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Aiqin Wang, Yaojiang Shi, Qiufeng Gao, Chengfang Liu, Linxiu Zhang, Natalie Johnson, Scott Rozelle,

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Trends and determinants of rural residential solid waste collection services in China

Aiqin Wang

*School of Economics and Management, Northwest University, Xi'an, China and
Center for Experimental Economics, Xi'an, China*

Yaojiang Shi and Qiufeng Gao

*Center for Experimental Economics in Education,
Shaanxi Normal University, Xi'an, China*

Chengfang Liu

Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing, China

Linxiu Zhang

*Center for Chinese Agricultural Policy,
Institute of Geographic Sciences and Natural Resources Research,
Chinese Academy of Sciences, Beijing, China*

Natalie Johnson

*Rural Education Action Program (REAP),
Freeman Spogli Institute for International Studies, Stanford University,
Stanford, California, USA, and*

Scott Rozelle

*Freeman Spogli Institute of International Studies, Stanford University,
Stanford, California, USA*

Abstract

Purpose – The purpose of this paper is to describe the trends in residential solid waste collection (RSWC) services in rural China over the past decade and analyze the determinants of these services using nationally representative data.

Design/methodology/approach – The authors draw on panel data from three rounds of village-level surveys of 101 villages. The three surveys were conducted in 2005, 2008, and 2012 in five provinces. The authors used fixed-effected regression approach to analyze the determinants of these services.

Findings – The results show that in the aftermath of increased investment and policy attention at the national level, the proportion of villages providing RSWC services in rural China increased significantly from 1998 to 2011. However, half of all villages in rural China still did not provide RSWC services as of 2011. Based on econometrics analysis, the authors show that villages that are richer, more populous, and villages with more small hamlets are more likely to provide RSWC services.

Originality/value – The analyses are based on primary survey data and the first to quantify trends in waste management services in the beginning of the twentieth century. The authors believe that the results will have significant policy implications for China in its continuing quest for better waste management policy.

Keywords Determinants, Panel data, Rural China, Public goods, Residential solid waste collection

Paper type Research paper



I. Introduction

Residential solid waste (RSW) is a problem of new significance worldwide. As a country industrializes and urbanizes, the economy grows and living standards rise, but – due to increased consumption – RSW production also increases. In 2012, the total amount of RSW generated in all cities in the world was 1.3 trillion kg (Hoornweg and Bhada-Tata, 2012). Managing this massive amount of waste is a large and important task. Improperly managed waste not only affects the health of local residents (Giusti, 2009; Yang *et al.*, 2010), but it can also cause (often irreversible) damage to water resources and the ecological environment (Liu and Diamond, 2005).

With its rapidly developing economy, China has now become the largest generator of total national RSW in the world (Hoornweg *et al.*, 2005; Chen *et al.*, 2010; Tai *et al.*, 2011). As household living standards in rural China have improved, rural RSW generation has also increased rapidly (Wu *et al.*, 2014). In 2010, the total annual quantity of waste from rural areas in China reached about 234 million kg, exceeding the quantities of urban RSW (157 million kg/year) for the first time (Huang *et al.*, 2012). Annual per capita quantities of rural RSW in China (360 kg; Li *et al.*, 2012) are now comparable to per capita solid waste produced in some developed countries (Japan: 380 kg, European Union: 210-660 kg; OECD, 2013).

Although the production of RSW in rural China grew considerably during the 2000s, RSW management – at least before 2010 – was neither standardized nor systematic (He, 2012; Huang *et al.*, 2011; Zhen and Liang, 2010). Proper RSW management consists of three crucial steps: residential solid waste (RSWC); the transportation of RSW to central treatment plants; and RSW treatment and disposal. Without RSWC services, villagers will litter; without RSW transportation and treatment services, RSW is often burned and buried (Liu and Huang, 2014). In all, the proper collection of RSW is the first and most important part in its management. Different villages have different RSWC services based on their economic and geographical factors (Li *et al.*, 2007; Huang *et al.*, 2011). Some studies have revealed that villages in most parts of rural China did not have access to either RSWC facilities (including dumpsters, waste pits, and waste storage buildings; Huang *et al.*, 2011) or RSWC workers (employees who collected RSW and cleaned the village roads regularly; Ye, 2007; Ye and Qin, 2008). In addition, very few village committees allocated capital to provide waste transportation or disposal services (Ye and Qin, 2008; Zhen and Liang, 2010). In the absence of these services, rural residents were forced to dispose of their waste on their own, invariably leading to practices that pose serious environmental and health risks – including water and soil contamination, air pollution (due to burning trash), and the spread of disease (Ye and Qin, 2008; Li *et al.*, 2010).

In recent years, the government has acknowledged this problem and taken steps to improve access to RSW management services in rural areas, including amending regulations and increasing investment. These new regulations include the revised “Law on the Prevention and Control of Environmental Pollution by Solid Waste” in 2005. This law brought RSW management under the scrutiny of public management for the first time. In 2010, the “Rural Life Pollution Control Technology Policy” directly banned rural residents from littering, piling up, or burning solid waste. Moreover, the 12th Five-Year Plan proposed building “clean and tidy villages” and highlighted the importance of the equal provision of basic public services to rural and urban areas.

These policy pronouncements – unlike in earlier years – were also accompanied by government investment. For example, between 2008 and 2012 the central government allocated a total of 15.5 billion yuan to a Rural Environmental Protection Special Fund. Upper level pressure also induced local governments to set aside a further eight billion

yuan to improve the rural environment (Ministry of Environment Protection of the People's Republic of China, 2008-2012). Unfortunately, no research – to our knowledge – has examined the change in RSW management services following these recent efforts (post-2005 or so) by policymakers to encourage better RSW management practices in rural areas in China.

In this study, we focus on the first and most important step in the process of proper RSW management – RSWC services. It is only when waste is properly collected that it can be transported to factories that can treat the waste properly. Given that until now few villages provide RSW transportation and treatment services (Ye and Qin, 2008), the government's focus and subsequent investment in RSWC services has become increasingly important. Thus we believe that it is important to specifically investigate the status of RSWC services in rural China. Furthermore, RSWC facilities and RSWC workers are two different aspects to the collection of RSW. It is important to separately distinguish between these two aspects. We assume that the combination of both RSWC facilities and RSWC workers are needed to be able to improve the overall situation of RSWC services in a way that is different (and better) compared to having either workers or facilities in a village.

There are many reasons why a village may be more likely to provide RSWC or management services. In rural China, the provision of public services is largely dependent on the economic development of the village and the geographic location of the village itself (Zhang *et al.*, 2006). The provision of RSWC services may depend on village net per capita annual income and the village's distance from the township government. Other studies have also found that the provision of RSWC services will also depend on the population of the village and the number of small hamlets it is comprised of (Ye and Qin, 2008). The decision to provide RSWC services is also dependent on political factors (Ye and Qin, 2008). Newer village leaders may be more likely to act more creatively. There is an old saying in China that refers to new leaders and their tendency to bring in new ideas: "a new broom sweeps clean." Finally, in China, village heads are either directly elected by villagers or appointed by the township or county-level government. Village heads that are elected through direct election may be more likely to cater to the need of local villages (and voters) more willingly.

At present, several studies have used cross-sectional data to examine the prevalence of RSWC services in rural areas at given points of time (e.g. Ye and Qin, 2008; Huang *et al.*, 2011). No studies have made use of panel data, which allow researchers to measure the changes in trends in RSWC services over time. It is our belief that only when we begin to understand the trends and determinants of RSWC services over time, can we begin to understand the extent to which these policy changes have been successful. Panel data also allows for a less-biased estimation of the determinants of RSWC services, so the use of a panel data set represents a major strength to our study.

The overall goal of this paper is to better understand the current state and trends (over the past 15 years) of RSWC services in rural China. To meet this overall goal, we have three-specific objectives. First, we show the temporal and spatial changes of RSWC services in rural China between 1998 and 2011. Second, we describe the determinants of RSWC facilities, RSWC workers and "Comprehensive" RSWC services in 2011. Finally, we analyze the village-level correlates of RSWC services across four periods of time – 1998, 2004, 2007, and 2011.

The rest of the paper is organized as follows: Section II describes the sampling, data collection, and statistical methods. Section III explains trends and determinants of rural RSWC services across four periods of time, as well as reports the results of the rest of our analysis. Section IV concludes and considers policy implications.

II. Sampling, data collection and statistical methods

The data used in this paper are from a nearly nationally representative survey in rural China conducted by the Northwest Socioeconomic Development Research Center and the Center for Chinese Agricultural Policy in 2005 (data for 2004), 2008 (data for 2007), and 2012 (data for 2011). The 1998 data presented here were collected in 2005 by asking village heads or village party secretaries to report on the situation from 1998. In total, 101 villages were randomly selected in 2005 from 50 townships in 25 counties located in five provinces (Figure 1). We revisited the same villages during each wave of the survey.

The sample villages were selected by a process that survey teams implemented uniformly in each of the sample provinces in 2005 (Figure 1). First, five provinces were randomly selected to represent China's five major agro-ecological zones: Jiangsu represents the Eastern coastal areas (Jiangsu, Shandong, Shanghai, Zhejiang, Fujian, and Guangdong); Sichuan represents the Southwestern provinces (Sichuan, Guizhou, and Yunnan), plus Guangxi; Shaanxi represents the provinces on the Loess Plateau (Shaanxi and Shanxi), Inner Mongolia and the rest of the provinces in the Northwest (Gansu, Ningxia, Qinghai, and Xinjiang); Hebei represents the North and Central provinces (Hebei, Henan, Anhui, Hubei, Jiangxi, and Hunan); and Jilin represents the Northeastern provinces (Jilin, Liaoning, and Heilongjiang).

After the provinces were selected, the second step of the sample selection involved choosing the counties, towns, and villages. Five counties were selected from each province, one from each quintile of per capita gross value of industrial output (GVIO) (Figure 1). GVIO was used because Rozelle (1996) shows that it is one of the best predictors of both standard of living and development potential, and is often more reliable than net rural per capita income. Within each county, the survey team chose two townships, one township with a per capita GVIO above and one township a per capita GVIO below the county median. Finally, within each township, two villages were chosen following the same procedure as the township selection.

The survey collected information at the village level. The questionnaire was completed by the village head and recorded information on RSWC services. In all three

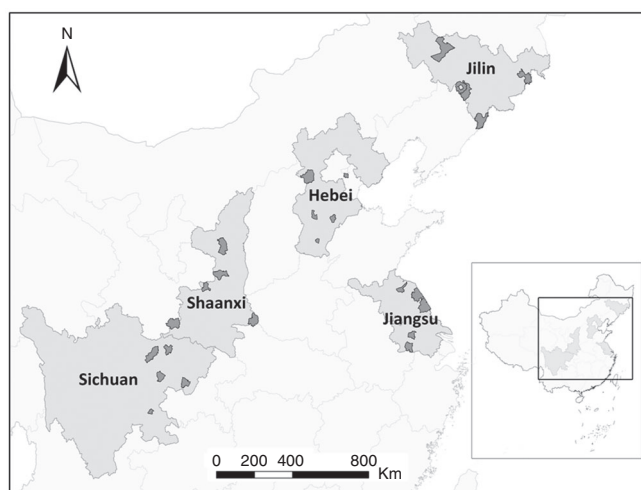


Figure 1.
Location of the
counties sampled
in the provinces of
Jiangsu, Hebei,
Jilin, Shaanxi,
Sichuan in China

rounds of the survey we collected information on two important services: RSWC facilities available in the village and whether or not the village committee employs RSWC workers[1]. These two outcome variables indicate the extent to which RSWC takes place in each village.

At the same time, we also collected village characteristics, including net per capita annual income, number of small hamlets (the number of groups within each village), total population, distance from town (the distance from the village committee to the township government), new leader (whether the village head was a new leader), and direct election (whether the village head was directly elected).

We use both descriptive statistics and multivariate analysis to evaluate the determinants of RSWC services. Based on the panel nature of our data, we estimate a fixed effects (FE) model to analyze the determinants of RSWC services (controlling for village-level FE). In this way we are able to control for all non-time varying observable and unobservable factors. The model is:

$$\Delta \text{RSWC services}_{i,t} = \alpha + \beta_1 \Delta \text{Village}_{i,t} + \varepsilon_{i,t} \quad (1)$$

where RSWC services_{*i,t*} indicates whether village *i* provide the corresponding RSWC services (RSWC facilities and RSWC workers) in year *t*. For a broader understanding of the determinants of RSWC services, we also merge our two primary variables (RSWC facilities and RSWC workers) into a single dependent variable that we refer to as comprehensive RSWC (when a village has both RSWC facilities and workers, comprehensive RSWC is equal to 1; when a village has only RSWC facilities or only RSWC workers or neither, comprehensive RSWC is equal to 0).

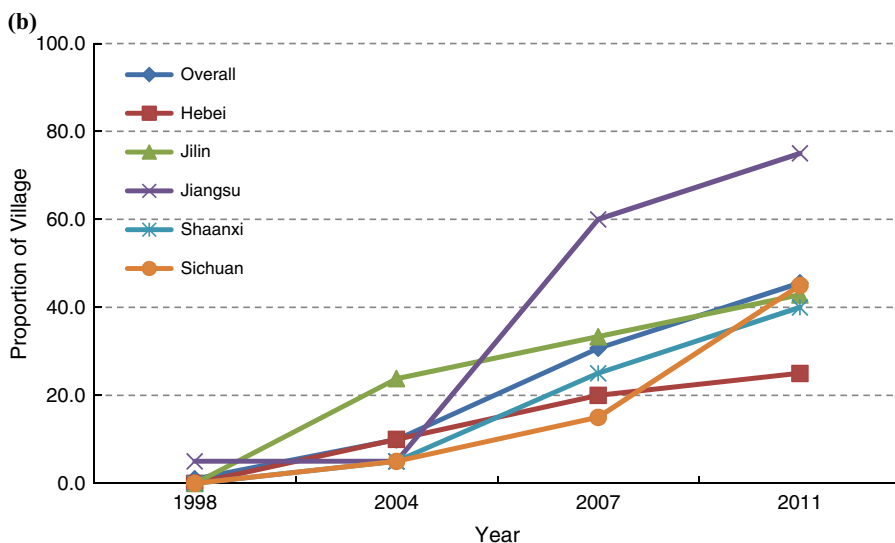
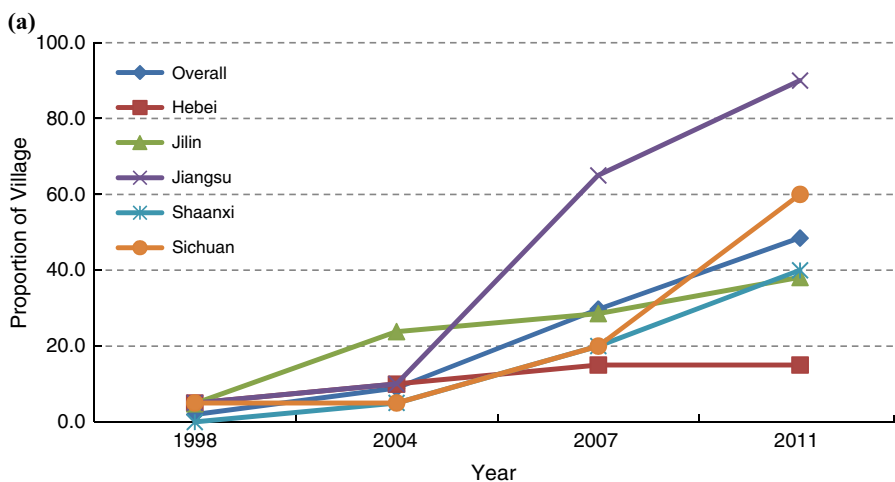
Village_{*i,t*} is a vector of village characteristics, including net per capita annual income, number of small hamlets, total population, distance from town, new leader, direct election. The symbols α and β_1 are the coefficients to be estimated. $\varepsilon_{i,t}$ is the error term. The summary statistics of all variables used in our model are presented in Table AI.

III. Results

Trends of RSWC services

Overall, we see that the proportion of villages with RSWC services increased steadily across this period for all provinces in our sample (Figure 2). In 1998, only 4 percent of villages in rural China had RSWC facilities (Figure 2(a)). Since making rural environmental management a top investment and policy priority in 2005, RSWC facilities have become increasingly widespread across rural China. The number of villages with RSWC facilities increased 12-fold over 13 years, reaching 50 percent of all villages by 2011 (Figure 2(a)). There was a similar increase in the proportion of villages with RSWC workers over this period. In 1998, only 2 percent of villages employed dedicated RSWC workers (Figure 2(b)). By 2011, the proportion of villages with RSWC workers had increased by a factor of 11-45.5 percent overall.

These overall trends are underlined by a large variation in the availability of RSWC services at the provincial and county level. Jiangsu showed the fastest increase in the proportion of villages with RSWC facilities (from 5 percent in 1998 to 90 percent in 2011) and RSWC workers (from 5 percent in 1998 to 75 percent in 2011). In contrast, Hebei showed the slowest increase, with the share of villages with RSWC facilities and RSWC workers reaching only 15 and 25 percent, respectively in 2011 (Figure 2). In Jiangsu, this higher provision rates may have come from the increasing need of



Notes: (a) RSWC facilities; (b) RSWC workers

Source: Author's survey

Figure 2. The trends of proportion of villages with residential solid waste collection services (percent) from 1998 to 2011

RSWC services arising from the rapid economic development in China's Eastern coastal regions. Hebei province, on the other hand, shares traits more similar to central and inland provinces and did not experience the same growth as Jiangsu. Further, Hebei did not gain from the preferential policies of the 2000 "China Western Development" plan as Sichuan and Shaanxi province did.

The other three provinces have nearly the same trends in the growth of RSWC facilities (from 5 percent in 1998 to around 50 percent in 2011, with the exception of Sichuan province, which grew to 60 percent in 2011) and RSWC workers (from 0 in 1998 to 40 percent in 2011). Sichuan also experienced a rapid increase in RSWC workers, from near 0 in 1998 to 40 percent in 2011. These results may be due to

the fact that more environmental officers in Sichuan began to focus on addressing rural environment problems, beginning in 2009 (China Environment News, 2011).

The wide gap between provinces is demonstrated by the strong variation between Hebei and Jiangsu provinces at the county level. Three of the counties sampled in Hebei still provided no RSWC facilities as of 2011. Less than 50 percent of villages in the other two counties in Hebei had RSWC facilities in 2011. By contrast, in the lowest scoring county sampled in Jiangsu, 75 percent of villages had RSWC facilities. Hence, it is evident that the variation in the provision of RSWC workers at the province and county levels is similar due to the consistent trends across the five provinces examined (Figure 2(b)).

In summary, then, the prevalence of RSWC services has made significant strides in recent years, though further development is still necessary. On the one hand, there was a remarkable increase in the provision of RSWC services over this period in rural China. On the other hand, as of 2011, the overall availability of these services remains relatively low across our sample.

Determinants of RSWC services

To obtain an initial understanding of the village-level determinants of RSWC services, we first examine the descriptive results for 2011. Table I shows that in 2011 RSWC services are more likely to be provided in villages that are wealthier, villages with more small hamlets, and villages with more people (Table I, rows 1-3). Notably, in most cases, the share of villages that have RSWC facilities is more than the share of villages with RSWC workers (Table I, columns 4-5). This result could suggest that the government may be more likely to invest in physical resources (RSWC facilities) than human resources (RSWC workers). In general, we can observe in our results that a smaller share of villages provides the full set of “comprehensive” RSWC services (i.e. there are not that many villages that have both RSWC facilities and workers; Table I).

There are a number of regularities in the correlates of RSWC services. Specifically, villages with higher net per capita annual income were more likely to have RSWC facilities, RSWC workers, and “comprehensive” RSWC services. For example, in the group of “high income” villages, there are more villages with RSWC facilities than RSWC workers (82.4 vs 76.5 percent). In the group of “low income” villages, the share of villages having RSWC facilities, RSWC workers, or “comprehensive” RSWC services are all the same (21.2 percent). These results suggest that low-income villages have equally poor collection services overall (i.e. they lack both facilities and workers), whereas higher income villages can afford to invest more in RSWC facilities (but, often do not have workers).

We also find that villages with a higher number of “small hamlets” are more likely to provide RSWC facilities, RSWC workers, and “comprehensive” RSWC services (Table I, row 2). In villages with a “few” small hamlets, the share of villages with RSWC facilities and “comprehensive” RSWC is the same. Interestingly, villages with “few” small hamlets have more RSWC workers (38.7 percent). More populous villages also are more likely to provide RSWC facilities, RSWC workers, and “comprehensive” RSWC services in general (Table I, row 3). Villages that are nearer to the township are more likely to have RSWC services (Table I, row 4).

Finally, we find that more villages provide RSWC workers (60 percent) when the village head is elected through a direct election. Nevertheless, the share of villages with leaders who are new, or directly elected that have “comprehensive” RSWC services are

Independent variables ^a	Group ^a (1)	Average value (2)	Share of obs. (3)	RSWC facilities (%) (4)	RSWC workers (%) (5)	Comprehensive RSWC ^h (%) (6)
(1) Net per capita annual income (yuan)	Low ^b	2,631	33	21.2	21.2	21.2
	Middle	5,039	34	41.2	38.2	29.4
	High	8,965	34	82.4	76.5	73.5
(2) Number of small hamlets	Few ^c	3.1	31	32.3	38.7	32.3
	Middle	5.6	36	44.4	41.7	36.1
	Many	11.1	34	67.7	55.9	55.9
(3) Total population (people)	Few ^d	630	33	30.3	39.4	27.3
	Middle	1,255	34	41.2	35.3	35.3
	Many	2,409	34	73.5	61.8	61.8
(4) Distance from town (km) ^c	Near ^e	1.2	28	67.9	57.1	53.6
	Middle	4.0	35	45.7	42.9	40.0
	Far					
(5) New leader	Away	13.3	38	36.8	39.5	34.2
	No ^f	0	58	50.0	46.6	41.4
	Yes	1	43	46.5	44.2	41.9
(6) Direct election	No ^g	0	10	40.0	60.0	40.0
	Yes	1	91	49.5	44.0	41.8

Notes: $n = 101$. ^aAll groups are divided based on village characteristic values in 2011. ^bWe divide net per capita annual income into three groups. We define a village as part of the “Low” income group if net per capita annual income is less than 3,800 yuan, the “Middle” group if income ranges between 3,800 and 6,500 yuan, and the “High” group if income is 6,500 yuan or more. ^cWe divide “number of small hamlets” into three groups. A village is considered to be in the “Few” group if the village has less than four hamlets, the “Middle” group if the village has between five to eight hamlets, and the “Many” group if the village has eight or more hamlets. ^dWe divide total population into three groups. We define a village to be in the “Few” group if the total population is less than 900 people, the “Middle” group if the total village population ranges from 900 to 1,700 people, and the “Many” group if a village has more than 1,700 people. ^eWe divide distance from village committee to the township government into three levels. We define a village in the “Near” group if the distance is less than 3 km, the “Middle” group if the distance ranges between 3 and 5 km, and the “Many” group if the village is more than 5 km from the nearest township. ^fVillage heads are either new (in the “Yes” group) or not (in the “No” group). ^gVillage heads are either directly elected (in the “Yes” group) or not (in the “No” group). ^hWe define the variable “Comprehensive” RSWC services as a village having both RSWC facilities and RSWC workers. In other words, if the village does not have either, or if the village has one of the two services (facilities or workers), then the village is not considered a provider of “Comprehensive” RSWC services (= 0). At the same time, if the villages have both waste facilities and waste workers, the village is then considered to have “Comprehensive” RSWC services (= 1)

Source: Authors’ survey

Table I. Proportion of villages with residential solid waste collection (RSWC) services and village characteristics in 2011

roughly equal. Further study is needed in order to deepen our analysis and understanding of the relationship between a village’s political attributes and its provision of RSWC services.

In some ways, our results from the multivariate analysis are consistent with our general findings from the descriptive findings (Table II). In particular, Table II shows that in the period from 1998 to 2011, villages with a higher net per capita annual income saw an increase to the village number of RSWC facilities and RSWC workers and overall “comprehensive” RSWC services. These results are almost significant at the 1 percent level. In addition, villages with more small hamlets are also shown to have a positive and significant correlation with the provision of

Dependent variable Independent variable	Fixed effects logistic model		
	RSWC facilities (1)	RSWC workers (2)	Comprehensive RSWC ^a (3)
(1) Net annual per capita income (thousand yuan)	18.41 (5.77)***	16.65 (6.0)***	13.32 (5.92)***
(2) Number of small hamlets	0.40 (2.44)**	0.36 (2.84)***	0.34 (2.76)***
(3) Total population	-0.004 (-1.10)	-0.004 (-2.20)**	-0.003 (-2.01)**
(4) Distance from town (km)	0.40 (-1.56)	0.56 (2.25)**	0.50 (2.05)**
(5) New leader (1 = yes, 0 = no)	-1.43 (-2.21)**	-0.91 (-1.51)	-0.84 (-1.48)
(6) Direct election (1 = yes, 0 = no)	1.34 (-1.42)	0.92 (-1.14)	1.80 (2.13)**
(7) Constant	-10.50 (-1.61)	-10.96 (-1.72)*	-9.60 (-1.83)*
(8) $\text{Ln}(\sigma_v^2)^b$	-17.68 (-0.03)	-17.67 (-0.03)	-17.70 (-0.03)
(9) Observations	404	404	404
(10) Number of villages	101	101	101

Table II.

Determinants of residential solid waste collection (RSWC) provision across four time periods (from 1998-2011)

Notes: z-Statistics in parentheses. ^aWe define the variable “Comprehensive” RSWC services as a village having both RSWC facilities and RSWC workers. In other words, if the village does not have either, or if the village has one of the two services (facilities or workers), then the village is not considered a provider of “Comprehensive” RSWC services (= 0). At the same time, if the villages have both waste facilities and waste workers, the village is then considered to have “Comprehensive” RSWC services (= 1). ^b $\text{Ln}(\sigma_v^2)$ is the logged variance of our random effect. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Source: Authors’ survey

RSWC services. In other words, villages with more small hamlets saw an increase in their RSWC facilities.

There are also several multivariate analyses that are inconsistent with our descriptive findings. In particular, we find that village population and distance from township government had no statistically significant relationship with the provision of RSWC facilities (Table II, column 1, rows 3-4). To our surprise, in fact, we find that village population and distance from the township government are negatively correlated with the provision of RSWC workers and “comprehensive” RSWC services. These results are significant at the 5 percent level. In other words, over time, more populous villages are less likely to have RSWC workers and comprehensive RSWC services (Table II, columns 2-3, and row 3). However, villages that are further from the township governments are significantly more likely to provide RSWC workers and comprehensive RSWC services ever time (Table II, columns 2-3, and row 4). This is true even when we hold village FE constant. This could suggest that in the time period between 1998 and 2011, the government has been increasingly providing more RSWC workers and “comprehensive” RSWC services for villages that have less people, and villages that are further away from the township government.

The multivariate analysis also reveals that new village leaders are negatively correlated with the provision of RSWC facilities (Table II, column 1, row 5). Village leaders who are directly elected are positively correlated with the provision of “comprehensive” RSWC services (Table II, column 3, row 6). This is an interesting result since it suggests that village heads who are directly elected (but not necessarily new) may be more willing to provide “comprehensive” RSWC services in order to meet villagers’ expectations for a clean environment.

The results of our multivariate analysis suggest that economic factors are still a primary determinant of whether or not villages have access to centrally provided RSWC services. This is consistent with previous studies on this topic (Ye and Qin, 2008;

Wang *et al.*, 2011). This suggests that RSWC services are still not reaching the poorest areas and, therefore, government should prioritize providing access to poorer rural areas in order to encourage these areas to develop sustainably.

IV. Conclusions

In this paper, we have used nationally representative data to describe the trends and determinants of RSWC services in rural China over the last 15 years. In our results, we report that the provision of both RSWC facilities and workers services increased rapidly in the first decade of the twenty-first century. In this way, government investment in RSW management has been partly successful. However, our results also suggest that the gap between different provinces remains large and the average prevalence of RSWC services remains low across the sample. And villages with a higher net per capita annual income and villages with more small hamlets saw an increase to the number of RSWC facilities, RSWC workers and overall “comprehensive” RSWC services. These suggest that investment has not been evenly distributed across the different regions. In the future, government should give more support to regions that are poorer and more inland.

At the same time, our multivariate analysis reveals that the government has also gradually turned to providing RSWC services in less populous villages and villages that are more remote (further away from the township government) in the period from 1998 to 2011. In this way, we can surmise that there may be an increasing focus on rural RSWC services, particularly in more remote villages.

In China, there are around 600,000 villages. Given that our sample is nationally representative, this suggests that as many as 300,000 villages across rural China still do not provide any kind of RSWC services. Although we do not measure the degree to which the provision of RSWC services improves the rural environment, we do note that provision of RSWC services is the first and most indispensable step in the chain of proper RSW management. Only when waste is rightly collected, it can be properly disposed of. Because net income and the number of small hamlets were the main factors affecting RSWC services, the government should allocate capital to poor regions to allow for sustainable environmental development.

This is a serious issue, but it is not unsolvable. As economies develop and modern industries grow, environmental pollution in turn increases. Fortunately, research has shown that investment in RSW management also increases (USA, Schreiner *et al.*, 1973; India, Fahiminia *et al.*, 2014). International research shows that once the provision of RSWC has been assured, there are three effective methods for processing rural RSW after RSWC. These methods include: training local officials to improve environmental awareness (classifying and recycling solid waste; Abduli *et al.*, 2009); redesigning waste transportation routes to decrease cost (as transportation is the main cost in RSW management); and improving on-site waste disposal technology, including vermicomposting technology (Li, 2011; Shah *et al.*, 2012), dispersed farmer-operated waste treating systems (Lu and Wang, 2008), simulated bioreactor landfills, and soil infiltration systems (Li, 2011).

China remains the world’s largest producer of RSW. Therefore, the government should not only increase investment in RSW management, but also study new technologies and training methods that may stimulate interest and increased efficiency in this area. In this paper, we examine the current state of RSWC services in rural China, as well as the trends in RSW management over the past 15 years. However, we do not evaluate the long-term effects of these services on the rural environment. Follow-up studies are needed to develop a comprehensive understanding of the situation and impact of RSW management in China today.

Note

1. The questions in the survey were “In the past year, did your village have dumpsters, garbage pits or garbage storage buildings needed to collect and contain solid waste?” and “In the past year, was there a staff person or persons employed by the village committee for the express purpose of regularly collecting trash from the collection facilities?”

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(The Appendix follows overleaf.)

Variable	Obs.	Mean	SD	Min.	Max.
<i>Rural residential solid waste collection services in 1998, 2004, 2007, 2011</i>					
Villages was building RSWC facilities (yes = 1; no = 0)	404	0.23	0.42	0.0	1.0
Villages employ RSWC workers (yes = 1; no = 0)	404	0.22	0.41	0.0	1.0
Villages provide comprehensive RSWC services (yes = 1; no = 0)	404	0.20	0.40	0.0	1.0
<i>Village characteristics</i>					
Net per capita income of the whole year (thousand yuan) ^a	404	0.3	0.3	0.0	1.8
Number of small hamlets	404	7.1	4.4	1.0	25.0
Total population	404	1,419.8	829.0	153.0	4,800.0
Distance from town (km)	404	5.6	7.0	0.0	115.0
New leader (1 = yes, 0 = no)	404	0.5	0.5	0.0	1.0
Direct election (1 = yes, 0 = no)	404	0.7	0.5	0.0	1.0

Table A1.
Summary statistics

Note: ^aThe minimum of net per capita income (per year) is 200 yuan
Source: Authors' survey

Corresponding author

Yaojiang Shi can be contacted at: shiyaojiang7@gmail.com

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