Assessment of the Intended Outcomes of the Newly Built Expressway in Sri Lanka

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The purpose of this work is to assess the achieved level of intended outcomes of the first expressway in Sri Lanka, focusing on the contributions of the industrial sector as a sustainable growth engine. The fixed effect estimation was based on a difference-in-difference framework. We found that the industrial sector value addition for the affected regions was greater than for the non-affected regions, i.e., by approximately 160 billion Sri Lankan rupees per annum, which accounts for 38% of the total impact on the regional gross domestic product (RGDP). The expressway induced 285 small and medium enterprises (SMEs), while the unemployment rate declined by 1.05% due the expressway.

Keywords: expressway, difference in difference, impact assessment, industrial sector, regional GDP, unemployment

INTRODUCTION

Despite the controversies among classical thoughts, the requirements of infrastructure for economic growth are emphasized by all schools of thought in economics. Researchers widely accept that improvements in infrastructure can contribute to economic growth and social welfare. The Sri Lankan authorities have thus invested huge amounts of money in road construction, including expressways—a policy decision justified by different points of view. The effectiveness of other infrastructure facilities across different regions also depends on their accessibility. Hence, road construction, which affects the largest proportion of the population, both within and outside of a region, is the most influential carrier of sustainable development. However, the controversial issue pertains to the national priorities regarding infrastructure schedules and the level of effectiveness. Gertler, Sebastian, Laura, Christelm, Vermeersch, (2010) mentioned that the purpose of development projects is to change outcomes and to improve the well-being of community members. More commonly, authorities simply focus on controlling and measuring the resources spent during the course of a project, as well as the performance of said project without assessing whether the project achieved its sustainable outcomes. Accordingly, the crucial public policy question is whether the construction of the first expressway in Sri Lanka achieved its intended outcomes and, in turn, whether it ensured the sustainable development of the affected regions in Sri Lanka?

The expansion of the road network directly generates new markets and expands market opportunities not only for the goods market, but also for the factor market. The outcome of such expansion indirectly influences investment decisions, which then transform into industrial production, household income, and public revenue. Improvement in the quality and quantity of road networks reduces the travel time and associated costs, which directly influence the goods and factor markets through factor productivity. As pointed out by Inthakesone and Kim (2016), the urban–rural connection roads provide market access opportunities to rural people and help them to diversify their income sources as they are linked with a greater variety of functional livelihood value chain systems. Guojun, Yang, and Zhang (2020), provided evidence within a difference-in-difference (DID) framework that poor rural counties grew faster in terms of gross domestic product (GDP) while slowing down the growth in rich rural counties due to the Chinese expressway system when compared to unconnected rural counties.

The purpose of this paper was to assess the impact of the expressway from Katunayaka International Airport, which is located in the western province, to Matara, which is located in southern Sri Lanka, on the industrial sector as a sustainable growth engine. We aimed to identify the causal effect of the expressway with regard to the intended outcomes of the project, such as industrial sector value addition, improving unemployment, and benefiting small and medium enterprises (SMEs). The impact assessment was carried out using the DID approach by employing a fixed effect estimation procedure for 14 years of panel data over the 2005–2018 period.

Our initial findings can be summarized as follows: The estimation results suggest that the expressway increased the industrial sector value addition in the affected regions (i.e., the western and southern provinces) by approximately 160 billion Sri Lankan rupees , which accounts for 38% of the total impact on the regional gross domestic product (RGDP). Meanwhile, the unemployment rate was reduced by 1.05% in comparison to the non-affected regions, and the expressway encouraged the development of approximately 285 SMEs in the affected regions.

The rest of the paper is organized as follows. Section 2 is devoted to discussing some of the related literature. Section 3 provides an economic overview and background information on the expressway project in Sri Lanka. Section 4 outlines the methodology. Section 5 describes the data and estimation results. Section 6 provides the conclusion and policy implications.

LITERATURE REVIEW

As Shahidur, Gayatri, Hussain, (2010) mentioned, impact evaluations, as a part of evidence-based policy making, are marked by a shift in focus from the inputs to the outcomes and results. Even if it is impossible for impact evaluations to capture exactly how infrastructure might affect economic outcomes, there is still important policy relevance in terms of how infrastructure provision influences the outcome variables of interest. It is important for the central government to review the economic viability of future infrastructure projects, as these are particularly sensitive issues for developing countries, which often finance infrastructure projects through foreign aid and domestic borrowings. Donor countries and agencies might also have an interest in the magnitude and significance of the impact of particular infrastructure projects on economic outcomes in developing countries.

The empirical literature provides evidence for a number of empirical approaches that have been used to investigate the socio-economic impacts of infrastructure development. Shahidur et al. (2019) mentioned that development projects and program evaluation approaches have evolved greatly over the past two decades toward impact evaluation. The issues of total impact estimation are typically addressed by randomized trial methods or treatment effect methods. The DID method is a convenient technique to use when the randomization of individuals is not feasible. Accordingly, researchers can estimate the effect of a specific intervention by comparing the changes in the outcomes over time between an affected group of the population that is enrolled in a project/program and a non-affected group of the population, under the assumption of a common time path and the availability of pre- and post-treatment data on the outcome variables of interest.

Provocative findings in the field provide both confirmatory and contradictory results. Yoshino, Nakahigashi (2000) conducted an empirical investigation on the productivity effects of infrastructure in Japan, and subsequently in Thailand, by employing a production function approach. They suggested that tertiary industries, such as the telecommunication sector, show greater productivity effects as a result of infrastructure development than do primary and secondary industries. They also revealed that regions with large urban areas appear to experience greater effects from the provision of new infrastructure. In a literature survey conducted by Pereira and Andraz (2013), they mentioned that the magnitudes of the effects of public investment in infrastructure development tends to be substantially higher for less developed countries.

In particular, Bouasone and Masaru (2019) estimated the impact of irrigation on household sticky rice productivity in Lao People's Democratic Republic by employing propensity score matching (PSM) and the DID method, and suggested that “the average sales value and total production of sticky rice for irrigated households is greater than those for non-irrigated households by around 36% to 38% per season.” With greater similarity to our work, Naoyuki and Umid (2017), estimated the changes in the growth rate of regional-level economic outcomes in affected regions as a result of the newly built railway connection in the southern part of Uzbekistan based on DID estimation, and their results suggested that the railway line increased the regional gross domestic product in the affected regions by approximately 2%. Wang, Ming, Xinyi, Longfeng and Paul (2020) found that the introduction of the high-altitude railway connecting Qinghai Province to Tibet increased the GDP per capita by 33%.

Benjamin, F. (2014) suggested that the Chinese National Trunk Highway System led to a reduction in GDP growth among peripheral counties outside of the network. Guojun et al. (2020) showed that the “Chinese expressway system helps poor rural counties grow faster in GDP while slowing down growth in the rich rural counties, compared with the unconnected rural counties” in the framework of the DID method. Wang et al. (2020) found that both rail and road transport infrastructure has a significant positive impact on economic growth in Southeast Asia, Central Europe and Eastern Europe. However, there was no significant correlation in other regions. Regional economic growth demonstrated a negative correlation with the development of road infrastructure in South Asia and with rail infrastructure in West Asia and North Africa. Wang et al. (2020) employed the spatial econometric technique with cross country data.

ECONOMIC OVERVIEW AND THE BACKGROUND OF THE PROJECT

Economic Overview

The economic growth rate continuously declined from 5% to 2.3% over the 2014–2019 period in Sri Lanka. The GDP per capita increased by 3.9% in 2019 in comparison to an increase of 6.7% in 2018. It is estimated at Sri Lankan Rupees (Rs) 688,719 in 2019, compared to Rs. 662,949 in 2018. The industry activities (value-added) grew by 2.7% in 2019 compared to the growth of 1.2% recorded in 2018. Being the second-largest contributor, the industrial sector accounted for 27% of the GDP of the economy. The unemployment rate increased from 4.4% to 4.8% over the 2013–2019 period. The population density per square kilometer increased from 342 to 346 during 2017- 2018 in Sri Lanka.

The regional GDP (RGDP) of the western and southern provinces accounted for 50% of the total GDP in 2015, while the other seven provinces accounted for the remaining 50%. The contribution of the industrial sector to the RGDP was 34.5% in the western province and approximately 18% in the southern province in the same year. The unemployment rate in the western province reduced by 1% in 2018 from 4.1% reported in 2015. However, in the southern province, the unemployment rate only reduced by 0.1% within the same time period. The RGDP per capita in the western province was estimated as 730,083 in 2015, compared to 901,562 Sri Lankan Rs in 2018. In the southern province, it was estimated as 432,493 Sri Lankan Rs in 2015 and 542,893 Sri Lankan Rs in 2018. The number of SMEs increased by 261 between 2013 and 2018, while this increased by 54 in the southern province. (Source of Data: Central Bank Annual Report 2019, Sri Lanka.)

Background of the Project

The full length of the Sri Lankan road network, including its expressway, is approximately 12,442.6 km (see Table 1). The expressway travels from Katunayake (the international airport) to Hambantota (the international airport and harbor) and consists of three phases, namely, the Southern Expressway, the Outer Circular Highway (OCH)—which is located in the Colombo Metropolitan Region—and the Colombo

Katunayake expressway (see Figure 1). In this work, we focused on the regions that were exposed to the positive effects of the newly built expressway from Katunayake to Matara that initially operated on or before March 2014 (see Table 2). The total length of this section is around 181 km, including 19 interchanges (namely, the Katunayake, Ja-Ela, Kerawalapitaya, Peliyagoda, Kadawatha, Kaduwela, Kothalawala, Athurugiriya, Kottawa, Kahathuduwa, Gelanigama, Dodangoda, Welipenna, Kurundugaha, Baddegama. Pinnaduwa, Imaduwa, Kokmaduwa, and Godagama interchanges).

This expressway has a four-lane capacity, and the maximum operating speed is 100 km/h. The expected travel time from Colombo to Matara through the Southern Expressway is 2 h. The Sri Lankan government spent 2534 million USD on the aforementioned section of the expressway, which is approximately 186 km in length. On average, the cost per kilometer was approximately 13.6 million USD (see Table 3). After starting the construction of the expressway, the prices of the land and property situated along the expressway rose. These property market dynamics may have affected the social and economic behaviors within and outside of the affected regions as the project spread throughout two provinces—the western province as the commercial hub of the country and the southern province. Table 4 indicates the land price movements across the selected areas.

FIGURE 1
THE EXPRESSWAY NETWORK IN SRI LANKA

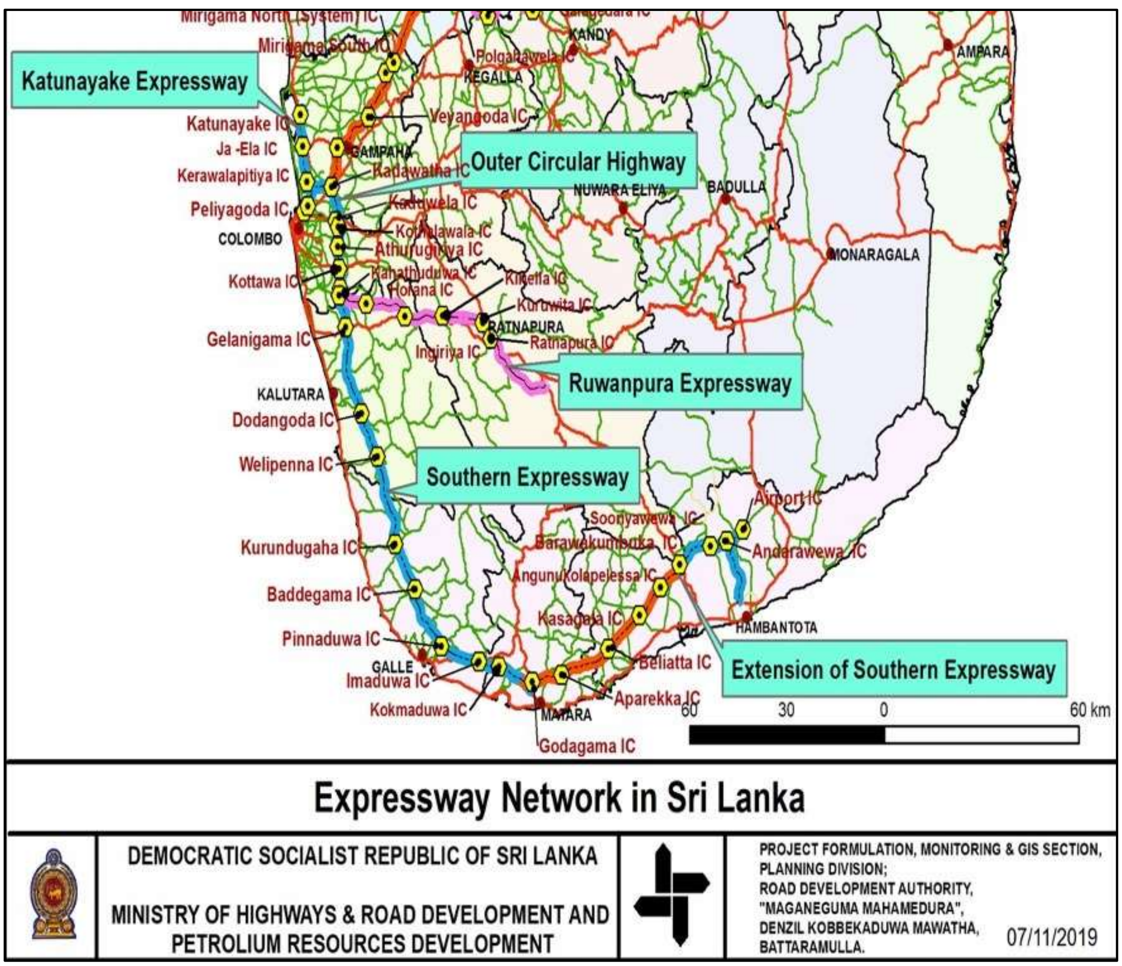


TABLE 1
NATIONAL HIGHWAYS IN SRI LANKA

Road Class	**Length**	
Class "E" roads		222.000 km
Class "A" roads		4217.420 km
Class “AA” roads	3720.310 km	
Class "AB" roads	466.920 km	
Class "AC" roads	30.190 km	
Class "B" roads		8003.167 km
All national highways ("A," "B,” and "E" class roads)		12,442.587 km

Source: Road Development Authority

TABLE 2
PARTS OF THE EXPRESSWAY IN OPERATION IN 2020

Route Number	Road Name	Length (km)	Open to the General Public
E001	Southern Expressway	**222.000**	
	Colombo to Galle	95.3	27.11.2011
	Galle to Matara	30.8	15.03.2014
	Matara to Hambantota	96	23.02.2020
E002	Outer Circular Highway (OCH)	**28.867**	15.03.2014
E003	Colombo–Katunayake Expressway	**25.800**	27.10.2013
	Total length of the expressway in operation (Katunayake to Hambantota)	276.667	

Source: Road Development Authority

TABLE 3
THE COST OF THE CONSTRUCTION OF THE EXPRESSWAY IN SRI LANKA

Expressway	Phase	Donor	Construction Period	Length (km)	Cost (USD Mn)	USD Mn per Km
Southern Expressway	Kottawa to Kurudugaha	Japan	2001–2011	67	463	7
	Kurudugaha to Pinnaduwa	ADB	2000–2011	29	277	9
	Pinnaduwa to Godagama	China	2011–2014	35	152	4
OCH	Kottawa to Kaduwela	Japan	2009–2014	11	212	19
	Kaduwela to Kadawatha	Japan	2012–2015	9	379	43
	Kadawatha to Kerawalapitiy	China	2013–2014	9	666	72
Katunayake Expressway	Colombo to Katunayake	Japan	2009–2013	26	385	15
Total				186	2534	13.6

Source: Professor Amal (2019)

TABLE 4
LAND PRICE CHANGES IN THE CITIES ALONG THE EXPRESSWAY

City	Percentage Increase in Land Price (2015 vs. 2012)	City	Percentage Increase in Land Price (2015 vs. 2012)
Kottawa	81%	Athurugiriya	32%
Pannipitiya	113%	Hokandara	49%
Panadura	124%	Kaduwela	46%
Kalutara	47%	Malabe	47%
Aluthgama	49%	Kadawatha	34%
Ambalangoda	79%	Waliweriya	143%

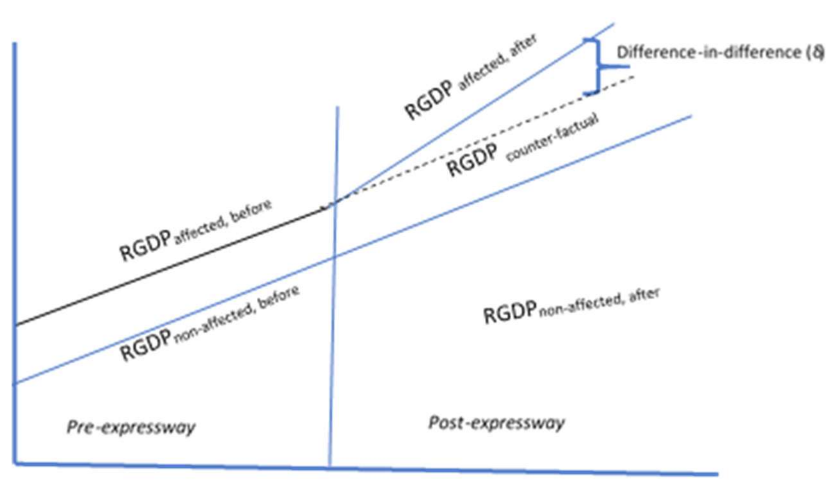
Source: Price Waterhouse Coopers: https://www.pwc.com/lk/en/services/deals/real-estate-advisory/publications/The-Nexus-between-Property-and-Road-Development-in-Sri-Lanka.html.

This expressway was constructed as a multipurpose project that included the following objectives: to develop the industries and services in the region; to encourage local and foreign investors to expand the job market; to reduce travel time and traffic congestion; to develop the towns within the interchanges as economic centers; to expand tourism in the region by ensuring fast access to international airports; to develop the ports of Galle and Hambantota; to enhance the values of the land and property in the region; and to reduce carbon emissions. In this work, we attempted to estimate the magnitude of the achievement of particular objectives regarding the economic performance for the regions exposed to the project compared to those that were not.

METHODOLOGY

To estimate the impact of the Expressway Project in terms of the economic dimensions, in particular, we considered variations in the outcome variables affected by the introduction of the project. To accomplish this, we employed the DID approach: Shahidur, et al. (2010) mentioned that this approach essentially compares affected and non-affected groups in terms of outcome changes over time comparative to the outcomes observed for a preintervention baseline. Accordingly, the data were decomposed into a control group and a treatment group on the basis of geographical location and time, which illustrated the differences between the pre- and post-intervention data. Figure 2 provides a graphical illustration of the DID method with the RGDP.

FIGURE 2
GRAPHICAL ILLUSTRATION OF THE DID METHOD WITH RGDP



First, we estimated the regional effects based on geographical context. Then, we considered the variations in the outcome variable in terms of the timing. Accordingly, a probabilistic expression for the DID coefficient can be illustrated as follows:

$$(E[Yit|i=AR,t\{After\}]-E[Yit|i=AR,t\{before\}])-(E[Yit|i=NAR,t\{after\}]-E[Yit|i=NAR,t\{before\}])=\delta \quad (1)$$

where E represents the population averages, Y is the outcome variable, i symbolizes the geographical regions (such as provinces or districts), t denotes the year, AR indicates the affected regions of the expressway, NAR indicates those regions not affected by the expressway, and δ denotes the DID coefficient.

Then, we controlled for time-invariant, region-specific effects and year-specific effects. However, variances in the outcome variables might be driven by other factors, in addition to the provision of the expressway and the aforementioned effects. Not considering these effects might have caused bias in our estimation results. Banerjee and Duflo (2009) and Ravallion (2009) explained that this is an external validity problem; accordingly, we need to determine the factors behind the cause of variance in each outcome variable. We can reach a less biased estimate of the DID coefficient by controlling for suitable time-varying covariates, and we can define the linear projection of the variable of interest by incorporating such time-varying covariates into the general form of the specification for the DID estimation framework as follows:

$$Y_{it} = \alpha_i + \gamma_t + X'_{it}*\beta + \delta*Ew\_d_{gt} + \varepsilon_{it} \quad (2)$$

where Y represents the outcome variable, X denotes the vector of the time-varying covariates, Ew_dgt is the dummy variable that indicates the observation belonging to the affected group after the provision of the expressway, i refers to the regions, g refers to the groups of regions (1 = affected group and 0 = non-affected group), t refers to the treatment before and after the provision of the expressway (t = 0 before and t = 1 after), and αi considers the heterogeneous factor of individual regions that requires for DID to meet the paroral trend assumption. Assume that the autonomous rate of growth α to be equal in both the affected and non-affected groups. The year-specific effects represented by γt and εit is stand-ins for the error term, which is assumed to be independent over time. The vector of the observed controls (X) as shown in table 5, can be classified according to the outcome variables corresponding to the provincial and district levels.

We used a fixed effects estimator to consider both the time-invariant unobserved characteristics and the year-specific effects. If such factors do not determine the nature of the changes in the control variables, a random effects estimator might be effective. However, this would ignore important information regarding the change in variables over time, when regional heterogeneous characteristics are correlated with time-varying covariates. Thus, we presented both type of estimations subject to the Hausman test for favorable estimation.

The assumption behind the estimation is that the changes in the outcome variables at the regional level in treated regions would be induced only through the expressway being the biggest project implemented in said regions, conditional upon the regions' time-invariant effects, evolving the social and economic characteristics (i.e., year-specific effects) and time-variant factors mentioned in Table 5.

TABLE 5
THE VECTORS OF THE OBSERVED CONTROLS

	Province				District	
	Ind	Unemployment	RGDP	SME_P^{*}	SME_{D2012}^{**}	SME_{D2014}^{***}
Regional population (Pop)	√	√	√	√		√
Regional agricultural contribution in RGDP (Agri)	√					
Marginal industrial value addition per person (M_ind)	√		√	√		
Average daily wage of informal construction sector (Master mason) (Wage rate)	√		√	√		
Goods transport vehicles (Transport)	√					
Number of industries registered under BOI & Ministry of commerce [small and medium enterprises (SMEs)]	√		√			
Departure for foreign employment (f_emp)					√	√
Banking density index (the number of bank branches for 100,000 persons) (Bank_den)	√		√	√	√	√
Population density (Pop_den) per kilometer					√	
Percentage of students that have minimum qualification to apply national universities (Uni_qualified)	√	√	√			
Number of teachers in thousands (Teacher)					√	√
Electricity sales for industries (GW/h) (E_sales_ind)		√				

*SMEp denotes the outcome variable of SMEs related to the provincial level.
**SMED2012 denotes the outcome variable of SME related to the district level subject to preintervention year 2012.
***SMED2014 denotes the outcome variable of SME related to the district level subject to preintervention year 2014

We examined the assumption of a regional effect of the provision of the expressway for two different levels, namely, the provincial level and the district level (see Table 6). The assessment of the impact of a particular intervention typically requires clear identification of the differences between the affected and non-affected groups. Inappropriate assignment of the observational data among the affected and non-affected groups might result in misperceptions in the assessment process. However, in our case, the expressway was operated section-wise and, as a result, the total length that we considered here was not operated at once. The expressway from Colombo (Kottawa) to Galle (Pinnaduwa) commissioned at the end of 2011. Two sections, i.e., from Colombo to Katunayaka International Airport in the western province and Galle to Matara in the southern province, were commissioned at the beginning of 2014. Although, quite a similar proportion of the length in both provinces in the affected groups was operated later, we considered the year 2012 as the pre-intervention baseline.

Taking this into account in the case of the district-level comparisons of the impacts on SMEs, we set two effective combinations of treated groups based on different pre-intervention baselines for 2012 [SMED2012] and 2014 [SMED2014]. Pereira and Andraz (2013) pointed out that infrastructure provisions induce different impacts on various economic sectors. Our scope of analysis covered the industrial sector value addition, Regional gross domestic product, number of SMEs, and unemployment rate so as to reveal the labor market effectiveness of the project. To measure the effectiveness of attracting private investment as an objective of the project, we considered the impact of the project on SMEs not only at the provincial level, but also at the district level.

TABLE 6
AFFECTED AND NON-AFFECTED REGIONS

Non-Affected Regions	**Affected Regions**	Pre-Intervention Baseline Year
Provincial Level	Provincial Level	
Eastern province	Western province	2012
Central province	Southern province	2012
North western province		
North central province		
Sabaragamuwa province		
Uva province		
Northern province		
District Level	District Level	
Batticaloa–Ampara	Colombo–Kaluthara–Galle	2012
Nuwaraeliya–Matale–Kandy	Gampaha–Matara	2014
Kurunegala–Putthalama		
Anuradapura–Polonnaruwa		
Kegalle–Rathnapura		
Monaragala–Badulla		
Vavniya		
Hambantota		

ESTIMATION RESULTS

Data

All estimations in this work were dependent on an exclusive panel data set containing information regarding the socio-economic characteristics of the regions in Sri Lanka. This was collected from annual statistic bulletins called the "Economic and Social Statistics of Sri Lanka" issued by the Central Bank of Sri Lanka, and from its annual reports from 2006 to 2019. The data set comprised 14 years of data over the period of 2005–2018, including all provinces and 20 out of the 25 districts, as shown in Table 6. Descriptive statistics for all outcome variables are provided in Table 7. Time trends of those variables with respect to the affected and non-affected groups are shown in Figures 3–6.

FIGURE 3
TREND OF INDUSTRIAL VALUE ADDITION

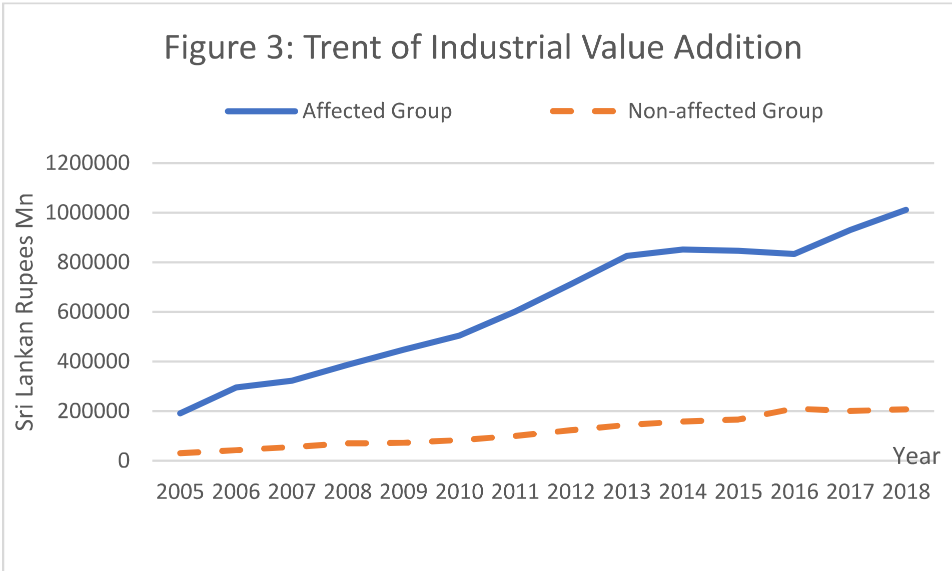


FIGURE 4
TRENDS OF PROVINCIAL SMES

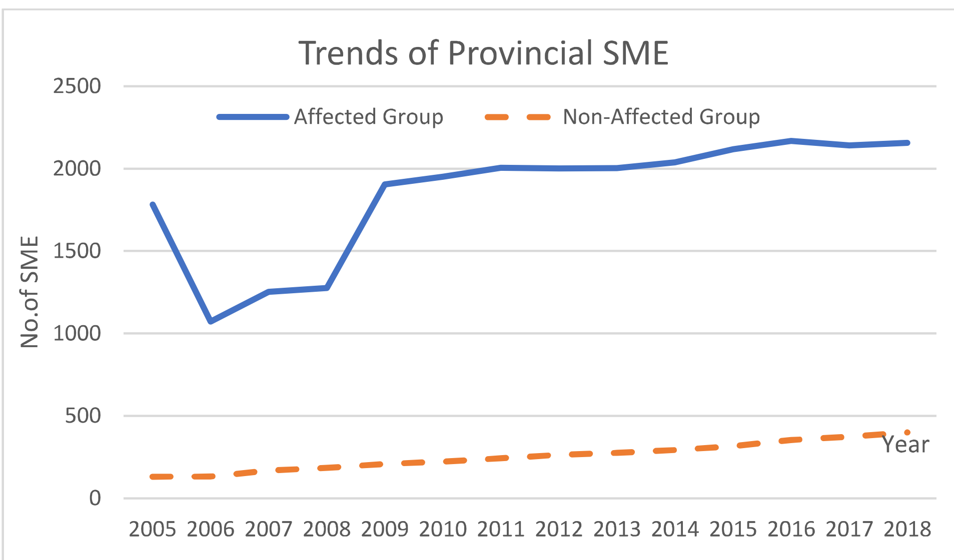


FIGURE 5
TREND OF UNEMPLOYMENT RATE

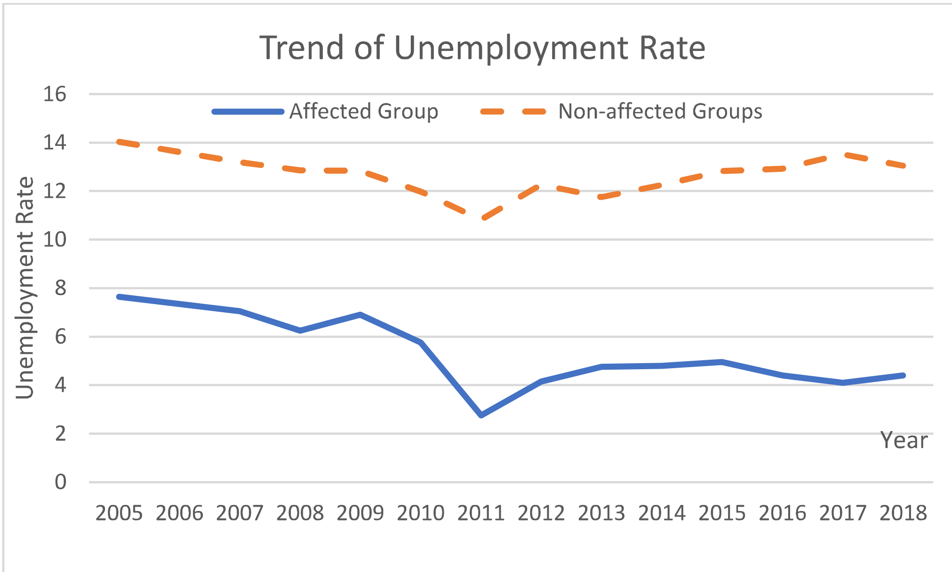


FIGURE 6
TREND OF RGDP

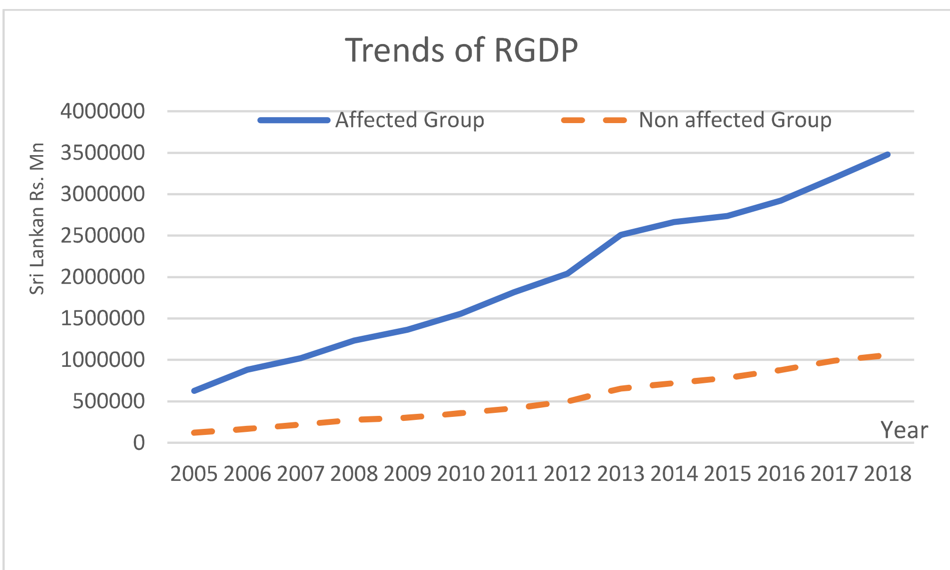


TABLE 7
SUMMARY STATISTICS FOR THE OUTCOME VARIABLES (2005–2018)

Provincial Level					
Affected Group	Number of Obs:	Mean	Standard Deviation	Maximum	Minimum
Industries	28	625,622.68	563,926.70	1,786,090	41,680
SMEs	28	1847.46	1671.25	4004	177
Unemployment	28	5.37	2.09	9.5	1.3
RGDP	28	2,003,072	1,613,508	5,525,674	187,116
Non-Affected Group					
Industries	98	133,934.66	103,492.77	482,416	3986
SMEs	98	117.08	104.51	350	4
Unemployment	98	4.83	1.50	8.2	2.2
RGDP	98	531,590.16	380,394.12	1,700,270	63,063
District Level					
Affected groups					
SMEs	70	783.28	886.41	2578	50
Non-Affected Groups					
SMEs	210	55.83	49.77	201	0

Estimation Results

We estimated Equation (2) using different outcome variables to assess the achievement of the objectives set by the expressway project mentioned above. Accordingly, the DID coefficient was estimated for the variable of interest by employing the fixed effect estimation procedure, and the results are reported in Table 8. The interaction term EW_dgt focuses on the comparison of the path for the counter-factual scenario without the provision of infrastructure to the actual performance of the regions after launching the sections of new expressway from Katunayaka to Matara. We preceded the estimation by employing not only the fixed effect, but also the random effect estimation procedures (see Appendix A). However, the Hausman test strongly rejected the random effect estimations.

Table 8 indicates that the RGDP for the affected regions was greater than for the non-affected regions, i.e., by approximately 420,784 million Sri Lankan Rs per annum. The year-specific effects in the estimation results might suggest that the general business climate in the transition economy, especially after a civil war which ended in 2009, might have significant relevance for the economic performance of regions. Data for the labor force and total investments, which are considered key variables of the growth model, were not available and, thus, were not used as the explanatory variables in the specification.

The other explanatory variables in our expanded specification explained 81% of the variance for RGDP and played a significant role with respect to the DID coefficient. SMEs and the banking density, with statistically significant positive coefficients, shed a light on the RGDP as proxies of private investment patterns. On the other hand, we used the marginal industrial product of a unit of population (M_ind) to capture the dynamics of industrial output in relation to population. This suggested that more labor inputs are required to maximize the regional industrial output. The wage rate—the average daily wage of the informal construction sector (Master Masons) as a leading wage rate of the informal sector—was positive and significantly influenced the RGDP. This might attract labor from the unproductive agricultural sector to the productive industrial sector and, in turn, increase the RGDP. We controlled for the minimum qualifications for applying to universities (Uni_qualified) to explain the variation of the RGDP due to the quality of human capital in the regions. However, the statistically significant coefficient of population (pop) and the positive but statistically insignificant coefficient of Uni_qualified can be interpreted as the size of the human resource pool (a proxy of the labor force) as a matter of the economic performance, and not the quality of it in the current situation of regional economies.

Table 8 indicates that the industrial value addition for the affected regions was greater than that for the non-affected regions, i.e., by approximately 160,432 million Sri Lankan Rs per annum. This is approximately 38% of the total impact on the RGDP due to commissioning the expressway. The national-level contribution of the industrial sector to the GDP in 2015 was around 27%. Similarly, the contributions of the industrial sectors of the western and southern provinces to the RGDP in the same year were approximately 34.5% and 18%, respectively. These figures shed a light on our estimations. The significant and negative coefficient of agricultural output (Agri) on industrial value addition indicates that the agricultural sector attracted human and physical capital from the industrial sector likely during the agricultural seasons in the year. Among other control variables, goods transportation vehicles (Transport) played a significant role in determining the industrial output. The population (Pop) was used as a proxy of the labor workforce for the industrial value addition. Moreover, SMEs were highly significant and positively associated with industries, which suggests that they contribute to the industrial value addition.

We obtained influential statistical evidence for the objective of minimizing the unemployment rate in the affected regions. According to Table 8, the DID coefficient for the unemployment rate was approximately –1.05, which implies that the unemployment rate decreased by 1.05% due to the development of the expressway from Katunayake to Matara. This estimation results were justified by the reduction of the unemployment rate in the western province in 2018 in comparison to 2015: The rate reduced by 1% in the western province and by 0.1% in the southern province. The coefficient on electricity sales for industrial sector (E_sale_ind), which was employed as a proxy of industrialization or automation in the industrial sector, became positive and significant. This might suggest that the automation process caused job opportunities to diminish slightly in those regions.

We tested the level of achievement of another objective, that is, attracting private investment toward the regions by employing SMEs as the outcome variable. We performed this estimation on regional-level data, as well as on district-level data (see Table 8). However, for eradicating inappropriate assignments of the observational data among the affected and non-affected groups, we conducted two estimations based on different pre-intervention years.

TABLE 8
FIXED EFFECT DIFFERENCE-IN-DIFFERENCE ESTIMATION OUTPUT

	Province				**District**	
	RGDP	**Ind**	**Unemp: Rate**	**SME_P**	**SME_{D2012}**	**SME_{D2014}**
$EW\_D_{g(2012\text{-}2018)}$	420,784*** (4.79)	160,432 *** (4.03)	–1.05 * (–1.69)	285 *** (3.52)	76 *** (9.65)	
$EW\_D_{g(2014\text{-}2018)}$						35.1*** (5.62)
Time_d	194,396*** (2.90)	64702 ** (2.19)	–0.09 (–0.34)	77.70 (0.23)	12.04 *** (3.02)	7.44*** (3.03)
Pop_den	2.50 *** (4.90)				0.083 * (1.74)	
Pop		1.22 *** (6.17)	–0.00001*** (–4.79)	0.002 *** (6.15)		0.0003*** (10.83)
Agri		–2.49 *** (–412)				
Wage rate	190 ** (1.88)	76.38 (1.38)		–0.28 *** (–3.00)		
SME	684 *** (7.00)	232.46 *** (5.70)				
Bank_den	2843 * (1.77)	798.60 (1.14)		2.61* (1.74)	0.162 (0.40)	–0.07 (–0.31)

Uni_qualified	2789 (0.89)	−183.23 (−0.13)	−0.19 (−0.95)			
Teacher					0.003 * (1.83)	
Transport		1.74 * (1.66)				−0.001 (−1.25)
F_emp					0.001 (1.58)	0.0001 (1.14)
E_sale_ind			0.003 * (2.30)			
M_ind	15671.7 ** (2.11)			5.30 (0.73)		
Constant	−5,850,476*** (-5.35)	−2,683,963** (6.23)	28.58 *** (6.47)	−5349.6*** (−5.79)	105.8 *** (3.22)	−171.2 (−6.43)
R^2	0.81	0.78	0.0078	0.87	0.86	0.68
Groups	9	9	9	9	18	17
Observations	125	126	126	12	252	238

Note: The t ratios are in parentheses; significance levels are indicated as ***, **, and * for the 1%, 5%, and 10% levels, respectively.

For the district-level estimation in case of SMEs, we considered Colombo, Kalutara, and Galle as the affected regions, which were commission by the end of 2011. As a result, we dropped the Gampaha district (in the western province) and Matara district (in the southern province) from the estimation. However, we considered the impact of the expressway in these two districts, which were commissioned in 2014. Similarly, the Colombo, Kalutara, and Galle districts, which were commissioned in end of 2011, were dropped from the estimation. The results are shown in Table 8. Accordingly, the coefficient we obtained for the DID interaction term was 285 for the case of the provinces, which included five districts over a seven-year affected period. The impact of the expressway in Colombo, Kalutara, and Galle (Table 8) was approximately 76 SMEs for the seven-year affected period. The impact of the expressway regarding Gampaha and Matara as the affected regions reported 35 SMEs in the case of the two districts over a four-year affected period. Three estimations were performed by augmenting the baseline specification with slightly different covariates and obtaining consistent coefficients for the DID interaction term.

CONCLUSION

For the first time, we examined the impact of the first expressway in Sri Lanka within the DID framework. This was an effort to assess whether the construction of the expressway achieved the intended outcomes and, in turn, provided sustainable development in the affected regions, especially through the contributions of the industrial sector as a sustainable growth engine. Our fixed effect estimation results based on 14 years of panel data over the 2005–2018 period indicated several impact assessments for provincial- and district-level outcome variables.

We found that the industrial value addition for the western and southern provinces was greater than that for other seven provinces due to the expressway, i.e. approximately 160 billion Sri Lankan Rs as an annual average, accounting for approximately 38% of the total impact on the RGDP. RGDP in affected regions was considerably bigger than that for the non-affected provinces i.e. 420 billion Sri Lankan rupees. This represents a sufficient outcome to ensure the sustainability of growth in the affected regions. We obtained influential statistical evidence for the objective of minimizing the unemployment rate in the affected regions by approximately 1.05% per annum. These indicators are quite natural and provide evidence for the sustainability of economic growth. Our empirical results further reveal that the provision of the expressway induced 285 SMEs in the affected provinces, while there was an increase of 74 SMEs in the Colombo, Kalutara, and Galle districts, and 35 SMEs in the Gampaha and Matara districts under different pre-intervention years.

In conclusion, it can be stated that the project reasonably contributed toward sustainable economic growth. In this regard, we suggest implementing peripheral complementary projects and programs, such as industrial zones, that can maximize the impact of the expressway project. In addition, there should be a particular focus on mobilizing sluggish mega projects, such as the Mathtala International Airport, the Hambantota Harbor, and the Hambantota International Conference Hall, as economically effective projects. Our findings are particularly useful for policymakers not only to shed light on reviewing the ongoing expressway project (i.e., the Central Expressway Project), but also to review the planned expressway project (i.e., the Ruwanpura Expressway Project) with the purpose of improving economic performance.

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APPENDIX

TABLE A1
RANDOM EFFECT DIFFERENCE-IN-DIFFERENCE ESTIMATION OUTPUT (2005–2018)

	RGDP	Ind	Unemp: rate	SME_P	$SME_{D\ 2012}$	$SME_{D\ 2014}$
Time_d	87,753 (1.27)	22,585 (0.69)	–0.48 * (–1.78)	–143 (–1.21)	7.58 * (1.62)	8.77 *** (3.45)
EW_d	–321,018 *** (–3.86)	–130,675*** (–3.36)	2.39 *** (2.37)	–354 *** (–2.50)	131.4 * (1.67)	217.4 *** (4.09)
$EW\_D_{g(2012–2018)}$	574,939 *** (6.20)	218148*** (4.73)	–0.77 (–1.21)	444 *** (2.85)	85 *** (8.94)	
$EW\_D_{g(2014–2018)}$						35.1*** (5.26)
Pop_den					0.49*** (14.7)	
Pop	0.18 *** (4.41)	0.05 * (1.77)	–0.000 (–0.52)	0.0007*** (20.05)		0.0003*** (12.33)
Agri		–0.64 (–1.17)				
Wage rate	563 *** (7.69)	162.3 *** (3.46)		0.15 (1.26)		
SME	608 *** (11.52)	209.7 *** (6.25)				
Bank_den	–962 (–0.91)	–718 (–1.34)		4.75 *** (2.65)	1.05 ** (0.21)	–0.155 (–59)
Uni_qualified	2575 (0.80)	1194.6 (0.76)	–0.04 ** (–1.91)			
Teacher					0.0031* (1.65)	–0.002 ** (–1.52)
F_emp					0.001* (1.84)	0.0001 (1.09)
E_sale_ind			–0.00093 (–0.76)			
M_ind	14,946 * (1.80)			15.59 (1.07)		
Transport		1.10 (0.74)				
Constant	–751,668*** (–3.37)	–203,392 ** (–1.93)	8.22 *** (5.12)	–1464 *** (–9.30)	–146*** (4.2)	–181.6 *** (–6.86)
R^2	0.96	0.92	0.0.23	0.87	0.94	0.76
Groups	9	9	9	9	18	17
Obs:	125	126	126	12	252	238

The z ratios are in parentheses; significance levels are indicated as ***, **, and * for the 1%, 5%, and 10% levels, respectively.