Impacts of pollution abatement projects on happiness: An exploratory study in China

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First published 2020

University of Nottingham
UK | CHINA | MALAYSIA

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Abstract: Pollution has been a global concern in recent decades, promoting related actions in an increasing number of areas. While pollution can lead to unhappiness, will pollution abatement simply increase people's happiness? We analyze relevant happiness data collected before and after China's South-to-North Water Diversion Eastern Route Pollution Control Project to test this idea. The empirical results indicate that the pollution abatement project may not enhance happiness in its duration. Some residents may temporarily sacrifice something (such as employment or income), which offsets the positive effect of environmental improvement on their happiness. In subgroup analyses, rural people are found to benefit more from environmental improvement and suffer less in happiness compared with the urban, and so are low-income people compared with the high-income ones. The findings offer new insights into the costs of pollution in terms of happiness and highlight the need to abate pollution meticulously.

Keywords: pollution abatement; happiness; population difference; pollution costs

Word count: 7,329 words

1. Introduction

Over the past centuries, the world economy has achieved unprecedented growth but the emission of pollutants has increased at almost the same pace. Environmental pollution is substantially endangering human health and quality of life (Landrigan et al., 2018; Yang and Liu, 2018), leading people to rethink the target of development. An increasing amount of attention has shifted from traditional economic indicators, such as GDP, to people's well-being (Costanza et al., 2014; Diener and Seligman, 2004; Stiglitz et al., 2009). Subjective well-being, popularly referred to as happiness, reflects one's subjective evaluation of his or her life as a whole (Diener et al., 2018; Sheldon and Lucas, 2014) and has been extensively used to evaluate public issues or value public goods (Diener et al., 2018; Welsch, 2006).

A large body of literature has developed investigating the influence of environmental pollution on individuals' happiness. Unsurprisingly, the correlation between them is found to be negative in both developed (Ambrey et al., 2014; Orru et al., 2016) and developing countries (Mendoza et al., 2019; Zhang et al., 2017a). The mechanisms behind it appear to be twofold: pollution not only negatively affects human physical health by increasing risk of diseases and stopping outdoor physical activity (Laffan, 2018; Landrigan et al., 2018; MacKerron and Mourato, 2013) to lower happiness, but also results in suboptimal psychological conditions by increasing environmental stress or perceived risk (Marques and Lima, 2011; Li et al., 2014; Li et al., 2018) to exert its influence. Moreover, the heterogeneous effects of pollution have been examined across subgroups of the population (Zhang et al., 2017b; Zheng et al.,

2019). These studies provide useful insights into the costs of environmental pollution, further highlighting the importance and urgency of pollution control.

It is gratifying that a considerable number of countries and regions have taken steps to tackle the pollution problem in recent years (UNEP, 2019a). Many efforts are also put into research on pollution control: scientists focus on better techniques and methods for pollution treatment (Wang et al., 2019; Yao et al., 2018; Yu et al., 2019) while social scientists pay close attention to related environmental regulations or policies, especially their influence on economic development (Abdullah and Morley, 2014; Z. Wang et al., 2016) and corporate activities (Chen et al., 2017; Naughton, 2014; Sun et al., 2019). However, research from the perspective of people's well-being is limited although a few studies have investigated the consequences of pollution control on certain socio-economic issues, such as unemployment (Hafstead and Williams, 2018; Kuminoff et al., 2015) and poverty (Li et al., 2015; Ma et al., 2019). It remains unknown whether there is any relationship between pollution abatement and people's happiness, which is worthy of exploration since it could help to find out what happens during treatment for pollution from the happiness perspective and provide implications on how to further improve societal conditions. To obtain initial but realistic insights into this question, we start the exploration with a typical example.

China has put much more efforts to abate pollution recently (UNEP, 2019b). The South-to-North Water Diversion (SNWD) Eastern Route Pollution Control Project (ERPCP) is one of the earliest large-scale cross-region water pollution abatement projects in this developing country, and also an important step toward achieving the

sustainable development goal. The SNWD Project is the world's largest inter-basin water transfer project, aiming at alleviating the severe water shortage in northern China and promoting sustainable economic and social development (Liu et al., 2013). However, the realization of this grand plan faced many challenges, one of which was the serious water pollution along the eastern route (Zhang, 2009). For this reason, the SNWD Eastern Route Project included in its first phase a large-scale pollution abatement project in addition to dispatching and allocating water resources. Three characteristics of the ERPCP render it suitable for our purpose. First, the project began in 2003, long before China launched intensive and comprehensive pollution control campaigns in 2012, when ecological civilization construction was incorporated into the overall approach of socialism with Chinese characteristics, thus facilitating a comparative analysis. Second, the project is grand in scale since the total planned investment was 23.84 billion yuan (Chinese Academy for Environmental Planning, 2003), so its impact would be not too weak to be shown and could be accessed with appropriate analysis. Last, by the time the first phase of the SNWD Eastern Route Project was completed (at the end of 2013), the water environment along the route had been considerably improved (Guo and Ren, 2013), which shows the ERPCP's effectiveness in abating pollution.

Specifically, we hope to: (1) discover the overall impact of the ERPCP on the happiness of local residents; (2) analyze how this project exerted the impact; and (3) examine the group differences in changes of happiness. For these purposes, we employ the difference-in-difference (DID) method to perform regression analyses

using the 2002 and 2013 data of China Household Income Project (CHIP) Survey, in which surveyed residents reported their happiness.

2. Data and Methods

2.1 Data sources

Several social surveys conducted by authoritative academic institutions involve happiness of individuals. However, when considering other factors such as time span and data accessibility, only the China Household Income Project (CHIP) Survey[1] stands out for our purpose. It has been carried out in 2002 and 2013, and the location information of respondents in its dataset is accessible, enabling us to identify whether a respondent lived in a pollution-control-planning area along the SNWD eastern route. Thus, it is employed as the main basis for empirical analyses. The 2002 and 2013 waves, organized by the Institute of Economics at Chinese Academy of Social Sciences and China Institute for Income Distribution at Beijing Normal University respectively, were jointly designed by Chinese and foreign experts and conducted with the assistance of National Bureau of Statistics of China. In particular, the questionnaires for both waves include attitudinal questions on "happiness" for the head or main member of a household, which read, "Generally speaking, how happy do you feel" and "All things considered, do you feel happy" respectively. The six possible responses for both questions are "very happy", "happy", "so-so", "not very happy", "not happy at all" and "don't know". We exclude the observations with the response of "don't know" and assign the other five responses with ordered values 5,

[1] http://www.ciidbnu.org/chip/index.asp

4, 3, 2, and 1, respectively. Moreover, the datasets include a series of individual and household characteristics and information about income, which enables us to effectively control factors at the individual level, such as gender, age, marital status, education, health, and household income.

As another important data source, the pollution control plan for the SNWD Eastern Route Project clarifies the coverage of main planning areas (including 5 cities and 17 counties in Jiangsu Province, and 10 cities and 43 counties in Shandong Province) and the distribution of various pollution abatement projects (Chinese Academy for Environmental Planning, 2003). In empirical analyses, we regard the municipal districts of the 15 prefecture-level cities and 60 county-level units as pollution-control-planning areas and mark the respondents of the CHIP basing on their regional codes and the area classification to structure the principal independent variable.

The other indispensable data source is the *China Statistical Yearbook for Regional Economy*, which includes the average income level of residents (i.e. annual per capita disposable income of urban households and annual per capita net income of rural households) at the regional level and provides a distinct basis for the division of income groups in the analysis of group differences. The gross domestic product (GDP) and industrial value added in various regions of China can be also found in this statistical yearbook, which is critical for sample grouping in the supplementary test for the second research purpose.

2.2 Empirical strategy

As an exogenous event, the SNWD-ERPCP changed the circumstances of some individuals, households and enterprises, constituting a quasi-experiment. In a natural experiment or quasi-experiment design, there is usually a treatment group (i.e., residents in the pollution-control-planning area in our case) affected by an event and a control group (i.e., residents in other eastern areas in our case) not affected by the event. One of the commonest econometric methods for its analysis is the DID method (Abadie, 2005). The basic model of the DID method here can be expressed as:

$$Happiness = \beta_0 + \delta_0 Y13 + \beta_1 ERPCP + \delta_1 Y13 \cdot ERPCP + \gamma X + \varepsilon$$

where $Happiness$ (i.e., self-reported happiness of the respondent) is the dependent variable we are concerned with, whose ordered attribute requires the adoption of ordered logistic regression in our analysis; $Y13$ is the year dummy variable (1 for year 2013 while 0 for year 2002), which enables the model to have different intercepts in different years so as to make it possible to reflect different distributions of statistical population in different periods; $ERPCP$ is the event dummy variable (1 means the respondent lived in a pollution-control-planning area while 0 means not); X represents the control variable group in this study, including gender, age, marital status, education, health, annual household income per capita and the province and county dummies; ε is the error term; β_0, β_1, δ_0, δ_1 and γ are the parameters to be estimated, and the interaction term coefficient δ_1 is of most concern, which measures the impact of this event on the dependent variable (i.e., the extent to which the happiness changed due to the SNWD-ERPCP).

The pollution-control-planning areas for the first phase of the SNWD Eastern

Route Project were primarily located in eastern China's Jiangsu and Shandong provinces (Chinese Academy for Environmental Planning, 2003). While eastern China usually refers to ten provinces and provincial cities, the CHIP surveyed residents in six such localities as Beijing, Hebei, Shandong, Jiangsu, Zhejiang and Guangdong. We extract data for these localities from the CHIP Survey datasets to compare the changes in the level of self-reported happiness of residents in the pollution-control-planning areas and other eastern areas surveyed. After deleting the observations with missing values, we have a final dataset including 9,500 observations from the eastern region, of which 4,303 are from the 2002 survey and 5,197 are from the 2013 survey. Table 1 presents the descriptive statistics of the variables.

{insert Table 1}

3. Results and analysis

3.1 Overall impact

Table 2 shows the results of the baseline regression model. The negative sign of the interaction item in column (a) indicates that the happiness of residents in the pollution-control-planning areas relatively declined compared with that of residents in other eastern areas surveyed, and such decline is statistically significant. After gender, age, marital status, health status and income are controlled, the sign of the interaction item doesn't change and remains significant. Further, the results hold for the samples from Jiangsu and Shandong. It can also be seen in Table 2 that the higher the income or the better the health status, the higher the level of happiness, which is consistent with previous research (Dolan et al., 2008; Graham et al., 2017).

{insert Table 2}

We thus obtain a basic answer to the first question: In general, the ERPCP did not lead the happiness of local residents to rise more than that of residents in other eastern areas in its duration. Of course, this does not suggest that the happiness of each respondent in the pollution-control-planning areas has relatively decreased. The results here only explain the average situation of the respondents surveyed in CHIP. But these results are somewhat unexpected and lead us to explore the next question, how the pollution abatement project has brought about this change.

3.2 Impact mechanism

According to the pollution control plan for the SNWD Eastern Route Project, there are five kinds of sub-projects involved: the urban wastewater treatment project, that is, upgrading the centralized treatment capacity of urban sewage via building or expanding sewage treatment plants, such as the extension project of wastewater treatment plants in Yangzhou; the pollutant control and diversion project, that is, recycling sewage or transferring it to other places after treatment, such as the tail water delivery project in downtown Xuzhou; the industrial structural readjustment project, that is, to "close, stop, merge, or transfer" some small-scale polluting enterprises, such as the shutdown project of pulp production lines of Feicheng Paper Mill; the integrated industrial management project, that is, requiring enterprises to implement clean production projects, standards-up and improvement projects, and wastewater reuse projects, such as the cleaner production project of Dongming Petrochemical Group; and the integrated river basin management project, that is, some comprehensive

pollution abatement projects inconvenient to be classified into the above four, such as the construction project of ecological functional conservation zone at the water source. For our purpose, above five kinds of projects are grouped into two major categories: Category A, or the municipal projects for the entire region, including urban wastewater treatment projects, pollutant control and diversion projects and some integrated river basin management projects; and Category B, or the special treatment projects for some industrial enterprises, including industrial structural readjustment projects, integrated industrial management projects and some integrated river basin management projects. Category A projects were planned in all above fifteen prefecture-level areas in Jiangsu and Shandong, and Category B projects were planned in only nine of them. To simplify the expression, we designate the areas with both categories of projects as Type Ⅰ, the areas with only Category A projects as Type Ⅱ, and other eastern areas that are not listed in the pollution control plan as Type Ⅲ. As mentioned earlier, the basis for judging whether a respondent falls into the treatment group is the county-level (district-level) unit in which the respondent lived. However, the pollution control plan for the SNWD Eastern Route Project doesn't clearly indicate which county-level (district-level) units would be affected by a specific pollution abatement project, and only shows the prefecture-level administrative region[2] in which each project is located. Hence the areas in our dataset are marked with different type labels (i.e., Type Ⅰ, Ⅱ and Ⅲ) according to what kinds of pollution abatement projects there are in their respective prefecture-level regions.

[2] It is the upper-level administrative division of counties and municipal districts in China.

From the viewpoint of direct outcomes, if effectively implemented, both Category A and Category B projects can improve the water environment along the eastern route and compensate for the environmental damage caused by previous extensive development to some degree. The threats faced by residents in these areas due to the harsh environment can be mitigated, and the significant beautification of ecological environment in some areas can also make local residents more positive, which may increase their happiness (Carrus et al., 2015; Krekel et al., 2016). For example, with the implementation of various kinds of pollution control projects (including both Category A and B projects), the water quality of the Nansi Lake, once black and smelly and regarded as a key area in ERPCP, has achieved continuous improvement and been stably reaching the Class III of the "Environmental quality standards for surface water (GB3838-2002)", leading a substantial rise in the livability index of surrounding areas and greatly satisfying the local residents' demand for a good living environment (People's Daily Online, 2014; W. Wang et al., 2016).

However, from the viewpoint of process, most local residents were unaware of the implementation of Category A projects, whose side effects were pretty slight; but this was not the case for Category B projects. The SNWD-ERPCP set a record in terms of rapidity and extensiveness of pollution abatement in China (Xu et al., 2019), which means the pollution-control-planning areas may have experienced a series of changes, including economic restructuring and transformation of development mode, in a relatively short period of time. Category B projects (that is, industrial structural readjustment projects and relevant projects) were exactly a type of carrier and

embodiment of such changes and transformation. There were usually many high-pollution enterprises, such as papermaking, fermentation, printing and dyeing factories, in areas where Category B projects were planned. In addition to implementing above pollution abatement projects, local governments also carried out a series of supporting work to achieve the pollution reduction targets. For example, in 2006, Shandong province promulgated and implemented the water environment quality standard for local watersheds that was much stricter than national standards, in which the emission standard of chemical oxygen demand was six times stricter than the national industry standards of the year (Guo and Ren, 2014). But "gains" are often accompanied by "pains" (Dechezleprêtre and Sato, 2017; Reed Walker, 2013), which were reflected in related enterprises and residents somehow. Some companies had to shut down their operations or move away and the employment and income of some people were inevitably negatively affected in this process (Liu et al., 2017; Yip, 2018). The impact of this change on happiness may be distinct since employment and income are directly related to people's most basic needs (physiological needs and safety needs). Unemployment, as the most influential factor, is generally considered to significantly reduce people's happiness (Easterlin et al., 2012; Kassenboehmer and Haisken-DeNew, 2009), and so is the decrease in income (Dolan et al., 2008; Frey and Stutzer, 2002). Moreover, the unemployment insurance system in this developing country was imperfect at that time (Vodopivec and Tong, 2008). Meanwhile, there is always a preference for "quiet life" (i.e., life without accidents or unexpected fluctuations) in Chinese culture (Fei, 2006; Qian, 1994). Even if the unemployed find

new jobs or receive compensation soon, they would have been more or less negatively affected. Therefore, this kind of "pain" cannot be ignored.

Table 3 lists the empirical results for examining the impacts of these two project categories. Column (a) compares the areas where only Category A projects were planned (Type Ⅱ areas) and other eastern areas not listed in the pollution control plan (Type Ⅲ areas). It is found that Category A projects raised the happiness of local residents, which confirms that general pollution abatement and environmental improvement can cause an increase in happiness. Column (b) shows that compared with residents in the areas where only Category A projects were planned (Type Ⅱ areas), those from the areas with both Category A and B projects (Type Ⅰ areas) experienced a reduction in their happiness. This indicates that the transformational pollution control represented by Category B projects is indeed accompanied by some sacrifices, and the people are hard to avoid being affected.

{insert Table 3}

To test the robustness of the results, we divide the samples into two groups according to the proportion of industrial value added in each area to the regional GDP and perform regression analyses (see Table 4) similar to those shown in Table 2. It turned out that the residents in an area with a high industrial ratio saw their level of happiness decreasing more significantly, while those in an area with a low ratio did not undergo a significant change in their happiness, which confirms our speculations.

{insert Table 4}

It can be seen from column (c) in Table 3 that in the case where the environmental

effects of pollution abatement and the sacrifice in the process coexisted, the happiness of residents still showed a decline during the observation period. According to Maslow's hierarchy of needs (Maslow, 1943), when low-level needs are not met, the satisfaction of high-level needs will not increase the utility, that is, the level of happiness will not be significantly raised. Only if one reaches the level necessary to maintain survival in the lower-level needs will the realization of higher-level needs raise his/her level of happiness. Here, employment and income are lower-level needs than a good environment since previous environment was not too severe to live in. When the satisfaction of these lower-level needs was disrupted, the effectiveness of environmental improvement would be kept at a minimum, and happiness would not show an upward trend.

3.3 Group differences

Considering the circumstances and perceptions of different groups in terms of environment, employment and income, we turn our attention to the differences in the change of happiness across groups. Given that there still exist gaps between urban and rural regions and between the rich and the poor in China (Wiedenhofer et al., 2017; Xie and Zhou, 2014), it is of practical significance to investigate the happiness changes of these different subgroups. We conduct regression analyses on the observations of urban and rural residents separately using the similar methods that obtained the results in column (b) in Table 2 and column (a) in Table 3. Based on the regression results of the interaction item, Fig. 1 shows that in the pollution-control-planning areas the level of happiness of rural residents declined less than that of urban

residents, and it significantly rose more when considering the effects of the Category A projects. Furthermore, we divide all observations into four groups according to the respondent's relative affluence, that is, the ratio of the annual per capita disposable income (for urban households) or the annual per capita net income (for rural households) of the respondent's household to respective local average, and conducted regression analyses separately. Fig. 2 shows that the happiness of residents living in the pollution-control-planning areas and in the lowest 25% income group did not show a significant decline, and it rose more due to the implementation of Category A projects. That is, the vulnerable people in the pollution-control-planning areas have paid less in the process of pollution abatement, and the happiness they have obtained from environmental improvement is relatively more.

{insert Fig. 1}

{insert Fig. 2}

Combined with the analysis in Section 3.2, this difference can be interpreted as follows. Vulnerable people, such as rural and low-income residents, are usually less likely to choose a cleaner living and working environment, and have to face more pollution exposure or environmental risks (Ma, 2010; Zhao et al., 2014). That is, as they were exposed to more environmental threats before these projects started, they might experience more significant effect of environment improvement. On the other hand, vulnerable groups have fewer vested interests in employment and income than other groups (Cheng et al., 2013; Démurger et al., 2009), so the "pain" caused by the changes and transformation in the context of pollution control to them may be

comparatively small.

4. Discussion and implications

4.1 Discussion and contributions

The existing literature has carefully examined the relationship between environmental pollution and individuals' happiness with various measurement methods and data sources (Li et al., 2019; Zhang et al., 2017a; Zheng et al., 2019) and valued environmental goods using the happiness approach (Levinson, 2012; Zhang et al., 2017b), which uncovers the explicit cost in happiness resulting from pollution. We extend the research in this field by investigating the changes in happiness during pollution abatement and revealing the implicit cost of pollution. Pollution abatement is expected to improve the quality of local environment and thus enhance residents' happiness. However, it turns out to be only part of the story, and researchers should not simply consider pollution abatement according to the mechanism through which pollution impacts happiness. Our empirical results show the "pain" or sacrifice made to achieve the purpose of pollution reduction cannot be ignored. It may offset the positive effect of environmental improvement and cause a relative decline in the happiness of residents, which could be regarded as a sequela of pollution in a sense. The discovery of this implicit cost (i.e., the possible decline in happiness during pollution abatement) takes us one step closer to fully understanding the total cost of pollution.

Some studies in economics and sociology have discussed the impacts of environmental regulations or policies on issues related to people's livelihood (Li et al.,

2015; Ma et al., 2019; Yip, 2018), but few of them have been developed from the perspective of happiness or have combined the impacts with the positive effect of environmental improvement in a single framework. Our research contributes to the literature on pollution control by comparing residents' happiness before and after a pollution abatement project and evaluating these two types of effects as a whole. Our findings emphasize the importance of integrating happiness changes into the evaluation framework or criteria in future research.

Moreover, we respond to the call for attention to inequalities in people's well-being (Brulle and Pellow, 2006; Helliwell et al., 2017). We find that pollution abatement has brought a relative increase in happiness to rural residents and low-income people when analyzing the group differences in happiness changes. This finding indirectly echoes existing evidence from the environmental justice literature which indicates that vulnerable people are often exposed to more environmental pollution or face more environmental risks (Schoolman and Ma, 2012), and also sheds new light on how to decrease happiness inequality (Yang et al., 2019).

4.2 Implications for practice

This research also has some practical implications. First, policymakers need to be aware of the implicit cost in individuals' happiness and comprehensively consider the price of environmental pollution. The countries (regions) in urgent need of developing their economies or achieving industrialization are suggested to avoid the developmental model of "growing (polluting) first and cleaning up later" if possible, and achieve national prosperity and happiness for the people in a high-quality and

sustainable way. Second, the "pain" reflected in happiness is worth pondering, though countries (regions) facing serious pollution challenges should take actions with no delay since the sooner to start, the less to pay. More efforts should be put into improving related compensation mechanisms and the social security system, and enhancing scientific planning, meticulous management and societal governance of pollution abatement to avoid the "one-size-fits-all" control (He et al., 2017; Ma et al., 2017). Last, there might be some potential opportunities to reduce inequalities during pollution abatement. The reassuring results that the vulnerable groups sacrifice less and benefit more remind us that it is possible to narrow the perceived gaps between urban and rural regions or between the rich and the poor by promoting pollution abatement.

5. Conclusions

In order to explore the relationship between pollution abatement and people's subjective well-being, we analyze the effects of a typical project using happiness data from CHIP. It is found that the pollution abatement project may lead the happiness of local residents to decline relatively in its duration, which reveals pollution's implicit cost in people's happiness in contrast with the explicit cost discovered by existing studies on the correlation between pollution and happiness. This can be attributed to the "pain" or temporary sacrifice in people's employment opportunities and incomes caused by some measures for pollution abatement, which offsets the positive effect of environmental improvement on happiness. The results of heterogeneity analysis indicate that rural and low-income residents appear to sacrifice less and benefit more

in happiness during pollution abatement. In general, this research can help readers to better understand the cost of pollution and realize the importance of meticulous management on pollution abatement.

Acknowledgements

This work is funded by the National Natural Science Foundation of China (Grant Nos. 71620107004, 71942006 and 71390525).

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Table 1. Descriptive statistics.

Variable	Definition	From pollution-control-planning areas				From other eastern areas of China			
		2002 (N=682)		2013 (N=787)		2002 (N=3,621)		2013 (N=4,410)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Happiness	Self-reported happiness (level 1-5: 5 for "very happy")	3.86	0.86	3.71	0.76	3.69	0.82	3.73	0.79
Male	Dummy: 1 for male respondent	0.66	0.47	0.63	0.48	0.60	0.49	0.59	0.49
Age		45.84	11.66	49.20	12.74	47.65	10.21	49.34	12.96
Married	Dummy: 1 for married respondent	0.96	0.21	0.92	0.28	0.95	0.21	0.90	0.30
Urban	Dummy: 1 for urban respondent	0.35	0.48	0.36	0.48	0.41	0.49	0.43	0.50
Edu	Years of schooling	8.62	3.17	8.59	3.57	9.01	3.20	9.52	3.58
Income	Annual household income per capita	4,657	4,463	18,670	16,331	7,538	6,562	25,987	24,026
Health	Self-reported health status (level 1-5: 1 for "very good")	1.87	0.80	2.01	0.87	2.18	0.78	2.00	0.81

Table 2. Regression analyses of impacts of SNWD-ERPCP on happiness of local residents.

	Dependent variable: *Happiness*		
	(a) Eastern areas	(b) Eastern areas	(c) Jiangsu & Shandong
ERPCP Y13*	-1.15***	-1.27***	-0.99**
	(0.30)	(0.31)	(0.41)
ERPCP	-0.68**	-0.42	-0.69*
	(0.32)	(0.31)	(0.41)
Y13	-0.04	-0.81***	-1.11***
	(0.10)	(0.11)	(0.29)
Male		-0.26***	-0.17**
		(0.05)	(0.07)
Age		0.02***	0.02***
		(0.00)	(0.00)
Married		0.55***	0.59***
		(0.08)	(0.13)
Urban		-0.20***	-0.09
		(0.07)	(0.10)
Edu		0.06***	0.05***
		(0.01)	(0.01)
Ln (*Income*)		0.49***	0.51***
		(0.04)	(0.05)
Health (base: so-so)			
very good		1.01***	1.14***
		(0.07)	(0.10)
good		0.50***	0.48***
		(0.05)	(0.08)
bad		-0.25**	-0.28*
		(0.13)	(0.17)
very bad		-1.31***	-0.87
		(0.39)	(0.53)
Province dummies	included	included	included
County dummies	included	included	included
N	9,500	9,500	4,567
Pseudo R^2	0.0451	0.0794	0.0949

Note:

***, ** and *: significant at 1%, 5% and 10% respectively.

Robust standard errors in parentheses.

Table 3. Regression analyses of influence mechanism of SNWD-ERPCP on happiness.

	Dependent variable: *Happiness*		
	(a) Type Ⅱ & Ⅲ areas	(b) Type Ⅰ & Ⅱ areas	(c) Type Ⅰ & Ⅲ areas
ERPCP Y13*	0.87**		-1.26***
	(0.36)		(0.31)
ERPCP	-0.58*		-0.44
	(0.34)		(0.31)
Y13	-0.82***	-0.11	-0.78***
	(0.11)	(0.38)	(0.11)
Area- I		0.11	
		(0.31)	
Area- I Y13*		-2.04***	
		(0.46)	
Male	-0.27***	0.02	-0.28***
	(0.05)	(0.13)	(0.05)
Age	0.02***	0.02***	0.02***
	(0.00)	(0.01)	(0.00)
Married	0.56***	0.34	0.55***
	(0.08)	(0.24)	(0.08)
Urban	-0.22***	-0.05	-0.21***
	(0.07)	(0.18)	(0.07)
Edu	0.06***	0.05**	0.06***
	(0.01)	(0.02)	(0.01)
Ln (*Income*)	0.51***	0.55***	0.47***
	(0.04)	(0.10)	(0.04)
Health (base: so-so)			
very good	0.99***	1.11***	1.00***
	(0.07)	(0.16)	(0.07)
good	0.52***	0.33**	0.51***
	(0.06)	(0.14)	(0.06)
bad	-0.21	-0.51*	-0.25*
	(0.13)	(0.29)	(0.13)
very bad	-1.34***	-1.05**	-1.33***
	(0.42)	(0.48)	(0.40)
Province dummies	included	included	included
County dummies	included	included	included
N	8,543	1,469	8,988
Pseudo R^2	0.0779	0.0869	0.0798

Note:

One for the dummy variable "*Area- I*" means that the respondent is from a Type Ⅰ area while zero means not (i.e., the respondent is from a Type Ⅱ area).

***, ** and *: significant at 1%, 5% and 10% respectively.

Robust standard errors in parentheses.

Table 4. Regression analyses of difference in happiness changes of residents in different areas grouped by ratio of local industrial value added (IVA) to GDP.

	Dependent variable: *Happiness*		
	All eastern areas surveyed	Eastern areas with low ratio of IVA/GDP	Eastern areas with high ratio of IVA/GDP
ERPCP Y13*	-1.27***	0.12	-1.18***
	(0.31)	(0.35)	(0.36)
ERPCP	-0.42	1.03***	0.32
	(0.31)	(0.29)	(0.38)
Y13	-0.81***	-0.28*	-0.81***
	(0.11)	(0.14)	(0.21)
Control variables	included	included	included
N	9,500	4,737	4,763
Pseudo R^2	0.0794	0.0728	0.0870

Note:

To keep this table simple, the regression results of control variables are not reported here.

***, ** and *: significant at 1%, 5% and 10% respectively.

Robust standard errors in parentheses.

Fig. 1. Difference in happiness changes between urban and rural residents.

Note: The capped spikes show the 95% confidence intervals. ***, ** and * indicate significance at 1%, 5% and 10% levels.

Fig. 2. Difference in happiness changes across income groups.

Note: The capped spikes show the 95% confidence intervals. ***, ** and * indicate significance at 1%, 5% and 10% levels.

Fig. 1

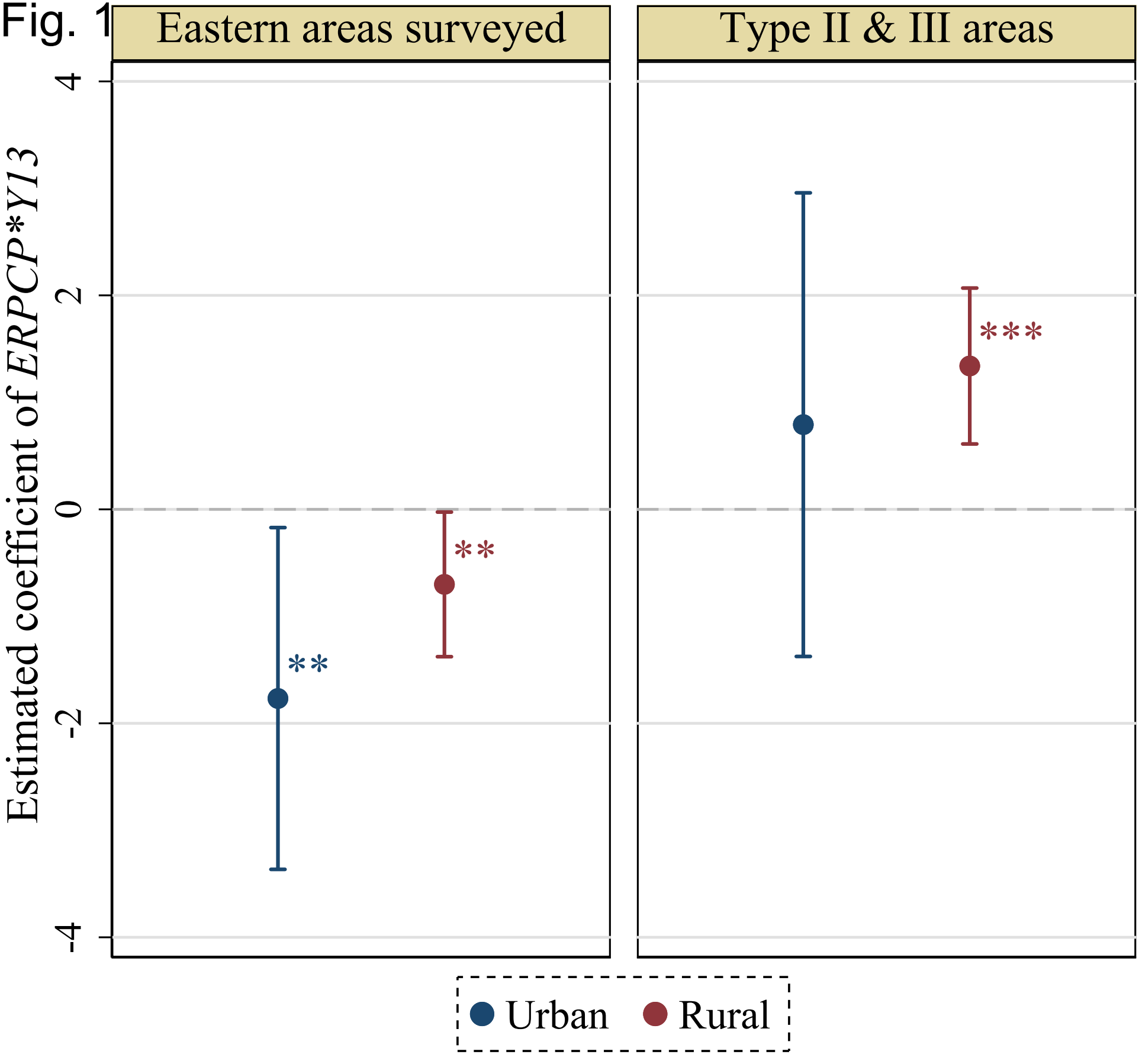
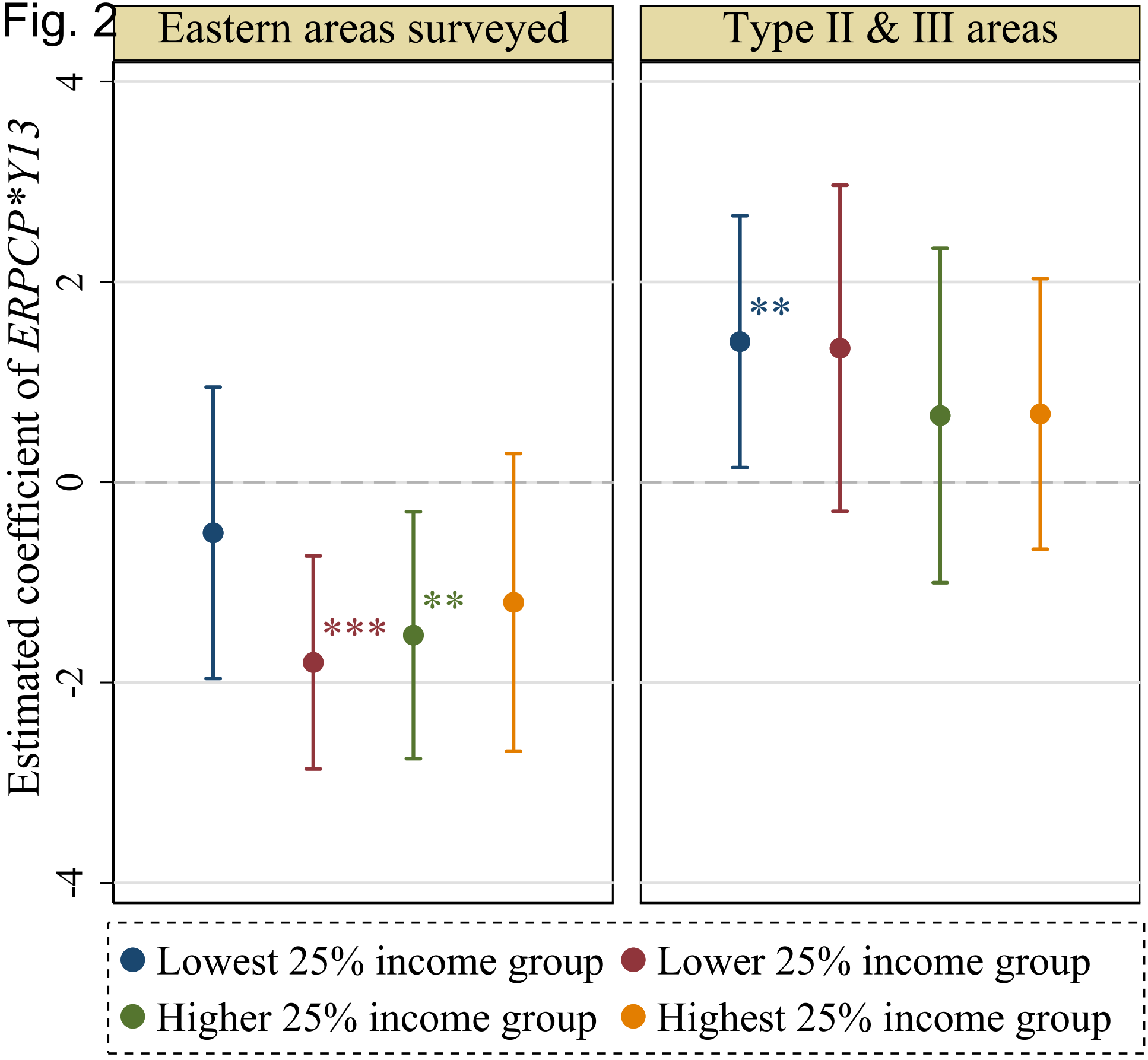

Eastern areas surveyed
Type II & III areas
Estimated coefficient of ERPCP*Y13
4
2
0
-2
-4
**
**
***
Urban
Rural

Fig. 2


Eastern areas surveyed
Type II & III areas
Estimated coefficient of ERPCP*Y13
4
2
0
-2
-4
***
**
**
Lowest 25% income group
Lower 25% income group
Higher 25% income group
Highest 25% income group