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Four decades of China's agricultural extension reform and its impact on agents' time allocation

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The Chinese Government has initiated a series of agricultural reforms since the 1970s to encourage agents to provide more services to farmers. In 2006, a new round of agricultural reforms was extended nationwide; however, the effectiveness of these reforms has not been examined. Based on a comparison of survey data sets before and after the reforms, we found that overall they significantly increased the time agents spend on agricultural extension services, although their effectiveness differs among three major components of the reforms. While the financial assurance reform had little impact on agents' time allocation, the administrative reform actually reduced the time allocation to agricultural extension. However, we found strong evidence that the 'three rights' management reform (comprising the rights of personnel, financial and asset management) successfully increased agents' time allocation to agricultural extension services. We also found that institutional incentives and the Government's investment did not increase the time agents spent on agricultural extension. The lack of incentives is a problem that needs to be addressed in future reforms. We found that professional agents spent more time providing extension services than their non-professional counterparts. We suggest that local Governments should avoid recruiting non-professional agents into agricultural extension stations.

Key words: administrative reform, agent, agricultural extension, China, 'three rights' reform.

1. Introduction

Progress in technology has been the major driver of China's agricultural production growth and will play an even more important role in the sustainable development of Chinese agriculture in the future (Swanson 2006; Rivera and Sulaiman 2009; Huang and Rozelle 2010). The most important way of spreading new technologies is agricultural extension services which, in turn, contributes greatly to China's agricultural technology progress (Hu *et al*. 2004; Huang and Rozelle 2010). In China, the Public Agricultural Extension System (PAES) has dominated these agricultural extension services

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with widely distributed Government institutions and a multitude of extension agents (Hu *et al*. 2004, 2009; Cai and Hu 2009; Babu *et al*. 2015).

The rapid development of China's PAES began with the rural contract responsibility system (RCRS) reform at the end of the 1970s (Hu *et al*. 2009; Huang *et al*. 2009). In order to provide effective agricultural extension services to farmers, who were enthusiastic to adopt new technologies after getting their own land during the RCRS reform, the local Government re-established PAES stations at the county and township level. However, the excessive increase in the number of extension institutions and agents resulted in a large financial pressure on the local Government (Hu *et al*. 2009). To address this issue, the Chinese Government initiated the PAES commercialisation reform in the mid-1980s. This reform encouraged agricultural extension agents to sell agricultural inputs, such as seeds, fertilisers and pesticides, to increase their incomes. This reform alleviated the financial pressure on the Government, but it also led public extension agents to focus on increasing their incomes by selling more pesticides and fertilisers to farmers (Huang *et al*. 2001, 2003; Hu *et al*. 2012). During this reform, far fewer public agricultural extension services were available for farmers, and one-third of the public extension agents spent more of their working time on commercial activities rather than providing services for farmers (Hu *et al*. 2004, 2012; Huang *et al*. 2009).

Meanwhile, the Chinese Government decentralised the authority over township agricultural extension agents from county to township. The authority over township agricultural extension agents affected agents' provision of services to farmers (Hu *et al*. 2009). Previous studies showed that when the authority over the township-level agents belonged to the county Government, agents spent more time providing extension services to farmers (Huang *et al*. 2001; Hu *et al*. 2009). Conversely, the township Government required them to spend more time on administrative affairs, meaning they had less capacity to provide agricultural extension services to local farmers (Huang *et al*. 2001; Hu *et al*. 2009). The authority included giving the management rights of personnel development, budgets and assets to the township Government agricultural extension agents. This reform was known as the 'three rights' reform.

In the early 1990s, faced with the stagnation of grain production, the Government conducted another reform to stabilise the agricultural extension service system (Huang *et al*. 2009). The management of the 'three rights' was returned from township to county Governments, and the number of agricultural extension agents recovered and increased rapidly to approximately one million. The financial burden induced by this personnel expansion cancelled the effects of the previous 'three rights' reallocation reform. Previous studies found that the financial problems caused by this expansion of personnel affected the PAES' day-to-day operations and made agents reluctant to work on agricultural extension (Qiao *et al*. 1999; Hu *et al*. 2004, 2009; Ke 2005).

To address the above problems, the Chinese Government formalised the 1990s commercial reforms by classifying agents by their source of funding: fully funded agents; partially funded agents; and self-funded agents (Hu *et al.* 2009). In the year 2000, the management of the 'three rights' was shifted second time from county to township Governments. However, a survey found that these measures did not cause agents to spend more time providing agricultural extension services to farmers, but rather on administrative affairs (Hu *et al.* 2004, 2009). Other studies found that these commercial activities stimulated farmers to overuse pesticides and fertilisers (Huang *et al.* 2001). In response, the Chinese Government launched a series of pilot PAES reforms in 2004, and in 2006, a new round of PAES reform began, which included a financial assurance reform and a further reform of the 'three rights' management, which shifted back from township to county Governments.

Several studies have examined the effects of the reforms before 2006 (Hu *et al.* 2009, 2012; Huang *et al.* 2009). However, nearly 12 years later, only a few scholars have investigated the impact of the 2006 reform and its key aspects, the latest in a lengthy series of agricultural extension reforms. Has the reform reached its goal? Has it improved agents' time allocation to agricultural extension services? Further, what are the most important factors affecting agents' time allocation to agricultural extension services? These issues have not yet been examined in the current literature.

2. Review of the reforms in the agricultural extension system in China

The new round of agricultural extension reforms started in 2006 sought to discourage agents from spending too much time on administrative affairs and commercial activities at the expenses of services to farmers. These reforms included not only the financial assurance reform and another 'three rights' management reform, solicited by the central Government, but also the administrative reform initiated by local Governments. The details of these reforms are discussed below.

2.1 The financial assurance reform

This reform aimed to reduce the time agents spent on commercial activities by providing them with financial assurance. In 2006, national document No. 30 proposed the separation between commercial activities and the agricultural extension services, thereby reaffirming the public welfare mandate of the agricultural extension. Subsequently, the original self-funded agents (whose revenue relied exclusively on commercial activities, such as selling pesticides and fertilisers) and partially funded agents (partially funded by the Government in addition to their commercial activities) became gradually fully funded by the Government. This reform was also reaffirmed in a series of subsequent documents.

2.2 The 'three rights' management reform

The 'three rights' management reform was geared towards agents at the township level. According to previous reforms, the 'three rights' of township agricultural stations were managed by township Governments, which caused the problem that township-level agents, who should have been spending more time than county-level agents working with farmers, spent even less time on agricultural extension than their county-level counterparts (Hu *et al*. 2009). Hence, national document No. 30 proposed that while the township agricultural stations could still be led by township Governments, the 'three rights' of these stations should be managed at the county level. Provinces adopted different management models in response. Based on their ability to withstand an additional financial burden, richer provinces were more likely to adopt a county-level 'three rights management', whereas poorer provinces which found that agents managed at the county level would not help with administrative affairs and were unable to spend money on recruiting more administrative staff were more likely to object to this change. As such, while some agricultural stations are managed at the county level today, others are still managed at the township level.

2.3 The administrative reform

The administrative reform was launched by local Governments and was also geared to township-level agents. National document No. 30 clearly stipulated that agricultural stations should mainly focus on providing services to farmers. However, due to the financial pressure and personnel shortage, many jurisdictions undertook the administrative reform of township-level agricultural stations. Some agricultural stations were integrated into administrative units. In some towns, agricultural stations were abolished, and offices were established to handle agricultural extension services as well as administrative affairs. In other towns, agricultural stations were integrated into comprehensive service stations to improve the efficiency and convenience of services to the farmers. This administrative reform was inconsistent with the central Government's stance and raised the possibility of reallocating agents' time from services to the farmers to administrative affairs.

3. Methodology and materials

3.1 Data sources

The data used in this paper comprise two parts. The first part consists of survey data collected before the agricultural extension reform in 2002 from seven provinces, 28 counties, 84 townships, 363 extension stations (198 at the county level and 165 at the township level) and 1,245 extension staff members (770 at the county level and 475 at the township level). The second part

consists of survey data collected after the agricultural extension reform in 2016 from seven provinces, 28 counties, 62 townships, 183 extension stations (116 at the county level and 67 at the township level) and 519 extension staff members (371 at the county level and 148 at the township level; a total of 531 extension staff members were interviewed, but 12 interviews were eliminated because of missing data). We also asked the station or extension service centre (ESC) leader to participate in our surveys. In total, we interviewed 423 and 222 station leaders in the first (2002) and second (2016) round of the survey, respectively.

In the first round of the survey, we randomly chose one province from each of China's seven major geographic regions (north-east, north-west, north, east, south, central and south-west), including Heilongjiang, Gansu, Hebei, Zhejiang, Guangdong, Hubei, and Sichuan provinces. In the second round, we chose regions based on four key crops that are grown in China's mainland, including rice, tea, apple and vegetables, ensuring that the agents surveyed in these regions were still involved in agriculture extension services. For rice and tea, we randomly chose provinces around the middle and lower reaches of the Yangtze River, South China and Southwest China. For apple and vegetables, we randomly chose provinces around the Bohai Sea and north-west China. The provinces surveyed included Hubei and Jiangsu (rice), Zhejiang, Guangdong, and Guizhou (rice and tea), Shaanxi (apple) and Shandong (apple and vegetables). We followed up with three provinces (those that were included in both surveys: Zhejiang; Guangdong; and Hubei) in the second round of the survey. Although we followed up with three provinces, the data set is unfortunately not a panel data set. We used only the data from 2002 in this paper's descriptive analysis.

The sampling principle was similar for both rounds. For each selected province, counties were divided into two groups according to the per capita net income of farmers, and two counties were randomly selected from each group. For each sampled county, townships were also divided into two or three groups according to farmers' per capita net income, and one township was chosen randomly from each group. At the county and township levels, agents were randomly selected for face-to-face interviews. The questionnaires for these two surveys were similar and related to agents' annual time allocation, personnel characteristics and county characteristics, among other areas. The agents were informed that the survey was in no way related to their work performance, thus encouraging them to share true information about their service hours.

3.2 Empirical model

We employed a tobit model to identify the impact of the 2006 agricultural extension reform on agents' time allocation and, therefore, on the degree of extension offered to the farmers. We divided agents' time into five categories: time on agricultural extension services; time on administrative work; time for

training; office time; and non-work time (i.e. weekends, vacations and public holidays). Because a non-trivial number of agents did not spend time on some of the categories, there was potential to obtain negative fitted values, if a common linear model were used, leading to negative predictions for the dependent variables (Wooldridge 2003). The tobit model avoids the problem of possible negative or positive deviations (Tobin 1958; Wooldridge 2010). The impact of agricultural extension reform on agents' time allocation was estimated using the following specification:

$$Y_i = \begin{cases} X_i\beta \text{ if } y* = X_i\beta + u_i > 0 \\ 0 \text{ if } y* = X_i\beta + u_i \leq 0, \end{cases} \quad (1)$$

where Y_i is four types of time allocation: (i) time for agricultural extension services; (ii) time on administrative work spent exclusively outside the office, for example working on public security and land requisition; (iii) office time; and (iv) time for training (we further separated training into technical and non-technical training). $X_i\beta$ is a vector of explained variables (the subscript i is for the i^{th} agent). $y*$ is a non-observable latent variable, and u_i is an independently normally distributed error term with zero mean and constant variance σ^2. More specifically, the model is set as follows:

$$\begin{aligned} Y_i = {} & \theta_0 + \text{FF}_i\theta_1 + \text{TRM}_i\theta_2 + \text{ADM}_i\theta_3 + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4 \\ & + X_5\beta_5 + \varepsilon_i, \end{aligned} \quad (2)$$

where FF is a dummy variable for agents fully funded by the Government (compared with non-fully funded agents, including partially funded and self-funded agents). TRM is a dummy variable for the management of the 'three rights' of the township agent at the county level (compared with those managed at the township level). ADM is a vector of station characteristics, including whether the station of the agent is an administrative station or a comprehensive station (compared with an agricultural extension station). X_1 is a vector of institutional incentive variables, including whether there is a subsidy for visiting the countryside, and Government investment, including per capita operating budget funding and per capita project grant funding (which support daily office and project expenditure, not the agents themselves). X_2 is a vector of policy variables, including whether there is a mandate for visiting rural areas to provide services to farmers and whether the agent is a 'Bao Cun cadre', who is in charge of the administrative affairs of one or several villages. Bao Cun cadres communicate between township Governments and village-level organisations and, as such, a Bao Cun cadre who operates as an extension service has to undertake many administrative tasks, such as publicise policies and regulations from the Government, mediate disputes among villagers and help villagers to increase their incomes. Thus, the coefficient of the Bao Cun cadre dummy variable would have a

positive impact on the time agents spend on administrative affairs. X_3 is a vector of county characteristics, including the per capita GDP and the percentage of agricultural contribution to GDP. X_4 is a vector of agent's characteristics, including whether the agent works at the township level and major demographic characteristics, such as gender, age, work experience, position, technical title, education and whether the agent's major is fit for extension services ('professional' hereafter). X_5 is a vector of province dummy variables. ε is the error term.

4. Descriptive analysis

4.1 Agents' time allocation before and after the agricultural extension reform

After the latest round of the Government's agricultural extension reform, agents' time allocation to agricultural extension services increased significantly (Table 1). According to Table 1, agents' average time on agricultural extension services in 2002 was 81 days, accounting for < 25 per cent of the year. In contrast, in 2015, agents spent 126 days, or approximately 34.5 per cent of the year, on agricultural extension services. Consistent with the reform's objective, the agents almost ceased commercial activities; their average working time on commercial activities decreased from 15.3 per cent of the year, or 56 days, in 2002 to approximately 1.4 per cent of the year, or 3 days, in 2015. Similarly, the average office hours decreased from 37 per cent of the year, or 135 days, in 2002 to 34.5 per cent, or 126 days, in 2015.

It should be noted that there is a significant difference in the time allocation of the agents at the county and township levels (Table 1). The average agricultural extension time for county-level agents increased by 25.6 per cent, from 86 days in 2002 to 108 days in 2015 and, as a proportion of days in the year, from 23.6 per cent to 29.6 per cent. In comparison, the average agricultural extension time for township-level agents increased by 135.6 per cent, from 73 days in 2002 to 172 days in 2015 and, as a proportion of days in the year, from 20 per cent to 47.1 per cent. The office hours of county-level agents did not change, while the office hours of township-level agents decreased by 22 days on average. We should also note that in 2002, township-level agents, who were supposed to work more closely with the farmers, spent less time on agricultural extension services than county-level agents, but this situation changed post-reform. These results suggest that the reform solved the problem that township agents, who were supposed to work more closely with the farmers, did not visiting the countryside often enough (Hu *et al.* 2009). Similar results were also obtained from the follow-up surveys in Zhejiang, Guangdong, and Hubei provinces.

Table 1 Agents' time allocation in 2002 and 2015

	Days per year				Percentage (%)			
	Agricultural extension	Commercial activities	Office hours	Other	Agricultural extension	Commercial activities	Office hours	Other
Whole sample								
2002	81	56	135	92	22.2	15.3	37	25.2
2015	126	3	126	110	34.5	0.8	34.5	30.1
County level								
2002	86	39	136	103	23.6	10.7	37.3	28.2
2015	108	2	136	118	29.6	0.5	37.3	32.3
Township level								
2002	73	83	134	75	20	22.7	36.7	20.5
2015	172	3	102	88	47.1	0.8	27.9	24.1
Follow-up sample								
2002	85	78	101	100	23.3	21.4	27.7	27.4
2015	133	2	120	110	36.4	0.5	32.9	30.1
County level								
2002	91	50	105	119	24.9	13.7	28.8	32.6
2015	112	1	133	120	30.7	0.3	36.4	32.9
Township level								
2002	79	108	98	80	21.6	29.6	26.8	21.9
2015	178	6	92	89	48.8	1.6	25.2	24.4

Note: To make a comparison between the 2002 and 2015 data, 2015 agricultural extension hours include agricultural extension hours and administrative hours, while office hours include office hours and training hours, as was the case in the 2002 survey.

4.2 The changes in the personnel structure before and after the reform

Figure 1 shows the number and percentage of agents fully or non-fully funded by the Government in 2002 and 2015. From Figures 1a,b, we see that of 1,245 agents, only 823, or 66 per cent, were fully funded by the Government in 2002. The remainder of the agents, therefore, relied on commercial activities for part of their income. After the financial assurance reform, in 2015, 473 of 519 surveyed agents, or 91 per cent were fully funded by the Government. This may partly explain why agents' average time on commercial activities decreased from 56 days in 2002 to approximately 3 days in 2015.

Figure 2 shows the management structure of township-level agents before and after the reform. From Figure 2a, we can see that in 2002, the 'three rights' of 442 of 475 township-level agents were managed by township-level Governments. In 2015, the 'three rights' of 119 of 148 township-level agents were managed by township-level Governments. The percentage of township-level agents whose 'three rights' were managed by county-level Governments increased from 7 per cent to 20 per cent, while the percentage of township-level agents whose 'three rights' were managed by township-level Governments decreased from 93 per cent to 80 per cent.

Figure 3 shows the unit properties of township-level agents before and after the reform. From Figure 3a, we can see that in 2002, all 475 township-level agents belonged to agricultural extension units. In 2015, 80 of 148 township-level agents, or 54 per cent belonged to agricultural extension units, 18 (12 per cent) to administrative units and 50 (34 per cent) to comprehensive units.

4.3 The agents' time allocation after the reform

Although the 2006 reform significantly increased agents' time allocation to agricultural extension services overall, the contributions of the three components of the reform were quite different (Table 2). The financial

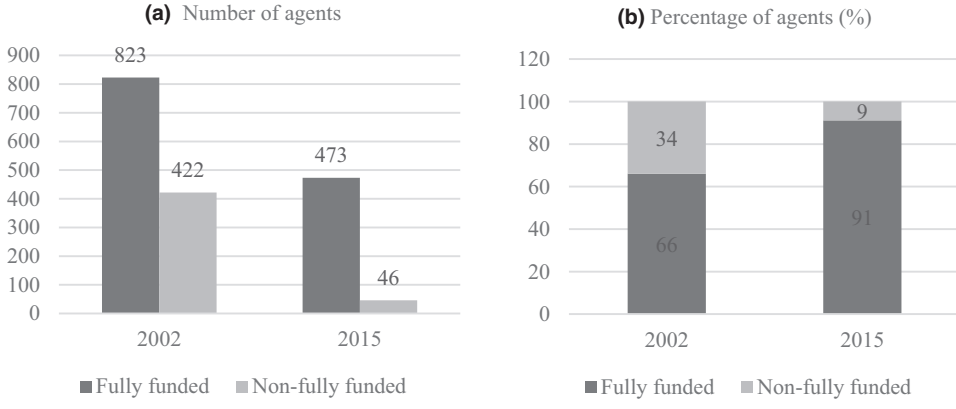

Figure 1 Agents fully or non-fully funded by the Government before and after the reform.

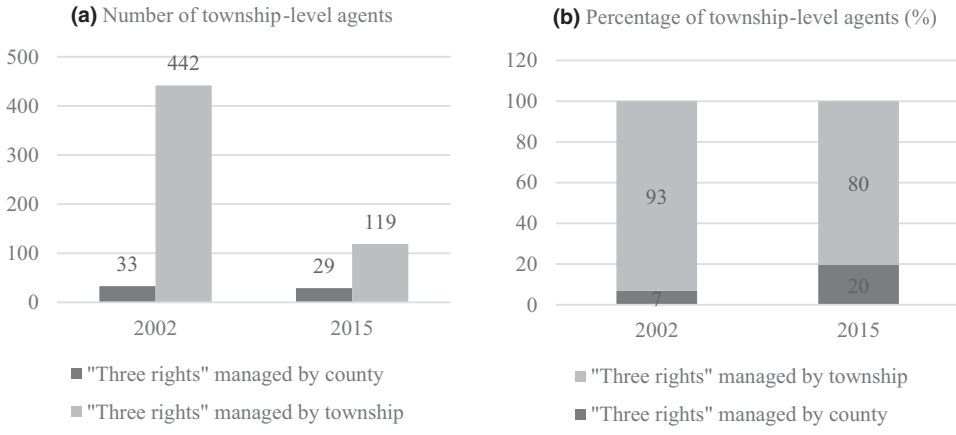

Figure 2 The management structure of township-level agents before and after the reform.

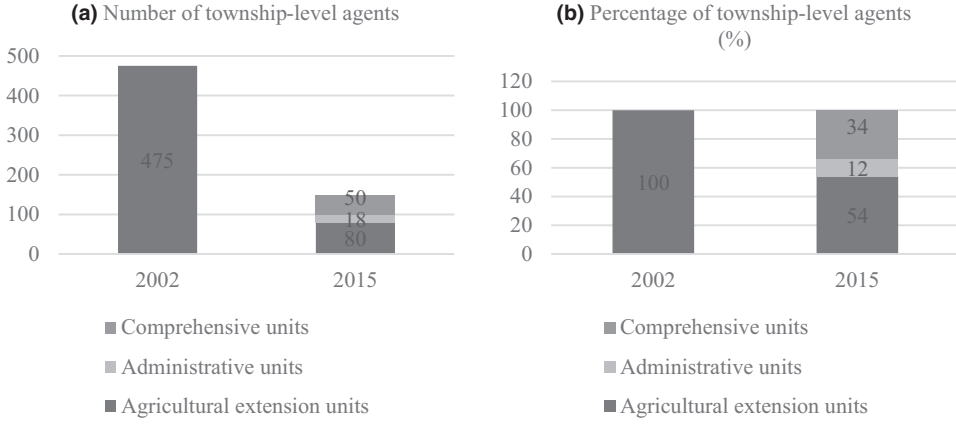

Figure 3 Unit properties of township-level agents before and after the reform.

assurance reform might not have increased agents' time on agricultural extension services. Table 2 shows that in 2015, only 46, or 9 per cent, of 519 agents were non-fully funded. These included five self-funded and 41 partially funded agents, indicating that the majority of the local Governments carried out the financial assurance reform. However, the results also show that fully funded agents' time allocation to agricultural extension services was only 96 days (or 26 per cent of the year), which was lower than that of non-fully funded agents, that is 131 days (36 per cent of the year). Fully funded agents spent less time on administrative work in rural areas (27 days, 7 per cent of the year) than non-fully funded agents (35 days, 10 per cent of the year). The above analysis suggests that after most agents were fully funded by the Government, the effect of the incentive for agents to work on agricultural extension was also weakened.

The 2006 'three rights' management reform increased agents' working time on agricultural extension. Table 2 shows that the average agricultural extension time for township-level agents whose 'three rights' were managed by county Governments was 132 days, or 36 per cent of the year, which was higher than that of the agents whose 'three rights' were managed by township-level Governments (109 days, or 30 per cent of the year), indicating that the reform increased agents' time on agricultural extension. The administrative time for township-level agents whose 'three rights' were managed by county Governments was 52 days (14 per cent of the whole year), which was lower than that of the agents whose 'three rights' were managed by township Governments (60 days, or 16 per cent of the whole year), indicating that the agents whose 'three rights' were managed by county Governments spent less time on administrative affairs and provided more agricultural extension services to the farmers. This also suggests that the 2006 'three rights' management reform caused agents to spend more time on agricultural extension services than administrative work.

The administrative reform may also have had a negative impact on agents' time allocation. The agents from the administrative units spent only 56 days (15 per cent of the year) on agricultural extension, far less than the 129 days (35 per cent of the year) of those who remained in agricultural extension institutions without the reform (Table 2). Some places tried to increase agents' time on agricultural extension by establishing comprehensive stations. However, the time that agents from comprehensive units spent on agricultural extension was 110 days (30 per cent of the year), which was still lower than the original agricultural extension institutions. It should be noted that the agents from administrative and comprehensive units increased their time for administrative tasks, from 51 days in unreformed agricultural extension units to 72 days in administrative units and 65 days in comprehensive units. In addition, the office hours for agents in administrative units were 123 days, which were higher than those in unchanged agricultural extension units (96 days) and comprehensive units (89 days). This also suggests that the administrative reform carried out by local Governments made agents spend less time on agricultural extension services.

Table 3 shows the impact of the reforms on agents' training participation. It should be noted that the effects of the reforms were quite different. The agents fully funded by the Government spent 5.4 days in training, whereas non-fully funded agents spent 4.1 days for that. The agents whose 'three rights' were managed by county Governments allocated less time to training, 5.1 days, than those managed by township Governments, 5.5 days. The agents in administrative and comprehensive units allocated 7.4 and 6.5 days to training, respectively, which was more than those in unreformed agricultural extension units, 4.3 days. These results show that the 2006 'three rights' reform reduced agents' time allocation to training, whereas the other two reforms increased agents' time allocation to training. Further analysis shows that both the financial assurance reform and the 2006 'three rights'

Table 2 Agents' time allocation after the agricultural extension reform (2015)

Reform	Sample size	Days per year				Percentage (%)			
		Agricultural extension	Administrative	Office	Training	Agricultural extension	Administrative	Office	Training
Total	519	99	27	121	5	27	7	33	1
Financial assurance reform									
Fully funded	485	96	27	123	5	26	7	34	1
Non-fully funded	46	131	35	96	4	36	10	26	1
The 2006 'three rights' reform (agents managed by)									
County	29	132	52	86	5	36	14	24	1
Township	119	109	60	100	6	30	16	27	2
Administrative reform									
Unreformed units	80	129	51	96	4	35	14	26	1
Administrative units	18	56	72	123	7	15	20	34	2
Comprehensive units	50	110	65	89	7	30	18	24	2

Note: The 2006 'three rights' management reform and administrative reform affect only the 148 township-level agents.

Table 3 Agents' training time after the agricultural extension reform (2015)

Reforms	Sample size	Training days				Percentage (%)		
		Total	Technical training	Non-technical training	Further studies	Technical training	Non-technical training	Further studies
Total	519	5.3	4.3	0.8	0.2	81	15	4
Financial assurance reform								
Fully funded	473	5.4	4.4	0.8	0.2	81	15	4
Non-fully funded	46	4.1	2.6	1.4	0.1	63	34	2
The 2006 'three rights' reform (agents managed by)								
County	29	5.1	4.4	0.6	0.0	87	13	0
Township	119	5.5	3.9	1.2	0.4	71	22	7
Administrative reform								
Unreformed units	80	4.3	3.7	0.3	0.2	87	7	6
Administrative units	18	7.4	4.3	2.7	0.4	58	37	5
Comprehensive units	50	6.5	4.4	1.7	0.4	67	27	6

Note: The 2006 'three rights' management reform and administrative reform affect only the 148 agents at the township level.

reform increased agents' time allocation to technical training and reduced time allocation to non-technical training, which might increase agents' efficiency, while the administrative reform had the opposite effect.

5. Empirical results

The descriptive analysis in Section 4 does not control for agents' personal characteristics and other factors. Table 4 shows the impact of agricultural extension reform on agents' time allocation after controlling for other variables. Six models were estimated: models (1)–(4) estimated the impact of reforms on agents' time allocation to types of work, that is time on agricultural extension services, administrative work, office hours and training, respectively. In models (5)–(6), we further divided agents' time on training into technical and non-technical training to estimate the impact of the reforms separately.

5.1 The impact of the 'three rights' management and administrative reforms on agents' time on agricultural extension

Township-level agents whose 'three rights' were managed by county Governments spent 31 more days (0.084×365) on agricultural extension than those managed by township Governments (Table 4, column 1). Compared with agents from unreformed agricultural extension units, those from administrative units spent 51 fewer days (-0.141×365) on average on agricultural extension. There was no significant difference in agricultural extension time between fully funded and non-fully funded agents. Although the coefficient of agents in comprehensive units was negative, we cannot say that there was a significant difference in agricultural extension time between agents from comprehensive units and agricultural extension units. We did not find any evidence that the reforms had a significant impact on agents' allocation of time to administrative affairs or office hours.

The administrative reform had a significant impact on agents' training time. The results show that agents from administrative and comprehensive units spent an average of 5.5 (0.015×365) and 3.7 more days (0.010×365) participating in training than those in unreformed units, respectively (Table 4, column 4). The other two reforms did not have a significant impact on agents' training time. If we further divide agents' training time into technical and non-technical, the results show that none of the reforms affected agents' time spent on technical training. The financial assurance reform significantly reduced agents' allocation of time to non-technical training, while the administrative reform significantly increased agents' non-technical training time. Although the administrative reform increased agents' allocation of time to training, which would have improved the efficiency of agricultural extension services, further analysis shows that the training was non-technical and related to administration rather than agricultural extension.

Table 4 The impact of agricultural extension reform on agents' time allocation

	Agricultural extension	Admin. affairs	Office time	Training time	Type of training	
					Technical	Non-technical
	(1)	(2)	(3)	(4)	(5)	(6)
Reform variables						
Fully funded (Non-fully funded = 0)	−0.013 (0.037)	0.008 (0.029)	−0.012 (0.039)	−0.006 (0.006)	0.001 (0.006)	−0.033*** (0.011)
The 2006 'three rights' managed by County (township = 0)	0.084* (0.046)	−0.025 (0.036)	0.038 (0.049)	−0.005 (0.007)	0.005 (0.006)	−0.023* (0.013)
Administrative (unreformed = 0)	−0.141*** (0.051)	0.021 (0.040)	0.057 (0.054)	0.015** (0.007)	−0.001 (0.007)	0.051*** (0.014)
Comprehensive (unreformed = 0)	−0.010 (0.036)	0.047 (0.029)	−0.024 (0.038)	0.010* (0.005)	0.002 (0.005)	0.026** (0.011)
Incentive and investment variables						
Subsidy (No subsidy = 0)	0.011 (0.022)	0.005 (0.018)	−0.004 (0.023)	0.003 (0.003)	−0.000 (0.003)	0.006 (0.006)
Per capita operating budget (10 thousand/ person)	−0.004** (0.002)	−0.003* (0.002)	0.001 (0.002)	0.0003 (0.0003)	0.0001 (0.0003)	−0.001 (0.001)
Per capita project grants (10 thousand/ person)	0.001 (0.001)	0.002** (0.001)	0.0002 (0.001)	−0.00025* (0.00014)	−0.00026* (0.00013)	0.0003 (0.0002)
Policy dummy variables						
'Bao Cun' cadre	0.012 (0.020)	0.111*** (0.016)	−0.084*** (0.021)	0.008*** (0.003)	0.008*** (0.003)	0.002 (0.006)
Mandatory rural visit policy	0.102*** (0.021)	−0.050*** (0.018)	−0.089*** (0.022)	0.008*** (0.003)	0.006* (0.003)	0.006 (0.006)

Table 4 (*Continued*)

	Agricultural extension	Admin. affairs	Office time	Training time	Type of training	
					Technical	Non-technical
	(1)	(2)	(3)	(4)	(5)	(6)
County characteristics						
Per capita GDP (10 thousand/ person)	−0.001 (0.002)	0.001 (0.001)	−0.008*** (0.002)	0.0002 (0.0003)	0.0001 (0.0002)	0.0008* (0.0005)
Agriculture-GDP ratio (%)	0.249*** (0.069)	−0.080 (0.056)	−0.275*** (0.072)	0.030*** (0.010)	0.024** (0.010)	0.048** (0.020)
Personal characteristics						
Township level (County level = 0)	0.134*** (0.049)	0.081** (0.039)	−0.007 (0.053)	−0.012* (0.007)	−0.0001 (0.007)	−0.047*** (0.015)
Professional (Non-professional = 0)	0.029* (0.017)	−0.021 (0.014)	−0.034* (0.018)	−0.001 (0.003)	−0.0001 (0.002)	−0.0002 (0.005)
Male (Female = 0)	−0.022 (0.017)	−0.068*** (0.014)	0.020 (0.018)	−0.001 (0.003)	0.0002 (0.002)	0.0003 (0.005)
Age (year)	−0.001 (0.003)	0.001 (0.002)	0.003 (0.003)	−0.0003 (0.0004)	−0.0007* (0.0004)	0.002** (0.001)
Work experience (year)	0.004 (0.002)	−0.003 (0.002)	−0.001 (0.003)	−0.000 (0.0003)	0.0003 (0.0003)	−0.002** (0.001)
Position (no managerial position = 0)						
Extension service centre leader	0.019 (0.024)	0.046** (0.019)	−0.016 (0.026)	0.004 (0.004)	0.001 (0.003)	0.006 (0.007)
Station leader	0.039* (0.021)	0.017 (0.017)	−0.013 (0.022)	0.004 (0.003)	0.004 (0.003)	−0.002 (0.006)
Employment status (Junior and other = 0)						
Senior staff	0.092*** (0.027)	−0.013 (0.022)	−0.066** (0.028)	−0.008** (0.004)	−0.005 (0.004)	−0.008 (0.008)
Mid-level staff	0.028 (0.020)	−0.005 (0.017)	−0.024 (0.022)	−0.001 (0.003)	0.0002 (0.003)	−0.001 (0.006)
Education (High school and below = 0)						
Bachelor and above	−0.034 (0.026)	0.015 (0.021)	0.046* (0.028)	0.009** (0.004)	0.007** (0.004)	0.012 (0.008)
Junior college	−0.028 (0.024)	0.032 (0.020)	0.035 (0.026)	0.002 (0.004)	0.001 (0.003)	0.011 (0.008)

Table 4 (*Continued*)

	Agricultural extension	Admin. affairs	Office time	Training time	Type of training	
					Technical	Non-technical
	(1)	(2)	(3)	(4)	(5)	(6)
Work specialisation(agronomy = 0)						
Plant protection	0.020 (0.024)	0.047** (0.020)	−0.025 (0.025)	−0.011*** (0.004)	−0.009*** (0.003)	−0.005 (0.007)
Horticulture	0.029 (0.026)	0.022 (0.021)	−0.030 (0.027)	−0.002 (0.004)	−0.0003 (0.003)	0.009 (0.007)
Soil fertility	−0.050* (0.027)	0.027 (0.023)	0.042 (0.029)	−0.009** (0.004)	−0.008** (0.004)	−0.008 (0.008)
Agricultural machinery	−0.023 (0.064)	0.049 (0.050)	0.022 (0.069)	−0.003 (0.009)	−0.011 (0.009)	0.029* (0.015)
Animal husbandry	0.082* (0.047)	−0.024 (0.038)	−0.012 (0.050)	−0.004 (0.007)	−0.009 (0.007)	0.019 (0.013)
Agricultural economics	−0.004 (0.082)	0.046 (0.064)	−0.194** (0.088)	0.006 (0.012)	0.003 (0.011)	0.018 (0.020)
Other	−0.102*** (0.025)	0.022 (0.021)	0.069*** (0.026)	−0.015*** (0.004)	−0.013*** (0.004)	−0.002 (0.007)
Constant	0.123 (0.079)	−0.026 (0.064)	0.393*** (0.084)	0.011 (0.012)	0.020* (0.011)	−0.108*** (0.028)
Observations	519	519	519	519	519	519

Note: All models control for province dummies. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

5.2 The impact of institutional incentives and Government investment on agents' time allocation

The institutional incentive variable for subsidising services to farmers in rural areas is insignificant in all models (Table 4), indicating that the institutional incentive is ineffective under the current management system. This may be due to the fact that most agents visit the countryside without the lure of subsidies (Hu and Sun 2018), and even when an agricultural extension station does offer financial incentives for those providing services to farmers in the countryside, these subsidies are available to all employees, rather than only as a reward to those who specifically visit rural areas (Hu and Sun 2018).

Per capita operating budget funding is an indicator of the wealth of the local Government (Hu *et al*. 2009), since the allocation of this budget largely depends on the economic development of the region. It has a statistically significant negative impact on agents' allocation of time to both agricultural extension and administration (Table 4, column 1). This suggests that, compared with less developed areas, agents in economically well-off areas not only spend less time providing agricultural extension services to farmers but also spend less time on administrative affairs. Per capita project grant funding has a statistically significant impact on increasing the time agents spend on administrative affairs, indicating that the project grant funding is used for administrative affairs rather than agricultural extension services. We also note that although the per capita operating budget and project grant funding are statistically significant in the first two models, their coefficients are quite small. If the per capita operating budget increased by one thousand yuan, agents' agricultural extension time decreased by 0.04 per cent, or 0.15 days in a year. The coefficient of per capita project grant funding is even smaller. The Government investment variables are economically insignificant, indicating that Government investment has no impact on agents' time allocation.

5.3 The impact of mandatory visits to the countryside on agents' agricultural extension time

The existence of a policy that makes the visits to rural areas mandatory for the agents has a significant impact on agents' allocation of time to agricultural extension services. The coefficient of the policy is statistically significant in all models, except for that of non-technical training. It is significant and positive in the models of agricultural extension and training as well as technical training, and significant and negative in the models of administrative affairs and office time. This suggests that if there is a mandatory travel policy, agents will allocate more time to agricultural extension and technical training than to administrative affairs and office time.

The Bao Cun cadre system had no impact on agents' agricultural extension time but had a significant effect in increasing their administrative time. The coefficient of Bao Cun cadres is significant in all models except those for

agricultural extension and non-technical training (Table 4). In the administrative affairs model, the coefficient of Bao Cun cadre is 0.111, which is much larger than the coefficient in the training model (0.008). This indicates that an agent who is a Bao Cun cadre may spend more time on technical training compared with other agents and even more time on administrative affairs.

5.4 The impact of agriculture-GDP ratio on agents' agricultural extension time

The coefficient of agriculture-GDP ratio is statistically significant in all models except administrative affairs (Table 4). It is positive and significant in the models of agricultural extension and training as well as technical and non-technical training. It suggests that agents in counties where agriculture drives the economy, and where the need for agricultural extension services is higher, would spend more time on agricultural extension, technical and non-technical training. The agriculture-GDP ratio is negative and significant in the office time model. It is possible that agents who are busy with agricultural extension services and training spend less time in the office. There is no significant difference in the administrative affair model, suggesting that agents in predominantly agricultural counties have a similar administrative burden to those in others.

5.5 The impact of professional designation on office and agricultural extension time

The coefficient of the variable 'professional' is positive and significant in the agricultural extension model, suggesting that professional agents spend more time on agricultural extension services than their non-professional counterparts. Moreover, the office time of professional agents decreased significantly, which leads to the same conclusion. This also indicates that agents' professional competencies motivate them to provide more services to the farmers. The recruitment process of the agents should, therefore, consider whether their area of specialisation is adequate for agricultural extension services, rather than simply transfer agents from other administrative positions.

The coefficient of township-level agents is positive and significant in the agricultural extension and administrative affairs models, and negative and significant in the non-technical training model (Table 4), suggesting that township-level agents spend more time on agricultural extension and administrative affairs than county-level agents but have fewer opportunities to participate in training, although most of it is non-technical.

5.6 The impact of leadership roles and seniority on agricultural extension time

The coefficient of ESC leader is only significant in the administrative affair model, suggesting that ESC leaders spend more time on administrative affairs

(Table 4). On average, ESC leaders spent 17 more days (0.046 × 365) on administrative affairs than non-leadership agents. The coefficient of station leader is insignificant in all models except that of agricultural extension, suggesting that station leaders spend more time on agricultural extension than other agents. On average, station leaders spent 16 more days (0.045 × 365) on agricultural extension than other agents.

The coefficient of senior staff is positive and significant in the agricultural extension time model, and negative and significant in the office and training time models (Table 4). This suggests that senior staff spend more time on agricultural extension than on office hours and training. On average, senior staff spent 34 more days (0.092 × 365) and 24 fewer days (0.066 × 365) on agricultural extension time and office time, respectively.

6. Conclusions and implications

This paper examined whether the latest agricultural reforms in China succeeded in increasing the agricultural extension services available to farmers. Overall, we found evidence that the reforms significantly increased agents' allocation of time to agricultural extension services. Agents' time spent on agricultural extension increased by an average of 56 per cent, from 81 days in 2002 to 126 in 2015. Township-level agents, in particular, spent more than double the amount of time on agricultural extension, with 172 days in 2015 compared to 73 in 2002. We also found that agents allocated less time to office hours in 2015 than in 2002. It is encouraging that agents' allocation of time to commercial activities decreased from 56 days in 2002 to only three in 2015, suggesting that agents have nearly ceased commercial activities. This may be primarily due to the fully funded financial reform.

We also found that before the reforms, township-level agents spent significantly less time on agricultural extension than county-level agents. This changed significantly after the reform, with township-level agents spending significantly more time on agricultural extension than their county-level counterparts. These results suggest that the reforms have solved the problem that township agents, who are supposed to work more closely with the farmers, are not visiting the countryside (Hu *et al.* 2009).

The three major reforms in 2006 (financial assurance reform, 'three rights' management reform and administrative reform) differ in their effectiveness. Our empirical study found no significant difference in agricultural extension time between fully funded and non-fully funded agents, which suggests that after the agents were fully funded by the Government, their incentive to provide services to farmers weakened. However, we found strong evidence that the 2006 'three rights' management reform successfully improved agents' allocation of time to agricultural extension services. For township-level agents, those whose 'three rights' were managed by county-level Governments spent 9.2 per cent more time on agricultural extension services than those managed by township-level agents. This also suggests that an effective

future step will be the promotion of 'three rights' management reform in provinces that have not adopted it yet. The administrative reform, on the other hand, significantly reduced agents' allocation of time to agricultural extension services. It also created more opportunities for agents to participate in training, but further analysis showed that this training was mostly non-technical. Therefore, the administrative reform should be revised to encourage agents to spend more time on providing services to the farmers and provide them increased opportunities for technical training.

In addition to the effectiveness of the three major reforms, we reached three additional conclusions which may inform future reforms to improve the access to agricultural extension services in China and beyond. First, incentive measures did not increase agents' allocation of time to agricultural extension services; the subsidy for rural visits had no effect on agents' time allocation. It should be noted that in most jurisdictions, subsidies are not intended for rural visits by agents, but rather for the welfare of the entire staff. The lack of incentives is, therefore, a problem that must be addressed in future reforms. Second, Government investment had no impact on agents' time allocation; neither the per capita operating budget nor the per capita project grant funding had an effect. These results are similar to those of Hu *et al*. (2009). Third, professional agents spend more time on providing agricultural extension services and less time in the office than their non-professional counterparts. Since the latest round of reform significantly increased the proportion of non-professional personnel (Hu and Sun 2018), in future this could become a problem reducing farmers' access to agricultural extension services. Therefore, local Governments should consider measures to avoid the recruitment of non-professional agents into agricultural extension stations.

Conflicts of Interest

The authors declare no conflict of interest.

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