WIDER Dev Conf 2019
Bangkok

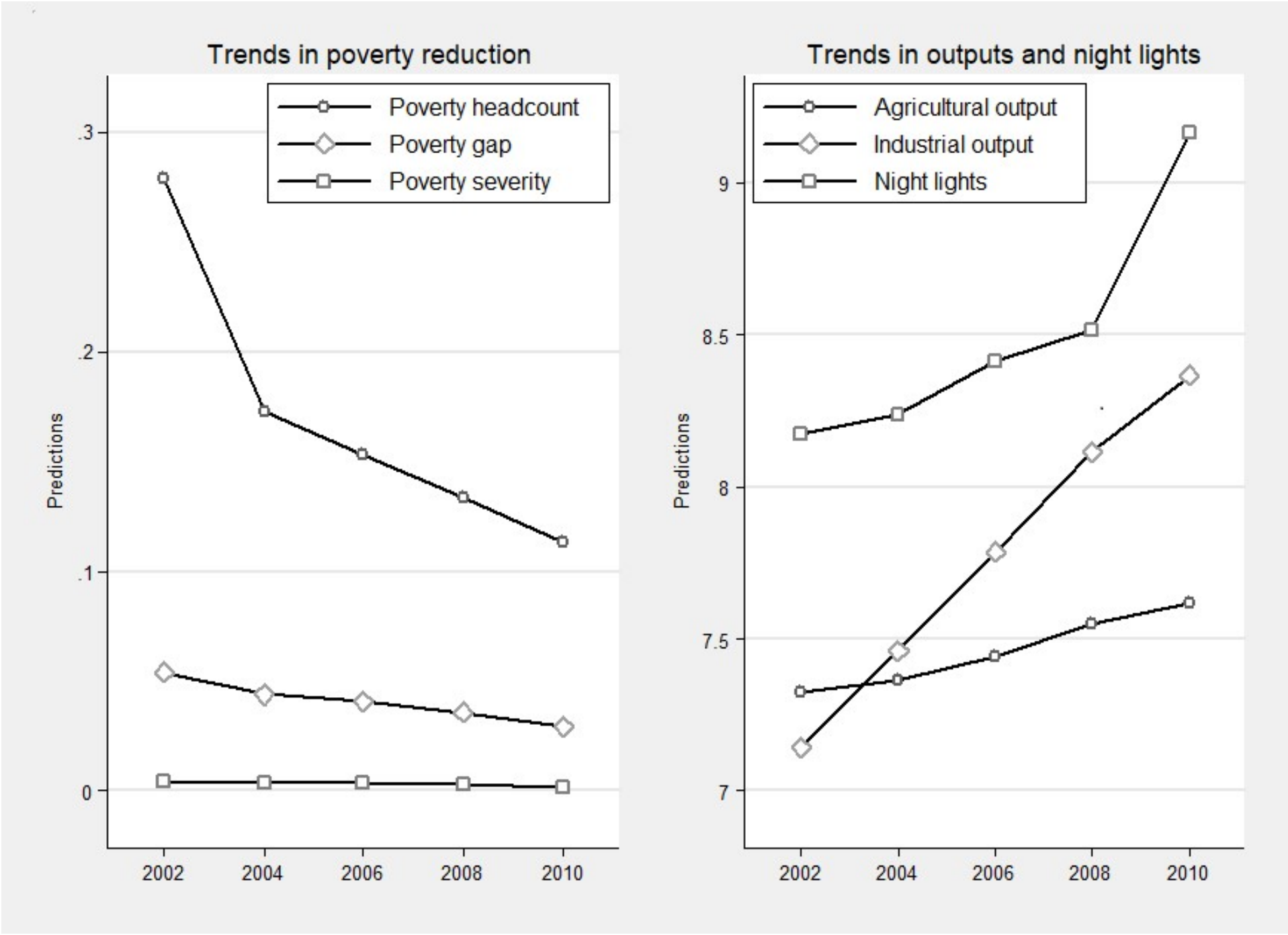
Industrial growth with poverty and equity? Predictions from night lights in Vietnam

Takahiro Yamada* and Christian S. Otchia+

*Ministry of Finance, Japan +Nagoya U.

September 2019

Stylized facts



Abstract

While agriculture did not work, industrial outputs performed as a strong driver for poverty reduction in Vietnam in 2000s (the poverty elasticity ranges from -0.678 to -0.381). The result suggests that there is no stable relationship between poverty-initial inequality, and poverty-initial inequality through industrial outputs.

- **Vietnam's development after the *Doi Moi* policy has been characterized by triple successes:**
  - A high economic growth, significant poverty reduction, and low inequality.

- By employing provincial panel data of Vietnam from 2002 to 2010, this study verifies **the relationship between industrial growth and poverty reduction** with the consideration of initial conditions using data in 2002 and 1997/98.

- The main estimation results show that
  - (i) **industrial sector outputs are a strong driver of poverty reduction,** while agriculture sector outputs do not have statistical significance
  - (ii) there is no stable relationship between poverty-initial inequality, and poverty-initial inequality through industrial outputs.

Contribution

Our paper extends the findings of Ravallion and Datt (JDE, 2002) and Ferreira et al. (JDE, 2010) by employing **unique evidence from Vietnam** to verify how the sectoral composition of growth and initial inequality interacted to affect poverty.

- India:
  - a country with **vast numbers of poor** people even now
    - the latest available poverty headcount ratio was 21.2% in 2011, according to PovcalNet
    - very high before that (54.8% as of 1983).

- Brazil:
  - **unequal distribution of income** with the Gini index approximately 0.6
  - record of poverty reduction was disappointing due both to low growth rates and a low growth elasticity of poverty reduction

- Vietnam:
  - **Large absolute poverty reduction** along with **higher and more inclusive economic growth** through structural change over the past 30 years since the *Doi Moi*;
    - **from the agricultural sector dominance to the manufacturing export–oriented economy,** which has been **backed by the introduction of foreign investments**.

Contribution (cont.)

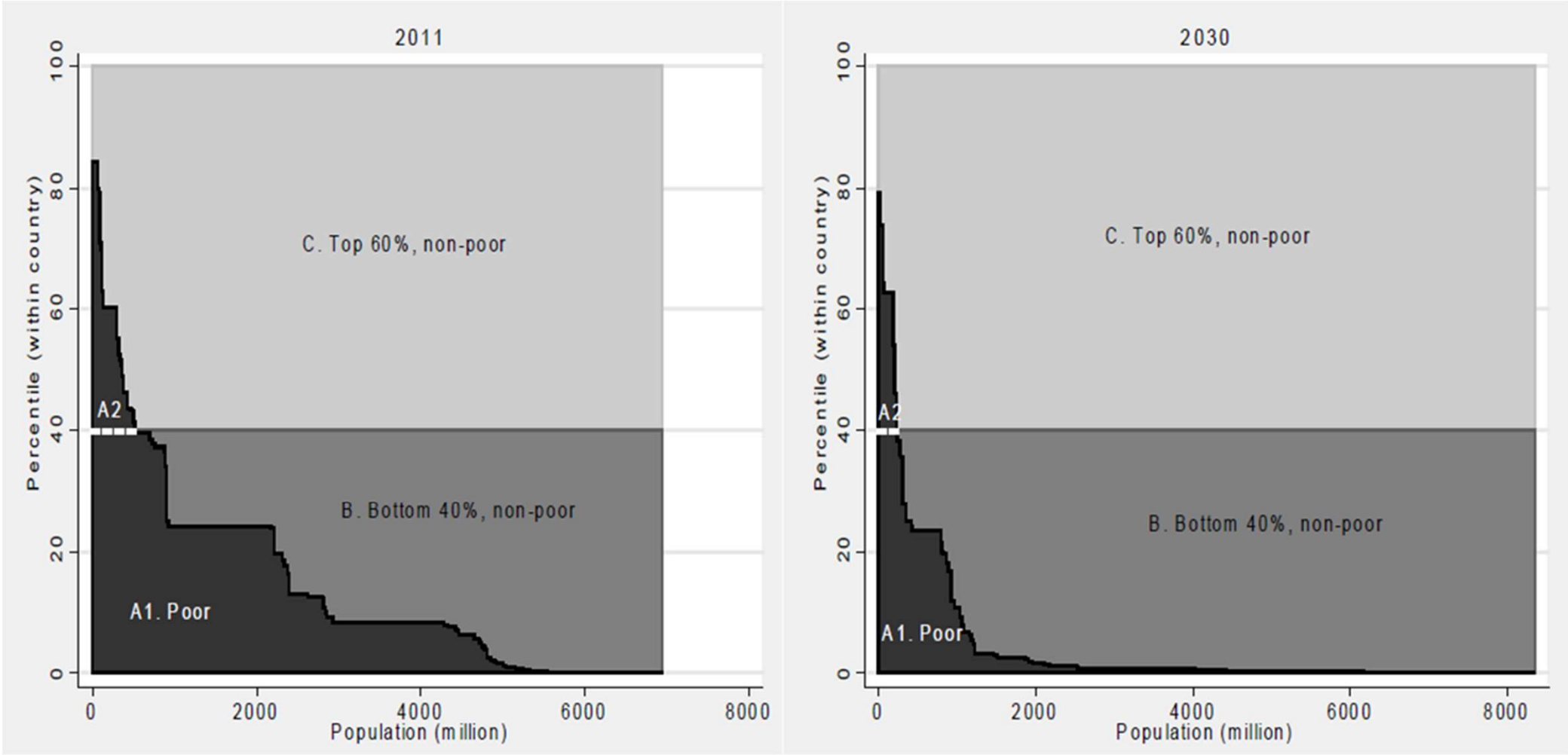
Our paper provides more robust estimations by employing the **nighttime lights data** as a proxy for industrial outputs, and the robustness check tool proposed by **Oster (JBES, forthcoming)**, the unobservable selection and coefficient stability test.

- The potentially **insufficient quality of growth indicators** due to measurement errors in less developed countries (Henderson et al., AER, 2012; Johnson et al., NBERWP, 2013; Keola et al., WD, 2015; Nordhaus, 2006; Ravallion and Chen, 1999),
  - which is the case in Vietnam, as well (International Monetary Fund [IMF], 2010)
  - use of **night lights data** given the strong correlation between night lights and industrial growth (Henderson et al., AER, 2012)

- **Oster (JBES, forthcoming)**
  - check the effect of omitted variable bias by changing the degree of observable and unobservable with the consideration of R-squared value

World has committed to poverty eradication, but…

Distribution of the extreme poor, non-poor bottom 40 percent and non-poor top 60 percent in 2011 and 2030

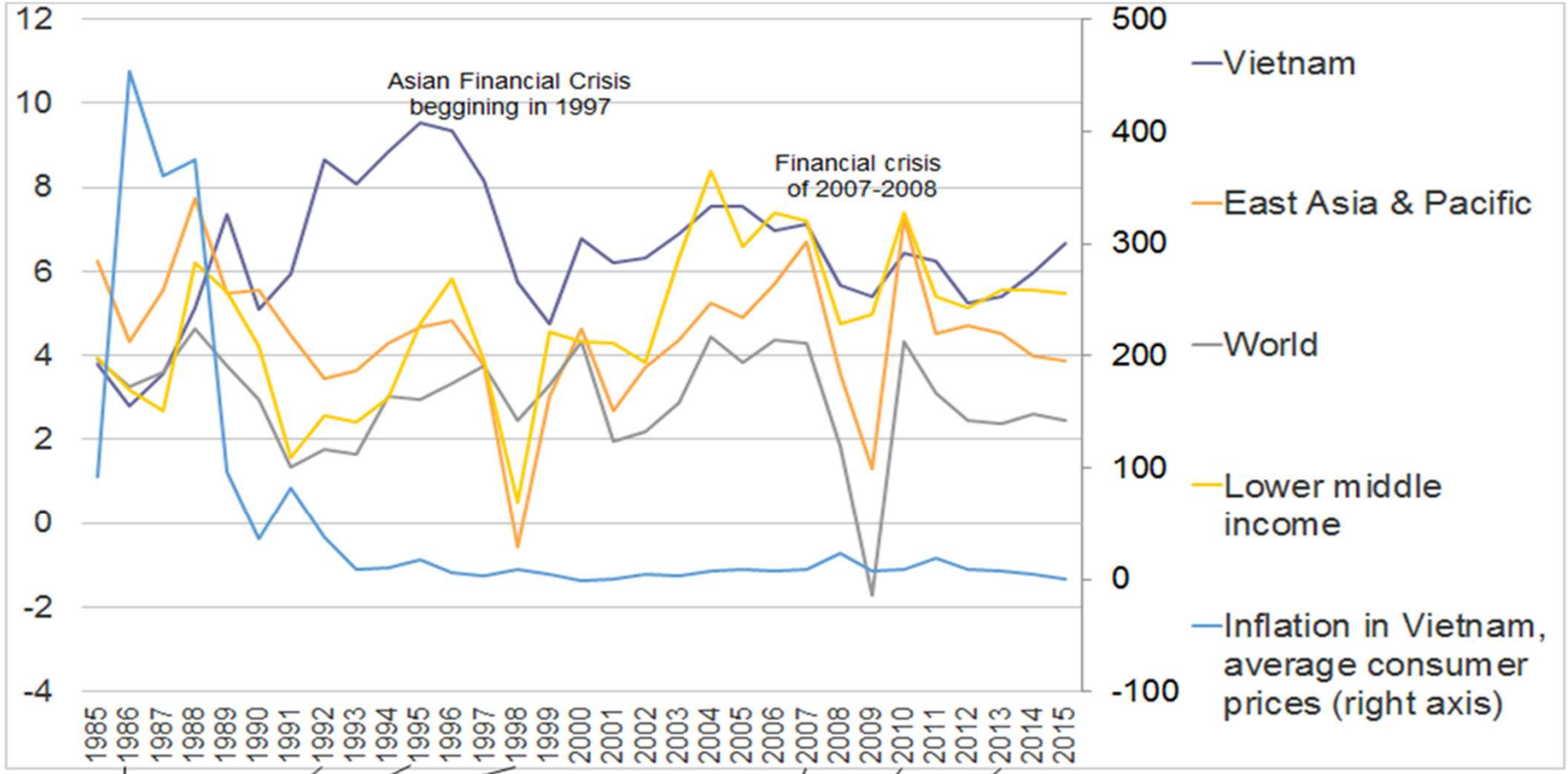


Source: Lakner et al (2014)

Note: Based on the idea by Beegle et al. (2014), Lakner et al. (2014) updated data for 2011 and 2030 (distribution-neutral growth, meaning not necessarily leading to either a worsening or an improvement in distribution).

Higher growth by integrating to the World economy via Doi Moi

Real sector development and major historical events in Vietnam



Major historical events of Vietnam

- DoiMoi launched in 1986
- Restart of ODA from Japan in 1992
- Diplomatic Normalization with U.S. in 1995
- Accession to ASEAN in 1995
- Became a member of APEC in 1998
- Accession to WTO in 2007
- Selected as a non-permanent member of the UN Security Council (2008~2009) in 2007
- Chair of ASEAN in 2010
- Serve on the UN Human Rights Council (2014~2016) in 2013.

Large poverty reduction and low and stable inequality

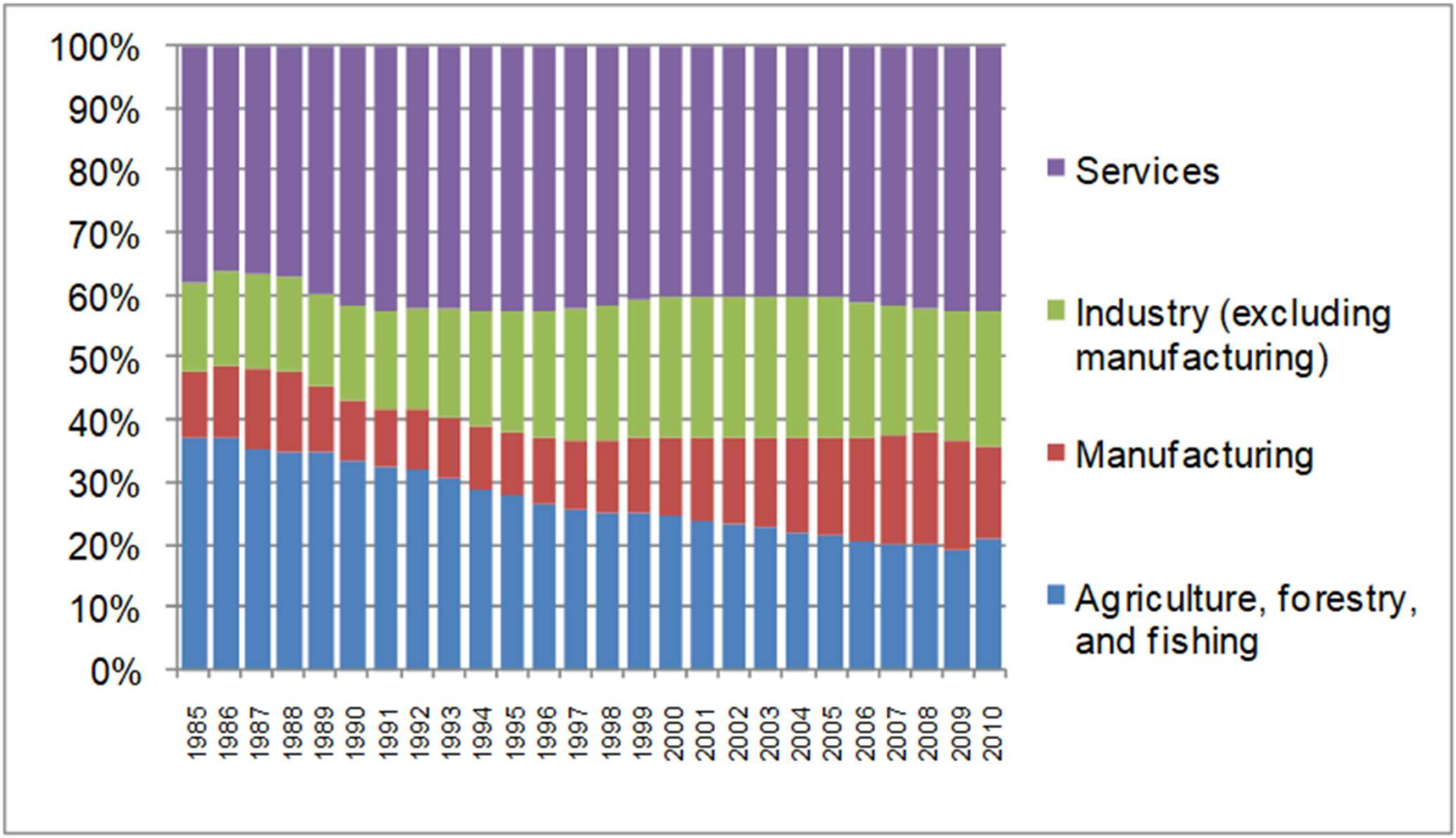
Poverty and inequality index in Vietnam

Year	Poverty headcount ratio		Poverty gap ratio		Gini index	
	GSO's overall poverty line	$1.90 a day (2011 PPP)	GSO's overall poverty line	$1.90 a day (2011 PPP)	GSO's overall poverty line	$1.90 a day (2011 PPP)
2002	33.5%	40.1%	5.6%	11.2%	0.299	0.376
2004	23.5%	31.4%	4.6%	8.5%	0.316	0.368
2006	17.8%	21.4%	4.3%	5.3%	0.316	0.358
2008	20.1%	16.8%	3.8%	3.7%	0.316	0.358
2010	18.3%	3.9%	3.0%	0.8%	0.333	0.393

Source: GSO, VHLSS2002, 2004, 2006, 2008, 2010 and PovcalNet, the World Bank.
Note: We use "overall poverty line" (GSO 2008, 2010) expressed as the monthly average expenditure per capita of household adjusted for the cost of living by region and overtime as follows: 160 thousand dongs in 2002; 173 thousand dongs in 2004; 213 thousand dongs in 2006; 290 thousand dongs in 2008; 430 thousand dongs in 2010, respectively. Poverty indicators using $1.90 a day (2011 PPP) are in parenthesis.

Agri to manufacturing

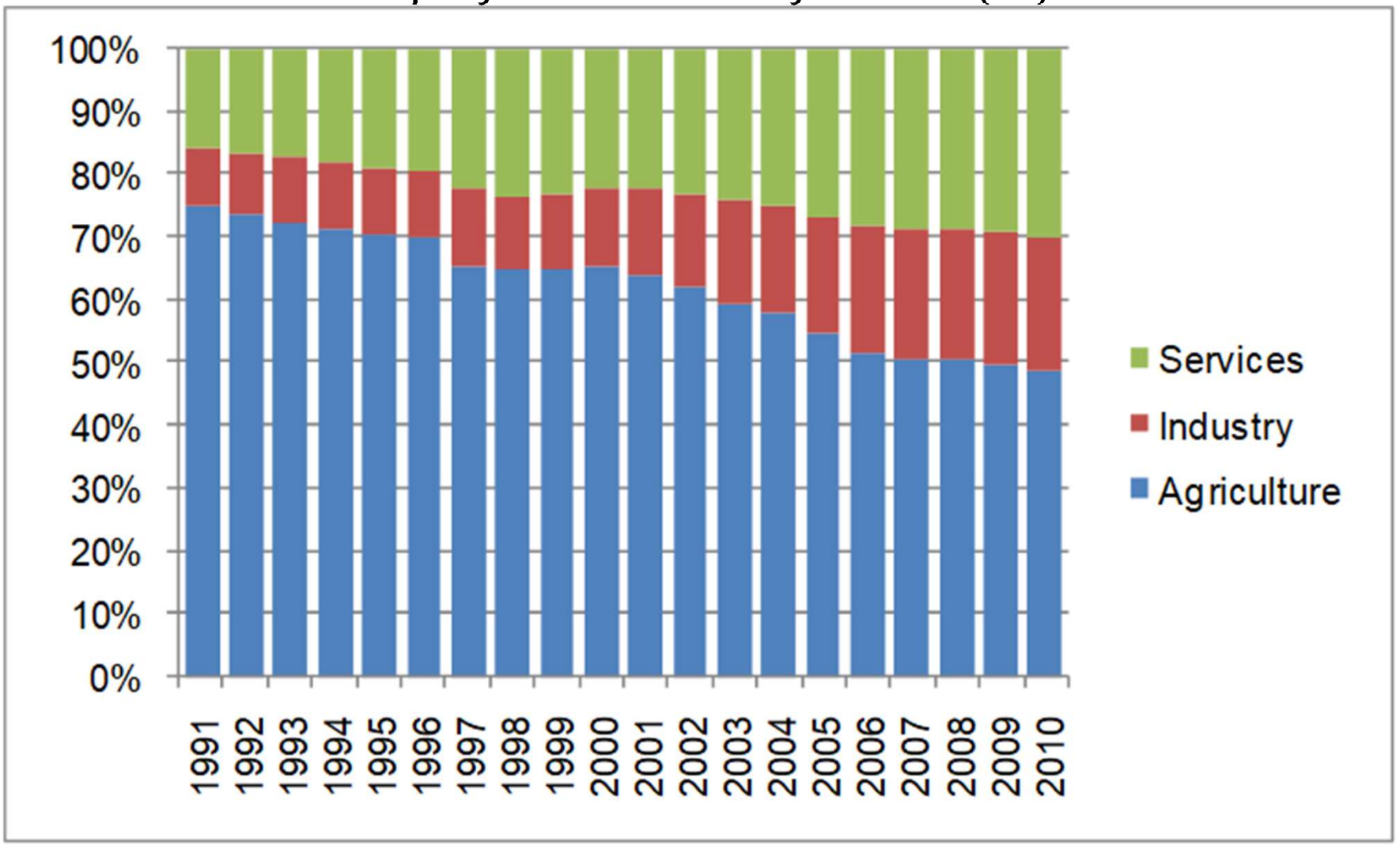
Value added by sector (constant 2010 US$)



Source: WDI, the World Bank.

Agri to manufacturing

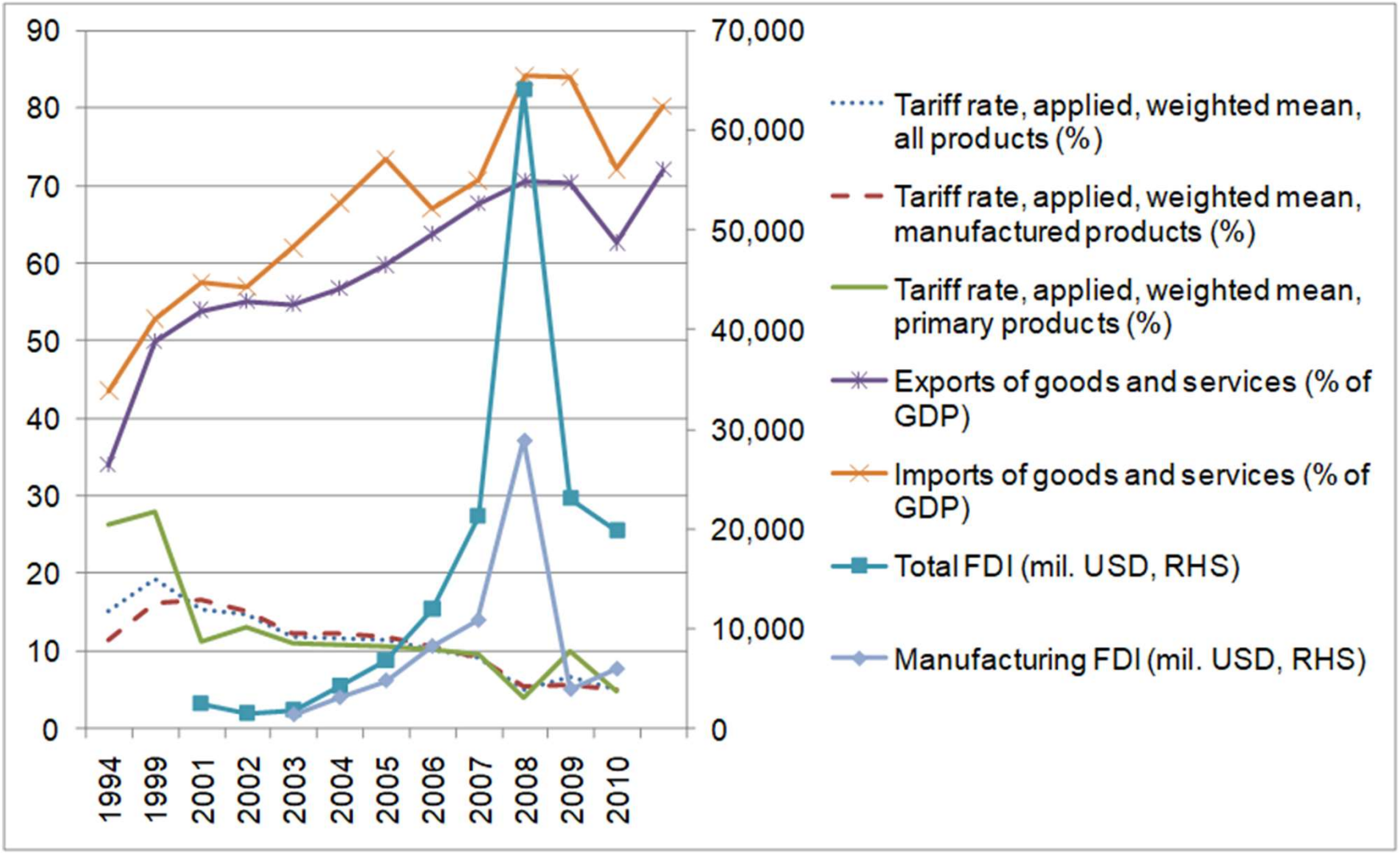
Employment share by sector (%)



Source: WDI, the World Bank.

Reduction of tariff rate, FDI inflows and export-oriented

Weighted mean applied tariff rate, FDI, and trade indicators of Vietnam



Sources: WDI, the World Bank using the World Integrated Trade Solution system, based on data from the United Nations Conference on Trade and Development's Trade Analysis and Information System (TRAINS) database and the WTO Integrated Data Base (IDB) and Consolidated Tariff Schedules (CTS) database. FDI data are from the Statistical Yearbooks of Vietnam; they include supplementary capital to licensed projects in previous years.

Note: The weighted mean applied tariff rate is the average of the effectively applied rate that is weighted by the product import shares corresponding to each partner country.

Concentration of FDI on manufacturing

Foreign direct investment (FDI) projects licensed by economic activity (total registered capital, USD million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agriculture, forestry, and fishing	58.9	30.4	49.5	47.3	107.6	51.1	169.4	58.6	223.5	134.5	36.2
Mining and quarrying	620.1	2,139.1	1,176.7	37.9	153.4	56.0	144.3	262.3	6,840.8	397.0	5.6
Manufacturing				1,401.1	3,110.2	4,818.4	8,270.9	10,882.5	28,902.4	3,942.8	5,979.3
Electricity, gas, steam, and air conditioning supply	1,184.0		0.0	0.0	17.2	20.4	0.0	9.6	3.7	183.9	2,952.6
Water supply, sewage, waste management, and remediation activities											10.1
Construction	24.1	9.5	80.2	25.3	212.8	171.1	641.4	993.3	492.1	652.0	1,816.0
Wholesale and retail trade; repair of motor vehicles, motorcycles, and personal and household goods	0.0	0.0	0.0	7.6	38.2	99.3	141.1	129.9	54.8	261.1	462.1
Transportation and storage/transport, storage, and communications	8.0	231.5	20.4	15.3	56.3	684.2	52.3	356.5	1,882.1	299.8	881.0
Hotels and restaurants	22.8	10.1	168.6	140.2	141.0	61.8	498.4	1,968.1	1,350.2	9,156.8	315.5
Financial, banking, and insurance activities	10.0	0.0	5.0	0.8	30.6	145.9	32.0	32.3	62.6	100.0	59.1
Real estate activities	0.0	0.0	0.0	183.7	200.9	460.8	1,818.8	6,114.8	23,702.8	7,808.4	6,827.9
Education and training	67.2	53.2	26.5	6.7	14.6	25.8	22.1	11.6	86.7	30.4	74.7
Health and social work				2.3	16.5	203.4	7.9	112.5	402.9	15.0	205.6
Recreational, cultural, and sporting activities				24.5	121.2	21.1	189.1	410.3	5.8	107.4	62.3
Community, social, and personal service activities	17.0	29.2	30.8	7.0	1.7	20.5	16.1	5.5	0.6	18.2	15.5
Total	2,012.1	2,503.0	1,557.7	1,899.7	4,222.2	6,839.8	12,003.8	21,347.8	64,011.0	23,107.3	19,703.5

Source: Author's compilation is based on the Statistical Yearbooks of Vietnam.
Note: FDI includes supplementary capital to licensed projects in previous years.

Contribution (cont.)

Our paper complements another group of reports in the literature that seek the answer to a recurring issue: whether the focus of development plans should be on growth, poverty, and/or inequality

- The recurring issue
  - e.g. Jain and Tendulkar, 1990; Kakwani and Subbarao, 1990; Kakwani et al., 2000; Ravallion, 2001; Kalwiji and Verschoor, 2007; Bourguignon, 2004; Lopez, 2006; Ravallion, 2007

- Growth-poverty relationship
  - Dollar and Kraay (JEG, 2002) and Dollar et al. (EER, 2016)
    - Growth is (still) good for the poor—the average incomes of nations rise proportionately with average incomes of the poor segments.

- Growth-inequality and poverty-inequality relationships are open questions.

- Sectoral Output Growth and Poverty Relationship
  - …Unique development on Ravallion and Datt (JDE, 2002) and Ferreira, Leite and Ravallion (henceforth FLR) (JDE, 2010):
    - (i) from cross-country to one-country case study using panel data, and (ii) from aggregate output to disaggregated output data.

Ravallion and Datt (JDE, 2002)

Confirmed the importance of farm yields and non-farm outputs, among others. Also, stressed the importance of initial conditions for poverty reduction through non-farm growth

- Regressed disaggregated sectoral outputs to poverty indices by controlling initial conditions for India's 15 states during 1960-1994.
- **Higher farm yields**, higher non-farm outputs, higher state development spending, and lower inflation were all poverty reducing.
- Non-farm growth process was more pro-poor in states with initially higher literacy, higher farm productivity, higher rural living standards relative to urban areas, lower landlessness and lower infant mortality.

Ferreira, Leite and Ravallion (JDE, 2010)

Confirmed that (i) the service sector growth was more poverty reducing than was growth in other sectors, and (ii) the effect of industrial growth varies across states depended on initial conditions.

- Disaggregated sectoral outputs by state and sector for a twenty-year period 1985-2004 to investigate the relationship between poverty reduction and outputs growth by sector given initial conditions.

- The main result suggested that **growth in the services sector was more poverty-reducing** than was growth in other sectors.

- The effect of growth in industry on poverty varied across states and its effect depends on initial conditions related to health, worker empowerment levels, and possibly also in education.

Econometric specification

$$lnPoverty_{it} = \alpha + \beta lnIndustry_{it} + \gamma lnAgriculture_{it} + \delta_t + \eta_i + \varepsilon_{it}$$

- where *i* denotes the province and *t* the year. $Poverty_{it}$ is the measure of poverty, $Industry_{it}$ denotes the real industrial sector outputs, and $Agriculture_{it}$ denotes the agricultural sector outputs.
- A time trend, δ, is included in the regression, and the error term includes a province-specific fixed effect (η_i), as well as the time-varying component (ε_{it}).
- In terms of poverty measures, we looked at the poverty headcount ratio and poverty gap.
- For all the specifications, we employed $Nightlights_{it}$ instead of $Industry_{it}$, to see the coefficient stability of $Industry_{it}$ to deal with the potential insufficient quality of growth indicators due to measurement errors in less developed countries.

Econometric specification (cont.)

$$lnPoverty_{it} = \alpha + \beta lnIndustry_{it} + \vartheta lnInitial\_Inequalty_{it} + \sigma lnIndustry_{it} \times lnInitial\_Inequality_{it} + \gamma lnAgriculture_{it} + \delta_t + \eta_i + \varepsilon_{it}$$

$$lnPoverty_{it} = \alpha + \beta lnIndustry_{it} + \vartheta lnInitial\_Inequality_{it-1} + \sigma lnIndustry_{it} \times lnInitialInequality_{it-1} + \gamma lnAgriculture_{it} + \delta_t + \eta_i + \varepsilon_{it}$$

- where $Initial\_Inequality_{it\ or\ t-1}$ denotes the variable of initial inequality. Our main variable of interest is the interaction term of industrial outputs and initial inequality. We interpret a negative (positive) coefficient of σ as evidence that initial conditions facilitate (impedes) the effectiveness of industrial outputs to poverty reduction.
- For all the specifications, we employed *Nightlights*$_{it}$ instead of *Industry*$_{it}$, to see the coefficient stability of *Industry*$_{it}$ to deal with the potential insufficient quality of growth indicators due to measurement errors in less developed countries.

Descriptive statistics

	N	Mean	SD	Min	Max
Poverty headcount	319	0.23	0.17	0	0.80
Poverty gap	316	0.04	0.05	0	0.28
Initial Gini (1997/98)	310	0.30	0.04	0.21	0.43
Initial Gini (2002)	320	0.32	0.04	0.25	0.40
Real industrial sector output (VND billion)	318	7,687	17,776	51	160,711
Real agricultural sector output (VND billion)	315	2,305	1,700	196	7,838
Night lights (sum of grid level intensity)	315	8,156	9,099	0	57,924

Source: Authors' compilation based on VLSS1997/98, VHLSS2002, 2004. 2006, 2008, 2010.

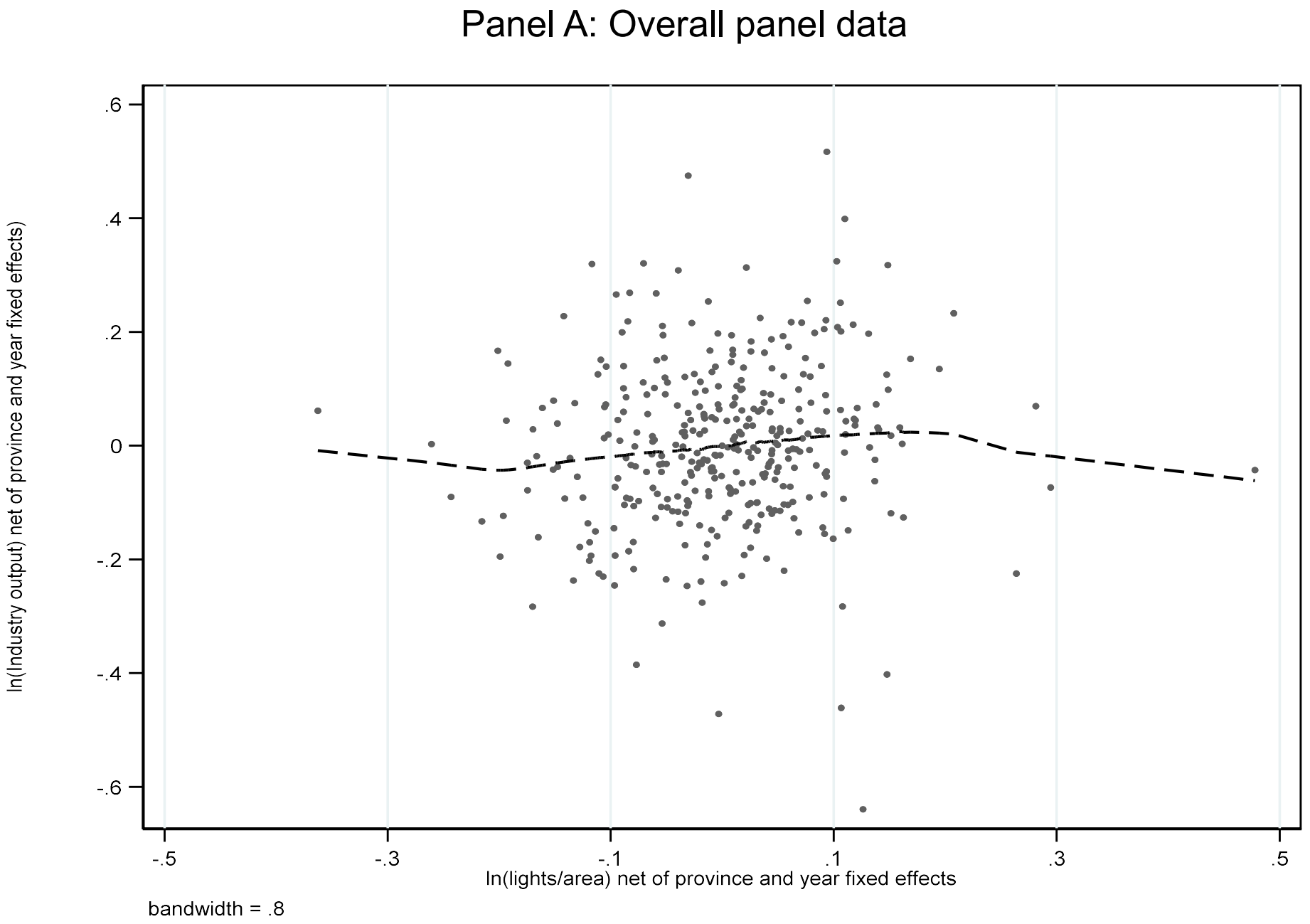
Summary statistics for night lights

(1) There are very few pixels with the digital numbers 1 to 2, and (2) the highest share of digital numbers is in the range of 6 to 10 for Vietnam and Canada, 3 to 5 for Bangladesh and the United States, and 21 to 62 for the Netherlands.

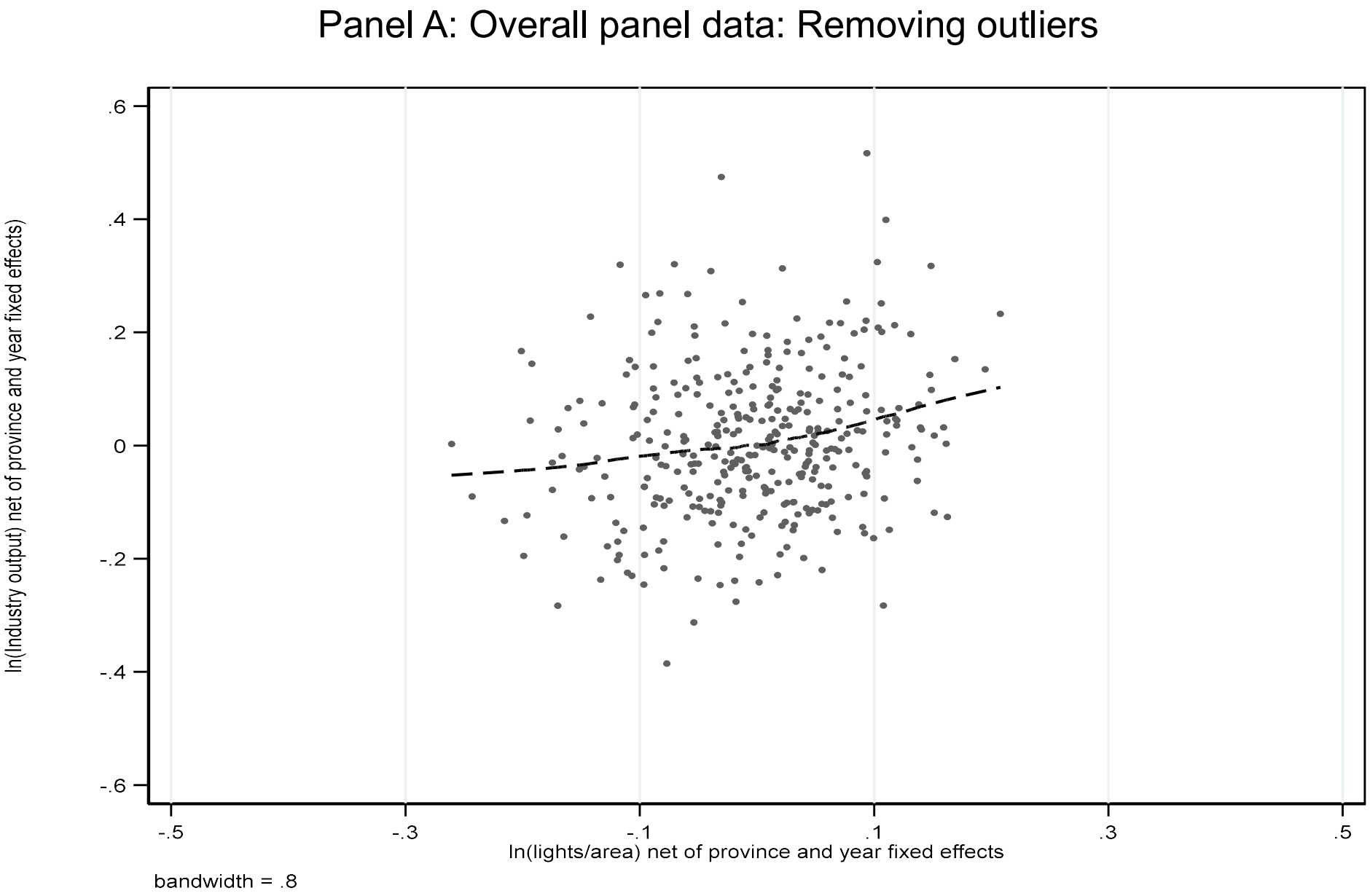
	Vietnam						Bangradesh	USA	Canada	Netherlands
Night Lights Digital Numbers	2002	2004	2006	2008	2010	1992-2008	1992-2008	1992-2008	1992-2008	1992-2008
0	0.60%	0.29%	0.39%	0.29%	0.34%	0.40%	66.73%	69.32%	93.89%	1.01%
1-2	0%	0%	0.003%	0%	0%	0.59%	0.64%	0.11%	0.00%	0.00%
3-5	18.26%	19.51%	23.47%	17.33%	6.58%	23.72%	24.47%	10.85%	1.65%	3.45%
6-10	35.77%	35.52%	33.18%	35.11%	37.52%	34.59%	5.27%	9.60%	2.48%	24.04%
11-20	25.23%	25.20%	23.53%	25.49%	30.88%	22.86%	1.69%	4.53%	1.09%	28.83%
21-62	20.13%	19.48%	19.42%	21.76%	24.65%	17.83%	1.13%	5.02%	0.83%	41.09%
63	0.01%	0.004%	0.02%	0.01%	0.02%	0.01%	0.06%	0.58%	0.05%	1.58%
Average night lights digital numbers	14.14	13.80	13.60	14.70	16.50	13.11	2.01	4.66	0.94	23.52
Pop. Density (per sq. km)	264	269	274	280	285	252	1,007	31	3	471
Percent urban	26	27	28	29	30	25	24	79	79	77
GDP per capita, PPP (cons. 2011 inter. $)	2834	3,196	3,609	4,009	4,408	2,667	1,689	44,684	36,335	39,971
GDP per capita (cons. 2010 US$)	842	950	1,073	1,192	1,310	793	524	43,780	42,360	44,198

Source: Authors' compilation based on Version 4 DMSP-OLS Nighttime Lights Time Series, Henderson (2012, Table 1, p1000), and the World Development Indicators (WDI) extracted on August 13, 2018.
Note: There are very few pixels with the digital numbers 1 to 2. This is due to the algorithms used to filter out noise in the raw data, meaning that some low-density and low-income pixels do not get counted; this leads to the undercount of lights nationally (Henderson et al., 2012, p. 1000).

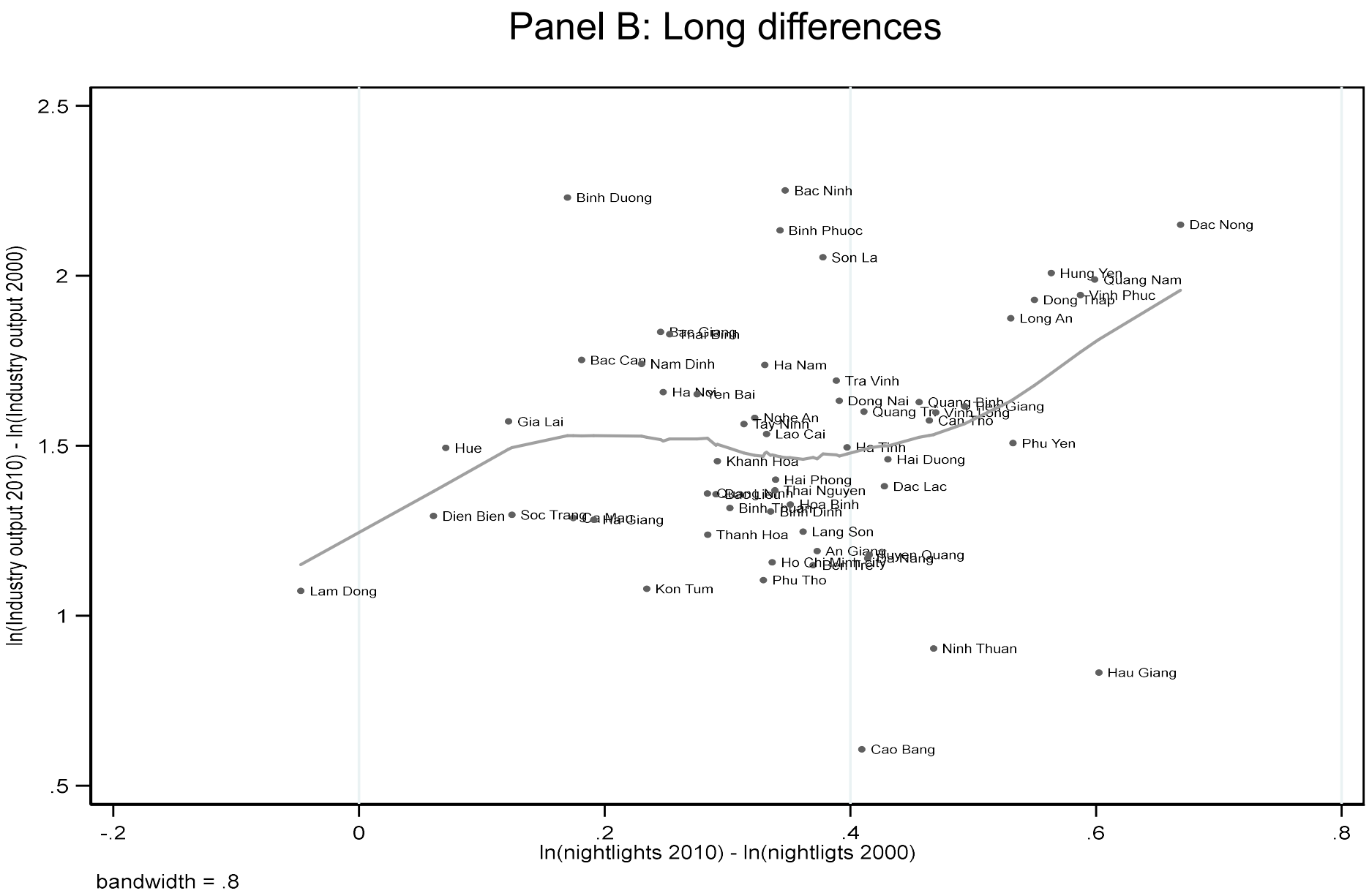
Correlation between industrial outputs and night lights



Correlation between industrial outputs and night lights



Correlation between industrial outputs and night lights



Regressions for the province poverty measures

	Headcount index (1)	Headcount index (2)	Poverty gap (3)	Poverty gap (4)
Panel A: Proxy of industrial sector is real industrial sector outputs				
Real industrial sector outputs	-0.377 ***	-0.383 ***	-0.484 ***	-0.486 ***
	(0.045)	(0.049)	(0.055)	(0.062)
Real agricultural sector outputs		0.077		0.170
		(0.098)		(0.177)
Observations	310	305	311	306
R-squared	0.713	0.708	0.5304	0.5214
Time	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes
Panel B: Proxy of industrial sector is night lights				
Night lights	-0.379 ***	-0.380 ***	-0.510 ***	-0.512 **
	-0.101	(0.118)	(0.184)	(0.221)
Real agricultural sector outputs		-0.010		0.078
		(0.120)		(0.225)
Observations	303	298	304	299
R-squared	0.597	0.602	0.440	0.437
Time	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes

Sources: General Statistics Office of Vietnam, VHLSS 2002, 2004, 2006, 2008, and 2010, and Version 4 DMSP-OLS Nighttime Lights Time Series.

Note: Standard errors in parentheses. They are robust, clustered at the province level. *** $p < .01$, ** $p < .05$, * $p < .1$. All variables are measured in natural logarithm. A negative (positive) sign indicates that the variable contributes to more (less) pro-poor growth. The regressions also included province-level fixed effect and time trend.

Allowing an interaction with initial inequality

	Headcount index (1)	Headcount index (2)	Headcount index (3)	Headcount index (4)	Poverty gap (5)	Poverty gap (6)	Poverty gap (7)	Poverty gap (8)
Panel A: Proxy of industrial sector is real industrial sector outputs								
Initial gini (2002)	5.452 ***	6.035 ***			9.572 ***	9.211 ***		
	(1.661)	(1.679)			(2.642)	(3.063)		
Initial gini (1997/98)			4.662 ***	2.135 **			6.151 ***	4.593 **
			(1.447)	(0.988)			(2.144)	(2.073)
Real industrial sector outputs	-1.016 ***	-1.081 ***	-0.959 ***	-0.530 ***	-1.679 ***	-1.608 ***	-1.310 ***	-1.037 ***
	(0.241)	(0.248)	(0.221)	(0.152)	(0.402)	(0.464)	(0.321)	(0.316)
Real industrial sector outputs x initial gini (2002)	-0.573 **	-0.656 ***			-1.070 ***	-1.014 **		
	(0.224)	(0.224)			(0.351)	(0.409)		
Real industrial sector outputs x initial gini (1997/98)			-0.468 **	-0.137			-0.682 **	-0.453 *
			(0.178)	(0.135)			(0.278)	(0.268)
Real agricultural sector outputs	0.078	0.048	0.112	0.117	0.184	0.176	0.206	0.244
	(0.089)	(0.090)	(0.091)	(0.089)	(0.170)	(0.180)	(0.177)	(0.184)
Observations	305	290	297	283	306	289	298	282
R-squared	0.732	0.730	0.737	0.742	0.551	0.568	0.536	0.560
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Winsorization: 1% and 99%	No	Yes	No	Yes	No	Yes	No	Yes
Panel B: Proxy of industrial sector is night lights								
Initial gini (2002)	4.348	6.060 **			4.001	2.930		
	(3.666)	(3.058)			(5.639)	(5.095)		
Initial gini (1997/98)			-2.108	1.647			-4.523	6.153 *
			(4.679)	(1.979)			(8.047)	(3.397)
Night lights	-0.763	-1.110 ***	-0.040	-0.601 **	-0.773	-0.934	0.120	-1.470 ***
	(0.505)	(0.418)	(0.694)	(0.288)	(0.800)	(0.686)	(1.208)	(0.486)
Night lights x initial gini (2002)	-0.353	-0.567			-0.249	-0.118		
	(0.452)	(0.374)			(0.689)	(0.626)		
Night lights x initial gini (1997/98)			0.320	-0.034			0.571	-0.532
			(0.523)	(0.234)			(0.895)	(0.410)
Real agricultural sector outputs	-0.024	0.038	0.058	0.167 *	0.056	0.225	0.167	0.338 *
	(0.115)	(0.093)	(0.118)	(0.085)	(0.219)	(0.175)	(0.222)	(0.175)
Observations	298	293	290	283	299	294	291	282
R-squared	0.630	0.694	0.620	0.714	0.466	0.578	0.442	0.572
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Winsorization: 1% and 99%	No	Yes	No	Yes	No	Yes	No	Yes

Sources: General Statistics Office of Vietnam, VLSS1997/98, VHLSS 2002, 2004, 2006, 2008, and 2010, and the Version 4 DMSP-OLS Nighttime Lights Time Series.

Note: Standard errors in parentheses. They are robust, clustered at the province level. *** p < .01, ** p < .05, * p < .1. All variables are measured in natural logarithm. A negative (positive) sign indicates that the variable contributes to more (less) pro-poor growth. The regressions also included province-level fixed effect and time trend.

The unobservable selection and coefficient stability test

Even after changing the degree of observable and unobservable based on Oster (JBES, forthcoming), the main estimation results are robust.

Treatment Variables	(1) Baseline Effect (Std. Error), [R^2]	(2) Controlled Effect (Std. Error), [R^2]	(3) Null Reject? (extrnl. evid.)	(4) Identified Set (δ = 1)	(5) Bias-adjusted β with δ = 2	(6) δ for β* = 0 Given Rmax
Panel A: Province poverty headcount ratio						
Real industrial sector outputs	-0.455*** (0.034), [0.583]	-0.383*** (0.049), [0.708]	Yes	[-0.678, -0.383]	-0.599	0.847
Panel B: Province poverty gap ratio						
Real industrial sector outputs	-0.484*** (0.055), [0.530]	-0.486*** (0.062), [0.521]	Yes	[-0.676, -0.486]	-0.660	0.511

Sources: General Statistics Office of Vietnam, VHLSS 2002, 2004, 2006, 2008, and 2010, and Version 4 DMSP-OLS Nighttime Lights Time Series.

Notes: Please see the text for discussion of this table. Results of the uncontrolled and controlled models are from OLS regressions. Null hypothesis is whether external evidence, a meta-analysis based on Ferreira et al. (2010), Ravallion and Datt (2002), suggests a causal impact. Robust standard errors are clustered at province level. Control variables includes real agricultural sector outputs, year dummy and province fixed effects. Standard errors in parentheses. *** p < .01, ** p < .05, * p < .1. Standard errors in parentheses. *** p < .01, ** p < .05, * p < .1.

Conclusion

- Industrial outputs performed as a strong driver for poverty reduction in Vietnam in 2000s (the poverty elasticity ranges from -0.678 to -0.381).
- Agricultural outputs-poverty relationship was not statistically confirmed.
- The result suggests that there is no stable relationship between poverty-initial inequality, and poverty-initial inequality through industrial outputs.

Thank you and comments are welcome.

Takahiro Yamada: takahiro.yamadajpn@gmail.com
Christian S. Otchia: otchia@gsid.nagoya-u.ac.jp