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Effects of infrastructure projects on government revenue: The case of expressway projects in the Northern Midland and Mountainous area of Viet Nam

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ADB Working Paper Series

**EFFECTS OF INFRASTRUCTURE
PROJECTS ON GOVERNMENT
REVENUE: THE CASE OF
EXPRESSWAY PROJECTS IN
THE NORTHERN MIDLAND AND
MOUNTAINOUS AREA OF VIET NAM**

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Abstract

This paper examines the effects of infrastructure projects on economic performance by studying the changes in government revenue in the Northern Midland and Mountainous region of Viet Nam. More specifically, this paper investigates the effects of two expressway projects, namely (1) the Noi Bai–Lao Cai project and (2) the Ha Noi–Thai Nguyen project. In this study, we focus on the government revenue of the region, including personal income tax revenue, other government revenue from business activities, and total revenue, because they reflect the economic performance that the infrastructure investment creates. To investigate the impacts of infrastructure projects, we utilize the difference-in-difference (DID) method and compare the government revenue between the traversed regions and the non-traversed regions in two periods: (1) the construction phase and (2) the operation phase of the projects. The main estimated results show significant increases in the government revenue along the two expressways, highlighting an economic increase in the region after the completion of the expressway projects.

Keywords: infrastructure, difference-in-difference analysis, tax revenues, Viet Nam

JEL classification: H54, O11, O23, R11

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1. INTRODUCTION

Infrastructure investment is undeniably one of the key policies for economic development and poverty reduction. High-quality infrastructure projects in transportation, telecommunication, power, or water supply exert favorable impacts on all players in economies, from firms and citizens to the government. Effective infrastructure reduces distribution costs, opens up more economic opportunities, encourages innovation, and boosts the performance of businesses. In addition, it plays a significant role in poverty reduction by creating more new jobs and giving the poor access to better healthcare and education (ADB 2017). Moreover, we need to bear in mind that infrastructure alone cannot play a significant role in poverty reduction. There will be a greater effect of infrastructure investment if the government and private sectors provide much more funds, for example in the form of loans, to support small and medium-sized enterprises (SMEs) in the region.

Investing in infrastructure is costly. ADB (2017) estimates that Asia alone needs \$26 trillion for infrastructure investment from 2006 to 2030. Despite the increasing contribution of the private sector, the main funding for investment still comes from governments. This circumstance raises a concern among governments and the public that investing in infrastructure would cause a heavy burden on government budgets. Especially after COVID-19, government deficit will rise, therefore private investment into infrastructure is very important. As Yoshino and Abidhadjaev (2017b) proved in the case of a high-speed railway project in Japan and Yoshino and Pontines (2018) showed in the case of a road tollway in the Philippines, infrastructure projects increase tax revenue and hence ease the finance burden of the government. This study revisits the issue by focusing on the effects of two expressway projects on the revenue of provincial governments in the Vietnamese Northern Midland and Mountainous area, the most underdeveloped region of the nation. Although there is an expectation that these two projects will play crucial roles in economic development, there is a lack of studies that have quantified the impacts. Therefore, we aim to estimate the changes in government revenue that the projects will cause by applying the difference-in-difference (DID) method and comparing government revenue between traversed and non-traversed regions.

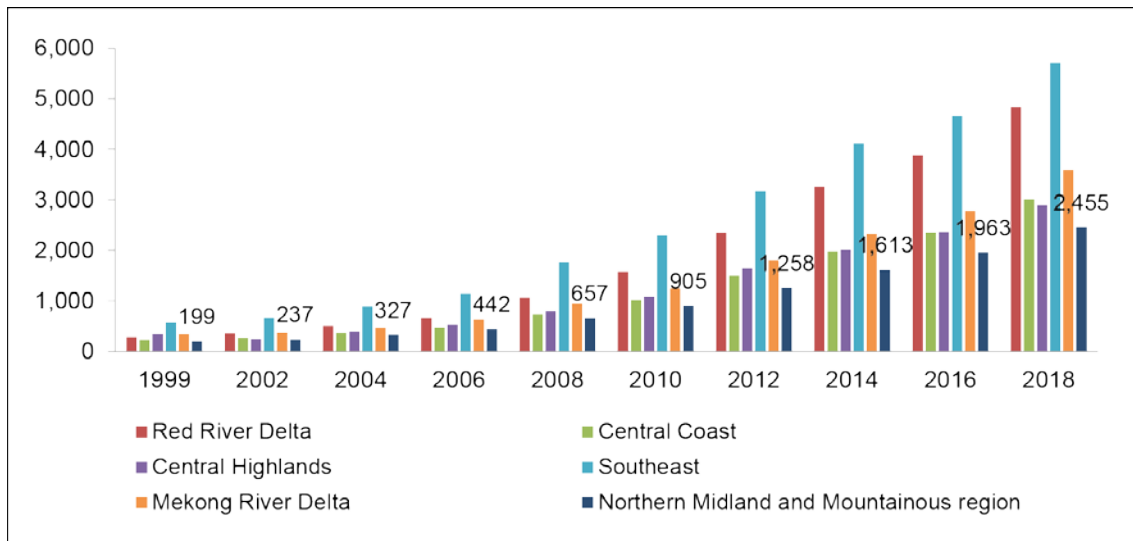
1.1 Overview of the Vietnamese Northern Midland and Mountainous Region

Since 2000, based on socioeconomic characteristics, Viet Nam has been divided into six regions, namely the Northern Midland and Mountainous region, Red River Delta region, Central Coast region, Central Highland region, South East region, and Mekong Delta region. The focus of this study is the Northern Midland and Mountainous region,¹ which is the poorest region in the country. Figures 1 and 2 below show the income per month and poverty rates of the region compared with other regions from 1998 to 2018. The General Statistics Office of Viet Nam (GSO) reports data on income and poverty rates based on data from a household survey, which it conducts every 2 years in Viet Nam. The figures show that, over the past 20 years, the Northern Midland and Mountainous area has remained the poorest region of Viet Nam in terms of both income and poverty rates. In 2018, the average income per month in the region stood at around VND2.5 million, less than half of that in the Southeast region, the richest one in the country. At

¹ The region consists of 14 provinces: Bac Giang, Bac Kan, Cao Bang, Dien Bien, Ha Giang, Hoa Binh, Lai Chau, Lang Son, Lao Cai, Phu Tho, Son La, Thai Nguyen, Tuyen Quang, Yen Bai.

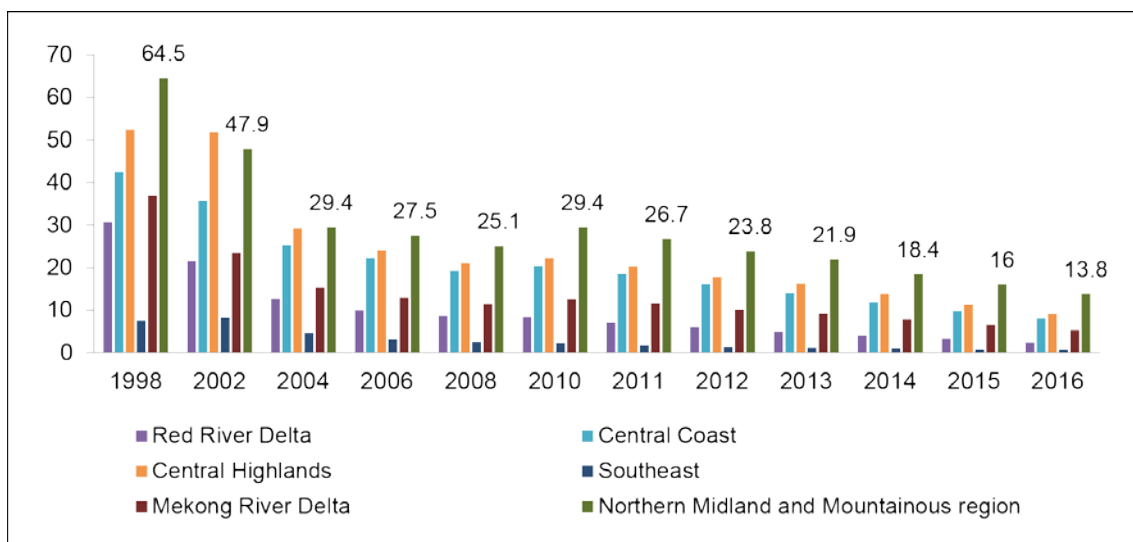
the same time, the region has stood out with the highest poverty rates over the last 20 years.

Figure 1: Income per Month in Vietnamese Regions (1999–2018)
(VND '000)



Data source: The General Statistics of Viet Nam (GSO).

Figure 2: Poverty Rates in Vietnamese Regions (1998–2016)
(Percentage)



Data source: The General Statistics Office of Viet Nam (GSO).

According to Pimhidzai (2018), in Viet Nam, the poor regions are concentrated in remote mountainous areas, including the Northern Mountainous area and the Central Highlands. One of the main reasons for this circumstance is the insufficiency of access to economic opportunities or education due to the low quality of the infrastructure system in the region (ADB 2014). Therefore, constructing a high-quality infrastructure project in the Northern Midland and Mountainous region of Viet Nam is particularly important for boosting economic performance as well as reducing poverty.

The infrastructure improvement should include not only constructing more quality transportation projects but also projects in other sectors, such as enhancing access to the Internet. For instance, the Internet would give students in the area better access to education through online or mobile learning. In 2008, the Vietnamese government have approved a master plan for an expressway system from the north to the south of the country as one of the key focuses of infrastructure improvement in the country. Among the approved projects, there are several projects in the Northern Midland and Mountainous area, including the Noi Bai–Lao Cai, Ha Noi–Thai Nguyen, and Bac Giang–Lang Son projects (Japan International Cooperation Agency (JICA) and Viet Nam Ministry of Transport 2010). There is an expectation that these projects will play a crucial role in improving the economic performance in the region. This study investigates the effects of two expressway infrastructure projects that ended and opened to traffic in 2014: the Noi Bai–Lao Cai and Ha Noi–Thai Nguyen projects.

1.2 Overview of the Highway Projects

The Noi Bai–Lao Cai highway has a length of 265 kilometers, starting in Noi Bai, a suburban area of Ha Noi, and ending at a busy gateway to the People's Republic of China (PRC) in Lao Cai. Most of the funding came from a loan from the Asian Development Bank (ADB), and the highway traverses five provinces/cities, Ha Noi, Vinh Phuc, Phu Tho, Yen Bai, and Lao Cai. This project is one section of the Greater Mekong Subregion Economic Corridor, which helps to connect the PRC's Yunnan province with Ha Noi and Hai Phong in Viet Nam. The construction process lasted from 2008 to 2014, and the expressway opened to traffic in 2014. Another important highway project in the area also opened to traffic in 2014: the Ha Noi–Thai Nguyen project. With a length of 65 kilometers, this project connects Thai Nguyen, a new production hub of Viet Nam, to Ha Noi. With finance from an ODA loan from the Japan International Cooperation Agency (JICA) and from the Vietnamese government, the construction of the Ha Noi–Thai Nguyen expressway began in 2009 and ended in 2014. There is an expectation that these two expressways will play a significant role in the economic development of not only the Northern Mountainous area but also the whole of northern Viet Nam, because they will not only improve the infrastructure quality of the region but also help to connect the PRC to Ha Noi and Hai Phong, two important cities of Viet Nam.

This paper concentrates on the impacts of these two expressway projects on the Northern Midland and Mountainous Area of Viet Nam for several reasons. First, compared with other regions, this region is the most undeveloped one in Viet Nam, and there is a lack of access to economic opportunities due to the inadequate quality of the infrastructure. Therefore, the new high-quality highway projects expect to play a bigger role in promoting the economy of this region. Second, until 2018, only two highway projects operated in five provinces. The remaining 10 provinces still suffered from low-quality old roads. This circumstance creates a context in which to investigate the effects of infrastructure projects by comparing the performance between affected provinces and non-affected provinces.

The total sample of data covers 14 provinces from 2009 to 2018. We divide the region into two groups: the affected group, which benefits from the projects, and the non-affected group, which does not benefit from the projects. The first group consists of four provinces: Phu Tho, Yen Bai, Lao Cai (Noi Bai–Lao Cai highway), and Thai Nguyen (Ha Noi–Thai Nguyen highway). Although both projects have a starting point in Ha Noi, we did not include Ha Noi in the study because it belongs to the Red River Delta region and is very different from the region in terms of socioeconomic factors. We also did not include Vinh Phuc, a province through which the Noi Bai–Lao Cai expressway passes, because this province belongs to the Red River Delta region and hence does not belong to the region of interest. The control group consists of ten provinces: Bac Giang, Bac Kan, Cao Bang, Dien Bien, Ha Giang, Hoa Binh, Lai Chau, Lang Son, Son La, and Tuyen Quang. We divided the data into two periods, the construction phase (2009–2014) and the operation phase (2015–2018). By separating the data into two periods, we could estimate the change in provincial governments' revenue between the construction and the operation phase of the highway projects using the difference-in-difference method.

The estimation results show that the infrastructure projects have favorable impacts on government revenue. After controlling for other key determinants of revenue performance, including the lag of GDP, share of the agricultural sector, and corruption restriction index, we observed significant increases in all three types of revenue, namely income tax revenue, revenue from business activities, and total domestic revenue, in the affected group since the completion of the expressways. These findings suggest a positive impact of expressway projects on economic activities in the affected provinces.

The structure of the paper is as follows. The next section, section 2, details how we conducted the empirical analysis. Section 3 provides more information on the utilized data. Section 4 presents the empirical results, and the last section concludes the paper.

2. DIFFERENCE-IN-DIFFERENCE (DID) METHOD ANALYSIS

One of the main purposes of investing in infrastructure projects is to encourage business activities, employment, and hence economic growth in the region. However, rather than looking at the effects on those variables, this study focuses on the effects of infrastructure projects on three types of government revenue, because the expansion of economic activities will reflect in increases in government revenues. New employment resulting from infrastructure development will result in higher incomes and higher income tax revenue. At the same time, the infrastructure could create more business opportunities, such as the opening of restaurants or factories, and thus raise the business-related tax revenue. Lastly, we also considered the total domestic revenue of provinces, which is the sum of not only personal income tax and revenue from business activities but also agricultural land use tax, revenue from fee and charges, and so on.

Among the 14 provinces in the region, four affected provinces benefit more from the operation of the expressways, which encourage business activities, create employment, and expand economic growth, hence increasing the government revenue of those provinces. Therefore, in this study, we expected to see a significant increase in the government revenues of the affected provinces in the operation phase compared with those of non-affected provinces and in the construction phase.

We applied the difference-in-difference (DID) method, which researchers have often used to study the effects of policy change, for empirical analysis purposes. The basic idea of this method is that, when a government introduces a policy change, there are two

groups, an affected and an unaffected group. We assumed that the two groups follow the same time trend, so, by comparing the affected group between the pre- and the post-change period as well as the unaffected group between the two periods, we would be able to capture the impact of the policy change (Lechner, Rodriguez-Planas, and Fernández Kranz 2016). In this study, we treated the operation of the expressways as a change in the region. The expressways bring changes to those provinces that they pass through and do affect the remaining provinces in the area. Several studies in the literature have applied the difference-in-difference method to investigate the role of infrastructure projects in economic performance. Applying the difference-in-difference method, Yoshino and Abidhadjaev (2017a) studied the impacts of a railway project on the economic performance of a region in Uzbekistan by dividing the region into three groups and distinguishing between four periods of time. This study revealed that this railway project boosted the GDP in the area that the railway passed through in the medium and the long term. Yoshino and Abidhadjaev (2017b) also found positive impacts of Kyushu high-speed railways on the total tax revenue in the affected regions of Japan. The outcomes of the DID analysis showed a significant increase in the total tax revenue in both construction and operation phases. In the cases of corporate tax and personal income tax, they observed rises in the construction and operation phases too.

Following this approach, we classified the region into two groups, namely treated and control groups. Four provinces (Phu Tho, Yen Bai, Lao Cai, and Thai Nguyen) belong to the treated group, and another ten provinces (Bac Giang, Bac Kan, Cao Bang, Dien Bien, Ha Giang, Hoa Binh, Lai Chau, Lang Son, Son La, Tuyen Quang) belong to the control group. Although the construction of the expressways finished in 2014, we expected that it would take several months for these projects to exert effects on the economic activities in the provinces. As a result, we divided the time into two periods: 2009–2014 (the construction phase) and 2015–2018 (the operation phase). It would have been desirable to obtain more data and compare the economic performance of the two groups between three periods, namely the pre-construction phase, the construction phase, and the operation phase. However, due to the unavailability of the data, we could only compare the government revenue between the construction and the operation phase. Figure 3 below provides an illustration of the DID analysis in this paper.

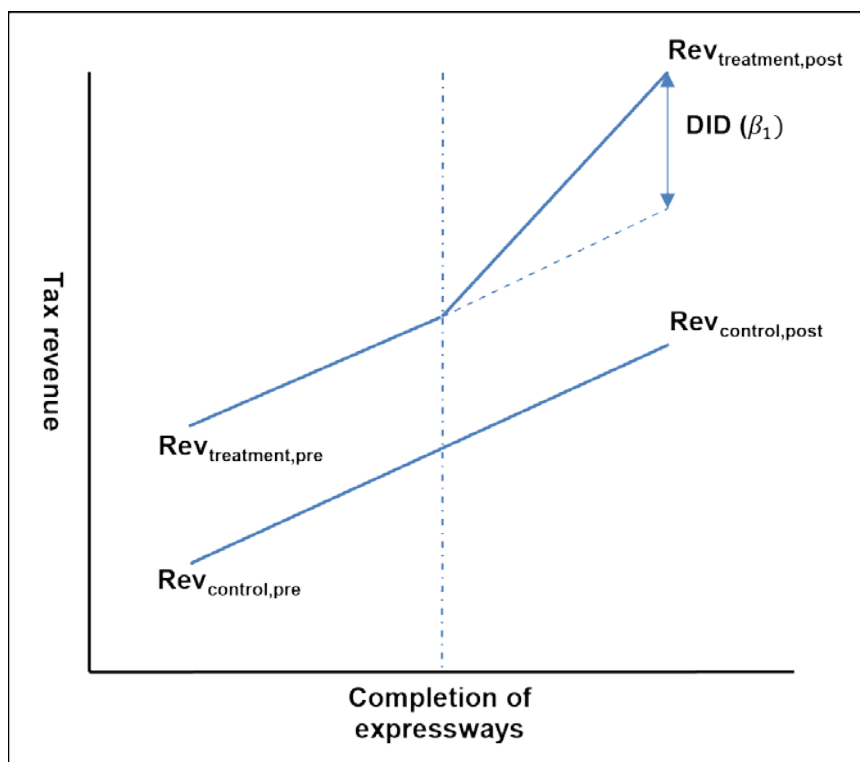
The econometric model of this study followed the model that Yoshino and Abidhadjaev (2017b) used to study the impact of the high-speed train line on government revenue in Japan:

$$Rev_{it} = \beta_1 D_{affected} \times D_{2015-2018} + \beta_3 X_{it} + \varepsilon_{it} + \varphi_t \quad (1)$$

where i stands for province i and t refers to year t . Rev_{it} represents the government revenue (income tax revenue, revenue from business activities, and total domestic revenue). Beside the total government revenue, we ran a regression using the revenue per capita as the dependent variable. The main independent variable is $D_{affected} \times D_{2015-2018}$. $D_{affected}$ is a binary dummy variable taking the value one if provinces belong to the regions through which the expressways pass. $D_{2015-2018}$ is also a binary variable, taking the value one if the observation belongs to the operation phase (2015–2018). $D_{affected} \times D_{2015-2018}$ equals one if the observations are those of affected provinces in the operation phase. Therefore, the estimated coefficients of $D_{affected} \times D_{2015-2018}$ illustrate the changes in revenue from the construction phase to the operation phase that occur in affected provinces but not in other provinces. X_{it} denotes the control variables: the lag variables of the GDP and GDP per capita, the share of the agricultural sector, and the corruption index. We controlled for the GDP and GDP per capita because they are proxies for the level of development of economies, which is a crucial determinant of government revenue (Gupta 2007). Due to the concern about reverse causality

because the government revenue might affect the GDP as well, in this study, rather than the current values, we added the lag values of the GDP and GDP per capita as explanatory variables. The composition of economies measured using the share of agriculture matters for government revenue performance because it is more difficult to tax certain sectors than others. For instance, it is more difficult to tax enterprises in the agricultural sector or those enterprises might be subjected to lower tax rates for political reasons (Bird, Martinez-Vazquez, and Torgler 2014). Therefore, a larger share of agriculture in economies is likely to be associated with lower revenue generated from business activities. In addition, it was necessary to consider institutional quality factors, such as corruption, as potential determinants (Gupta 2007).

Figure 3: Illustration of the DID Method



Source: Drawn by the authors following Yoshino and Abidhadjaev (2017b).

In this study, we simply used a fixed-effect model for estimation purposes.² Of course, there still exists a concern about endogeneity, and utilizing instrumental variables would be a better solution. However, we could not find any valid instrumental variable to handle this problem.

² Considering that the panel data only cover a short period of time, we do not run unit root tests or tests for cointegration in this paper.

3. DATA DESCRIPTION

We obtained the data used in this paper from three sources: provincial statistical yearbooks, the general statistics office of Viet Nam (GSO), and the provincial competitiveness index (PCI). The data on three types of government revenue, income tax revenue, revenue from business activities, and total domestic revenue, come from provincial statistical yearbooks, and we deflated them based on the nominal and real GDP. Provincial statistics offices collect and report these data based on data from provincial treasury and finance departments. Table 1 shows the details of the main components of revenue from business activities and total domestic revenue based on Vietnamese regulations. We constructed this table based on information about the Viet Nam State Budget Disclosure of Final Accounts of Vietnamese provinces from the website of the Ministry of Finance of Viet Nam (mof.gov.vn). Revenue from business activities is a combination of many types of business-related taxes that provincial governments collect from enterprises, including private, public, and foreign enterprises. The total domestic revenue comprises the revenue of provincial governments from enterprises and individuals, including several types of taxes, charges, and fees.

Table 1: Components of Revenue from Business Activities and Domestic Revenue

	Main Components
Revenue from business activities	Value-added tax (VAT) Enterprise income tax Business license tax Natural resource consumption tax
Domestic revenue	Revenue from business activities Personal income tax Registration fee Fees and charges Real estate-related taxes and fees Agricultural land use tax

The data for several other variables, including the deflated GDP and the value added of agriculture, are also from the provincial yearbooks. We computed the GDP per capita and share of agriculture (value added of agricultural sector/GDP) in the economy based on the data that we obtained from the yearbooks. The data on population are from the website of the GSO. The corruption restriction index data are from the PCI index, which is a cooperation between the United States Agency for International Development (USAID) and the Viet Nam Chamber of Industry and Commerce (VCCI) compiles. The corruption index is the informal charge index of the CPI, which reflects how well Vietnamese provinces perform in restricting corruption. A higher corruption restriction index means a lower level of corruption. Based on the obtained data, we constructed a panel data set that contains annual data of 14 provinces in the region from 2009 to 2018.

Table 2: Descriptive Statistics

Details	Unit	Obs.	Mean	SD	Min.	Max.
All provinces						
Total domestic revenue	VND billion	129	1,587.79	1,407.80	253.50	8,633.49
Revenue from business activities	VND billion	128	828.05	710.63	109.37	4,481.70
Income tax revenue	VND billion	129	68.71	118.38	0.32	877.32
Domestic revenue per capita	VND million	129	1.77	1.11	0.62	6.81
Revenue from business activities per capita	VND million	128	0.94	0.61	0.29	3.53
Income tax revenue per capita	VND million	129	0.07	0.09	0.00	0.69
GDP	VND billion	130	18,228.6	13,305.0	3,908.6	72,064.2
			2	3	3	1
GDP per capita	VND million	130	20.50	8.27	9.79	56.82
Share of agriculture		130	0.24	0.05	0.10	0.38
Corruption restriction index		140	5.38	0.96	2.81	8.05
Treatment group						
Total domestic revenue	VND billion	36	2,710.19	1,808.76	719.56	8,633.49
Revenue from business activities	VND billion	35	1,406.97	915.84	379.84	4,481.70
Income tax revenue	VND billion	36	145.64	192.51	20.85	877.32
Domestic revenue per capita	VND million	36	2.67	1.51	0.96	6.81
Revenue from business activities per capita	VND million	35	1.39	0.74	0.51	3.53
Income tax revenue per capita	VND million	36	0.13	0.15	0.03	0.69
Control group						
Total domestic revenue	VND billion	93	1,153.32	910.50	253.50	5,759.94
Revenue from business activities	VND billion	93	610.18	460.06	109.37	2,005.87
Income tax revenue	VND billion	93	38.93	46.76	0.32	322.39
Domestic revenue per capita	VND million	93	1.42	0.63	0.62	3.40
Revenue from business activities per capita	VND million	93	0.77	0.45	0.29	2.51
Income tax revenue per capita	VND million	93	0.04	0.03	0.00	0.19

Figures 4, 5, and 6 show the trend of income tax revenue, revenue from business, and total domestic revenue from 2009 to 2018. To estimate the differences in the growth of the revenue between the construction phase and the operation phase, we computed the revenue index based on the average revenue of the provinces in each group. To show the trend of revenue growth from expressways that are open to traffic, we set the index in 2015 at 100. We divided the data of the regions into two groups, affected provinces and non-affected provinces, and compared the growth of the revenue in the two groups. The graphs indicate that, after the completion of the projects, the growth rate of all three types of revenue is significantly higher in the provinces that the expressways pass through compared with the non-affected provinces. Especially, we observed more significant gaps in the cases of income tax revenue and revenue from business activities. In the case of income tax revenue, the revenue index in 2018 of the treatment group is around 200, while that of the control group is just about 149, a much lower number. Also in 2018, the index of business revenue of the treatment and control groups is approximately 149 and 121. These figures illustrate a pattern in the area whereby, after the completion of the infrastructure projects, the revenue in those provinces through which the expressways pass increase at much higher rates than those in other provinces. Even though we needed to conduct more a sophisticated analysis and control other factors to answer the question of whether expressways facilitate more economic opportunities and thus increase the government revenue in the affected provinces, these

graphs give a hint about the significant gaps in revenue between the treatment and the control group.

Figure 4: Income Tax Revenue between Affected Provinces and Non-Affected Provinces

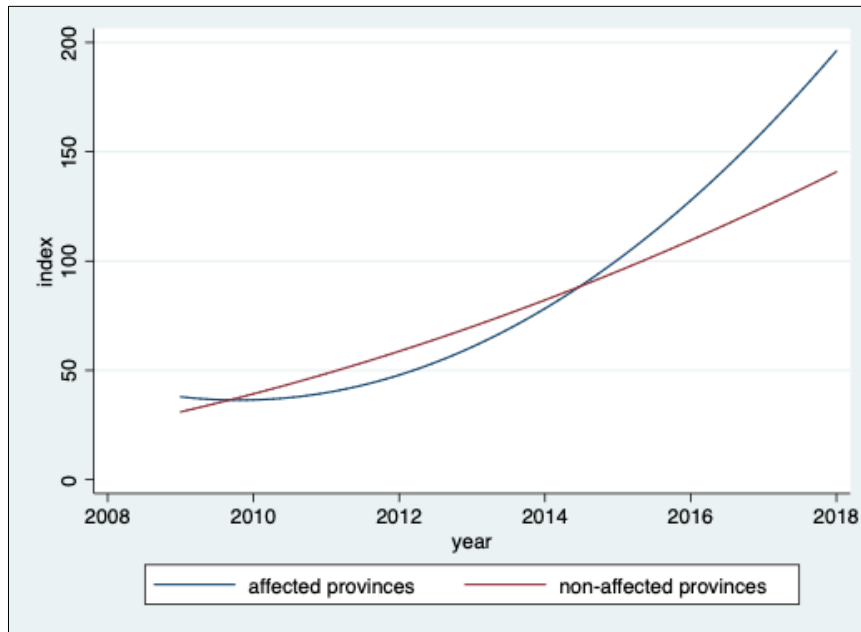


Figure 5: Revenue from Business between Affected Provinces and Non-Affected Provinces

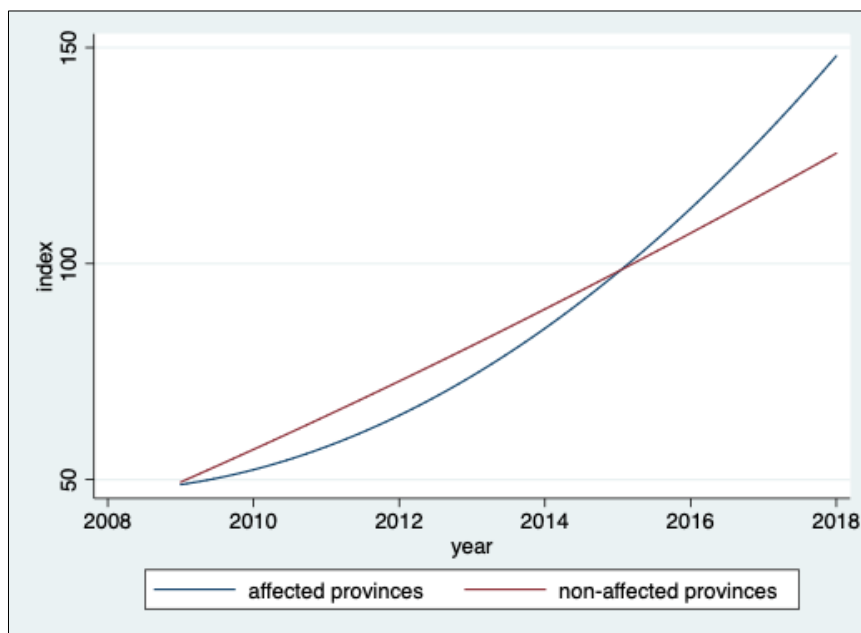
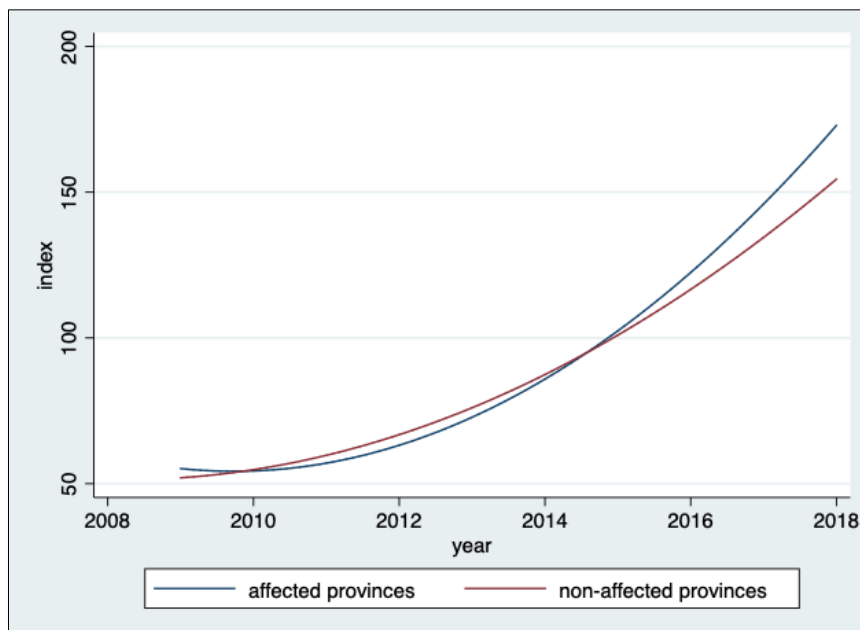


Figure 6: Domestic Revenue between Affected Provinces and Non-Affected Provinces



4. EMPIRICAL RESULTS

Tables 3, 4, and 5 below present the empirical results of the regressions on income tax revenue, revenue from business, and total domestic revenue, respectively. The first two columns of each table show the results for the total revenue, while the other two show the results for revenue per capita. The within R squared value is quite high, from around 0.71 to 0.94, suggesting that the econometric models perform quite well in capturing the real data. The estimated coefficients of the main explanatory variable, $D_{affected} * D_{2015-2018}$, are significantly positive in most of the cases, suggesting positive impacts of infrastructure projects on all three types of government revenue. In addition, the GDP and GDP per capita appear to play enhancing roles in government revenue, while the results of the share of agriculture differ between income tax revenue and revenue from business.

4.1 Effects of Infrastructure Projects on Income Tax Revenue

Table 3 presents the outcomes of the regressions on income tax revenue. Column 2 in Table 3 contains the results of the regression on the total income tax when including all the control variables. The estimated coefficient of the main variable, $D_{affected} * D_{2015-2018}$, stands at around 35.59. This number indicates that the operation of expressway projects adds more VND38.51 billion to the income tax revenue of the affected provinces compared with the non-affected provinces. Considering that the mean of income tax revenue of the affected provinces is around VND146 billion, the increase makes up a substantial ratio, around 24% of the average revenue. In addition, the income tax per capita of affected provinces increases by around VND0.0372 million after the completion of the infrastructure projects. These figures imply that the Noi Bai–Lao Cai and Ha Noi–Thai Nguyen expressways are beneficial to the provinces that they traverse because they help to create new jobs and economic opportunities,

raise the income of the people who live in those provinces, and therefore increase the income tax revenue of the provinces.

As expected, the results of the lag of GDP and GDP per capita are positive and significant at the 1% level. These results confirm that the size of the economy and income level of citizens are important factors that determine the personal income tax that the local government collects. However, the positive coefficients for agriculture are quite unexpected.

Table 3: Effects on Income Tax Revenue

Dependent Variable	(1)	(2)	(3)	(4)
Independent Variable	Income Tax	Income Tax	Income Tax per Capita	Income Tax per Capita
<i>D_{affected}</i> * <i>D₂₀₁₅₋₂₀₁₈</i>	29.71** (0.038)	35.59*** (0.006)	0.0365** (0.029)	0.0372*** (0.006)
GDP _{i,t}	0.0102*** (0.000)	0.0123*** (0.000)		
GDP per capita _{i,t}			0.00884*** (0.000)	0.0115*** (0.000)
Agriculture share _{i,t}		659.1** (0.030)		0.595* (0.099)
Corruption restriction _{i,t}		2.772 (0.233)		0.00388 (0.157)
Constant	-106.5*** (0.000)	-313.7*** (0.004)	-0.106*** (0.000)	-0.320** (0.110)
Within R_squared	0.771	0.796	0.705	0.735
Observations	115	115	115	115
Number of groups	14	14	14	14

Note: p-value in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

4.2 Effects of Expressway Projects on Revenue from Business Activities

Table 4 shows the regression results on government revenue from business activities. The estimated coefficients of the DID variable are positive for both total revenue and revenue per capita but only significant in the case of total revenue. The results presented in column 2 in Table 4 indicate that, on average, the operation of infrastructure projects adds around VND232.5 billion to each province that benefits from the infrastructure projects. This is a considerable increase in government revenue, considering that the mean of the total revenue from business activities in one year for provinces in the whole region is around VND828 billion and the figures for provinces in the treatment and control groups are approximately VND1,406 billion and VND610 billion.³ This finding provides evidence that, once the expressways are open to traffic, they bring more access to economic opportunities to the private sector, especially businesses, in the area. In return, local governments benefit from the business growth because they can collect more taxes.

³ More details on government revenue appear in Table 1: Descriptive Statistics.

Similar to the results for income tax revenue, the lags of GDP and GDP per capita are significant factors that are positively associated with revenue from business activities. The estimated coefficients of the share of the agricultural sector are significantly negative, as expected. This result favors the view of Gupta (2007) that a larger share of agriculture is negatively associated with the revenue performance of developing countries' governments because it is more difficult to tax businesses in the agricultural sector than in the manufacturing and service sectors. Table 4 also presents unexpected results for the corruption restriction variable. The significantly negative coefficients of this variable suggest that governments that perform better in terms of restricting corruption actually collect less revenue from business activities. This finding supports the "grease of the wheels" hypothesis about the effects of corruption on business activities in the region. According to this hypothesis, in economies with administrative inefficiency, enterprises might benefit from bribery because it helps them to overcome administrative delays and speed up transactions (Méon and Weill 2010).

Table 4: Effects on Revenue from Business Activities

Dependent Variable	(1)	(2)	(3)	(4)
Independent Variable	Business Revenue	Business Revenue	Business Revenue per Capita	Business Revenue per Capita
$D_{affected} * D_{2015-2018}$	264.7** (0.035)	232.5* (0.081)	0.107 (0.149)	0.0977 (0.368)
GDP _{i,t}	0.0512*** (0.000)	0.0440*** (0.000)		
GDP per capita _{i,t}			0.0615*** (0.000)	0.0402*** (0.000)
Agriculture share _{i,t}		-2,171** (0.039)		-4.399*** (0.003)
Corruption restriction _{i,t}		-37.12** (0.032)		-0.0588** (0.014)
Constant	-44.74 (0.338)	795.0*** (0.004)	-0.235*** (0.001)	1.538*** (0.001)
Within R_squared	0.797	0.815	0.724	0.781
Observations	114	114	114	114
Number of groups	14	14	14	14

Note: p-value in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

4.3 Effects on the Total Domestic Revenue

After running tests to estimate the effects on income tax revenue and revenue from business activities, we ran further tests to estimate the effects on the total domestic revenue (see Table 1). The results of the $D_{affected} * D_{2015-2018}$ variable are positive and significant at the 1% level in all the tests. More specifically, column 2, Table 3, shows that, after controlling for the lag of GDP, agriculture share, and corruption restriction index, the total revenue rises by about VND479.7 billion compared with the unaffected provinces. Given that the mean of the total domestic revenue of provinces in the region is only approximately VND1,588 billion, it is apparent that the operation of new expressways exerts substantial effects on the economic activities and financial performance of the local government of the affected provinces. In addition, the domestic

revenue per capita increases considerably by around VND0.442 million. One point to note here is that the majority of the increase in the total domestic revenue comes from the increase in revenue that local governments collect from business activities. The increase in business revenue that Table 4 shows is around VND232.5 billion, making up almost half of the total increase.

The estimated coefficients of the lag of GDP and GDP per capita remain significantly positive. The size of the economy and income level of provinces are crucial determinants of the total domestic revenue that provincial governments generate in the region. The results for the share of agriculture are not significant in the case of the total domestic revenue but are significantly negative in the case of the domestic revenue per capita.

Table 5: Effects on Total Domestic Revenue

Dependent Variable	(1)	(2)	(3)	(4)
Independent Variable	Domestic Revenue	Domestic Revenue	Domestic Revenue per Capita	Domestic Revenue per Capita
$D_{affected} * D_{2015-2018}$	490.1*** (0.007)	479.7** (0.012)	0.452*** (0.008)	0.442** (0.021)
GDP _{i,t}	0.128*** (0.000)	0.124*** (0.000)		
GDP per capita _{i,t}			0.133*** (0.000)	0.118*** (0.000)
Agriculture share _{i,t}		-1,203 (0.335)		-3.248* (0.086)
Corruption restriction _{i,t}		-4.466 (0.764)		-0.0394* (0.086)
Constant	-606.4*** (0.000)	-231.7 (0.508)	-0.824*** (0.000)	0.461 (0.341)
Within R_squared	0.936	0.937	0.895	0.902
Observations	115	115	115	115
Number of groups	14	14	14	14

Note: p-value in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

5. CONCLUSION

Aiming to reveal the impacts of infrastructure projects on economic performance, this research studied the case of two expressway projects (Noi Bai–Lao Cai and Ha Noi–Thai Nguyen) in the Northern Midland and Mountainous area of Viet Nam, the least developed region in the country, and produced several notable findings. The estimation results favor the argument of many policy makers who see infrastructure development as a key policy that would facilitate better access to economic opportunities and education and thus better economic performance in the region. Even after controlling for several significant determinants of government revenue, the analysis suggested that local governments of provinces that belong to the treated group could collect more government revenue after the expressways open to traffic. The increase in revenue could be observed in not only personal income tax and revenue from business activities but also total domestic revenue. These findings suggest the role of infrastructure projects in economic activities because better performance of an economy would result in higher government revenue, especially tax revenue. For instance, the rise in personal income

tax suggests higher income of citizens because of the creation of more employment opportunities. The expressways also give more chances to expand the business of enterprises and increase the business-related taxes that the government collects.

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