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Dynamic impacts of the East–West Economic Corridor on incomes, employment and poverty in Da Nang, Vietnam

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ABSTRACT

The present study measures, explains, and compares the impacts of the first two years (2006 through 2008) of the Southeast Asian East-West Economic Corridor project on the level and distribution of incomes and the incidence, depth, and intensity of poverty in rural, semi-rural, and urban households in Da Nang province, Vietnam. Using t-tests, Gini coefficients, Foster-Thorbecke-Greer poverty indicators, and multiple regression analyses, we test six hypotheses.

Official statistics at the national level revealed that the road has conferred no clear advantage on Da Nang province when compared with other provinces, regions or cities within Vietnam. However, a micro-level within-province survey sample of 114 households demonstrates that proximity to the road had made people better off. Although transportation employment as a whole was not significantly correlated with income because skill levels required for that sector are variable, the transportation sector has provided new jobs to the poorest of the poor. Generally, the incidence and depth of poverty remain highest in the rural areas farthest from the road; while the semi-urban area closest to the road has witnessed the biggest decline in the incidence, depth and intensity of poverty. To redress inequities in accessing the advantages of the road, we recommend that the government provide human capital training to allow workers to qualify for higher-level jobs; special programs to aid small scale household enterprises; and more extensive health, education, and welfare programs for the poorest rural areas.

Key words: Impact study, highway, Vietnam, poverty, income distribution

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บทคัดย่อ

การศึกษาในครั้งนี้ต้องการศึกษาผลกระทบของโครงการพัฒนาแนวพื้นที่เศรษฐกิจตะวันออก-ตะวันตกที่มีต่อรายได้ การจ้างงาน และความยากจนของครัวเรือนทั้งในพื้นที่ชนบท พื้นที่กึ่งเมืองกึ่งชนบท และพื้นที่ในเมือง จังหวัดดานัง ประเทศเวียดนาม โดยทดสอบสมมติฐานทั้งหมด 6 ข้อ โดยใช้ค่าสถิติ t ค่าสัมประสิทธิ์จีนี่ ค่าดัชนีความยากจนของ Foster-Thorbecke-Greer และการวิเคราะห์สมการถดถอย

จากสถิติในระดับประเทศแสดงให้เห็นว่าการสร้างถนนไม่ได้ให้ประโยชน์แก่จังหวัดดานัง เมื่อเปรียบเทียบกับจังหวัดอื่นๆ หรือภูมิภาคอื่นในเวียดนาม อย่างไรก็ตามการสำรวจข้อมูลระดับจุลภาคภายในจังหวัดจำนวน 114 ครัวเรือน พบว่าการสร้างถนนทำให้ผู้คนมีความเป็นอยู่ดีขึ้น ถึงแม้ว่าการจ้างงานในภาคการขนส่งจะไม่มีเกี่ยวข้องกับรายได้อย่างมีนัยสำคัญ แต่ภาคการขนส่งสร้างงานให้กับกลุ่มผู้ที่ยากจนที่สุด อย่างไรก็ตามภาวะความยากจนยังคงปรากฏอยู่โดยเฉพาะพื้นที่ชนบทที่ห่างไกลจากโครงการ ในขณะที่ความยากจนในพื้นที่กึ่งเมืองกึ่งชนบทลดลงมากที่สุด เพื่อแก้ปัญหาความไม่เท่าเทียมกันในการเข้าถึงโครงการดังกล่าว ผู้เขียนแนะนำให้รัฐบาลเพิ่มการลงทุนมนุษย์ เพื่อให้แรงงานสามารถทำงานคุณภาพสูงได้ ส่งเสริมโครงการวิสาหกิจขนาดเล็ก และโครงการด้านสุขภาพ การศึกษาและสวัสดิการ แก่ผู้ยากจนในพื้นที่ชนบท

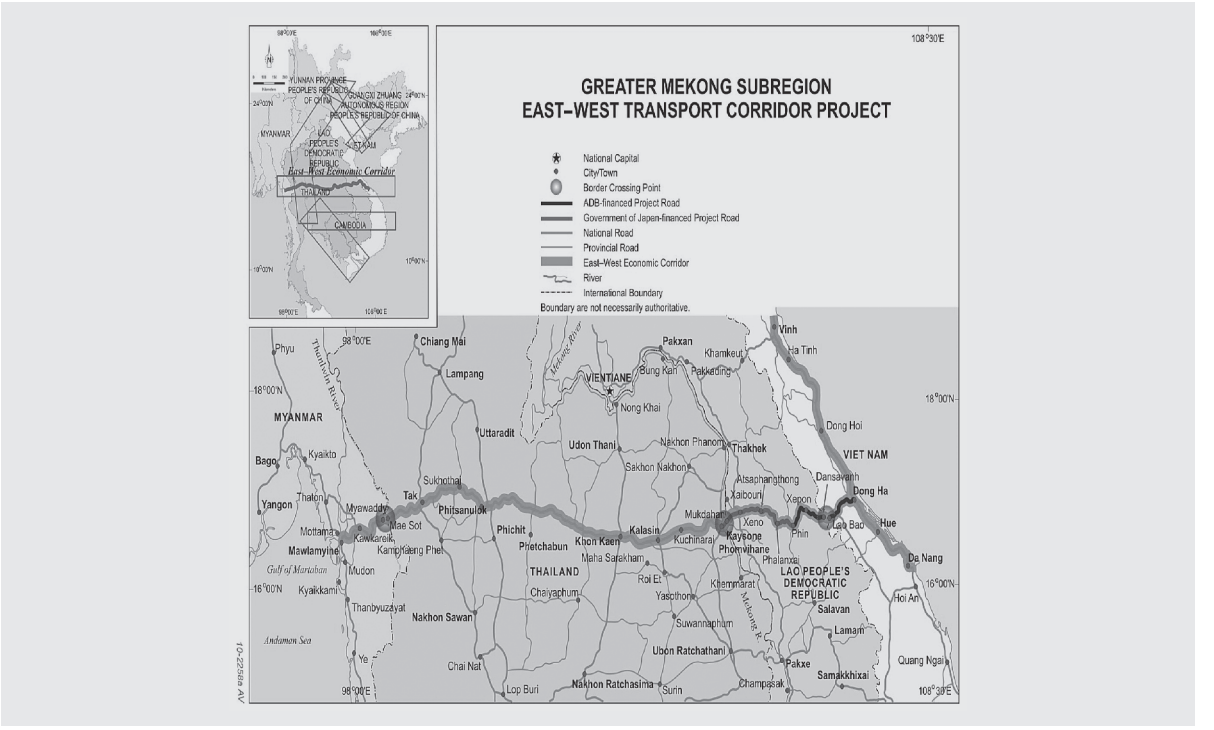
คำสำคัญ: การศึกษาผลกระทบ เวียดนาม ความยากจน และการกระจายรายได้

1. THE REAL-WORLD PROBLEM OF THE STUDY AREA AND ITS ECONOMIC SIGNIFICANCE

The East-West Economic Corridor (EWEC) project of the Asian Development Bank (ADB) was agreed upon in 1998 and 2001 by the member nations Myanmar, Thailand, Laos, and Vietnam. It was partially funded by Myanmar, Thailand, Laos, Vietnam, and China, with the remainder of required investment capital coming from the ADB. The road was initiated in 2002 but got seriously underway only in December 2006, when the corridor was operationally opened. Although even today the EWEC remains under construction in Myanmar, its Vietnamese leg was physically completed by the end of 2008. The economic corridor is a long road stretching 1 450 km (Figure 1). It starts from Mawlamyine (Myanmar) at its western boundary; crosses through seven provinces of Thailand (Tak, Sukhothai, Phitsanulok, Phetchabun, Khonkaen Kalasin and Mukdahan); traverses Savannakhet province in Laos; and cuts through Quang Tri and Thua Thien Hue provinces in Vietnam before ending at its eastern boundary of Da Nang city. The part of the EWEC that cuts through Laos and Vietnam is known locally as road 9E.

The EWEC was designed to provide the infrastructure for linking and galvanizing the economies of these countries. Without roads, it was reasoned, the movement of goods, people, and information would be hamstrung, and the positive benefits from trade and globalization would be erased by prohibitive transportation costs. In parallel to the physical construction of roads and bridges, harmonization of transportation regulations (wheelbase size, vehicle registration, driver licenses, which side of the road to drive on) must also be realized. To date, this has been achieved only to a very limited extent, causing delays and changes of vehicles at national border crossings.

Figure 1. The EWEC and its path into Vietnam



Compared with the three other countries linked by the EWEC, Vietnam has fared well overall. In Myanmar, for example, a repressive political regime has led to rebel uprisings between Mawlamyine and the Thai border at Mae Sot, such that only 18 of 200 kilometers of the road have actually been constructed. Nor has Laos, a completely landlocked economy, succeeded in creating attractions that will cause FDI capital and traveler expenditures to stay within, instead of simply transiting, the country. Thailand has done well largely because the road has helped to link the country with itself and with a second road network leading south from Kunming, China to Malaysia. Indeed, Thailand occupies more than half (777 km) of the total length (1 450 km) of the EWEC.

Vietnam shares some of Thailand's advantages since roads have also been improved, after decades of delay, to link North with South; and most critically, the western interior with the eastern coast. The EWEC falls into the latter category as it passes through Quang Tri, Thua Thien Hue and part of Da Nang province before ending in Da Nang city. Although at the national level, several other east-west road and infrastructural systems have been constructed by other sources of funding over the same period, the EWEC is by far the largest and most visible. Da Nang city is its greatest potential beneficiary, even when it is not the final destination of commercial transactions. For example, the EWEC also connects upward to the much smaller town of Vinh (Figure 1), but the road's main economic and development impacts target the bustling port city of Da Nang. This is because Da Nang is privileged to lie both on the ocean, with a deep-water seaport, and at one of the two endpoints of the East-West Economic Corridor.

The EWEC thus provides enormous potential for improving the well-being of Vietnamese throughout the country, particularly in the three North Central/Central Coastal provinces. The processes predicted to lead to that well-being improvement include enhanced employment opportunities in transportation-related sectors,

lower transportation costs for firms and exporters, improved upstream and downstream linkages for farmers, and reduced costs of consumption items for consumers as a whole.

2. THE SCIENTIFIC PROBLEM

Despite the vast economic potential of the EWEC, there has yet been no systematic study that objectively quantifies the positive impacts of the EWEC on the Vietnamese economy in general or on Da Nang in particular. Even less has there been any attempt to measure the negative impacts of the roads. But after six years of the EWEC's operation since December, 2006, impact analysis is required to determine to what extent the Vietnamese population, particularly in the EWEC terminal point Da Nang, has actually benefited from this major international highway. Policy analysts and ministry officials could gain from such an evaluation in their planning for future infrastructural investments and the complementary policies that could bring the positive impacts of the road to any pockets of the population who may have been left behind.

Although the present study will attempt to rigorously quantify the impacts of the road on Vietnam, casual observation already suggests that those impacts have been mixed. For instance, despite the EWEC's potential for passenger traffic of tourists and migrants, it is principally known for the heavy trucks that carry timber and other bulky goods between Laos and Vietnam. There are also substantial negative impacts in terms of drug smuggling from the Golden Triangle of Laos into Vietnam, and the trafficking of women into other countries for the purposes of prostitution. Since drug smuggling carries the death penalty in Vietnam, it is very difficult, and even dangerous, for researchers and government agencies to attempt to quantify such impacts; but they are quite real.

3. GOAL AND SPECIFIC OBJECTIVES OF THE STUDY

The twin goal of this study is therefore to measure the impacts of the East-West Economic Corridor (EWEC) on household income, employment creation, income distribution, and the reduction of the incidence, depth and intensity of poverty in rural, semi-urban, and urban areas of Da Nang province; and to suggest policies for removing any roadblocks that prevent those positive impacts from being fully realized. Da Nang was chosen as the site of application because of the convergence of the EWEC with location at a seaport, as well as with more traditional north-south roads.

In order to meet that goal, three specific objectives were set, to:

1. Compare data from Da Nang with other provinces, regions and cities within Vietnam to determine whether the road has conferred any clear advantages on Da Nang.

2. Test for significant differences of means in the detailed output, income and expenditure patterns of 15 categories of households (five income quintiles in each of three areas at increasing distance from the Da Nang city center: urban, semi-urban, and rural).

3. Suggest policies for strengthening the positive contributors, and neutralizing the negative contributors, to growth with equity for the Da Nang region.

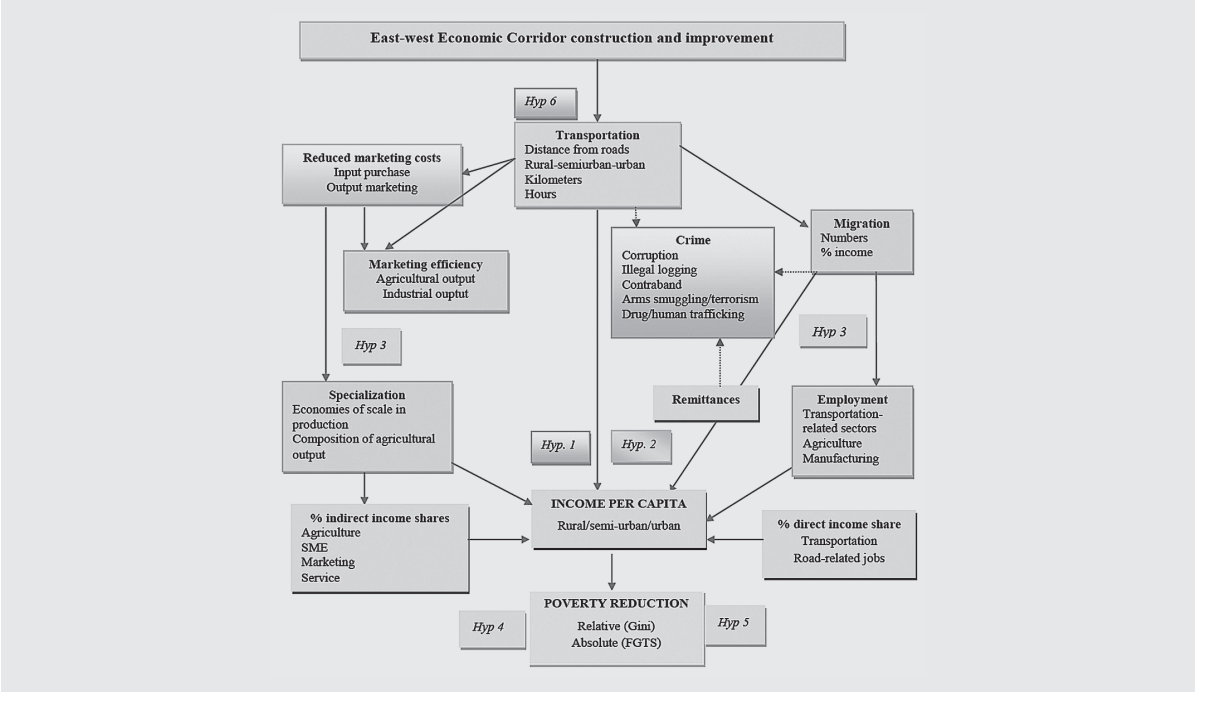
4. REVIEW OF THE LITERATURE, CONCEPTUAL FRAMEWORK AND TESTABLE HYPOTHESES

The previous literature suggests an integrated conceptual framework (Figure 2) that will be used to test a set of six hypotheses in Da Nang similar to those from previous studies.[4] If evidence for a given hypothesis is vague, incomplete or inconclusive, it will be rejected. Non-rejection of all six hypotheses would mean that economic development is virtually taking care of itself; no significant policy correctives by government will be necessary. Rejection of any of the hypotheses, however, will signal the need for one or more targeted policy interventions.

4.1 DIRECT EFFECT ON NATIONAL GDP AND INCOME PER CAPITA

Fan and Chan-Kang (2008) used an econometric model to estimate the impact of roads on rural and urban income growth in China over the period 1982-1999 (Income per capita box at the lower centre of Figure 2). Low-grade (essentially rural) road construction in China delivers benefit/cost ratios four times greater than converting a low-grade into a high-grade road, but the marginal returns are the highest in the least developed western and southwestern region. Warr (2008), applying a multi-household general equilibrium model to Lao data, found that putting in a dry season road where none exists has a 6-fold greater impact on GDP (and a 17-fold greater impact on poverty reduction) than converting a dry-season road into an all-season road. But opening new areas also costs more than upgrading existing roads, and the impacts are highly region-specific.

Figure 2. Conceptual pathways of impact of the EWEC on income, employment poverty, and poverty



4 Figure 2 is slightly more comprehensive than the data we have available in order to show the entire socioeconomic system within which road impacts may operate.

These findings have led us to formulate hypotheses 1 and 2 for the specific case of Da Nang:

1. From the national viewpoint, the road has conferred a clear advantage on Da Nang province when compared with other provinces, regions and cities within Vietnam.

2. Within Da Nang province, the EWEC has led to improvements over the period 2006 through 2008 in output value, income, and sources of income among rural, semi-urban and urban households.

4.2 IMPACTS ON EMPLOYMENT, MIGRATION, SPECIALIZATION AND MARKETING EFFICIENCY

Mu and van de Walle (2011) used double difference and matching methods to show that road construction significantly enhanced the development of local markets, food availability, service sector employment, and school attendance, particularly in rural areas (**Specialization** and **Marketing efficiency** boxes on the left-hand side of Figure 2). But lack of education among minorities and other geographic, community and household heterogeneities frequently reduce those impacts.

In parallel research, Lichter and Fugitt (1980) for the United States found that counties containing interstate roads consistently maintained an advantage over non-interstate counties in net migration, the proportion experiencing net immigration (or a turnaround in net migration), and employment growth. This was particularly true of less remote areas and service employment—both nonlocal and tourist-related. Similarly, Gachassin, Najman and Raballand (2010) discovered that roads offer enhanced access to employment activities, and reduced the rate of labor activity by reducing the need to work as migrant agricultural laborers (**Migration** and **Employment** boxes at the right of Figure 2). They concluded that roads should be a priority where non-agricultural development is a real possibility. Taken together, these findings from previous studies led us to formulate hypothesis 3, to the effect that *Proximity to the road makes people economically better off through job creation, specialization and reduced inequality*.

4.3 EFFECTS ON POVERTY REDUCTION

Evidence for the benefits of road improvements in terms of poverty reduction (**Poverty** box at the bottom of Figure 2) is far from overwhelming. In Thailand for example, Fan, Yu, and Jitsuchon (2008) found that additional government spending on rural road construction lags far behind the impacts of agricultural research, rural education and irrigation in poverty reduction. Dercon et al. (2009), using instrumental variables modeled through the Generalized Methods of Moments and controlling for household fixed effects in Ethiopia, estimated that access to all-weather roads reduced poverty by 6.9 percentage points and increased consumption growth by 16.3 percent. In contrast, agricultural extension reduced headcount poverty by a full 9.8 percentage points and increased consumption growth by 7.1 percent. In Vietnam, Nguyen (2011) found positive and significant impacts of roads on work hours and the resulting income per year; but no significant impacts on consumption-based measures of poverty expenditure, the share of non-farm income, or school attendance. To determine whether such findings also apply to the Da Nang area, we have formulated hypotheses 4 and 5:

4. The distribution of income (Gini) for the whole sample has grown more equal over time as economic opportunities have opened to all classes of workers.

5. The incidence, depth, and intensity of poverty have declined for the whole sample and each of the three subsamples over time.

4.4 DIRECT EFFECTS INVOLVING TRANSPORTATION

The problem of realizing the full benefits of infrastructural investments is often that the poor lack the means of transportation required to fully benefit (**Transportation** box at the top of Figure 2). For instance, Brycesson et al. (2008) have indicated that, in extremely remote areas of Ethiopia, road improvements may catalyse the expansion of social-service provision. However, given the poor's relative lack of motor vehicles and ability to pay for public transport, they are by no means a sufficient condition for enhancing the mobility of the rural poor. To test the overall direct and indirect effects of transportation improvements in the specific case of the Da Nang economy, we have formulated hypothesis 6: *Those who are closer to the road, have obtained transportation employment, or have jobs related to the road are better off.*

4.5 NEGATIVE IMPACTS IN TERMS OF CRIME

Although we lack sufficient data to test a hypothesis on this dimension, the adverse impacts of road construction on the environment and the short-term dislocation of people and businesses are well-known. Furthermore, Emmers (2003) paints a gloomy portrait of the negative social impacts of such projects in Southeast Asia (**Crime** box in Figure 2). These include drug trafficking, illegal migration, contraband, arms smuggling, money-laundering, transnational prostitution, trade in human body parts, piracy, arms smuggling, illegal logging, credit card fraud, fraudulent bankruptcy, and corruption and bribery at all levels.

4.6 DATA AND METHODS OF ANALYSIS

We shall employ two data sets to test these hypotheses. First, official secondary data at the national level were carefully compiled for the years 1995 through 2009, from a variety of separate data files available at the General Statistical Office of Vietnam (http://www.gso.gov.vn). Descriptive statistical analysis of these first data was used to test hypothesis 1 to determine whether or not Da Nang, and to a lesser extent its sister provinces Quang Tri and Thua Thien Hue, have actually benefited from the road in the ways predicted by the literature.

Secondly, we drew a micro-level primary data sample of 114 households from the 2006 and 2008 Vietnam Household Living Standard Surveys (VHLSS) in rural, semi-urban, and urban areas of Da Nang province. To capture dynamic impacts, we divided the VHLSS data into three datasets: 2006, 2008, and a joint unbalanced panel of all households from both years. Gini coefficients, Foster-Thorbecke-Greer poverty indicators, and t-tests were applied to the VHLSS dataset to test hypotheses 2 through 5; both at the provincial level and by urban, semi-urban and rural subunits. Finally, multiple regression analysis was employed to evaluate hypothesis 6.

5. RESULTS AND DISCUSSIONS OF THE RESULTS

5.1 EVIDENCE REGARDING HYPOTHESIS 1 AT THE NATIONAL LEVEL

Table 1 summarizes the General Statistical Office data on demography, human capital formation, and unemployment. It is clear from the left-most columns of the table that the EWEC has not spurred population growth in Da Nang. The city ranks 8th out of 10 compared with other cities. Even more strikingly, the North Central/Central coast region in which Da Nang lies is the most sluggish of the six geographical regions of

Vietnam. The advantages of being the Eastern endpoint of the EWEC and a major seaport have thus clearly failed to produce a surge of population into or even within Da Nang. Other factors operating at the national level, such as government investment, FDI, other highway and bridge construction, and the priorities of government must be exerting influences upon population that are stronger than being a road hub.

The next two columns of Table 1 allow us to determine whether or not the road has likely contributed to human capital development. A clear upswing in human capital is discernible in Da Nang city as compared to Hanoi, Haiphong and Ho Chi Minh City. Indeed, over the four years 2006 through 2010, Da Nang went from the lowest of the four cities to occupying second place after Haiphong. At first glance, this might could be construed as a possible impact of new roads and infrastructure.

Table 1. National statistics on demography, education, and employment

	Demographic growth		Human K growth		Unemployment reduction	
	Cumulative ratio 2009/1995	Growth rank	% high school graduates 2010/2006	Growth rank	Unemployed ratio 2005-2009/ 1996-2000	Reduction rank
VIETNAM	**0.19**		**1.15**		**0.75**	
Cities						
Da Nang	0.40	8	1.15	1	n.a.	
Hanoi	1.66	1	1	3		
Binh Duong	1.34	2				
Binh Phuoc	0.65	3				
Kon Tum	0.55	4				
Ho Chi Minh City	0.54	5	0.97	4		
Gia Lai	0.50	6				
Ba Ria-Vung Tau	0.41	7				
Lam Dong	0.39	9				
Dong Nai	0.35	10				
Haiphong			1.07	2		
Regions						
North central and central coast	0.10	6	1.22	2	0.74	4
Southeast	0.52	1	1.03	5	0.84	6
Central highlands	0.51	2	1.18	3	0.56	1
N. midlands/mountains	0.17	3	1.42	1	0.65	2
Red River Delta	0.15	4	1.1	4	0.72	3
Mekong River Delta	0.11	5	1.01	6	0.78	5
North East						

Note: empty cells represent unavailable data.

Source: Adapted from General Statistical Office of Vietnam, http://www.gso.gov.vn

However, the North midlands and mountains grew even faster than the North Central and central coast region of which Da Nang is a part, such that an alternative explanation begins to emerge: the undereducated provinces are converging upon the higher educated provinces. This is of course a very positive trend for Vietnam as a whole, but it undermines the case that the EWEC, rather than the general economic development of the country, explains the patterns of increased human capital in Vietnam.

Since education is growing faster, Da Nang should be witnessing greater job creation—particularly in skilled jobs -- than other areas. However, the last two columns of table 1 show that, once again, the North central coast of which Da Nang is a part lies by no means at the extreme end of downward trends in unemployment. The North Central/Central coast region ranks fourth of six regions for decreased unemployment between the beginning (1996-2000) and ending (2005-2009) half-decades.

Perhaps, instead, the impact has been in the sectoral composition of the Da Nang urban and provincial economy. Table 2 reports trends in agricultural specialization, industrial growth, and retail sales growth for key cities and regions in Vietnam. First of all, there is no evidence that the EWEC has allowed farmers to specialize in Da Nang province. Not Da Nang, but instead Ho Chi Minh City, has the highest percentage and rank of cash crops in the cities reported; and the North Central and central coast region is only average in terms of specialization.

As an alternative to agricultural growth and specialization, has the major impact of the EWEC lain in spurring industrial output growth (next two columns of Table 2)? Again, the answer seems to be no. During 1995-2009, the areas of fastest industrial growth have been the Red River Delta region, and the cities of Dong Nai and Hanoi. Although the North Central/Coastal region including Da Nang ranked second for those years, detailed analysis shows that the region fell to fourth place for the sub-period 2002-2009, during which the EWEC was supposed to be giving it a clear advantage!

Such industrial output gains may in turn be reflected as increased retail sales within the country. However, retail sales (next two columns of Table 2) show that Da Nang is in fact the lowest ranking of the cities for which data is available; and the North Central/ Central coast the lowest-ranking of the six major regions of the country. There is thus very little indirect evidence of the demographic, educational, employment, retail development or sectoral impacts of the EWEC road project.

Table 2. National statistics on agricultural specialization, industrial growth, retails sales, and FDI attraction.

	Agriculture specialization		Industrial growth		Retail sales growth	
	2009 % cash crop	Rank	Cumulative ratio 2009/ 1995	Growth rank	Cumulative ratio 2009/ 1995	Growth rank
VIETNAM	**60**		**6.74**		**10.16**	
Cities						
Da Nang	62	4	5.92	3	5.83	4
Hanoi	70	3	8.32	2	12.92	2
Binh Duong						
Binh Phuoc						
Kon Tum						
Ho Chi Minh City	92	1	4.94	4	8.47	3
Gia Lai						
Ba Ria-Vung Tau						
Lam Dong						
Dong Nai			10.54	1		
Haiphong	84	2			33.51	1

Table 2. (Continue)

	Agriculture specialization		Industrial growth		Retail sales growth	
	2009 % cash crop	Rank	Cumulative ratio 2009/ 1995	Growth rank	Cumulative ratio 2009/ 1995	Growth rank
Regions						
North central and central coast	56	4	6.96	2*	2.59	6
Southeast	86	2	6.16	3	7.02	4
Central highlands	86	1	5.41	6	37.75	1
North midlands/ mountains	60	5	5.53	5	0.38	3
Red River Delta	77	3	9.40	1	29.61	2
Mekong River Delta	53	6	5.69	4	4.25	5

Note: empty cells represent unavailable data.

* Ranked 4th for the sub-period 2002-2009.

Source: Adapted from General Statistical Office of Vietnam, http://www.gso.gov.vn.

Although the main objective of the road is to intensify the transfer of goods for domestic and inter-country trade, it should also intensify the flow of migrants, entrepreneurs, and tourists. So what of the *direct* evidence of heightened traffic in the 14 provinces of the North Central and Central coast region? Here again, there is little (Table 3): trends in the intensity of passenger use per kilometer for key regions and cities show that Da Nang, Quang Tri and Thua Thien-Hue have increased at no better than average or below-average rates among the 14 provinces of the North Central/Coastal region. Indeed, these provinces ranked only 4th, 8th and 7th in 2009; and achieved rates of change ranking only 7th (Da Nang), 8th (Quang Tri) and 12th (Thua Thien-Hue) over the 2000-2009 period.

Table 3. Growth in passenger road use in the 14 North Central/Central Coastal provinces

Passenger volume (million persons/km)	2000	2001	2003	2005	2006	2007	2008	2009	Rank 2009	Rank of change 2000-2009
Province										
Da Nang	**326**	**299**	**501**	**464**	**521**	**626**	**731**	**796**	**4**	**7**
Ha Tinh	180	186	218	375	441	678	751	1180	3	1
Quang Binh	85	98	122	151	218	262	288	389	13	2
Nghe An	635	650	807	1075	1214	1523	2212	2487	1	3
Ninh Thuan	84	95	117	150	162	163	244	283	14	4
Thanh Hoa	215	230	257	304	396	463	579	715	6	5
Khanh Hoa	308	314	214	541	618	665	696	782	5	6
Quang tri	256	245	195	214	301	368	429	557	8	8
Binh Dinh	702	739	748	971	1053	1228	1307	1333	2	9
Quang Nam	300	328	360	414	524	483	495	554	9	10
Quang Nga	285	259	235	289	297	345	438	504	11	11
Thua Thien Hue	426	431	459	522	593	691	627	707	7	12
Binh Thuan	297	301	324	389	431	438	457	475	12	13
Phu Yen	389	399	440	470	416	437	474	511	10	14

Source: Adapted from General Statistical Office of Vietnam, http://www.gso.gov.vn.

The descriptive statistics in the first three tables, based on national secondary data from the GSO, lead us to strongly reject hypothesis 1: "*From the national viewpoint, the road has conferred a clear advantage on Da Nang province when compared with other provinces, regions and cities within Vietnam.*" There is no evidence from the national data that the road has had any beneficial impact on key macroeconomic variables.

6. MICRO-LEVEL ANALYSES OF THE VHLSS DATA

Do *primary* data from the Vietnam Household Living Standards Survey (VHLSS) from 2006 and 2008 within Da Nang itself tell the same story as the *secondary* data used above? What are the detailed impacts of the road in different areas (rural, semi-urban and urban) with respect to income, income distribution and consumption? If we can detect significant trends based on more detailed micro-level explanatory variables, they may elucidate hitherto-hidden impacts of the EWEC.

Hypothesis 2 states that "*the EWEC has led to improvements over the period 2006 through 2008 in output value, income, sources of income among rural, semi-urban and urban households.*" To test this hypothesis, we pooled the data for the two years 2006 and 2008 and added a zero-one dummy variable for 2008 to divide the sample into two groups. We then tested for significant differences for the values of a given variable between the two groups (Table 4) using the t-statistic at the 1.67 level of better (probability of significance $\leqslant 0.10$).[5] Positive changes are indicated in the upper half of the table, negative changes at the bottom. Within each section, items are listed by descending order of percentage change.

Table 4. T-tests of significant differences in means of key variables between the 2006 and 2008, VHLSS surveys for Da Nang province

Variable	Mean in 2008	Mean in 2006	Diff. 2008-2006	% change 2008/2006	t-stat	Sig. (2-tailed)
Significant increases from 2006 to 2008						
% income from migration	.204	.000	.204	52345%	6.592	.000 ***
Internet and telephones	630	44	586	1318%	4.741	.000 ***
Educational expenditure per student	2606	1282	1324	103%	3.756	.000 ***
Health expenditures	3201	1698	1504	89%	2.116	.036 **
Income from small-scale family enterprises	17633	10394	7238	70%	2.934	.004 ***
Expenditures on personal services	361	214	147	69%	3.847	.000 ***
Coal and other fuel expenditures	4918	3029	1888	62%	5.466	.000 ***
Rice expenditures	2627	1624	1003	62%	5.228	.000 ***
Total expenditures	66416	41416	25000	60%	4.240	.000 ***
Fabric purchases	1915	1212	703	58%	4.105	.000 ***
Water expenditures	364	248	116	47%	2.670	.008 ***
Electricity expenditures	1602	1123	479	43%	3.122	.002 ***
Parking expenditures	154	114	40	35%	2.087	.038 **
Soaps and toilet article expenditures	997	833	164	20%	2.127	.035 **

[5] A test significance level of $\leqslant 0.10$ is usually acceptable in socio-economic studies. This indicates that the researchers accept a 1 in 10 chance of making an error in accepting a hypothesis when it is in fact not true.

Table 4. (Continue)

Variable	Mean in 2008	Mean in 2006	Diff. 2008-2006	% change 2008/2006	t-stat	Sig. (2-tailed)
Significant decreases from 2006 to 2008						
% expenditures on autos, motorbikes and bicycles	.003	.005	-.002	-44%	-3.740	.000 ***
% value from rice and grains	.092	.240	-.148	-62%	-3.190	.002 ***
% value from animal products	.078	.238	-.159	-67%	-2.434	.021 **
% value from vegetables	.006	.019	-.013	-71%	-1.751	.090 *
Book expenditures	40	200	-160	-80%	-4.714	.000 ***
Medical expenditure	3201	29963	-26761	-89%	-3.999	.000 ***
% income transportation employment	.009	.107	-.098	-92%	-4.941	.000 ***
Eating out expenditures	250	4349	-4099	-94%	-11.904	.000 ***
% value from fruits	.001	.060	-.058	-98%	-2.371	.025 **

Source: Calculations of VHLSS household data from 2006 and 2008.

*** = Significant at ≤ 0.01 level, ** ≤ .05 level, * Significant at ≤ 0.10 level.

It is clear from the top half of table 4 that immigration and small and medium enterprise (SME) income have shot up astronomically as a result of the full operation of the EWEC. To a lesser extent, educational and health expenditures and income from small-scale household enterprises have also risen. These changes signal a dramatic opening-up of possibilities for engaging in new economic activities and for accessing life-style improvement.

Meanwhile, the bottom half of the table suggests that improvements in transportation have permitted a significant reduction in transportation costs associated with the use of automobiles, motorcycles, and bicycles; as well as a movement away from direct employment in the transportation sector. The road has sparked a major shift within total agricultural output value away from grain, fruits and vegetable and towards industrial crops and legumes. It has also permitted a reduction in the costs of medical expenditures, books, and magazines. We thus have initial strong support from hypothesis 2.

6.1 PEARSON CORRELATION AND ONEWAY ANOVA COMPARISONS OF DISTANCE AND URBANITY

As a second way to show the possible impacts of the road within the VHLSS datasets, we may test for all significant differences in variables for 2008 based on proximity to the EWEC, which can be approximated by distance in kilometers (Table 5). The top half of table 5 shows the individual variables that vary significantly and *positively* with distance in kilometers, while the bottom half reports those that vary significantly and *negatively*.

From the top of the table we see that religiosity, charitable donations, good works, ceremonies, agricultural incomes and non-food expenditures all go down the closer one lives to the EWEC. Conversely, the bottom of the table shows that expenditures on various commodities (personal services, soap, parking, utilities, food, and education) all go up the closer one lives to the EWEC. This evidence provides strong proof that the EWEC has improved material welfare but has reduced observable spiritual and moral behavior. The tendency toward crime may thus have risen, as intimated in Figure 2.

Table 5. Significant correlations with distance from the EWEC (n=228)

	distance (km)	Sig.	significance rank
Positive correlations			
Total agricultural land	0.381	0.001	1
Value of rice harvested	0.371	0.001	2
Value of industrial crops harvested	0.339	0.001	3
Value of fruit crops harvested	0.306	0.001	4
Engel coefficient for religious expenditures	0.299	0.001	5
Value of by-products	0.294	0.001	6
Value of vegetable and annual plants	0.259	0.001	7
Ceremonial expenditures per capita	0.225	0.001	8
Engel coefficient on non-food	0.278	0.003	9
Per capita light bulbs and other hardware	0.190	0.004	10
Other spending	0.250	0.007	11
Non-food expenditures per capita	0.222	0.018	12
Donations per capita	0.155	0.019	13
Income from agri-service	0.151	0.023	14
Per capita total expenditure	0.143	0.031	15
Negative correlations			
Food expenditure	-0.409	0.000	1
Parking	-0.256	0.000	2
Per capita personal services	-0.221	0.001	3
Per capita garbage expenditure	-0.219	0.001	4
Engel coefficient for food	-0.278	0.003	5
Education of household head (years)	-0.180	0.006	6
Sex of household head (male = 1, female = 0)	-0.175	0.008	7
Highest diploma attained (code 0-12)	-0.164	0.013	8
Expenditures on daily consumption items	-0.231	0.013	9
Soaps and toilet articles	-0.161	0.015	10
Utilities expenditures	-0.133	0.045	11
Internet and telephones	-0.133	0.046	12
% income from service sector	-0.129	0.051	13
Total education of all hh members (years)	-0.117	0.077	15

Note: Per capita, values, spending and expenditures are in thousand VN dong.
Source: Calculations from VHLSS household data from 2006 and 2008.

Based on both Tables 4 and 5, we fail to reject hypothesis 3, that "*proximity to the road makes people economically better off through job creation, specialization and reduced inequality*." (However, the road does not seem to make people morally better off.)

6.2 EVOLUTION OVER TIME OF THE GINI COEFFICIENT AND FGT MEASURES OF POVERTY

Table 6 reports trends in the Gini coefficient of relative inequality for the Da Nang VHLSS survey sample between 2002 and 2008. The Gini coefficient is a measure of the relative distance of the actual distribution of income from a hypothetical distribution of perfect equality; the lower the number, the better. The quintile (and decile) ratios express the ratio of the total income of the top 20% (10%) to the lowest 20% (10%) of the

population. The inter-annual volatility of these ratios for the available Da Nang data -- as well as the switching of relative severity between years -- seem very improbable. The VHLSS data for each year may therefore have been collected from samples that changed too greatly.

Table 6. Trends in the inequality of income distribution in the Da Nang VHLSS

Year	Sample	Quintile ratio	Decile ratio	Gini coefficient
2002	Rural	10.5	20.5	0.4
	Urban	6.7	12.5	0.3
	Semi-urban	5.8	8.3	0.3
	Total	**11.5**	**21.8**	**0.4**
2004	Rural	2.9	3.8	0.2
	Urban	4.9	7	0.5
	Semi-urban	4.6	6.7	0.3
	Total	**4.8**	**7.2**	**0.3**
2006	Rural	4.3	5.3	0.3
	Urban	3.5	4.5	0.2
	Semi-urban	11.8	22.8	0.6
	Total	**6.3**	**11.2**	**0.4**
2008	Rural	6	8.3	0.4
	Urban	5.7	7.6	0.3
	Semi-urban	3.2	5.1	0.2
	Total	**5.4**	**7.5**	**0.3**

Source: Calculations from VHLSS household data from 2006 and 2008.

If, on the other hand, one can believe that the data do represent the real changes that have occurred, there are interesting implications for testing the Kuznets (1955) inverted-U curve for the changes of inequality in the successive stages of the development process. The rural area goes down and then steadily upward, the urban area upward, downward and then back to its original level, and the semi-urban area is constant, undergoes a huge rise, and then drops to the lowest vale of the three areas. We may accept hypothesis four which states that "*The distribution of income (Gini) for the whole sample has grown more equal over time as economic opportunities have opened to all classes of workers*." Except for the year 2006, there has been a steady downward trend in both quintile and decile ratios and the Gini coefficient for the sample as a whole.

The three Foster-Greer-Thorbecke (FGT) indices of absolute poverty include the "incidence" (head count), "depth" (average level) and "intensity" (level squared) of shortfalls below the poverty line.[6] It is clear from the data from 2006 and 2008 (Table 7) that the greatest reductions in the probability of being poor and in the shortfall below minimum income have been in the semi-urban areas. Indeed, poverty reductions in the semi-urban sample have slightly surpassed those in the urban sample. This is a direct result of the fact that, on average, semi-urban areas lie closest to the EWEC. Meanwhile, a higher percentage of rural dwellers remain poor, they are on average poorer than in the other areas, and the cases of extreme poverty are also higher.

6 For further details, please see Foster, Greer and Thorbecke (2010).

Table 7. Trends in the incidence, depth and intensity of poverty between the urban, semi-urban and rural samples

Sample	Incidence		Depth		Intensity	
	2006	2008	2006	2008	2006	2008
Urban	52%	37%	.15	.11	.06	.04
Semi-urban	81%	36%	.29	.09	.13	.04
Rural	75%	63%	.27	.20	.12	.08

Source: Calculations from VHLSS household data from 2006 and 2008.

Based on these results, we fail to reject hypothesis five, to the effect that "*The incidence, depth, and intensity of poverty have declined for the whole sample and each of the three subsamples over time*." That conclusion is further strengthened by the fact that proximity to the road has brought about the greatest decline in poverty.

6.3 REGRESSION ANALYSES

We now proceed to estimate three equations with data from the 114-household primary household sample in order to test hypothesis 6: *Those who are closer to the road, have obtained transportation employment, or have jobs related to the road are better off*. Logically speaking, being "better off" should involve a) having more income and b) avoiding intense poverty c) over time. To capture a, we have posited the following logical relationship for econometric modeling:

Household income per capita = f (Distance from EWEC-, salaries from transportation and other road-related activities+; expenditures on transportation+, expenditures on education and the service sector+ | Gender, age, workforce, education, school-attending children, Year = 2008).

The "+" and "–" signs indicate the expected direction of impact on the *dependent variable* household income per capita. The *independent variables* preceding the ";" are those to be specifically tested in the hypothesis. The *conditional* variables of indeterminate sign following the "|" are used to detect significant differences by the socioeconomic status of households for eventual policy interventions. Any independent or conditional variables found to be significant at the 0.10 level or better will be judged to have a demonstrable effect on the dependent variable.

To model b (the causes of intense poverty), we hypothesized the following econometric relationship:

Intensity of poverty = f (Urbanity (0 rural, 1 semi-urban, 2 urban)-, migration income+, expenditures on transportation+, income from small-scale household enterprises+ | Gender, age, education, school-attending children, Year = 2008).

Finally, to model c, we have formulated the following relationship to track changes between 2006 and 2008:

Dynamic income change = f(Change in household location+, % income from sales and marketing+, Total education of all hh members+, Total expenditures– | Age, Household size (members).

It should also be noted that since, at least for the Da Nang sample of 114 households, urbanity and distance to the road are "collinear" variables (Pearson correlation coefficient = 0.51), we must choose one or the other for inclusion in each of econometric equation.

Table 8 reports the most satisfactory[7] equation for explaining income per capita through transportation and other variables. Although income has increased significantly between 2006 and 2008, there is little evidence that the EWEC or transportation in general has had much to do with it. While distance from the EWEC is marginally significant, the signs on % salaries from transportation, and % expenditures on vehicles of various types are all non-significant. It is, rather, a set of other variables that significantly determine income: service expenditures, particularly on education per student; male gender; and expenditure on religion, charity and good works. Education increases income per capita by making labour more productive. On the other hand, as the size of the workforce (the number of workers in the household) increases, it is harder to increase income per capita; this suggests disguised unemployment. Incomes are also significantly lower in households with children attending school, an aged head, and/or hired factory workers.

It has been shown in many previous studies that poverty cannot be simply assumed to be the flip-side of the coin of income, and that different variables may be the most significant in causing each. In the case of Da Nang there are, nonetheless, several similarities between the two equations. Table 9 presents a second regression to explain the intensity of poverty by transportation and other variables. The intensity rather than the incidence or the depth of poverty was used because of the greater inter-household differentiation afforded by the third FGT measure, which is the square of the second.

[7] "Satisfactory" in regression analysis means that at least one indicator for each of the hypothesized independent variables is included, even if its t-statistic is not significant. However, only those conditional variables that prove to be significant — and hence relevant for policy purposes — are included. The F-statistic of the entire equation should be greater than 4, the signs should be logically interpretable, and the adjusted R-squared should be the highest among equations judged to be equally good from all other points of view.

Table 8. Regression analysis to explain income per capita

	B	Std. Error	Beta	t-stat	Sig.
Proximity to EWEC					
Distance from EWEC (km)	527.2	312.5	0.04	1.69	0.093
Transportation-related variables					
% salaries from transportation in total income	5093.5	3461.2	0.03	1.47	0.143
% expenditures on automotive, motorbikes, and bicycles in total expenditures	-49509	115375	-0.01	-0.43	0.668
% income from hired labour in manufacturing	-3921	2161.3	-0.04	-1.81	0.071
Other economic variables					
Engel_service	35526	796.2	0.79	44.62	0.000
Expenditure per capita religion, charity and good works	0.1	0	0.11	6.33	0.000
Average educational expenditure per student (total education expenditure/ boys + girls attending school)	0.7	0.2	0.08	3.18	0.002
Sociodemographics					
Sex of hh head (male = 1, female = 0)	2849.4	1101.3	0.08	2.59	0.010
Age of hh head (years)	-75.3	32.3	-0.13	-2.33	0.021
Workforce (male & females 17-60)	-1680	416.2	-0.18	-4.04	0.000
Average education per hh member (total years education / total hh members)	1778.1	184.3	0.52	9.65	0.000
No. of boys+girls attending school/hh	-2295	554.2	-0.13	-4.14	0.000
Year dummy (2008 =1, 2006 = 0)	6145.2	1135.9	0.15	5.41	0.000
Adjusted R-squared: .946		**F-statistic: 256.4 (.000)**			**df =189**
dependent variable = income per capita					

Source: Estimations on VHLSS household data from 2006 and 2008.

Table 9. Regression analysis to explain the intensity of poverty

	B	Std. Error	Beta	t-stat	Sig.
Proximity to EWEC					
Urbanity (0=rural, 1=semi-urban, 2=urban)	-0.01	0.01	-0.06	-0.69	0.491
Transportation related activities					
% expenditures on automotive, motorbikes, bicycles	3.01	1.35	0.14	2.23	0.027
% migration income in total household income	-0.06	0.03	-0.14	-2.52	0.012
Other economic variables					
% income from small-scale family enterprises	0.09	0.02	0.27	4.47	0.000
Socio-demographics					
Age of hh head (years)	0	0	1.06	9.04	0.000
Number of children attending school	0.04	0.01	0.44	6.08	0.000
Year dummy (2008 =1, 2006 = 0)	-0.02	0.01	-0.12	-1.75	0.082
Gender of hh head (male = 1, female = 0)	-0.02	0.01	-0.14	-1.86	0.064
Average education per household	-0.01	0	-0.85	-6.47	0.000
Adjusted R-squared: 0.546		**F-statistic: 31.4 (.000)**			**df = 219**
Dependent variable = intensity of poverty					

Source: Estimations on VHLSS household data from 2006 and 2008.

Consistent with the income equation above, the year dummy 2008 (as compared with 2006) reduces the intensity of poverty, as does having a male household head and higher education. Furthermore, households with older heads and school-attending children are at greater risk of falling into intense poverty. This said, other determinants of poverty intensity are not the simple mirror-image or negation of the determinants of income. Migration now seems to be a strategy for alleviating the intensity of poverty, while operating a small-scale family enterprise is not. Marginal households should therefore migrate elsewhere rather than attempting to run a small business locally. As well, vehicle expenditures have now become a significant and positive cause of intense poverty. This implies that distant poor households are forced to spend an inordinate percentage of their limited income just to connect to the market economy. Table 10 presents a regression to explain the dynamic change income between 2006 and 2008 by transportation and other variables. The dependent variable is the percentage change in income of each household over the first two years of the active implementation of the EWEC (2006-2008). Since some households moved between the two years, we included change in location. The results show that no variables, including change in household location and education, act to significantly increase income.

Table 10. Regression to explain dynamic income change, 2006 – 2008

	B	Std. Error	Beta	t-stat	Sig.
(Constant)	2.16	0.32		6.84	0.000
Change in hh location	0.20	0.14	0.21	1.43	0.161
Total education of all hh members (years)	0.01	0.01	0.29	1.46	0.151
Total expenditure (thousand VND)	0.00	0.00	-0.31	-1.88	0.067
Age of household head (years)	-0.01	0.01	-0.28	-1.86	0.070
% income from sales and marketing (%)	-0.93	0.50	-0.27	-1.87	0.069
Change in household size (member)	-0.12	0.04	-0.49	-2.92	0.006
Adjusted R-squared = 0.175		**F-statistic = 2.631 (.030)**			**df = 188**
Dependent variable = change in income 2008 over 2006					

Source: Estimations on VHLSS household data from 2006 and 2008.

Rather, it is a set of negative variables that explain the loss of income by some households. We find that total expenditures are negatively correlated with the increase in income over a two-year period; implying that savings and investment are more important than consumption. Furthermore, the age of the household head and % income from sales a marketing are negatively correlated with improvements in income. Change in members is also negative; suggesting that larger families tend to consume more than they produce, another sign of disguised unemployment. This set of variables is important in the consideration of the most effective policies and programs to target poverty reduction in the Da Nang area.

Based on these three regressions, we may now test hypothesis 6 that "*Those who are closer to the road, have obtained transportation employment, or have jobs related to the road are better off.*" The hypothesis is flatly rejected for the income regression of table 8, since none of those variables is significant. It is also rejected by the intensity of poverty regression of Table 9, since expenditures on vehicles actually increase the intensity of poverty. Finally, it is rejected by the results of Table 10, since declines in income between 2006 and 2008 have resulted from using the road more for sales and marketing.

7. SUMMARY AND CONCLUSIONS

This study has measured, explained, and compared the impacts of highway development on the level and distribution of income and on absolute poverty in rural, semi-rural, and urban households in Da Nang province between 2006 and 2008. The study employed t-tests, Gini coefficients, Foster-Greer-Thorbecke indicators, and multiple regression analyses.

These research methods have led us to reject hypotheses 1 and 6 (Figure 2); give weak acceptance to hypothesis 2; and accept hypotheses 3, 4, and 5. Specifically, official *secondary* statistics at the national level suggest that the improvement in highway infrastructure conferred no clear advantage on Da Nang province when compared with other provinces, regions and cities within Vietnam.

However, from the viewpoint of a carefully selected *primary* sample of 114 households, proximity to the road clearly makes people better off within Da Nang provine. Incomes have increased and with them the ability to spend on education and communication (internet and telephone) and to migrate to higher-paying jobs. Meanwhile, gains in transportation efficiency have reduced medical expenditures. Transportation employment is not significantly correlated with income because skill levels required for that sector are quite variable, but the transportation sector has provided new jobs to the least well-off.

The incidence, depth, and intensity of poverty have all decreased over the period in which the EWEC has been put into operation. Generally, the incidence and depth of poverty are highest in the rural areas farthest from the road. In contrast, the semi-urban area closest to the road has witnessed the biggest decline in the intensity of poverty.

7.1 IMPLICATIONS FOR POLICY AND SOCIAL PROGRAMS

Policy analysts and ministry officials can gain valuable insights from these results for use in their planning for future infrastructural investments and the complementary policies that could bring the positive impacts of the road to any pockets of the population who may have been left behind. The results of the present research suggest, in line with previous studies, that the impacts of roads alone are not as strong as anticipated, that the impacts are highly location-specific; and that supplementary policies are necessary to enhance those impacts. First of all, to maximize advantages from the road, the government could provide human capital training to allow workers to qualify for higher-level jobs, particularly in the rural areas and in the transportation sector. Special programs to help poor households afford schooling for all their children in the short run will help to eliminate poverty in the long run.

Furthermore, government, communities and other institutions could coordinate their efforts to achieve economies of size in specialization for trade. Since the percentage of income from small-scale household enterprises is correlated with poverty, special training and advantageous loan programs could be set up for such households to either improve their businesses or shift to the non-household private sector.

Finally, it is important to set up special monetary transfers, health services, and education programs for those, generally in the rural areas, living farthest from the road. Given the implicit decline in morality as evidenced by the reduction in donations and other moral behaviour, welfare programs, moral education and police vigilance should also be heightened.

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