Does Innovation Increase Labor Wage and Boost Firm's Financial Performance? Evidence of Agricultural Firms in Vietnam with Bayesian Approach

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Many studies have agreed that innovation leads to product and process improvements, allows firms to grow more quickly, be more efficient, and ultimately be more profitable than non-innovators. In this study, we explore the impact of innovation (including product innovation, process innovation, organizational innovation, and marketing innovation) on firms' financial performance and employees' wages in Vietnamese agricultural firms. We take a survey from 257 agricultural firms in Vietnam and analyze our dataset with the Bayesian multiple regression approach. Our results show that product, process, and marketing innovations positively affect firms' financial performance, while organizational innovation contributes positively to an increase in average labor wage. These results give some inside implications for firms and the government in distributing resources efficiently for promoting different aspects of innovation.

***Key words*:** innovation; financial performance; labor wage; Bayesian regression.

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1. Introduction

The topic of innovation and its benefits to the firm has attracted the attention of many researchers for a long time. According to Rosenbush et al. (2011), continuous innovation activity is the main source of a long-term firm's success. Firms that fail to engage in innovation are putting themselves at higher risk [Kotler, 2000]. Innovation can bring many benefits to businesses, such as improving productivity, reducing costs, being more competitive, increasing the value of your brand, establishing new partnerships and relationships, increasing turnover, and improving profitability. In contrast, businesses that fail to innovate, take the risk of losing market share to competitors, falling productivity and efficiency, losing key staff, experiencing shrinking margins and profits, and going out of business. However, many other studies argue that innovation is not always good for firms. Demirel and Mazzucato (2012) observe that the positive impact of innovation from R&D on firm growth is highly conditional upon a combination of firm-specific characteristics such as the firm's size, patenting, and persistence in patenting. For small firms, R&D boosts growth for only a subset of firms, particularly those that patent persistently for a minimum of five years. For large firms, on the other hand, R&D may hurt growth, potentially resulting from the low R&D productivity these firms have suffered from since the mid-1990s. These results raise important issues related to links between R&D and a firm's growth (for both small and large firms), as the role of persistence in innovation in boosting firms' performance.

Apart from affecting business, product or process innovation influenced labor productivity and wages, as documented in several studies. Given the links between labor productivity and wages, a likely implication of this positive relationship is that innovation is associated with higher wages in more productive firms. Angelini et al. (2009), while studying ten manufacturing and service sectors in seven European countries (France, Italy, Germany, the Netherlands, Portugal, Spain, and the UK), found the polarizing effects of technological change on wages. According to this study, higher wage polarization was typical in industries where product innovation was intense, and wage compression was associated with the diffusion of new process technologies. Shi and Liu (2021) even pointed to a reverse causal relationship between innovation and wage. Using the data from 37 manufacturing industries in China from 2002 to 2019, this paper shows that increasing wages contribute to innovation, and labor productivity acts as a mediating channel between the former and the latter. Besides exploring the causality between innovation and wages, Cirera and Soares Martins-Neto (2020) point out that firms that innovate already pay higher wages before becoming innovators and increases in wages associated with starting innovation activity. Therefore, in reality, the impacts of innovation on labor wages are still controversial.

Compared to other industries, agriculture is one of the most crucial to the health of an economy. Agriculture is the backbone of a country's economic structure since it produces food and raw materials and employs a sizable portion of the population. However, the relative stagnation of agricultural output in developing nations in recent decades highlights the need for innovative approaches to enhance rural living. Investing in innovations in agriculture can con-

tribute to substantial potential increases in agricultural production and revenue. Therefore, to reduce poverty, fulfill expanding food demand, and cope with the negative consequences of climate change, developing nations must drastically boost agricultural innovation and the technology farmers rely on (World Bank). Agriculture producers may benefit from innovation by increasing production while better managing natural resources. It helps to assure long-term profitability and reduces production's negative environmental consequences, such as pollution and trash.

Vietnam is a country in Southeast Asia having many advantages for developing agriculture. Since the Doi Moi economic reform in the 1980s, Vietnam has transformed from being a nation heavily affected by food shortages to one of the world's leading producers and exporters of many agricultural products, such as coffee, peanuts, and rice. In addition, agriculture has been the largest employer across economic sectors in Vietnam, employing around 18 million Vietnamese in 2020. However, in recent years, the agricultural sector in Vietnam has faced many difficulties. They include climate change, problems of resource use, inefficiency and unsustainability, pressure from foreign competitors, and the need to improve the quality of products to match global standards, etc., that have forced Vietnam's agricultural sector to upgrade. Understanding the role of innovation, over recent years, the Vietnamese government has implemented many policies and incentives to promote the innovation of businesses operating in the agricultural sector. Even though one can claim that innovation is the only way to develop Vietnamese agriculture, no study quantitatively measures the impacts of innovation on the labor wage and financial performance of Vietnamese agricultural firms. This paper attempts to fill the research gap on the relationship between innovation, labor wage, and firm performance by testing the findings of the relevant literature in the context of the agricultural firms in Vietnam.

In this study, we examine the influences of four types of innovation as defined in the Oslo Manual [OECD and Eurostat, 2005], including product, process, marketing, and organization innovations on Vietnamese agricultural firms. Among 400 sent-out questionnaires, we got back 257 valid answers. We use the Bayesian multiple regression models to analyze our dataset, given that the Bayesian estimation method has several advantages compared to the ordinal frequenttist approach. Indeed, 1) Bayesian methods can solve the problem of inference in maximum likelihood computed using numerical Hessians, which are not always very good, and 2) Bayesian estimation can solve the biased parameter values by estimating in conjunction with informative prior distributions. Our empirical results confirm that product, process, and marketing innovations have positive impacts on firms' financial performance, while organizational innovation has led to an increase in average labor wage.

The paper is organized as follows: Section 2 summarizes the relevant literature; Section 3 presents the data and research methodology; Section 4 discusses the findings; Section 5 provides conclusions and some recommendations.

2. Methodology

The Oslo Manual [OECD and Eurostat, 2005] classifies innovation into four includes product, process, organization, and marketing innovations, which are briefly defined below:

- *Product innovation:* A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components, and materials, incorporated software, user-friendliness, or other functional characteristics.

- *Process innovation:* Process innovation assumes a new or significantly improved production or delivery method. It includes significant changes in techniques, equipment, and software.
- *Marketing innovation:* Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing. Marketing innovations are aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, to increase the firm's sales.
- *Organizational innovation:* Organizational innovation is the implementation of a new organizational method in the firm's business practices, internal organization, or external relationship.

Using these four types of innovations, we built an analytical framework as in Fig. 1 below.

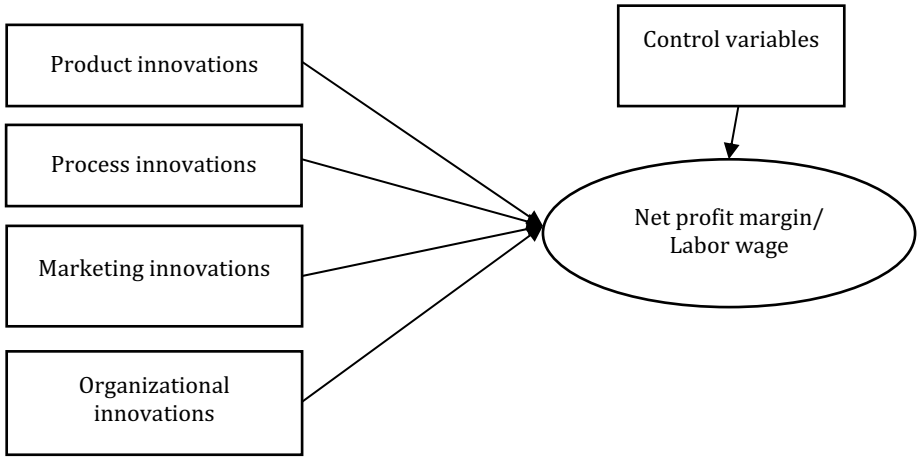

Fig. 1. *Analytical framework*

In this study, we examine the impacts of those four types of innovation on labor wage and financial performance of Vietnamese agricultural firms using Bayesian multivariate regression. Compared with the ordinal approach in estimating multiple regression, the Bayesian estimation method has several advantages. Indeed, Bayesian methods can solve the problem of inference in maximum likelihood computed using numerical Hessians, which are not always very good. Next, Bayesian methods help to relax the assumption of constant variance in the normal disturbances made by maximum likelihood methods, resulting in extended models. On top of that, Bayesian estimation can solve the biased parameter values by estimating them in conjunction with informative prior distributions. Let's consider a general multiple regression:

$$(1) \qquad Y = \alpha + \delta_1 I_1 + \delta_2 I_2 + \delta_3 I_3 + \delta_4 I_4 + \beta_1 X_1 + \ldots + \beta_k X_k + \varepsilon,$$

where Y is the dependent variable (labor wage and firms' financial performance); I_1–I_4 are binary variables for four types of the above-mentioned innovation (that takes value 1 if a firm has innovation and 0 otherwise) with corresponding parameters; X_i ($i = 1,\ldots,k$) are control variables for firms' characteristics with corresponding parameter vector ; and is the error term.

The main difference between ordinal frequentist statistics and Bayesian statistics in estimating parameters of Equation (1) is that Bayesian treats unknown parameters as probability distributions that are to be inferred instead of true values as in frequentist statistics. In Bayesian statistics, probability expresses a degree of belief. Bayes' theorem is used as a tool to update probabilities in the light of new information and is given by

$$p(\theta \mid D) \propto L(D \mid \theta)\pi(\theta), \tag{2}$$

where θ denotes a set of unknown quantities, D denotes observed quantities, $p(\ )$ is the probability density of a probability distribution, and $\propto$ reads as «is proportional to». The posterior probability, $p(\theta \mid D)$, is obtained by updating the prior information, $\pi(\theta)$, with the likelihood, $L(D \mid \theta)$.

In our model, since Y is continuous, we assume that ε is independent, and identically distributed with the Normal distribution: $\varepsilon \overset{iid}{\sim} \text{Normal}(0, \sigma^2)$ where σ^2 is the commonly shared variance of all observations. Let $\theta = (\delta_1, \delta_2, \delta_3, \delta_4, \beta_1, \ldots, \beta_k)'$ is vector of parameters in Equation (1). We use an informative prior, which assumes that the θ's follow the multivariate normal distribution with covariance matrix $\sigma^2 \Sigma_0$ and impose the inverse Gamma distribution to σ^2. Specifically,

$$\alpha, \delta_1, \delta_2, \delta_3, \delta_4, \beta_1, \ldots, \beta_k \mid \sigma^2 \sim \text{Normal}\left((a_0, d_1, d_2, d_3, d_4, b_1, \ldots, b_k), \sigma^2 \Sigma_0\right),$$

$$\frac{1}{\sigma^2} \sim \text{Gamma}\left(\nu_o/2, \nu_o \sigma_0^2/2\right).$$

This gives us the multivariate Normal-Gamma conjugate family, with hyperparameters $a_0, d_1, d_2, d_3, d_4, b_1, \ldots, b_k, \Sigma_0, \nu_o, \sigma_0^2$. For this prior, we will need to specify the values of all the hyperparameters. Since we have little information about the location of the regression parameters in α and θ, we assign the respective prior means to be 0, and the prior standard deviations to be large values, say 20. Similarly, we also assign small hyperparameter for ν_o, σ_0^2 so that $\nu_o/2 = \nu_o \sigma_0^2/2 = 0.001$.

According to the Bayes rule, the joint posterior distribution of α, θ and σ^2 is proportional to the product of the likelihood and the joint prior distribution:

$$p(\alpha, \theta, \sigma^2 \mid Y) \propto \frac{1}{\left(\sigma^2\right)^{(n+2)/2}} \exp\left(-\frac{\left(Y - \alpha - \delta_1 I_1 - \delta_2 I_2 - \delta_3 I_3 - \delta_4 I_4 - \beta_1 X_1 - \ldots - \beta_k X_k\right)^2}{2\sigma^2}\right), \tag{3}$$

However, the joint posterior distribution in (3) is not analytically tractable with respect to drawing inferences for the relevant parameters and hyperparameters. We, therefore, need to extract the marginal posterior distribution of each parameter by integrating other parameters

from the joint posterior distribution. The process of extracting the marginal posterior distribution and Markov Chain Monte Carlo (MCMC) procedure with a Metropolis-Hastings step follows Sinay and Hsu (2014). We implement our estimation process in R software with the package «BAS».

3. Data Description

We examine the impact of four types of innovation as described in Section 2 on Vietnamese agricultural firms' financial performance and labor wage. Agricultural firms are defined as enterprises engaged in the production, processing, marketing, distribution, or exporting of agricultural products. We sent out 400 questionnaires, and the questionnaires were answered by owners or managers. To ensure the representativeness of the sample, companies were selected from different regions in Vietnam. The data collection process was conducted from September 2021 to December 2021. Face-to-face, drop-off, and email methods were employed to distribute the questionnaire, and 257 returned copies were found to be valid. Table 1 below describes the collected variables, their definition, and the summary statistics.

Table 1.

Summary statistics of variables

Variable	Definition	Mean	Std.	Min	Max
	Firms' financial performance				
ROA	Return on assets. Calculated by dividing a company's net profit by its total assets	0.531	0.273	0.001	0.996
The net profit margin	Calculated by dividing a company's net profit by its total revenue	0.263	0.215	0.001	0.828
	Labor wage				
Average wage	Calculated by dividing a company's total paying wage by number of labors by 31/12 of the year. (Unit: Millions VND)	7.555	2.081	4.435	12.786
	Innovation				
Product innovation	Equals 1 if the firm has any activities related to product innovation. Otherwise, equal 0	0.863	0.344	0	1
Process innovation	Equals 1 if the firm has any activities related to process innovation. Otherwise, equal 0	0.710	0.454	0	1
Marketing innovation	Equals 1 if the firm has any activities related to marketing innovation. Otherwise, equal 0	0.719	0.450	0	1
Organizational innovation	Equals 1 if the firm has any activities related to organizational innovation. Otherwise, equal 0	0.492	0.501	0	1
	Control variables				
Firm size	Natural logarithm of total assets. (Unit of total assets: Millions VND)	6.371	1.621	0.909	8.930
Leverage	Total debt / Total assets	0.508	0.274	0.004	0.992
Sales	Natural logarithm of sales (Billions VND)	6.841	3.908	0.170	13.912

4. Results and Discussions

This section reports Bayesian estimation results of multiple regression models. We perform 30000 MCMC iterations in which the first 15000 draws are used as a burn-in process, and we report the next 15000 draws. In Bayesian estimation, we examine the mean (or median) of the after-burn-in MCMC process to conclude about effects of regressors on the outcome. The effects are considered «significant» if the 95% credible interval (from 2.5% to 97.5% percentiles of the MCMC process) does not contain zero. To ensure the MCMC iterations convergence, we implement the Geweke test for each MCMC process using package «coda» in R.

4.1. Impacts of innovations on firm's financial performance

We first examine the effects of innovation on Vietnamese agricultural firms' financial performance via two indicators: ROA and the net profit margin. Table 2 below shows the Bayesian estimations for the dependent variable as ROA, while Fig. 2 illustrates the distribution for the after-burn-in MCMC process for each regressor. Among the four types of innovations, our results confirm the positive effects of the product, process, and marketing innovation on ROA. In contrast, organizational innovation has no effect on the ROA. The Geweke test Z-scores prove the convergence of all MCMC processes.

Table 2.

Bayesian estimation of multiple regression model with dependent variables is the ROA

Variables	Mean	Stdev.	$P_{2.5}$	$P_{97.5}$	Geweke test Z-score
Y = ROA					
Intercept*	0.529	0.013	0.506	0.558	1.023
Product innovation*	0.243	0.039	0.179	0.334	0.894
Process innovation*	0.205	0.030	0.142	0.259	0.639
Marketing innovation*	0.108	0.032	0.038	0.163	–1.038
Organizational innovation	–0.029	0.026	–0.090	0.014	–1.783
Firm size*	0.040	0.009	0.023	0.059	0.682
Leverage	–0.021	0.049	–0.119	0.075	1.849
Sales	–0.001	0.003	–0.008	0.005	1.773

Note: * indicates variables that have «significant» effects on ROA. $P_{2.5}$ and $P_{97.5}$ indicates the 95% credible interval of the after burn-in MCMC process.

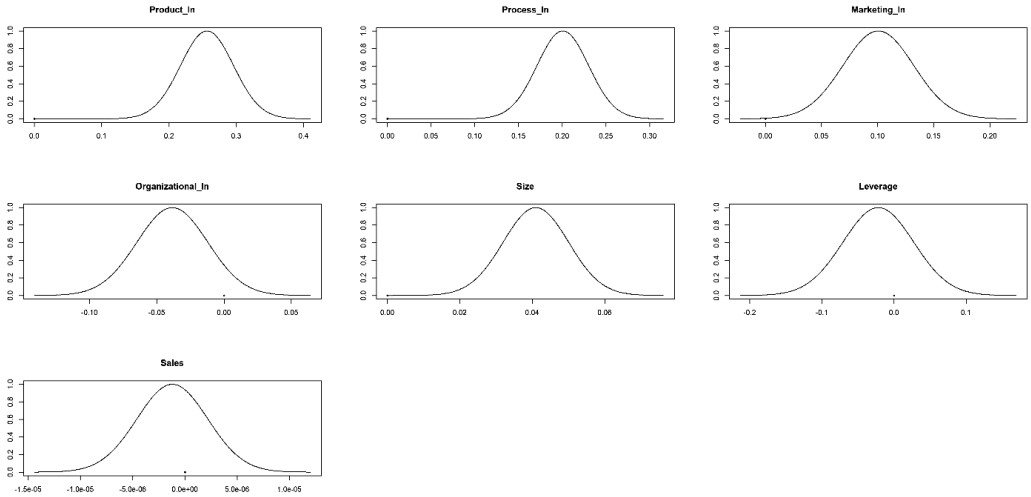

Fig. 2. The distribution of after burn-in MCMC process for each regressors with the dependent variable is ROA

Product and process innovations are closely related to the concept of technological developments, and they are usually significantly correlated to each other Li et al. (2007). Product and process innovation is so important because it can help firms create new spaces in a seemingly crowded market. By identifying the gaps and imposing into a new space, firms can find an audience and satisfy consumer needs in a way, that is new and refreshing. In other words, by incorporating product innovation in business channelization, the firm will have the option to give itself a favorable position over rivals or competitors in the market. This result confirms the findings of Tung (2012) that continuous product innovation increases the capacity of a firm to serve wide-ranging consumer needs, thereby upholding their loyalty. A similar result can also be found in Lin et al. (2013) and Ramadani et al. (2019).

In addition to product and process innovation, innovation in marketing helps to explore new markets, which will ultimately lead to an increase in sales and profitability of the business. Marketing innovations have helped companies compete successfully, and it is no less important than technological ones [Medrano et al., 2021]. Great marketing helps people to get information and be interested in firms' products. Besides, as mentioned in Lee et al. (2019), the relationship between a new product and firm performance is increased with the introduction of marketing innovation.

Table 3 and Fig. 3 below show the Bayesian estimation of the multiple regression model when the dependent variable is the net profit margin. Totally accordance with the results of ROA, we also find out the positive impacts of a product, process, and marketing innovations on Vietnamese agricultural firms' net profit margin.

Table 3.

Bayesian estimation of multiple regression model with dependent variables is the net profit margin

Variables	Mean	Stdev.	$P_{2.5}$	$P_{97.5}$	Geweke test Z-score
Y = the net profit margin					
Intercept*	0.264	0.009	0.246	0.281	–1.723
Product innovation*	0.085	0.027	0.032	0.138	–1.744
Process innovation*	0.058	0.02	0.019	0.098	0.802
Marketing innovation*	0.156	0.022	0.114	0.199	0.542
Organizational innovation	–0.027	0.018	–0.062	0.009	1.804
Firm size*	0.067	0.006	0.055	0.079	0.892
Leverage	–0.043	0.034	–0.109	0.023	1.640
Sales	0.000	0.002	–0.005	0.004	–1.693

Note: * indicates variables that have «significant» effects on the net profit margin. $P_{2.5}$ and $P_{97.5}$ indicates the 95% credible interval of the after burn-in MCMC process.

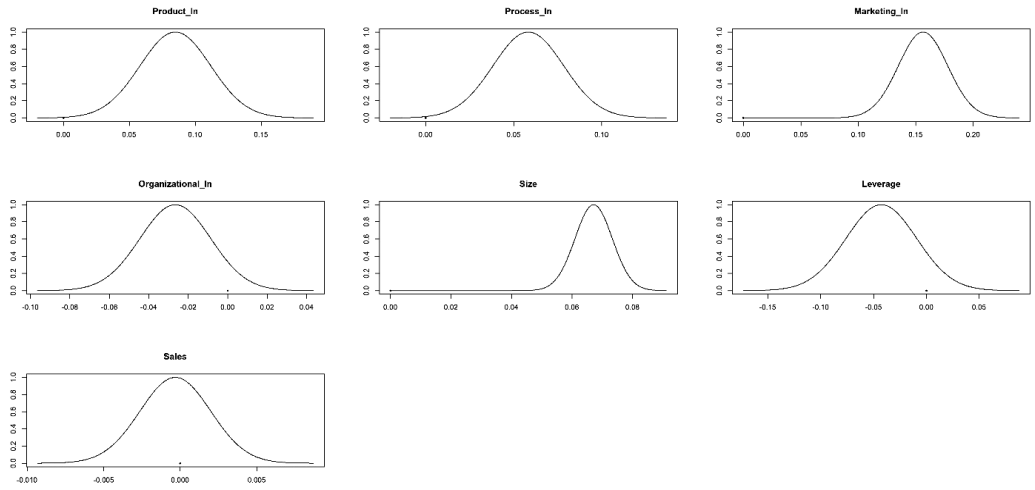

Fig. 3. The distribution of after burn-in MCMC process for each regressors with the dependent variable is the net profit mar

The above results draw some implications for firms to raise their financial performance. First, managers of firms should put additional emphasis on product and process innovations as

they are important instruments for achieving sustainable competitive power. It is important to note that product innovation doesn't always involve the creation of a completely new product that addresses a completely new issue. Product innovation may happen when firms improve an existing product or add a new feature to the existing product. Besides, agricultural firms should also allocate more attention to innovations in the marketing avenue apart from solely relying on technological innovations.

4.2. Impacts of innovations on labor wage

To detect the influences of innovations on labor wage, we run a model where the dependent variable is labor wage. Table 4 and Fig. 4 illustrate the Bayesian estimation of our multiple regression. The result shows that organizational innovation is the only type of innovation helping to increase the labor wage in Vietnamese agricultural firms. The Geweke test Z-scores prove the convergence of all MCMC processes.

Table 4.

Bayesian estimation of multiple regression model with dependent variables is the labor wage

Variables	Mean	Stdev.	$P_{2.5}$	$P_{97.5}$	Geweke test Z-score
Y = Labor wage					
Intercept*	7.342	0.113	7.059	7.824	1.402
Product innovation	–0.194	0.374	–0.795	0.414	1.004
Process innovation	–0.340	0.213	–0.836	0.128	1.452
Marketing innovation	0.193	0.243	–0.530	0.403	–1.904
Organizational innovation*	2.402	0.276	2.024	2.870	0.052
Firm size	0.042	0.048	–0.134	0.156	0.590
Leverage	0.134	0.493	–0.735	0.844	–1.894
Sales	–0.012	0.019	–0.064	0.045	1.027

Note: * indicates variables that have «significant» effects on labor wage. $P_{2.5}$ and $P_{97.5}$ indicates the 95% credible interval of the after burn-in MCMC process.

In the equation for wages (the estimation results presented in Table 4), only an intercept and the «organizational innovation» appeared statistically significant, while all other variables were insignificant. At this stage, the authors do not attempt to «improve» the equation and refrain from extensive comments on this result as it may require collecting additional information and a separate study beyond the objectives of this paper. Meanwhile, the result looks well anticipated since the dependence of wages on the firm's financial results may be nearly absent in inelastic labor markets, especially in companies with the dominance of the low-skilled labor force. It is not unusual to see that the bulk of net profit (after tax, debt service payments, etc.) is allocated between beneficiaries as dividends or reinvested.

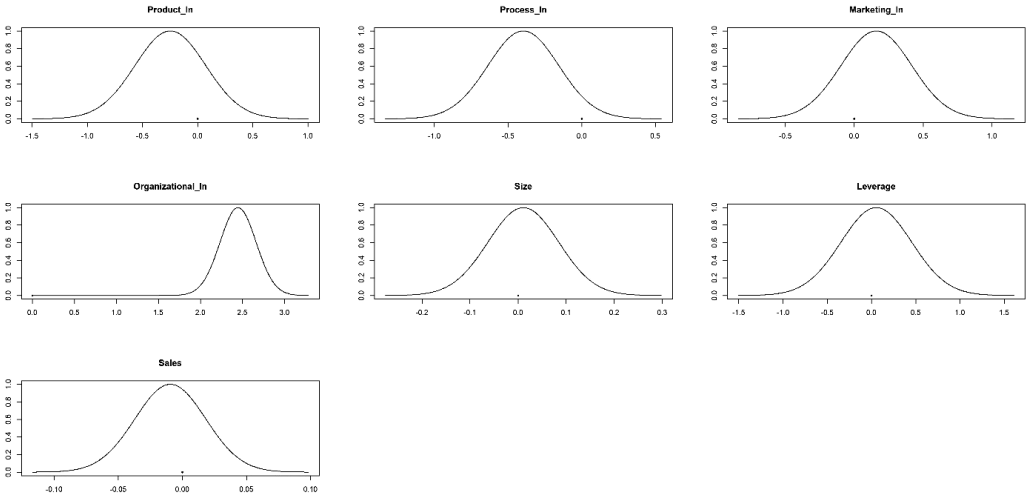

Fig. 4. The distribution of after burn-in MCMC process for each regressors with the dependent variable is the labor wage

Although product, process, and marketing increase agricultural firms' financial performance, organizational innovation is the only type of innovation that helps to boost labor wages. Organizational innovation is the implementation of a new organizational method in the firm's business practices, workplace organization, or external relations. Organizational innovations in the workplace involve the implementation of new methods for distributing responsibilities and decision-making among employees for the division of work within and between firm activities, as well as new concepts for structuring activities, such as the integration of different business activities [OECD, 2005]). By re-distributing responsibilities and decision-making among employees, organizational innovation could help to enhance productivity and thus boost the average labor wage.

5. Conclusions

Agricultural firms play an important role in Vietnam for their contribution to food security and employment. In the new era, innovations support agricultural firms' sustainability since they help firms to maintain a competitive edge in increasingly competitive global and regional markets. However, literature remains limited about the impact of each innovation type (product, process, marketing, and organizational innovations) on firms' financial performance and labor wage in the agricultural area. This study aims to contribute to the literature concerning the gaps mentioned.

Using data from 257 valid questionnaires, we analyze our dataset with Bayesian multiple regression models. Our results show that product, process, and marketing innovations have positive impacts on firms' financial performance, while organizational innovation has led to an increase in average labor wage. These results give some inside implications for firms and the government in distributing resources efficiently for promoting different aspects of innovation.

First, managers of firms should put additional emphasis on product and process innovations as they are important instruments for achieving sustainable competitive power. Second, agricultural firms should also allocate more attention to innovations in the marketing avenue apart from solely relying on technological innovations. Lastly, organizational innovation such as re-distributing responsibilities and decision-making among employees could help to enhance productivity and thus boost the average labor wage.

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