THE IMPACT OF TECHNOLOGY ON STRUCTURAL IMBALANCE OF LABOR IN MANUFACTURING INDUSTRY OF VIETNAM

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Abstract

This study aims at pointing out the impact of technology on the imbalance of labor structure in Manufacturing and Processing Industry of Vietnam. Empirical analysis is implemented by using a panel dataset carefully integrated from the annual labor data and value added (VA) data from 2012 to 2018 and the statistic of technology data from 2012 to 2018 of the Vietnam General Statistics Office (GSO). The paper tested the endogeneity in the model, overcame the defects of the model and selected the fixed effect model to assess the impact of external technology acquisition, research and development activities. Imbalance index (d) used to measure the level of structural unbalance of labor in manufacturing Industry of Vietnam. The results show that general technology, including purchasing technology and R&D activities had an effect on d index.

Keywords: *acquisition technology, Imbalance index, R&D activities, structural unbalance of labor and technology*

1. Introduction

The manufacturing industry plays an important role in the development of Vietnam's economy because it always contributes the largest percentage to the country's gross domestic product (GDP). Moreover, the manufacturing industry also contributes a large of VA value and the number of jobs to the economy.

The imbalance in the labor structure is the situation of redundancy labor or labor shortage in some economic sectors in manufacturing and processing industry of Vietnam. Acemoglu and Autor (2011) show that new technologies increasingly substitue routine jobs and tasks in the US. As a result, the demand of middle-skilled and low - skilled people has decreased while the demand of both high-skilled and low-skilled ones has increased. In Vietnam, there is a labor shortage in the industry group using high technology while the industry group using low technology is having serious redundancy.

In term of technology, the different options can be classified according to the importance and level of compromise of technological investments in the firm. Firms can acquire technology by accessing from not only internal sources through efforts R&D activities but also external sources through transfer of technology, technical licensing agreements or import of capital goods (Tambunan, 2009). However, firms cannot afford to develop or create all the strategically needed technologies through in-house R&D activities owing to high risk, high cost, and restricted time (Cho and Yu, 2000; Whangthomkum et al., 2006). Meanwhile, external technology acquisition is the purchase of technology from domestic enterprises, universities or foreign enterprises. This not only helps firms avoid exposure to the costs and risks associated with domestic development (Jones and Jain, 2002), but also deals with customer requirements for timely and better services, to enhance product complexity, and to sustain competitive advantages under further increased competitive pressures (Jagoda et al., 2010).

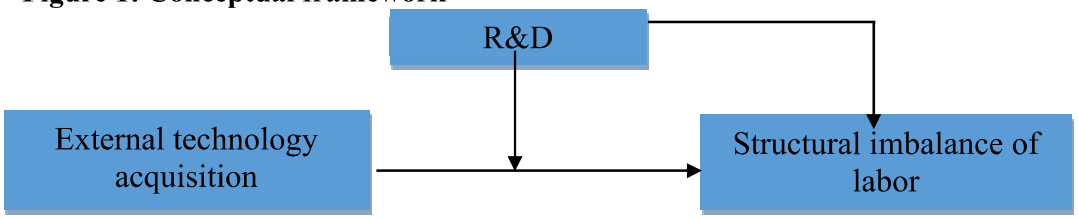
Therefore, in this study, analyze the recent data on technology to show the impact of it on labor structure in Manufacturing Industry of Vietnam. In particular, we propose the effect of external technology acquisition and domestic R&D on the change of the number of labors among economic industries.

2. Method

2.1. Conceptual framework and theoretical prediction

This study evaluates the impact of technology factor on structural imbalance of labor in Manufacturing and Processing Industry of Vietnam with the theoretical framework as shown in Figure 1.

Figure 1: Conceptual framework



The above model shows that structural imbalance of labor is affected by external technology acquisition and internal R&D activities. Moreover, the R&D is also a control variable in the relationship between external technology acquisition and structural imbalance of labor**.** Although domestic R&D activity is not used much by a lot of enterprises and have no meaning in model, we still discuss it as an important issue.

The following section discuss the theory of technology, the theory of the structural imbalance of labor, the impact technology on structural imbalance of labor in manufacturing and processing industry of Vietnam.

2.1.1. The theory of technology

The modern theory of the process of technological change can be traced to the ideas of Schumpeter (1942), who distinguished three steps or stages in the process by which a new technology permeates the marketplace. The first stage is invention – the first development of a scientifically new product or process. The inventions may be patented, though many may be not. Eitherway, most inventions never actually develop into a innovation, which is accomplished only when the new product or process is commercialized and made available on the market. The second step is invention and innovation that carried out in private firms via a process called as "research and development". Lastly, a successful innovation gradually comes to be widely available for use in relevant applications through adoption by firms or individuals, a process labeled diffusion.

2.1.2. The theory of the structural imbalance of labor

The imbalance in the labor structure is the situation of redundancy labor or labor shortage in some economic sectors. In this study, the imbalance between secondary industries in manufacturing industry is considered. However, study aimed considers the difference between industries according to technology level. Therefore, we will focus on assessing the imbalance in secondary industries divided according to using technology level.

2.2. Methodology and data

This section discusses the sample selection procedure, variables selection, the model used for the research and the statistical techniques.

2.2.1. Measures

We use an index to measure the level of structural imbalance from Ando and Nassar (2017). The imbalance is considered by the author based on assessing the balance of productivity in difference group in the overall economy. We suppose that the economy consists of n sectors. VA_s and E_s respectively the value added and the number of employees of the s sector (s = 1,…, n). The meaning of d is as follow:

$$d := \sqrt{\sum\nolimits_s d_s^2} \qquad (3.1)$$

d_s is determined by:

$$d_s := \frac{E_s}{\sum_k E_k} - \frac{VA_s}{\sum_k VA_k} \qquad (3.2)$$

According to (3.2) can be easily switch to (3.3):

$$d_s = -\frac{E_s}{\sum_k E_k}\left(\frac{P_s - P}{P}\right) \qquad (3.3)$$

Overall, d includes both the labor structure and the added value of all economy. d > 0 is labor redundancy, d < 0 is labor shortage.

2.2.2. Sample and Data set

Empirical analysis is implemented by using a panel dataset carefully integrated from the annual labor data and value added (VA) data from 2012 to 2018 and the statistic of technology data from 2012 to 2018 of the Vietnam General Statistics Office (GSO). The static and copper models are estimated based on data collected from 24 industries in the manufacturing sector in Vietnam for the period 2012-2018. It's all 485 observations.

2.2.3. Research model

To consider the factors affecting the imbalance of labor structure, we use this model:

Model 1: Empirical model without interactive variables

$$d_{it} = \alpha_0 + \alpha_1 tech\_vsic_{it} + \alpha_2 patents_{it} + \alpha_3 dactrung_{it} + \alpha_4 Trade_{it} + \alpha_5 LI_{it} + c_{it} + u_{it}$$

Model 2: Empirical model with interactive variables

$$d_{it} = \alpha_0 + \alpha_1 tech\_vsic_{it} + \alpha_2 patents_{it} + \alpha_3 dactrung_{it} + \alpha_4 congnghe*hapthu_{it} + \alpha_5 tlCN\_R\&D_{it} + \alpha_6 Trade_{it} + \alpha_7 LI + c_{it} + u_i$$

Where:

• cit+uit is measurement error that is assumed to have independent distribution. To overcome the regression error according to cross data, the study uses panel data to regress.

• Other variables are explained in Table 1.

Table 1: Description of variables used in analysis

STT	Variable name	Description	Expected dimensional impact
1	**Variable show technology**		
	tech_vsic	External technology acquisiton of enterprises	+/-
	patents	The total number of patens	+/-
2	**Group of interactive variables between technology and absorption capacity: congnghe_hapthu$_{it}$ equal congnghe*hapthu**		
	CN_sxtt	The proportion of technology acquisition if manufacturing machinery is modern	-
	CN_tttt	The proportion of technology acquisition if communication equipment is modern	+

	tlMuaCN_dnnn	The proportion of technology acquisition from state owned enterprise	+
	tlMuaCN_dncp	The proportion of technology acquisition from joint stock enterprise	-
	tlMuaCN_dnFDI	The proportion of technology acquisition from FDI enterprise	+
3	**Interactive variable between muaCN and the moderating role of internal R&D: tlCN_RD**		
4	**Variable show trade technology**		
	Trade	The total of import and export value	-
5	**Interactive variable between muaCN and the structural change of labor**		
	LI	Structural change of labor index	+

3. Results

3.1. Structural imbalance of labor in manufacturing and processing industry of Vietnam

Figure 3.1.1: Proportion of labor and proportion of VA in the industry group using low technology

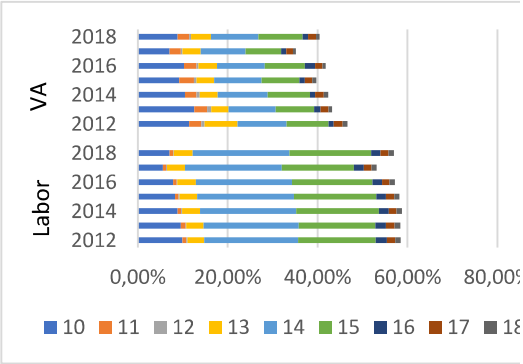
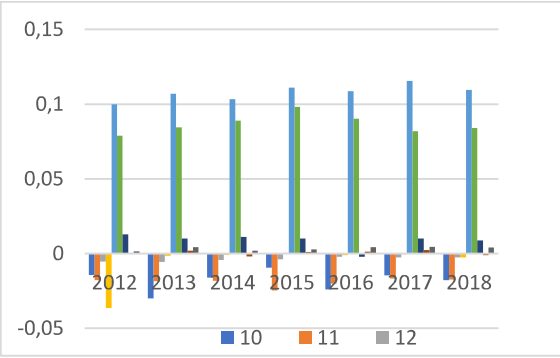


Figure 3.1.2: Imbalance index of the industry group using low technology in manufacturing industry



Source: Author's calculations from the Enterprise Survey data

There are 4 industries using low technology have proportion of labor higher than proportion of VA, including sectors 14, 15, 16, 18. However, there are only sectors 14 and 15 have a serious difference between proportion of labor and proportion of VA. Moreover, it tends to rapidly increase. Sectors 10, 11, 12, 17 tends to reduce both proportion of VA and

proportion of labor. The proportion of VA is also decrease but this change is not as high as the proportion of labor so the proportion of VA is higher than the proportion of labor.

According to Figure 3.1.2, sectors 14, 15 are the most structural imbalance of labor with the most redundant labor. Moreover, it tends to rapidly increase. Sector 16, 17, 18 are also redundant labor but d – index is low. The others are short of labor. Specially in sector 13, is decrease from -0,036 to (2012) to (-0,002) in 2018. The reduce rate is 93,29% in 2018 vs. 2012

Figure 3.1.3: Proportion of labor and proportion of VA in the industry group using high technology

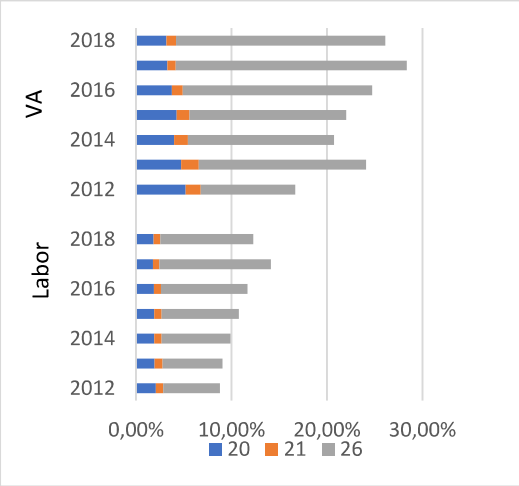
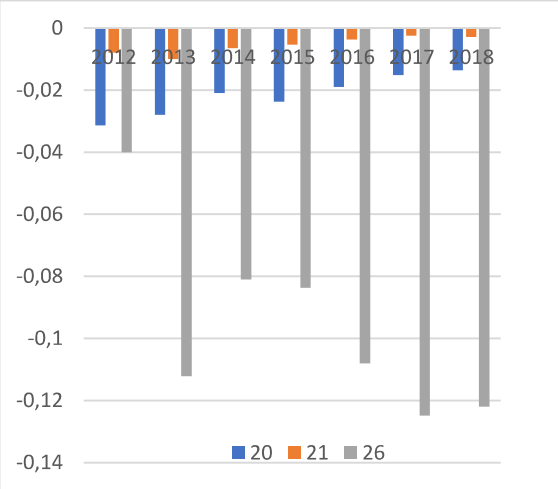


Figure 3.1.4: Imbalance index of the industry group using high technology in manufacturing industry

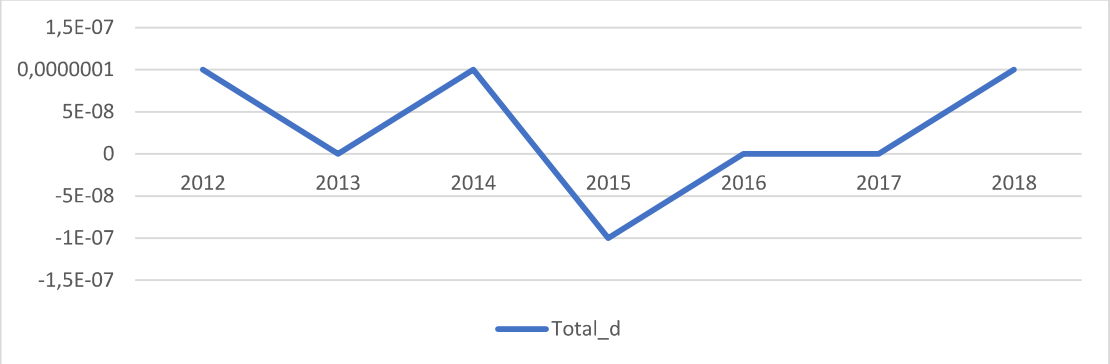


Source: Author's calculations from the Enterprise Survey data

For the industries group using high technology, the proportion of VA is always higher than the proportion of labor. Specially in sector 26, the proportion of VA is rapidly increase about 2,4 times in 7 years. In the opposite, sectors 20 and 21 tends to decrease in both the proportion of VA and the proportion of labor in the research period.

According to Figure 3.1.4, all of sectors in the industry group using high technology fell into the situation of labor shortage. Specially in sector 26, it tends to rapidly increase. d index in sector 26 is increase from -0,04 in 2012 to -0,12 in 2018, increase 3 times in 7 years. Although sectors 20, 21 have d – index < 0, the labor shortage is improving and tending to approach 0.

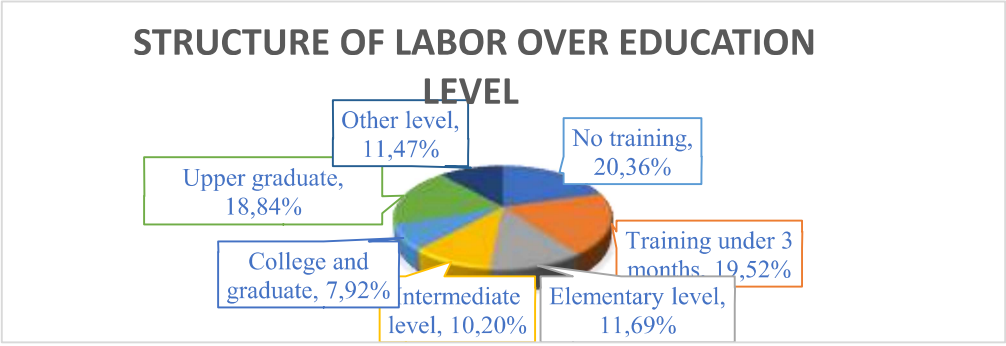
Figure 3.1.5: Imbalance index in manufacturing and processing industry



Source: Author's calculations from the Enterprise Survey data

From 2015, d – index is rapidly increase in manufacturing industry, the industry is more and more fall into redundant labor. The reason of this problem can be explained as: Firstly, labor productivity in manufacturing and processing industry tends to increase. The growth rate of labor productivity in the period 2012 – 2015 is 4,05% per year and reach 5,86% per year in the period 2016 – 2018. Secondly, the industry group using high technology have high labor productivity so that it can improve production efficiency, increase VA value. However, in this group, the labor must have high qualification to operate technology while the qualification of the labor in manufacturing industry is hardly high.

Figure 3.1.6: The labor qualification in manufacturing industry of Vietnam



Source: Author's calculations from the Enterprise Survey data

Thirdly, most of labor in this industry work in the industry group using low technology. Labor productivity is low because the labors have low qualification so the VA value is low.

3.2. Results and discussion

Bảng 3.2.1: Regresion results of the impact of technology on the structural imbalance of labor using SGMM method

	(1)		(2)	(3)
	All_groupSGMM		High tech_grSGMM	Low tech_grSGMM
Tongd1	0.965***		0.923***	0.993
	(0.000)		(0.000)	(0.000)
Tech_vsic	0.0001		0.0002*	0.0001
	(0.423)		(0.091)	(0.185)
tlCN_sxtt	-0.012		0.015**	0.008
	(0.100)		(0.033)	(0.235)
tlCN_tttt	-0.0103		0.006	-0.003
	(0.087)		(0.200)	(0.368)
MuaCNdnnn	0.032**		0.002	-0.0004
	(0.012)		(0.760)	(0.960)
MuaCNdncp	-0.0009		0.011***	-0.002
	(0.866)		(0.007)	(0.553)
MuaCNdnfdi	-0.016		-0.128***	0.001
	(0.292)	(0.000)	(0.893)	
tlCN_RD	-0.007*		-0.007*	-0.006***
	(0.092)		(0.066)	(0.006)
Patents	-2.786		0.0001	-12.93
	(0.998)		(0.945)	(0.967
Trade	-0.002***		0.001*	-0.0008*
	(0.011)		(0.056)	(0.054)
LI	-0.002**		-0.002	0.0009
	(0.027)		(0.168)	(0.308)
Observations	485		54	202
Hausman	0.000		0.000	0.000
Number of instruments	120		54	103
AR1 (p-value)	0.050		0.035	0.106
AR2 (p-value)	0.484		0.723	0.331
Hansen-J test (p-value)	0.191		0.152	0.441

*Notes: '***', '**' and '*' show estimated coefficients statistically significant at 1%, 5% and 10%*

Source: Author's calculations from the Enterprise Survey data

According to test results, the majority of estimated coefficients statistically significant at 1%, 5%, 10%. The estimated results show that the lagged variable is accepted at the 1% significance level.

Bảng 3.2.2. Regresion results of the impact of technology on the structural imbalance of labor using spatial method

(1)	
	All_group
tlCN_sxtt	0.123***
	(0.000)
tlCN_tttt	-0.142***
	(0.000)
MuaCNdnnn	0.006*
	(0.091)
MuaCNdncp	-0.021***
	(0.000)
MuaCNdnfdi	0.012*** (0.002)
Sample size	441
Hausman	0.0000

*Notes: '***', '**' and '*' show estimated coefficients statistically significant at 1%, 5% and 10%*

Source: Author's calculations from the Enterprise Survey data

From the regression results through SGMM method and spatial method in tables 3.2.1 and 3.2.2:

- External technology acquisition has a negative impact on the structural imbalance of labor in the manufacturing industry of Vietnam. Specially in the group industry using high technology. External technology acquisition can improve production efficiency, increase VA value. However, the qualification of the labor in manufacturing industry is hardly high, therefore it is difficult for enterprises to recruit workers. This is the reason why the coefficient of the variable Tech_vsic has a positive value. The variable Tech_vsic is measured through the total value of purchasing technology.

- Group of interactive variables between technology and absorption capacity

The coefficient of the variable tlCN_sxtt has a positive value, which indicates that this variable has a negative impact on the imbalance. That is, technology bought from developed countries will increase the structural imbalance of labor. This can be explained by the fact that Vietnam's labor force is not good enough to absorb this type of technology,

so the number of employees meeting the requirements for this technology is not high, therefore it is difficult for enterprises to recruit workers. The dummy variable tlCN_sxtt represents modern manufacturing machinery, while the variable tlCN_tttt represents modern communication equipment.

In contrast, the variable tlCN_tttt has a positive impact on the structural imbalance of labor. This can be explained by the fact that modern communication equipment such as personal computers and Internet are very popular in Vietnam. Therefore, workers in Vietnam can easily absorb this type of technology.

The coefficient of the variable MuaCNdnnn and MuaCNhnFDI has a positive value, which indicates that this variable has a negative impact on the imbalance. In contrast, the coefficient of the variable MuaCNdncp has a positive impact on the structural imbalance of labor with negative value. The dummy variable MuaCNdnnn, MuaCNdnFDI, MuaCNdncp represent technology bought from state owned enterprise, FDI enterprise, joint stock enterprise.

- Interaction variable between external technology acquisition and research and development activities.

The variable tlCN_RD has a negative coefficient, showing that research and development activities complement the acquisition of technology of the enterprise and decrease the structural imbalance of labor in the use of technology.

Meanwhile, research and development activities are not much developed in Vietnamese enterprises. The number of patents is very low, the proportion of enterprises conducting research and development activities only accounts for nearly 50%, the technology transfer ability of enterprises on R&D products is also very low, including the operation of domestic and foreign transfer (this rate is only about 1%). These may explain why the research and development activities of manufacturing industry don't have much impact on the imbalance of labor structure.

- Group of variables showing the impact of export – import activities

The coefficient of the variable Trade has a negative value, which indicates that this variable has a positive impact on the imbalance. Export activities in manufacturing industry are primarily export product of the industry group using low technology such as wearing apparel or leather and related product. As the results above, this group have low VA in spite of using lots of labor so this is the reason why variable Trade has a positive impact on the imbalance. This result is consistent with the study of Hoang Manh Hung and Nguyen Khac Minh (2018) about the impact of trade openness on structural imbalance of labor.

- Group of variables showing structural change of labor impact on d – index

The coefficient of the variable LI has a negative impact on the imbalance. If the structural change of labor is increase, the structural imbalance of labor will be increase, too.

4. Conclusion

According to the results of regression by SGMM method and spatial method for the whole industry, it can be determined that there are always 10 technological factors affecting the imbalance of labor structure of the industry divided into 4 groups: Group of interactive variables between technology and absorption capacity, Interactive variable between muaCN and the moderating role of internal R&D, trade technology, Structural change of labor within industry

From the above analysis, a number of following recommendations are made. The first and foremost thing is the role of the government in implementing the education and training system that provides the source of qualified workers to meet the labor demand of enterprises. Secondly, the selection of which technology to buy should also be examined to suit the specific conditions of each enterprise. Finally, the government should adopt incentive policies to encourage FDI enterprises to take advantage of their abundant capital to promote research and development activities.

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