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# Impacts of accessing extension on agricultural production profit

## Empirical evidence from the Vietnam Access to Rural Households Survey

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**Abstract:** This paper aims to evaluate the impact of accessing agricultural extension on households' agricultural profit. Results from pooled cross-sectional data show that each additional time of access is associated with a 15.5 per cent increase in agricultural profit. However, this relation is not linear and if it exceeds 6 times, it will eventually cause more harm than good. We also construct a household and time-fixed effect model to eliminate the effect of unobserved factors. The local extension service impact on agricultural profit is 15.2 per cent for 2010–12; 19.8 per cent for 2012–14 and 25.5 per cent for 2014–16.

**Keywords:** Agricultural extension, fixed effects

**JEL classification:** A16, C31, C33

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# 1 Introduction

Despite the decreasing trend in the share of agriculture in Viet Nam's Gross Domestic Product (GDP), agriculture is still a key sector in the Vietnamese economy. The share of agricultural GDP in total GDP fell from 18.73 per cent in 2006 to 16.32 per cent in 2016[1], but this sector has still played an important role in ensuring food security, creating employment and income for nearly 50 per cent of the population, reducing poverty, contributing to economic development, and ensuring the political and social stability of the country. Despite suffering from unfavourable conditions, the agricultural sector has reached a relatively high growth rate (an average of 3.68 per cent per year during the 1986-2016 period (General Statistics Office of Vietnam, 2017)) and a high and increasing trade surplus. In 2016, Viet Nam had 10 agricultural products with an export turnover of over US$1 billion per year (rice, coffee, cashew, rubber, tea, fishery…). The value of Viet Nam's agricultural export has increased 10 times from US$2.6 billion in 1995 to US$25.2 billion in 2016 (Vietnam Customs, 2017).

Among contributing factors to the development of the agriculture sector, we cannot fail to mention the significant role of agricultural extension. It helps improving farmers' capacity, agriculture productivity, and environment protection, and contributes to the development of the Vietnamese rural area through the transfer of technical advances and information, knowledge dissemination and skills training (Vietnamese government, 2018). The Vietnamese agricultural extension system was formally established following the Government's promulgation of Decree 13/1993/CP on extension work and this decree has been subsequently amended and renewed to reflect the actual situation of economic development.

International literature has been proving the impact of agricultural extension services on farmers' livelihood. Agricultural extension increases productivity and thus income via direct and indirect channels. First, agricultural extension helps transferring technology advances from research centers to farmers. Second, the local extension staff also collect farmer concerns and report to public agencies. And last but not least, extension programs, even when there is little new technology available, can still help improve farmers' managerial skills Birkhaeuser et al., 1989). Orivel (1981) reviews previous papers and concludes that there is a strong correlation between extension services and agricultural productivity. In a later review, Birkhaeuser et al. (1989) analyse 47 studies undertaken in 17 countries and an international study covering 24 developing countries. 33 over these 47 studies show a significant and positive impact of extension services. Recent studies have also confirmed the positive correlation between getting access to agricultural extension and crop productivity, agricultural profit, household consumption, and poverty reduction (Faruq, Katsushi, & Takahiro, 2013; Dercon, Gilligan, Hoddinott, & Woldehanna, 2009). Pan and Singhal (2015) take another step to explore the relationship between agricultural insurance and malaria in Uganda. Using a regression discontinuity approach, their paper shows that households who were eligible for the government agricultural extension program are 8.8 percentage points less likely to suffer from malaria.

Contrary to the rich literature of the international agricultural extension impacts, there are only few studies on this topic in Viet Nam. Phan (2012) conducted a review on the extension activities in Viet Nam during the 2010–11 period and on the demand for extension services in 2015. He specified that most stakeholders were satisfied with extension services (85 per cent of surveyed farmers were highly satisfied with extension services, 47 per cent of the farmers evaluated that

1 Calculation based on the data of GSO

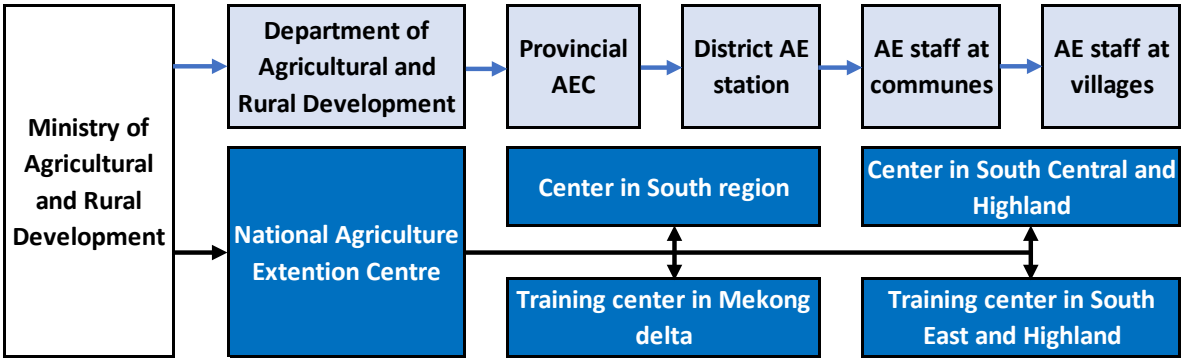
extension information on mass media is effective, and 90 per cent of the farmers applied their learned skills from extensions services in their production). Another research by Do (2014) specified that extension services increase annual income of tea households in the Northern Region of Viet Nam by VND1.2 million (US$60). In general, these studies are only at the regional level or provide a simple evaluation of the impacts of extension services.

This paper aims to fill in this gap by looking for the answer to the research question: "*What are the impacts of agricultural extension on farmers' agricultural production profit in Viet Nam?*" Using the data from the Viet Nam Access to Rural Households Survey (VARHS) and a fixed-effect model, this paper explores the causal effect of agricultural extension on household agricultural profit, taking into account the accumulation of knowedge and heterogeicity of households. This paper is structured as follow, section 2 provides background information on the agricultural extension system in Viet Nam, section 3 describles data and emperical strategies of the paper, sections 4 and 5 present descriptive and emperical results and section 6 concludes the paper.

## 2 Overview of agricultural system in Viet Nam

The Viet Nam extension system was set up from the central to the local levels. At present, all 63 provinces and central cities in Viet Nam have an Agricultural Extension Center (AEC) (or an Agriculture and Fishery Extension Center) under the Department of Agriculture and Rural Development (see Figure 1 below). There are 596 districts and towns with agricultural production (among 955 districts and towns in the whole country) that have an Agricultural Extension Station (or an Agricultural and Fishery Extension Station). At commune level, there are 51 provinces and cities having grassroots extension staff with one to two staff in each commune, and each village has at least one staff in charge in agricultural extension. In addition, there are nearly 700 commune extension clubs with nearly 20,000 participants (NAEC, 2016).

Figure 1: Viet Nam Agricultural Extension Structure




Source: Authors' illustration based on Information from the NAEC (2016).

This far-reaching system is designed to deliver various agricultural extension information, which can be categorized into 6 main topics, including breeding, fertilizer, irrigation, disease, market and credit, through different channels. In 2016, the Agricultural Extension system in Viet Nam published 145,600 extension publications (including leaflets, technical guidebooks, CD) and cooperated with more than 20 mass media organizations to broadcast contents related to the Agricultural Restructuring Plan and the New Rural Development Program on TV, radio, newspapers, websites and local speakerphones. In 2016, 567 national extension staff and 9,900 local extension staff received official training and 6 "cross farm visit" were organized to improve capacity of the extension system. Apart from these indirect channels, local extension staff might

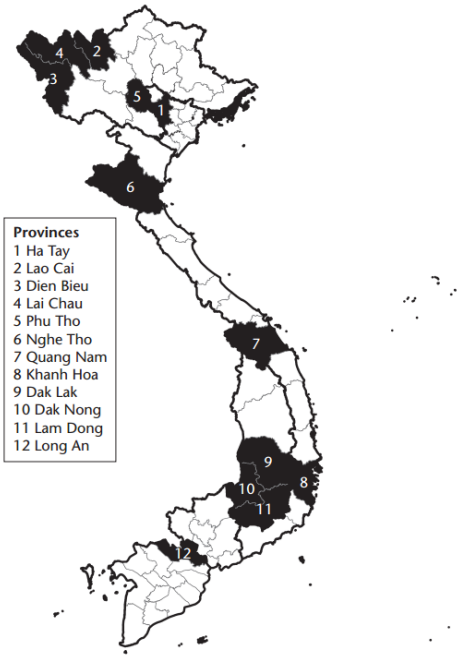
also visit farms directly to give consultation on new agricultural products/techniques, investigate potential diseases or provide information.

Despite these achievements, the extension system of Viet Nam still has certain limitations. The content of extension activities as well as support policies are not distinctive among beneficiaries and each target group. This leads to extension services being implemented in a top-down manner, not stemming from practical needs (Duong, 2013).

## 3 Data and empirical strategy

### 3.1 Dataset

This paper uses the data form the Viet Nam Access to Rural Households Survey (VARHS) in the 2010, 2012, 2014 and 2016 waves[2]. The survey was conducted every two years with the participation of more than 2000 rural households in nearly 500 communes, in 12 provinces in Viet Nam (as can be seen from the VARHS report map. The survey provides various information at the household level, member level or land plot level.



Source: Tarp (2017)

The VARHS has throughout been targeted at gathering high quality data about issues such as saving, investment, land use, interaction with formal and informal markets, and participation in rural institutions and rural social structure. More specifically, the VARHS includes an extensive number of ethnic and rural poor households that have been relatively excluded from traditional growth processes.

As we only focus on the impacts of agricultural extension, therefore, we only look at households with an agricultural income that accounts for at least 5 per cent of their total income, these household accounted for about 13.19 per cent of the total sample. To include households with too small a fraction of agricultural profit will cause bias because their behaviour is different from other households which take agricultural production as a main livelihood. The structure of data from the 2008 survey is different from the following rounds and does not have the necessary variables, therefore, it was excluded from our sample.

Apart from the household level data, we also collect data on variation of weather from the Viet Nam General Statistics Office (2017), including the rainfall and temperature at provincial level in accordance with each survey round.

[2] VARHS was a survey conducted in cooperation between University of Copenhagen (Denmark); Central Institute of Economic Management (of Ministry of Planning and Investment); Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) of the Ministry of Agriculture and Rural Development (MARD) and; Institute of Labour Science and Social Affairs (ILSSA) of the Ministry of Labour, Invalids and Social Affairs (MOLISA).

### 3.2 Addressing reverse causality and selection bias

Our main purpose is to analyse the impacts of extension services on farmers' agricultural production profit. The first thing we need to address is reverse causality (endogeneity), which answers the question: Do richer households have more access to extension services than poorer households? Our preliminary results show a mixed picture.

As mentioned in the previous section, the vast majority of extension services in Viet Nam are provided by the government, which are free of charge. Therefore, theoretically, income would not be a factor that affects households' ability to access extension services. However, there are still some factors that maybe more favourable for richer households to access extension services, such as farmer's education, relationship with agricultural extension, access to credit, farm size, assets … which have been specified in many previous studies (Bravo-Ureta, B.E., and A.E. Pinheiro, 1993).

In the case of Viet Nam, these factors could be the distance from households to the commune center, where most extension services take place[3] or the fact that richer households are more likely to have a motorbike, which makes it easier for them to access extension services[4]. Another possible explanation is that richer people have better connections with government staff, and we assume that friends/relatives of government officers are more likely to be invited to the agricultural extension meetings[5].

However, one might argue that poorer households rely on agricultural production more than richer households[6], and therefore, they have a greater incentive to participate in an extension meeting and communicate with extension staff. We did a simple test on the relationship between households' income and whether they have access to extension services. The results show that there is no significant difference in terms of total households' net income, but there is a significant difference in their real agricultural profit (at 1 per cent significant level).

The second constraint of this research is that this is neither a randomized experiment nor a natural experiment. There are government extension staff in most of the communes in Viet Nam and except for some very specific cases, every farmer can get access to these services. For that reason, we cannot reject the hypothesis of selection bias, in which the characteristics of households who have access to extension services are different from those who do not.

To settle these problems, some different methods were used. Firstly, we control for those observable characteristics that can explain the households' ability to access extension services. Secondly, we use the fixed-effect model to control for any unobservable characteristics of households which are not changing over time. We also use the time-fixed effect to control for factors that are changing over time and constant between different households.

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3 On average, this distance of the richest quintile is 2.1km while it is 2.5km for the poorest quintile.

4 Only 54.4 per cent of the poorest income quintile have a motorbike, while more than 95 per cent of the richest quintile have at least 1 motorbike.

5 Our analysis shows that 30.6 per cent of the people in the richest group have a friend or relative or household member who are government staff. This number is 15 percentage points higher than those who are at the lowest income group.

6 On average, the proportion of agricultural income is 42.1 per cent for the poorest group and 33.4 per cent for the richest group.

### 3.3 Identifying outcome variables

Before going to the detailed model, we would need to define outcome variables and the treatment variable. Conventionally, other authors use the log of households' income per capita as the main dependent variable (Urgessa, 2015). Other research also uses households' agricultural income per capita as an outcome indicator (Betz, 2009; Catherine Ragasa et all, 2016) However, according to our calculation based on this dataset, on average, households' income from agriculture only accounts for about 30 per cent of their total income. Besides, in many households, only some labour participated in agricultural activities. Therefore, measuring agricultural profit per capita would under-estimate the impacts of the change in the agricultural profit.

Therefore, we would use the log of real households' agricultural profit as the main outcome indicator. As most agricultural extension activities focus on crop production and livestock-raising as well as the small proportion of households engaged in aquaculture and forestry production (7.6 per cent and 2.4 per cent respectively), we would focus on the crop and livestock production to avoid bias and outliner in our sample. In the following part of this paper, we will refer to profit from these two activities as agricultural profit.

### 3.4 Addressing accumulation of knowledge

The second challenge of our paper is to identify the treatment indicator, due to the rich information of the dataset on households' access to extension services. The most straightforward way is to use the dummy variable: "*Over the last 12 months, has anyone in your households visited an agricultural extension agent or attended a meeting to seek advice or obtain assistance on growing crops or raising domestic animal*", which is similar to (Patcha Sattaka, Somsri Pattaratuma, Ganjanes Attawipakpaisan, 2017). On the one hand, this approach is easy to measure and analyse, but on the other hand, it lacks measurement of frequency. Data show that the number of meetings between households and agricultural extension staff (including times when a household' member goes to meetings or extension staff visit households) ranges from 0 to 57 times per year. And using one dummy variable means households who meet extension staff 1 time per year is treated like households who visit 57 times per year, which is improper. Therefore, "*number of time that household member meets extension staff*" could be a potential treatment indicator (Patcha Sattaka, Somsri Pattaratuma, Ganjanes Attawipakpaisan, 2017).

Our next hindrance is to address the problem of knowledge accumulation. We use households' data for 4 survey rounds, including 2010, 2012, 2014 and 2016. If households access extension services in 2014 and do not get access to extension services in 2016, a rational explanation is that they have acquired enough information and could be working on the application of this information to their production. In such a case, using year 2016 as a year without treatment effect is not reasonable.

On account of the above factors, we finally decided to use 2 variables as treatment variables and 2 different regression models correspondingly.

The first variable is the average number of time that a household member meets extension staff per year (*variable M*)[7]. Our assumption is that it is less likely that households only access extension services during the odd years (when surveys were not carried out) but not the even years (when surveys were carried out). This variable, to some extent, will be able to represent the level of households' access to agriculture extension services and eliminate the bias from knowledge

[7] Equal to (total number of times in 4 rounds of the survey)/4

accumulation. However, as this data is identical for households during all 4 rounds, we would use the data as pooled cross-sectional data with commune-fixed effect to control for any unobserved differences between communes. The equation to estimate the impacts would be:

$$I_{pit} = \beta_0 + \beta_1 M_{pi} + \beta_3 H_{pit} + \beta_4 F_{pit} + \beta_5 W_{pt} + \gamma_c + \alpha_t + \varepsilon_{pit} \quad (1)$$

Where:

$I_{ict}$ is the profit from agricultural production of households *i* in province *p* at time *t*

*M* is Average number of times that a household member meets extension staff per year, this is a constant overtime for each household.

*H* is the vector of household head's characteristics, including gender, age and educational level.

*F* is characteristics of households in general, including: Households' saving and assets; percentage of dependent members; whether any households' member joined a local group or political group; number of people who could help during emergency; whether households have any friends, relatives or members who are government officers; proportion of agricultural income in total income; total agricultural land; share of land that is irrigated by a reliable source (canal).

$W_{pt}$ is variables reflect the variation of rainfall and temperature of province *p* in time *t*, including. This data was obtained from GSO (2017) at province level[8].

$\gamma_c$ is the fixed effect for communes to control for the differences between communes

$\alpha_t$ is the time-fixed effect to control for unobserved factor that is changing over time but similar between households (government policy, exchange rate, crisis …)

The most important factors that can affect households' agricultural profit that are changing over time and different between households - which can cause omitted variable bias - are the development of the irrigation system and the weather conditions[9]. To control for the development of irrigation system, we include variable "Proportion of households' agricultural land that is irrigated by a canal" [10]. To control for the different weather conditions, we include the variation of rainfall and variation of temperature.

Nonetheless, one might argue that the impacts of "number of times households meet agricultural extension staff" on households' income is not a linear relationship. This is a valid argument because it takes a lot of time to absorb new knowledge and techniques. Therefore, only meeting agricultural extension staff 1-2 times does not make much difference to households' production, or even, make them worse off given the wasted time. To test this hypothesis, we come up with a polynomial form of the treatment variable M. The equation for this is:

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8 There is only data of 15 Hydro-metrology Data Collection Points in Viet Nam. Some of the provinces do not have a data collection point so we use data of their neighbour province, assuming that the variation of weather is identical in the same ecological region.

9 These two variables have a strong effect on agricultural productivity, hence, affect household's income.

10 We ignore the other sources, such as dig well, drilled well, river, spring… because they are less likely to change over time.

$$I_{pit} = \beta_0 + \beta_1 M_{pi} + \beta_1 M_{pi}^2 + \beta_3 H_{pit} + \beta_4 F_{pit} + \beta_5 W_{pt} + \gamma_c + \alpha_t + \varepsilon_{pit} \quad (2)$$

Where $M_{pi}^2$ is the squared of average number of times that households' member meets extension staff per year.

### 3.5 Addressing heterogenicity of households

Using the number of times households participate in meetings/workshops or have extension staff visit is a measure to address the accumulation of knowledge, however, it does not help to address the difference in characteristics of the treatment and control group. Besides, this variable does not actually represent the importance of this connection to households' production. There is a chance that households go to meetings/workshops only to find these meetings/workshops are not related to their production. Therefore, we come up with another variable that indicates "*Whether households have received assistance/information from extension services and whether it affects their production decisions"* (variable *A*)[11]. This is a combination of two factors, including (i) households obtain assistance or information on new seeds, varieties or breed, use of fertilizer, irrigation, pest infestation and animal livestock diseases from agricultural extension agents or meetings and (ii) this information/assistance has a strong influence on households' crop or livestock production activity. To reduce the effect of knowledge accumulation, we would compare households who have received the treatment effect in one round but did not receive treatment effect in the previous round and households who did not receive treatment effect in both corresponding rounds. We would run three separate regressions for three different periods, including 2010–12; 2012–14 and 2014–16. For example, for the period 2010–12, households who received assistance/information from extension services and it affected their production decision in 2012 and did not receive assistance/information from extension services in 2010 would be considered a treatment group. Households who neither receive assistance/information from extension services or this assistance/information does not affect their agricultural production decision in 2012 nor 2010 would be considered a control group. The explanation of these groups is illustrated in Table 1.

Table 1. Description of panel design

| Period | Group | Whether households have received assistance/information from extension services and it affects their production decisions | | | |
|---|---|---|---|---|---|
| | | 2010 | 2012 | 2014 | 2016 |
| 2010-2012 | Treatment | No | Yes | | |
| | Control | No | No | | |
| 2012-2014 | Treatment | | No | Yes | |
| | Control | | No | No | |
| 2014-2016 | Treatment | | | No | Yes |
| | Control | | | No | No |

Source: Authors' own.

The equation for this variable is:

$$I_{pit} = \beta_0 + \beta_1 A_{pit} + \beta_2 H_{pit} + \beta_3 F_{pit} + \beta_4 W_{pt} + \gamma_i + \alpha_t + \varepsilon_{it} \quad (3)$$

The difference between equation (3) and equation (1) and (2) is that the treatment variable A varied over time, therefore, it is possible for us to include entity-fixed effect ($\gamma_i$) instead of commune-fixed effect. This model is not as good as the model in equation (1) and (2) at addressing knowledge

11 Similar to income, we would only keep information/assistance that related to household crop and livestock production and affected their crop/livestock production decision.

accumulation, but it is better at controlling for any factors that may differ across households which are constant over time.

After the regression, we also construct a test to examine the parallel trend assumption between the treatment and control group by conducting the same regression in equation (3) with the same treatment effect. However, we replace households' agricultural profit by their income from other sources, such as fishery and wage[12]. If the trend is similar (parallel), there would be no significant difference in the outcomes of these two groups and we can reject the hypothesis that there is an unobserved factor that is affecting both treatment variable and outcome variables that are changing over time.

# 4 Descriptive analysis

## 4.1 Summary statistics of households' extension access

Table 2. Summary statistics of households' access to extension services by proportion

| Year | Percentage of households use extension services (percent) | | | Agricultural extension affects households' decision |
|---|---|---|---|---|
| | Total | Via. Meetings | Via. Visiting of Extension Staff | |
| | (1) | (2) | (3) | (4) |
| 2010 | 47.85 | 43.25 | 12.02 | 17.57 |
| | (49.97) | (49.56) | (32.53) | (38.07) |
| 2012 | 53.15 | 49.22 | 22.37 | 22.32 |
| | (49.91) | (50.01) | (41.68) | (41.65) |
| 2014 | 54.01 | 48.63 | 14.05 | 18.44 |
| | (49.85) | (49.99) | (34.76) | (38.79) |
| 2016 | 44.70 | 40.56 | 16.52 | 11.96 |
| | (49.73) | (49.11) | (37.15) | (32.46) |
| Average | 50.21 | 45.68 | 16.35 | 17.57 |
| | (50.00) | (49.82) | (36.98) | (37.74) |

Notes: Standard errors in parentheses. Column (1) displays the average percentage of households which over the last 12 months, at least one household member visited an agricultural extension agent or attended a meeting to seek advice or obtain assistance on growing crops or raising domestic animals. Columns (2) and (3) are detailed information on whether they get access to extension services through meetings (Column 2) or have extension staff visit their house (Column 3). Please note that they can get access to extension services by both of these measures, so Column 1 is not the total of Column 2 and Column3. Column 4 is percentage of households who get information/assistance from extension services and this information/assistance affects their agricultural production decisions. Number of observations: N2010=1,764; N2012=1,985; N2014=2,007; N2016=1,689

Source: Authors' calculation based on VARHS 2010, 2012, 2014, and 2016

Summary statistics of the treatment variables are displayed in Table 2 and Table 3, in which, Table 2 displays the treatment effect in the form of dummy variable and Table 3 displays them in the form of a continuous variable. As seen in Table 2, on average, about half of the farmers in the sample get access to extension services in all four rounds of the survey. In 2012 and 2014, the percentage of farmers accessing agricultural extension services is higher than in the other rounds, however, the differences are not significant.

Most farmers get access to extension services through meetings or workshops (45.25 per cent), which vary in terms of content, form as well as duration. Regarding content, agricultural extension

12 We also wanted to test for income from forestry but there were not enough observations.

has shifted its focus on improving productivity of the traditional crops and livestock toward high-value commercial crops/livestock, large-scale production and climate-smart agriculture. In terms of form, these could be meetings/workshops at a commune center or village center; field seminar where they show farmers the results of new products/ technologies/ production procedures or it could be a vocational training course for farmers. Depending on the purposes of the meetings/workshops, they can last for a few hours or a few weeks.

Only 16.35 per cent of the farmers had extension staff visit their houses. The extension staff visit farmers' households when farmers need a more specific consultation to implement their knowedge, or more simply, to check for diseases in farmers' crop/livestock.

Despite the fact that about half of the farmers get access to extension services,there is only 17 per cent of them admitting that the information/assistance they got actually affected their production decision. There are several reasons that explain this situation. Firstly, farmers might not have enough resources to put the new knowledge into practice. Most of them require resources, including land, capital, labour and irrigation, which are not always available in all households. Secondly, farmers might not want to change their current farming practices, in cases where implementing new farming practices require less resources[13] but due to risk adversion, they don't want to apply these new practices. The third reason could be because of the weak capacity of the extension staff or the design of these meetings/workshops/visits that make farmers not obtain enough information to understand the new techniques.

Table 3. Summary statistics of households' access to extension services by number of times

| Year | Number of times households get access to extension services | | |
|---|---|---|---|
| | **Total** | **Via. Meetings** | **Via. Extension staff visits** |
| | (1) | (2) | (3) |
| 2010 | 2.40 | 1.85 | 2.23 |
| | (1.65) | (1.24) | (0.98) |
| 2012 | 2.34 | 2.16 | 2.16 |
| | (2.06) | (2.94) | (0.96) |
| 2014 | 2.94 | 2.22 | 2.16 |
| | (2.79) | (1.77) | (0.96) |
| 2016 | 2.43 | 1.60 | 2.20 |
| | (1.73) | (0.93) | (0.97) |
| Average | 2.53 | 1.96 | 2.19 |
| | (2.06) | (1.72) | (0.97) |

Notes: Standard errors in parentheses. Column 1 displays the average number of times households get access to extension services (only among households who have access to extension services; households who do not access extension services are not taken into account). Columns 2 and 3 are the detailed number of times they go to meetings or are visited by extension staff (the calculation is similar, only the average of those who have access to the corresponding measures).

Source: Author's calculation based on VARHS 2010, 2012, 2014, and 2016

Table 3 provides more information on the frequency of participating in meetings/workshops and visits (only for households who have access to extension). On average, the number of these participations and visits is 2.53 times per year, which equals approximately 10 times over 4 survey rounds. The average time they participate in meetings/workshops is 1.96 times while with households who have extension staff visit, the average number of visits is 2.19 times. This is not

[13] For example, 1 Must 5 Reduction and 3 Reductions 3 Gains movements encourage rice-growing farmers to reduce their amount of seedling, fertilizer and chemicals but can still maintain the same yield.

hard to understand because when extension staff paid a visit to households at the implementing period, it requires more contacts than just an introduction period in meetings/workshops.

### 4.2 Summary statistics of households' characteristics

Table 4 presents summary statistics of households in the group who was influenced by extension services and those who were not influenced or do not get access to extension service at all. The results in this table also confirm our previous prediction on the difference between the characteristics of these two groups.

On average, 83 per cent of the household heads in the treatment group are male, which is 7 per cent higher than in the control group. They also have a higher educational level, are more likely to have a motorbike (85 per cent compared to 79 per cent), have more labour (67 per cent of the members are in working age compared to 61 per cent in the control group) and have better social capita (join more groups, have more friends or relatives who can support them during emergencies). This re-enforces our decision to use the individual fixed-effect model to control for these differences.

Table 4. Summary statistics of households

| | Control | Treatment | Difference | P-value |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Whether HH head is male** | 0.76 | 0.83 | -0.07 | 0.000*** |
| **Age of HH head (years)** | 52.27 | 52.70 | -0.43 | 0.183 |
| **Highest general educational level of HH head** | 2.81 | 2.89 | -0.08 | 0.000*** |
| **Money value of all savings today ('000 VND)** | 29,692 | 24,933 | 4,760 | 0.009*** |
| **Money value of all durable goods ('000 VND)** | 36,512 | 30,888 | 5,624 | 0.458 |
| **Have at least 1 motorbike (1=Yes; 0=No)** | 0.79 | 0.85 | -0.05 | 0.000*** |
| **Distance to people's committee (km)** | 2.19 | 2.28 | -0.09 | 0.237 |
| **Percentage of labour (per cent)** | 0.61 | 0.67 | -0.06 | 0.000*** |
| **Number of members in social groups** | 1.85 | 2.19 | -0.34 | 0.000*** |
| **Number of members in political groups** | 1.45 | 1.83 | -0.38 | 0.000*** |
| **Number of people who farmers can borrow money** | 4.34 | 4.66 | -0.33 | 0.032** |
| **Have friends/relatives who are gov. officer (1=Yes; 0=No)** | 1.82 | 1.82 | 0.00 | 0.767 |
| **Have members who are gov. officer (1=Yes; 0=No)** | 1.96 | 1.93 | 0.03 | 0.000*** |
| **Standard deviation of temperature** | 3.57 | 3.53 | 0.03 | 0.352 |
| **Standard deviation of rainfall** | 148.26 | 158.61 | -10.35 | 0.000*** |

Notes: Columns (1) is summary statistics of the control groups, which are households who do not have access to extension services or do have extension services but their information does not affect their agricultural production decisions. Column (2) is statistics of the treatment groups, which are households who seek for information/assistance from extensions services and it affects their agricultural production decisions. Column (3) is the differences between these two group and the significant level of these differences is displayed in column (4). *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level.

Source: Author's calculation based on VARHS 2010, 2012, 2014, and 2016.

# 5 Empirical results

## 5.1 Access to extension and accumulation of knowledge

We started by analysing the impacts of accessing extension services using accumulated variable to households' agricultural profit. Regressions (1) and (2) in Table 5 show that accessing extension services has positive impacts on households' agricultural profits. That means, holding all else equal, each additional time of accessing extension services is associated with a 15.5 per cent increase in their agricultural profit and this result is similar to the Regression (4) without time- and commune-fixed effect. These results are similar to our prediction about the positive relationship between them, where households who have more access to extension services are more likely to apply new technologies and practices. Therefore, for the same production scale (land area), they will earn more profit.

Table 5. Effects of accessing to extension services

| VARIABLES | Log of Income from Agriculture (1) | Log of Income from Agriculture (2) |
|---|---|---|
| Average number of times households access extension service per year | 0.154*** | 0.153*** |
| | (0.028) | (0.027) |
| Constant | 9.153*** | 8.723*** |
| | (0.357) | (0.330) |
| Time-fixed effect | Yes | No |
| Commune-fixed effect | Yes | No |
| Other control variables | Yes | Yes |
| R-squared | 0.252 | 0.211 |
| Number of observations | 1,670 | 1,670 |

Notes: Robust standard errors in parentheses. *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level. Models are clustered at commune level. Table 5 displays results of regression in equation (1) where the treatment variable is in normal form. Column (1) displays results using time- and commune-fixed effect. Column (4) displays the results without time- and commune-fixed effect for comparison. Commune-clustered standard error also tested but it gives similar results. Only coefficient and standard errors of some key variables of interest are displayed. Other control variables are mentioned in the empirical strategy section.. Number of observations=1,670.

Source: Author's calculation based on VARHS 2010, 2012, 2014, and 2016.

We also test for the hypothesis that the relationship between the number of accesses and households' agricultural profit is not linear as in Equation (2), and these results are displayed in Table 6. This table shows a positive coefficient of the treatment variable while the coefficient of its squared term is positive. This means that accessing extension services increases households' agricultural profit at first, but then later decreases their income.

Table 6. Effects of accessing to extension services – Polynominal form

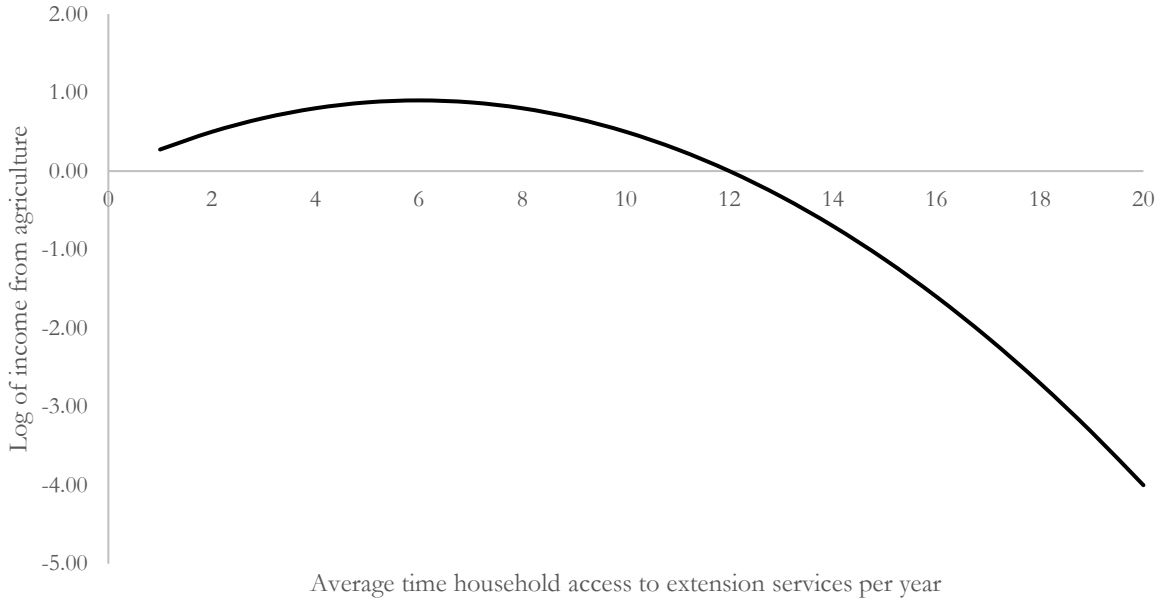
| VARIABLES | Log of Income from Agriculture (3) | Log of Income from Agriculture (4) |
|---|---|---|
| Average number of times households access extension services per year | 0.301*** | 0.306*** |
| | (0.048) | (0.046) |
| Squared of Average number of times households access extension service per year | -0.025*** | -0.026*** |
| | (0.007) | (0.007) |
| Time-fixed effect | Yes | No |
| Commune-fixed effect | Yes | No |
| Other control variables | Yes | Yes |
| R-squared | 0.259 | 0.220 |
| Number of observations | 1,670 | 1,670 |

Notes: Robust standard errors in parentheses. *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level. Table 6 displays results of regression in equation (2) where the treatment variable is in polynomial form. Column (1) displays results using time- and commune-fixed effect. Column (2) display the results without time- and commune-fixed effect for comparison. Only coefficient and standard errors of some key variables of interest are displayed. Other control variables are mentioned in the empirical strategy section.

Source: Authors' calculation based on VARHS 2010, 2012, 2014, and 2016.

This situation is illustrated in Figure 1 below where the curve representing the relationship of treatment effect on households' agricultural profit is concave with the local maximum of 6. That means accessing extension services only has positive impacts when it is less than 6. If households access extension staff more than 6 times per year, each additional time of access will have negative impacts on their agricultural profit. There could be several explanations for these relationships, including: (1) Diseases in crop or livestock: in the case where disease outbreak happens in livestock or crops, households will have to invite extension staff to their house many times to examine and receive treatment; (2) Households just go to extension meetings/workshops to communicate with other households, get a small gift or just simply by curiosity, the more they come, the less time they spend for productive activities. However, in this sample, the proportion of households that get access to extension services more than 6 times/year is just less than 1 per cent.

Figure 1: Relationship between log of income and average number of times meeting agricultural extension staff




Source: Authors' illustration based on regression results.

## 5.2 Effective extension and households' heterogeneity

As mentioned earlier, there are different characteristics between the group of households that access extension services and those which do not. Therefore, in order to eliminate these differences, we use the time and individual fixed-effect model in Formula (3) to estimate the impacts of agricultural extension on household's agricultural profit. We conduct the analysis for 3 periods, including 2010–12; 2012–14 and 2014–16 as shown in Table 7. We believe that our results are unbiased, and the relationship can be interpreted as causal because we have eliminated the unobserved factors which are different between the two groups and constant over time (e.g. whether farmer is hard working or not; quality of their land; …) and factors that are changing over time but similar between these two groups (e.g. economic depression, change in government policies, ….). The most important factors that affect both households' agricultural profit and extension which is changing over time and the difference between households are development of irrigation infrastructure (areas with a better irrigation system are able to produce more types of crop, therefore, they could get better access to extension services) and weather (in the years with extreme weather events, government would organize more training courses to support farmers' mitigation. However, these two variables have already been included in this model.

Table 7. Impacts of agricultural extension on agricultural profit

| Dependent variable: Log agricultural profit<br>VARIABLES | 2010-2012<br>(1) | 2012-2014<br>(2) | 2014-2016<br>(3) |
|---|---|---|---|
| Whether households get information/assistance from extension agent or meeting and it affects their decisions | 0.152*<br>(0.69) | 0.198***<br>(0.076) | 0.255***<br>(0.109) |
| Time-fixed effect | Yes | Yes | Yes |
| Individual-fixed effect | Yes | Yes | Yes |
| Other control variables | Yes | Yes | Yes |
| R-squared | 0.052 | 0.044 | 0.046 |
| Number of observations | 2,306 | 2,845 | 2,823 |
| Number of households | 1,155 | 1,542 | 1,635 |

Notes: Robust and commune clusterted standard errors in parentheses. *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level. Table 7 displays results of regression in equation (3) where we use time- and individual-fixed effect to estimate the impact of being affected by extension services' information/assistance on households' agricultural profit. Column (1) – (3) display results for each period. Only coefficient and standard errors of some key variables of interest are displayed. Other control variables are mentioned in the empirical strategy section.

Source: Authors' calculation based on VARHS 2010, 2012, 2014, and 2016.

The relationship between getting access to agricultural extension and agricultural profit is positive. In all three periods, the results are statistically and economically significant where agricultural profit of households who are affected by extension are much higher than households who don't have access to extension services or whose extension services did not affect their production decision (15.2 per cent in 2010–12; 19.8 per cent in 2012–14 and 25.5 per cent higher in 2014–16).

One might say that households who are affected by extension services might have a higher growth rate of agricultural profit, thus the estimation could over-estimate the impacts of agricultural extension. To rule out the possibility of this un-parallel trend, we examine the impact of accessing extension services by different types of households' income. There are different types of households' incomes in the dataset, including income from crop, livestock, forestry, aquaculture, wage income and other incomes. As our treatment variable is whether households get information/assistance from extension agent or meeting and it affects their crop and livestock production decisions, if there is any unobserved factor that is correlated with being in a treatment group and households' income, we will see a significant difference in the impacts of being in the treatment group on all types of households' income. Otherwise, if the impacts are only significant for agricultural profit, we can be confident that there is no unobserved factor that causes omitted variable bias, and there is a causal relationship between extension services and agricultural profit.

The results are reported in Table 8 where we estimate the impacts of being on treatment group on households' aquaculture and wage income. As predicted, we do not find any statistically significant effect on these types of income. This result rules out the presence of other plausible explanations of our results, and we believe that the relationship is causal.

Table 8. Placebo test on the impact of extension of households' aquaculture and wage income

| | Log of real aquaculture income | | | Log of real wage income | | |
|---|---|---|---|---|---|---|
| VARIABLES | 2010-2012 | 2012-2014 | 2014-2016 | 2010-2012 | 2012-2014 | 2014-2016 |
| Whether households gets information/ assistance from extension agent or meeting and it affects their decisions | -0.252 | -0.354 | N/A | -0.046 | 0.006 | 0.057 |
| | (0.421) | (0.515) | | (0.094) | (0.084) | (0.119) |
| Observations | 233 | 207 | N/A | 1,506 | 1,995 | 2,010 |
| Number of households | 170 | 153 | N/A | 912 | 1,238 | 1,291 |
| Time-fixed effect | Yes | Yes | | Yes | Yes | Yes |
| Individual-fixed effect | Yes | Yes | | Yes | Yes | Yes |
| Other control variables | Yes | Yes | | Yes | Yes | Yes |
| R-squared | 0.221 | 0.303 | N/A | 0.246 | 0.117 | 0.105 |

Notes: Robust and commune clusterted standard errors in parentheses. *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level. Table 8 displays results of regression in equation (3) where we use time- and individual-fixed effect to estimate the impact of being affected by extension services' information/assistance on real households' aquaculture income and wage income. Column (1) – (3) display results for each period. Regression in 2014-2016 period for impacts on real aquaculture income is not proceeded due to the small number of observations. Only coefficient and standard errors of some key variables of interest are displayed. Other control variables are mentioned in the empirical strategy section.

Source: Authors' calculation based on VARHS 2010, 2012, 2014, and 2016.

## 6 Conclusions

The Vietnamese government has specified that agricultural extension is vital to the diffusion of technologies, contributing to poverty reduction and increasing the value in the agricultural sector. Following that viewpoint, the Vietnamese government has established a comprehensive extension system from the central to village level as mentioned in section 1. Besides, in each period, the development orientation of agricultural extension is adjusted according to the requirement of the socio-economic conditions. Specifically, in the current context of international integration and pressures from climate change, the Vietnamese agricultural extension has shifted its focus gradually from increasing quantity to increasing quality and resilience.

Despite the importance of agricultural extension, there was only little research that evaluated the impacts of accessing agricultural extension to household's agricultural profit. Therefore, this paper will contribute to fill in this knowledge gap and provide evidence for the development of agricultural extension.

Our results show that each additional time that holding all else equal, households access extension services (including households going to meetings/workshop and extension staff visiting households) is associated with 15.5 per cent increase in a households' agricultural profit. However, it also shows that this relation is not linear but concave. Too frequent meetings (more than 6 times/year) will decrease households' agricultural profit instead of raising them. This is the result of a model which we set up to address the accumulation of knowledge. In this model, we estimate the impacts of the average times of a household access to extension service per year for the four years of the survey.

We also conducted another regression model to address the heterogeicity of households by controlling for time- and individual-fixed effects. We also use the Local Average Treatment on Treated (LATE) instead of Intended Treatment on Treated (ITT) as in previous model. This means that we only estimate the impact of accessing extension services with households who actually apply the information/assistance of extension in their production at a certain level. The results came out much larger than in the previous model, where the income of households whose production is influenced by extension services is 15.2 per cent higher in 2010–12; 19.8 per cent higher in 2012–14 and 25.5 per cent higher in 2014–16. From these findings, this paper suggests the Vietnamese government in general and the central extension management unit should focus more on the effect of agricultural extension as opposed to the number of extension meetings/workshops that households participate in.

Despite using different techniques to overcome the limitations in data, this paper can only reduce some part of the bias due to knowledge accumulation and the analysis still has a quite strong assumption. In order to truly get rid of this drawback, the questionnaire should be revised to collect agricultural extension in the last two years, leaving no information gap. Another limitation of this paper is the lack of analysis on the mechanism of impacts, or how does agricultural extension help improve farmers' profit.

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