*** (0.159)	-0.752*** (0.101)	-0.546*** (0.124)
Distance × Period <sub>t-2</sub>	0.064*** (0.009)	0.117*** (0.011)	0.047** (0.019)	0.033** (0.016)
Distance × Period <sub>t-1</sub>	0.049*** (0.018)	0.213*** (0.014)	0.173*** (0.013)	-0.007 (0.025)
Distance × Period <sub>t0</sub>	0.095*** (0.011)	0.222*** (0.012)	0.211*** (0.019)	0.059** (0.028)
Distance × Period <sub>t+1</sub>	0.088*** (0.024)	0.111*** (0.014)	0.241*** (0.025)	0.018 (0.027)
Distance × Period <sub>t+2</sub>	0.130*** (0.015)	0.128*** (0.018)	0.300*** (0.023)	0.042 (0.031)
Distance × Period <sub>t+3</sub>	0.101*** (0.018)	0.168*** (0.023)	0.294*** (0.024)	0.083*** (0.026)
Distance × Period <sub>t+4, forward</sub>	0.220*** (0.023)	0.202*** (0.025)	0.377*** (0.016)	0.084*** (0.027)
Construction	0.030 (0.101)	0.902*** (0.059)	0.077 (0.075)	0.496*** (0.135)
Constant	19.74*** (1.108)	12.262*** (0.736)	17.427*** (0.752)	12.930*** (1.255)
<i>N</i>	886	886	886	886
<i>R</i> <sup>2</sup>	0.03	0.07	0.13	0.04

Notes: Clustered standard errors, corrected for small number of clusters.

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Source: Authors.

## 6. CONCLUSIONS

Given the massive amounts of money injected in recent years by many countries in the region on infrastructure it is high time that we evaluate the economic impact and benefits of these investments. The traditional empirical studies on infrastructure have taken the macroeconomic approach of examining the aggregate impact of investment

on growth and productivity. Recently, however, micro-econometric studies have also gained popularity. This study is in line with the latter approach of using quasi-experimental approaches to examine infrastructure projects.

In this study, we examined the impact of the STAR highway located in Batangas province, Philippines, on the public finance of the cities and municipalities through which it directly passes. Specifically, in order to evaluate the impact of the STAR highway, we exploit a unique, disaggregated dataset on the tax and non-tax revenues of the cities and municipalities in Batangas province. These data consist of property taxes and business taxes as well as non-tax revenues covering regulatory fees and user charges.

We find based on our modified difference-in-difference model that it is on business taxes that the STAR highway had a robust statistically significant and economically growing impact. We also find that this so-called “highway effect” of STAR on business taxes also extends to municipalities located in Quezon, a neighboring province of Batangas. These results suggest that certain infrastructure projects may not only have concentrated or “localized” effects, but it can also have wider effects that extend to the regional economy. Furthermore, it appears that the STAR highway had a significant impact not only on public finance, but also on property taxes and regulatory fees. These findings support the widely held belief that infrastructure investments matter. Given the desire of countries in the region to seek alternative sources of sustainable development financing, boosting tax revenues may not only come from an effective revenue system such as better tax administration and adopting various forms of direct and indirect forms of taxation. The findings from our micro-case study suggest that infrastructure investments can have an indirect role to play in boosting tax and non-tax revenues through reducing transportation costs and enhancing the activity of firms and workers located along the highway.

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