Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 8, 4629-4643

# Applying Sgmm Estimation Method To Assess The Impact Of Technological Change On The Imbalance Of Labor Structure: A Study In The Manufacturing And Processing Industry In Vietnam

**Le Van Chinh*[1] , Le Phuong Thao[2] , Nguyen Anh Tuyet[3] , Bui Anh Tu[4] , Nguyen Thi Thanh Huyen[5]**

[1]*Thuyloi University – Email: chinhlv@tlu.edu.vn*
[2]*Thuyloi University – Email: thaolp@tlu.edu.vn*
[3]*Thuyloi University – Email: tuyetna@tlu.edu.vn*
[4]*Thuyloi University – Email: buianhtu@tlu.edu.vn*
[5]*Thuyloi University – Email: huyenntt@tlu.edu.vn*

## Abstract

This study aims to show the impact of technological change on the imbalance of labor structure in the manufacturing industry in Vietnam from the period 2012-2018. The panel data set is integrated from the annual enterprise survey data set and the enterprise technology use data set of the General Statistics Office. Since the current imbalance in the labor structure may have been affected by this situation in the past, the study has assigned a regression model with the SGMM estimation method to assess the impact of changes in employment. Since the current imbalance in the labor structure may have been affected by this situation in the past, the study has assigned a regression model with the SGMM estimation method to assess the impact of changes in employment technology on the imbalance in labor structure. The imbalance index (index d) measures the imbalance of labor structure in the manufacturing and processing industry. The results show that, for the whole industry, the inequality in the past, technology purchased from state-owned enterprises increased the imbalance index. In contrast, the purchase of advanced communication technology, import and export activities of the industry, intra-industry labor restructuring, and technology purchase combined with self-research and implementation reduces the loss index symmetrically. In addition, the results will be different when looking specifically at other groups of industries using different levels of technology, including high-tech and low-tech industries.

**Keywords**: technological change, technology acquisition, patent, imbalance index.

## 1. INTRODUCTION

The manufacturing and processing industry is one of the critical industries. It plays an important role in the development of Vietnam's economy, accounting for the largest proportion of gross domestic product (GDP). Moreover, this industry also creates many jobs for the economy.

Labor imbalance is the surplus or shortage of labor in sectors in the economy. Technological factors can explain this situation. Acemoglu and Autor (2011) show that new technologies increasingly substitute routine jobs and tasks in the United States of America. 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, the industry group using high technology faces a labor shortage while there is a severe surplus of labor in the low-tech industry.

In terms of technology, enterprises can access technology from internal sources through research and development (R&D) activities and external sources through technology transfer, technical licensing agreements, or import means of production (Tambunan, 2009). However, enterprises cannot afford to develop or create all the necessary strategic technologies through internal R&D activities due to high risks, high costs, and limited time (Cho & Yu, 2000; Whangthomkum et al., 2006). Meanwhile, buying technology outside is buying technology from domestic enterprises, universities, or foreign enterprises. This not only helps businesses avoid incurring costs and risks associated with domestic development (Jones & Jain, 2002) but also addresses customer requests for timely and good services more to enhance product complexity and maintain a competitive advantage in the face of increasing competitive pressure (Jagoda et al ., 2010).

With the above issues, it is necessary to study the impact of technological change on the imbalance of labor structure. Especially for Vietnam's manufacturing and processing industry, which attracts the most workers with the advantage of cheap labor; however, the application of technology in production will lead to a change in output and unpredictable dynamics in the industry's workforce. Therefore, this study will analyze the impact of technological change on labor imbalance in Vietnam's manufacturing and processing industry.

## 2. LITERATURE REVIEW

### 2.1. Research on technology factors

Research on technology and its role in affecting business performance have been mentioned a lot.

Some studies suggest that technology has a positive impact on business performance. For example, research by Zahra (1996b) shows that purchasing external technology positively relates to firm performance. In addition, the study by Jae-Seung Han et al. (2012) investigates the positive impact of outside technology purchases on the market value of firms.

On the contrary, some studies suggest that the purchase of external technology hurts the performance of the business. Specifically, Jones et al. (2001) show that technology purchases hurt product development, markets, and corporate finance. Still, internal resources have an additional effect on technology purchases, thereby increasing the performance of the firm's products.

Ki H.Kang, Gil S. Jo, and Jina Kang (2015) suggest that technology acquisition has an inverse U-shaped relationship with technology innovation performance and does not complement the internal R&D activities set. Meanwhile, Williamson (1985) points out the role of external technology purchase on innovation activities and firm performance, whether it can be positive or negative, and the investment. That technology can also supplement or substitute for internal R&D activities.

As such, this section shows the components of technology, including the purchase of external technology or products from R&D. Furthermore, technology acquisition and R&D can have complementary or alternative effects, thereby increasing or decreasing the effectiveness of technology's impact on business performance.

### 2.2. Studies on disequilibrium and the impact of technological change on disequilibrium

Recent articles and studies such as McMillan and Rodrik (2011), McMillan et al. (2014), Timmer et al. (2014), and Vries et al. (2015) use structural transformation indices. Specifically, McMillan and Rodrick (2011) show that changes in overall productivity can be subdivided into productivity changes within industries and changes in the division of labor across sectors (also known as changes in restructuring).

While Duarte & Restuccia (2010); Herrendorf, Rogerson & Valentinyi (2014) show that structural change becomes the fundamental driver for long-term development in advanced economies. However, the studies using the structural change index have not been uniform. Then, Ando & Nassar (2017), when measuring structural deformation: Industry productivity, structural change, and growth, introduced a new index to reflect the degree of disparity between the proportions of labor and capital's share of industry's productivity – the Euclid index.

In Vietnam, Hoang Manh Hung & Nguyen Khac Minh (2018) research has shown several factors such as population size, trade openness, urbanization, or foreign direct investment to the situation imbalance in the whole economy.

Some studies on technological factors to labor, such as Charles et al. (2013); Jaimovich and Siu (2012), argue that technological progress has reduced jobs in manufacturing and increased services. However, Fourastie (1949) argued that the impact of technology on labor shifting from the low-tech sector to the high-tech industry creates high labor productivity. This transformation process changes the added value of drives and the proportion of labor between industries, which can shift the equilibrium in the labor structure.

However, studies that delve into the impact of technological change on the imbalance are scarce. Especially the studies that look specifically at this situation in the manufacturing industry have been divided according to different technology levels. In addition, very few studies approach technology in absorbing external technology or technology obtained from internal R&D activities. Therefore, it is necessary to have more in-depth studies on the impact of technological factors on the labor imbalance in the manufacturing and processing industry in Vietnam.

## 3. METHODOLOGY

### 3.1. Data collection

For the SGMM estimation model, the research is carried out based on the annual enterprise survey data set by the General Statistics Office (GSO) and the survey data on technology use in the production of enterprises in the manufacturing and processing industry in Vietnam during 2013 – 2019 and adjusted for inflation.

In addition, based on the technology classification table from UNSTATS, the UN of the OECD has classified the high-tech industry into two groups: high-tech industries (sectors 20, 21, and 26) and low-tech industries (sectors 10 to 18).

Specifically, the study uses an array dataset including 2,667 businesses over seven years from 2013 to 2019 (with 9,415 observations).

### 3.2. Research data processing

#### 3.2.1. Methods of measuring technological change

The process of technological change in a country can be done in two forms: firstly, developing endogenous technology and a type of created technology called endogenous technology; secondly, the development of exogenous technology, which is called exogenous technology. Endogenous technology is formed from R&D activities, and exogenous technology or buying outside technology.

R&D activities

Endogenous technology is formed from R&D activities including two stages: i) the research stage is formed due to practical needs or as a result of basic scientific research; ii) the implementation phase is the stage where the research results can be applied or not, if not applicable, another type of research must be done.

Based on the European Commission's assessment of technological innovation (2013) and the OECD Science, Technology and Industry scorecard, the study measures new technologies derived from enterprise R&D activities through the number of patents granted by the enterprise, including national and international patents.

Technology Acquisition

While exogenous technology or the purchase of outside technology of the enterprise is shown through the use of technology, production machinery, equipment, and information and communication technology that the enterprise purchases in the course of its operation, production, and business activities. The study uses the investment value of each secondary sector in Vietnam's manufacturing and processing industry to purchase technology, production machinery and equipment, and information and communication technology.

In addition, the role of technological change will differ from the perspective of technology origin and type of technology. First, technology purchased from developed or developing countries will be more suitable, which can promote the ability of industries to absorb that technology. Second, according to technology level, technology includes traditional technology and modern and advanced technology.

Therefore, the study will use the criteria of technology purchase from developed countries and acquisition of modern advanced technology to assess technological change in industries.

### 3.2.2. Method of measuring the imbalance index

We use the index measuring the degree of structural imbalance from the study of Ando and Nassar (2017). The authors consider the inequality here based on assessing the balance in productivity between sectors in the overall economy.

Assume that the economy consists of n industries: $VA_s$ and $E_s$ are the value added and the number of employees of the industry respectively; $s$ $(s = 1, \dots, n)$. The definition of the value of d is as follows:

$$d \coloneqq \sqrt{\sum_s d_s^2} \quad (3.1)$$

Where, the ds is defined by:

$$d_s \coloneqq \frac{E_s}{\sum_k E_k} - \frac{VA_s}{\sum_k VA_k} \quad (3.2)$$

From (3.2) can be easily transformed to (3.3):

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

Thus, index d includes all industries' labor and value-added structure.

### 3.2.3. Model to estimate the impact of technological change on the imbalance of labor structure

To consider the factors affecting the structural imbalance, we designate the model as follows:

$$d_{it} = \alpha_0 + x_{it}\beta' + \alpha_i + \varepsilon_{it} \quad (3.4)$$

In which is the index of structural imbalance of the whole economy or each industry (s); x is the vector of explanatory variables, including some factors affecting the structural imbalance.

Model (3.4) is static; it has not shown the influence of the level of structural imbalance in the past on the inequality at present (if it exists), and the use of technology in the present will continue to be used in the future. Therefore, we continue to consider the dynamic model (3.5), in which the lagged dependent variable appears as the explanatory variable.

$$d_{it} = \alpha_0 + \gamma d_{i,t-1} + x_{it}\beta' + \alpha_i + \varepsilon_{it} \quad (3.5)$$

In which d is the index of structural imbalance of secondary industries or the whole industry, and x is the vector of explanatory variables, including variables showing technological change and some other macro variables. Specifically, the explanatory variables are described in table 3.2 below:

**Table 3.2 : summary of explanatory variable in the model**

| No | Variables | Description | Expected impact direction |
|---|---|---|---|
| 1 | **Technological factors** | | |
| | muaCN | Acquire external technology | +/- |
| | patents | Total number of patents | +/- |
| 2 | **Group of variables interacting with technology factors** | | |
| | t1CN_sxtt | Rate of purchasing advanced production technology | - |
| | t1CN_tttt | Rate of buying advanced communication technology | + |
| | tlMuaCN_dnnn | Rate of technology purchased from state-owned enterprises | + |
| | tlMuaCN_dncp | Rate of technology purchased from joint-stock companies | - |
| | tlMuaCN_dnFDI | Rate of technology purchased from FDI enterprises | + |
| 3 | **Interaction variable between technology purchase factor combined with domestic R&D activities:** t1CN_RD | | |
| 4 | **Technology through commercial activity** | | |
| | Trade | Total import and export value | - |
| 5 | **Interaction variables between technology and intra-industry restructuring** | | |
| | LI | Intra-industry restructuring | + |

Source: Synthesis author

For model 3.5, the presence of a lagged dependent variable will create an endogeneity problem. To deal with this problem, we use the systematic GMM estimate (SGMM) to analyze the results economically.

## 4. RESULTS AND DISCUSSION

### 4.1. The situation of imbalance in labor structure in the manufacturing and processing industry in Vietnam

If the index d is negative in 2016 and 2017, or if the manufacturing industry falls into a labor shortage situation, in most of the remaining years, the index d will be positive, labor surplus in the industry.

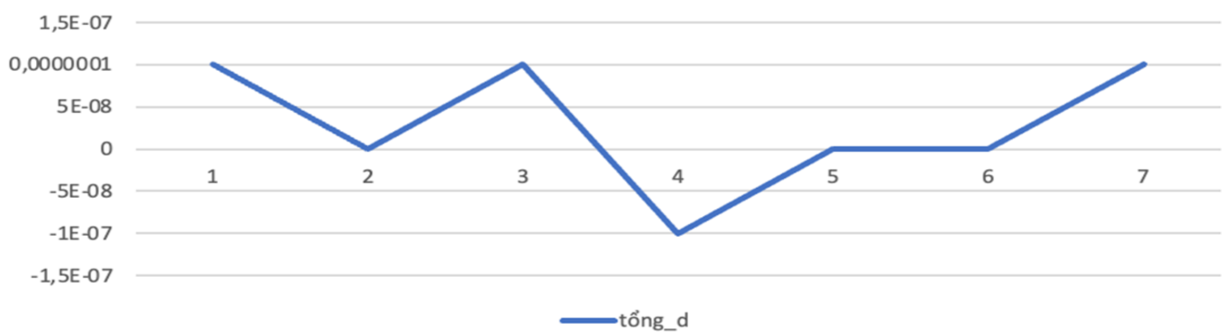


**Figure 4.1 : index of manufacturing imbalance in Vietnam during the study period**

Source: Calculated from GSO's enterprise survey data on technology use

In general, in the manufacturing industry as a whole, the primary trend is labor surplus. However, the imbalance is different when analyzed by technology level.

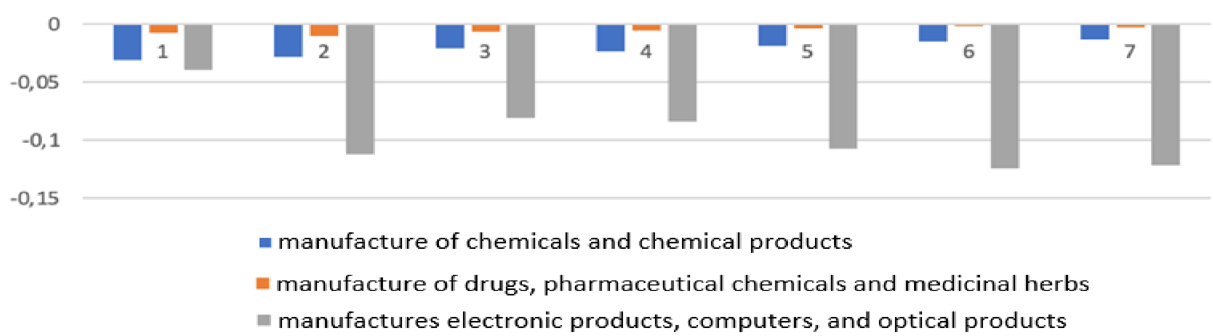


**Figure 4.2: Imbalance index of high-tech industries**

Source: Calculated from GSO's enterprise survey data on technology use

Based on Figure 4.2, it can be seen that the imbalance index of the industry group using high technology always reaches a negative value, showing that this industry group is always in a state of labor shortage. Especially for the manufacturing of electronic products, computers, and optical products (26), the labor shortage is increasing rapidly. In 2019, the imbalance index representing the shortfall increased by 205.05% compared to 2013, a 3-fold increase within 7 years (increased from -0.04 to -0.12). Although industries 20 and 21 still have labor shortages, the level is gradually improving and approaching 0.

This shows that Vietnam's labor level does not meet industries that require high technical expertise to operate and use high technology.

Moreover, purchasing technology from developed countries with high efficiency gradually replaces basic labor in this industry group. As studied in the previous section, although using less labor, with the replacement of high technology, production efficiency is improved, the output value is high, and tends to increase rapidly.

For low-tech industries, key, labor-intensive sectors of Vietnam's industry. This is a group of industries with a labor surplus but low value-added output.

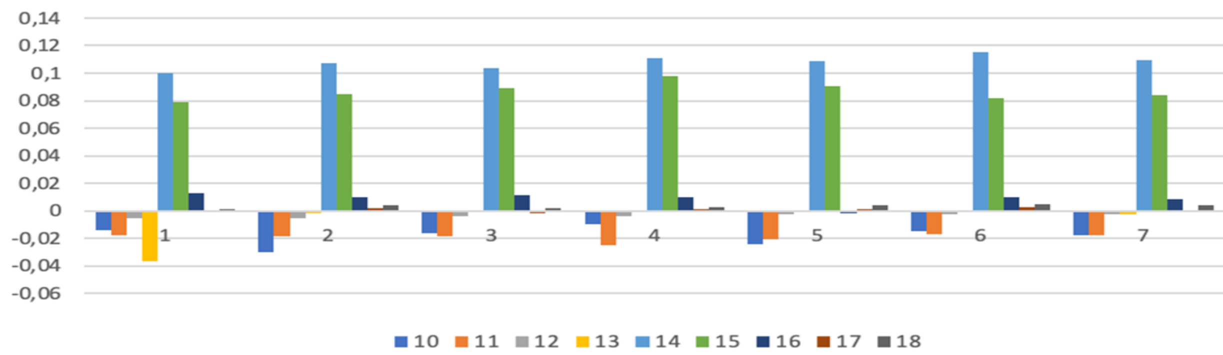


**Figure 4.3: Imbalance index of low-tech industries**

Source: Calculated from GSO's enterprise survey data on technology use

For four industries, food processing (10), beverage production (11), tobacco product production (12), and textiles (13) are very labor-intensive industries. The labor force in the manufacturing industry is abundant, but labor productivity is not high. Moreover, low technology with low utilization efficiency does not entirely replace and support labor, so there is still a labor shortage in these four industries. Still, the level is not high and tends to improve. While sectors 10 and 11 do not have much volatility, sectors 12 and 13 are approaching zero rapidly. Especially, sector 13 has a decreasing shortage to a steady state when it drops from -0.03 to -0.002. The rate of reduction of the original disequilibrium in 2019 of industry 13 was 93.29%.

Sector d indexes 17 and 18 are trending around the equilibrium. Specifically, sector 17 has the highest shortage with d of -0.01 and the highest surplus of labor with a d of 0.01. Sector 18 has always had an abundance of labor but at a low level, with the highest d being approximately 0.04. Generally, these two industries have a relatively stable labor structure.

Sectors 14, 15, and 16 are the three sectors with the largest imbalance. While the d index of industry 16 tends to decrease from approximately 0.012 (in 2013) to 0.008 (in 2019), industry 14.15 tends to increase. Labor surplus is serious in two industries, 14 and 15, when the d index is always high and tends to increase gradually over the years. Specifically, industry 14 had an increase from 0.100 (in 2013) to 0.109 (in 2019), peaking when index d = 0.115 (in 2018). Sector 15 had an increase from 0.078 in 2012 to 0.08 in 2019, peaking in 2016 when index d = 0.098.

Thus, in the industries using low technology, only 4 industries 14,15,16,18 have surplus labor, and the rest are short of labor. However, the majority of employees in the low-tech industry work in industry group 14 (accounting for 21.55% of the total number of employees in 9 low-tech industries in 2019) and industry 15 (accounting for 18.2% of the total number of employees in 9 low-tech industries in 2019), so the labor surplus index in the low-tech industry group is much higher than the labor shortage index. Therefore, the general trend of 9 groups of industries using low technology is labor surplus.

**The reasons for the imbalance in the labor structure mentioned above:**

For the whole industry, the increase in labor productivity causes the demand for labor to decrease, leading to a surplus of labor in the manufacturing and processing industry. From 2013 - 2016, the average growth rate of labor productivity of the whole industry reached 4.05%/year. From 2017 - 2019 reached 5.86%/year, an increase of 1.81% compared to the previous period. Although labor productivity has increased due to low labor skills in Vietnam, the total value of VA has increased slightly. In contrast, Vietnam's population is in a state of the golden population, a productive labor force, so the labor scale is rising. This explains why the increase in labor productivity is why the entire manufacturing industry in Vietnam still has a labor surplus. Moreover, the surplus labor of the industry is mainly unskilled labor with low professional qualifications. At the same time, the shortage of laborers is highly qualified workers, so the imbalance is difficult to compensate for through the shift of labor from low-tech to high-tech industries.

As analyzed above, the industry group using high technology is falling into a shortage of highly qualified workers, while the industry using low technology tends to have a general surplus of labor. The group mentioned two different reasons for this situation for each industry group as follows:

Firstly, the reason for the high-tech group: This is a group of industries mainly using advanced technologies purchased from developed countries with high efficiency, thus creating high productivity in the production, processing, and manufacturing processes, improving production efficiency, and producing high VA values. However, this group of industries uses high technology, so it requires highly qualified workers to operate the technology. In contrast, the current level of labor in the industry has not yet been met.

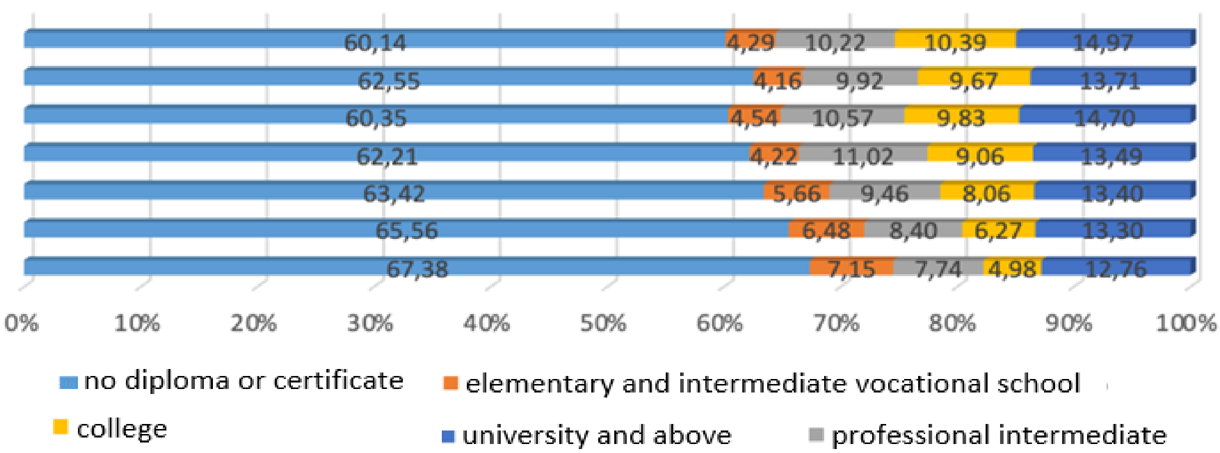


**Figure 4.4: Labor qualifications of workers in Vietnam's manufacturing and processing industry**

Source: Calculated from GSO's enterprise survey data on technology use

Based on Figure 4.4, it can be seen that more than 60% of workers have low qualifications and no certificates. Meanwhile, only 25% of workers have college or university degrees. Although the proportion of workers with college or university degrees tends to increase during the research period, the growth rate is slow at only

2.47%/year. The majority are still unskilled workers.

Secondly, For low-tech industries: Low-tech industries are mainly traditional, labor-intensive industries. The proportion of employees in this industry group is high, mainly unskilled. Low labor productivity combined with low-efficiency technology application, so the VA value of this industry group is not high. The difference when the VA value is low, and the proportion of employees is high makes this industry group redundant with low-skilled workers. Specifically, the majority of workers work in sectors 14 (apparel production) and 15 (leather and related products), while these are two groups with severe labor surplus. The proportion of employees in two industries, 14 and 15, in 2019 was 21.55% and 18.20%, respectively. Moreover, the proportion of employees in these two industries is increasing, while the proportion of VA tends to decrease or still increase slower than the proportion of employees.

The above analysis shows an imbalance in the structure between industry groups in the manufacturing and processing industry. What technological factors are affected by the above inequality? The following content will partly answer this question based on the model estimation results.

### 4.2. Analyze experimental results

The study estimates dynamic models for technological factors affecting the index of imbalance in the labor structure of the entire Vietnamese manufacturing and processing industry according to the SGMM method (results presented in Table 4.1). For the SGMM method, there are 3 models: whole industry model (column 1, table 4.1), industry group model using high technology (column 2, table 4.1), and industry group model using low technology (column 3, table 4.1).

**Table 4.1 : summary of estimation results by SGMM method**

| | (1) Toan_nganhSGMM | (2) CN_caoSGMM | (3) CN_thapSGMM |
|---|---|---|---|
| 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) |
| Số quan sát | 485 | 54 | 202 |
| Hausman | 0.000 | 0.000 | 0.000 |
| Số công cụ | 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 |

Ghi chú: p-values trong ngoặc; * p<0.10, ** p<0.05, *** p<0.01

Source: Author's calculated

According to Roodman (2007), the number of instrumental variables used when estimating SGMM should not exceed the number of groups. The results show that this criterion is always satisfied when the maximum number of tools used for the three models is 120, 54, and 103, respectively, equivalent to the number of groups of 356, 40, and 146, respectively. In addition, first-order correlation is acceptable, but second-order autocorrelation is not. Estimating models meet this requirement when the p-value for AR1 is always very small, and the p-value for AR2 is always more significant than the 10% significance level (the lowest level in the models is 0.331). Hansen-J tested the rationality of the tools used. The p-value of this test in the models is also always more significant than 10% (the lowest level in the models is 0.152), which means that we cannot reject the null hypothesis that the instrumental variables used are reasonable. In summary, the estimated models presented in Table 4.1 are valid.

The estimated results show that the lagged variables of the imbalance index are statistically significant at a 1% level. Thus, the structural imbalance in the previous period will affect the level of inequality in the whole industry in the following period. This result is similar for the group of industries using high technology.

From the estimation results by two SGMM methods in table 4.1, it can be seen that:

For the technology acquisition variable (tech_vsic), the coefficient of this variable in the whole industry and the two high and low industries is positive. The high-tech industry model's coefficient is statistically significant at 10%. This shows that buying technology will increase the imbalance in the labor structure.

### Group of variables that interact with technology factors

Acquisition of advanced technology for production (tlCN_sxtt) increases the imbalance index in the labor structure. Using advanced technology in the production process increases labor productivity, creating high value. However, it needs workers with high professional and technical skills to operate it. This is a limiting factor in Vietnam because Vietnamese workers are mainly simple. Therefore, the use of advanced production technology makes the proportion of VA increase faster while the labor ratio tends to decrease. This creates a labor shortage, which increases the imbalance, especially for the group of industries using high technology. At the significance level of 0.05, purchasing advanced production technology in this industry group will increase the imbalance index by 0.0156.

Meanwhile, acquiring advanced communication technology (tlCN_tttt) reduces the imbalance index in the labor structure. This is significant through the estimation results in both SGMM and spatial methods with 90% and 99% confidence. The reason is that the proportion of workers with college and university degrees in Vietnam and the manufacturing industry accounts for many workers with professional and technical qualifications. The ratio of workers with college and university degrees/the workers with intermediate experienced qualifications/ technical workers is 1/0.18/0.41 in 2019. Therefore, this group of workers can absorb and meet the requirements for this advanced communication technology. As a result, the imbalance in the labor structure is reduced.

Technology acquisition from state-owned enterprises (tlCN_dnnn) increases the imbalance index in the labor structure. This is significant in both estimation methods, with 90% and 95% confidence. According to the SGMM estimation method for the whole industry, using 1 more technology purchased from state-owned enterprises will increase the imbalance index by 0.032.

According to the estimated results, technology acquisition from joint stock companies (tlCN_dncp) will reduce the imbalance in the labor structure. Using one more technology purchased from joint-stock companies will reduce the imbalance index by 0.021 at a 1% significance level for the entire manufacturing industry. However, the results are different for the industries using high technology, when buying technology from joint-stock enterprises increases the imbalance index in the labor structure. With a positive coefficient of the dependent variable at a 1% significance level, using a different technology purchased from joint stock companies, the imbalance index of the high-tech industry group increased by 0.011.

Technology acquisition from FDI enterprises (tlCN_dnFDI) will increase the imbalance index in the labor structure of the whole industry. At a 1% significance level, using one more technology purchased from FDI enterprises will increase the imbalance index by 0.012. However, for the high-tech industry group, purchasing technology from

FDI enterprises reduces the imbalance index in the labor structure. At a 1% significance level, using one more technology purchased from FDI enterprises will reduce the imbalance index by 0.128.

### Technology acquisition activities combined with self-research and development activities of enterprises in the industry

According to the estimation results by the SGMM method, with 90% confidence, the variable tlCN_RD reduces the imbalance index in the whole industry. Using more technology through this activity caused the industry imbalance index to decrease by 0.007. However, the results are different when looking specifically at the industries with high and low technology user groups. Technology purchase combined with self-research and development in the industry reduces the imbalance index. For the industry group using high technology, using one more technology purchased through the above activity will reduce the imbalance index by 0.007 with 90% confidence. Using one more technology purchased through the above action for the low-tech industry group will reduce the imbalance index by 0.006 with 99% confidence. Buying additional technologies for R&D activities of the industry increases the initiative in applying technology in the production process. This factor will reduce the imbalance in the labor structure.

Domestic R&D activity is expressed through the number of patents. The reality shows that this activity in Vietnam has very few enterprises, so the results through SGMM estimation are not meaningful, indicating that the use of technology does not reflect much loss balance in the labor structure of the manufacturing and processing industry.

**Import and export activities of the industry**: The greater the trade openness, the lower the imbalance. For Vietnam's manufacturing and processing industry, the main export items are in the group of labor-intensive industries. As analyzed above, it is labor intensive, but the VA value is not high, thus increasing the imbalance. This result is consistent with Hoang Manh Hung and Nguyen Khac Minh (2018) study on the impact of trade openness on the imbalance of labor structure. According to the estimation results by the SGMM method, if the trade openness increases by 1 unit, the inequality will decrease by 0.002 with 99% confidence.

**The problem of labor restructuring**: The more the processing and manufacturing industry undergo the restructuring of labor, the more the imbalance increases. At the 5% significance level, using more technology from this activity will increase the imbalance index by 0.002. This can be explained by the fact that labor tends to continue to move in the low-tech industry. In contrast, the high-tech industry still attracts very few workers because the level of labor is not a satisfactory timely response to industry requirements. In other words, the surplus labor of the industry is mainly simple labor with low professional qualifications. At the same time, the shortage of laborers is highly qualified workers, so the imbalance can hardly be compensated through the shift of labor from low-tech to high-tech industries.

## 5. CONCLUSION

The study shows that the labor structure imbalance is affected by technological change. The factors affecting reducing the imbalance index are the purchase of advanced communication technology, import and export activities of the industry, intra-industry restructuring, and technology purchase combined with self-research and development activities of enterprises in the industry. Factors that increase the imbalance index include lag of imbalance and technology purchased domestically from state-owned enterprises.

However, due to the characteristics of each industry, there will be differences when considering specifically the group of industries using high technology and the group of industries using low technology. According to the SGMM estimation results, the imbalance index in the high-tech industry is affected by seven factors. The factors that reduce the imbalance index are technology purchased domestically from FDI enterprises; technology purchase combined with self-research and development activities of enterprises in the industry. Factors that increase the imbalance index are lag of imbalance, technology purchase in general, purchase of advanced production technology, technology purchase from joint-stock companies, and import and export activities of the industry.

For the low-tech industry group, the SGMM method shows three influencing factors. Two factors reduce the imbalance index in this industry group: technology purchases combined with self-research and development activities of enterprises in the industry; the industry's import and export activities. On the contrary, the driving factor that increases the imbalance index is the lag of the disequilibrium.

From the above analysis, the following recommendations are made.

Firstly, the role of the government in implementing the education and training system is to provide qualified labor to meet the labor needs of enterprises. At the same time, enterprises must have policies to encourage employees and improve conditions for them to hone their skills in the working process.

Secondly, the choice of which technology to buy also needs to be surveyed to suit the specific conditions of each business.

Finally, the Government should have incentive policies to encourage FDI enterprises to take advantage of their abundant capital to promote research and development activities. Thereby positively impacting the performance of FDI enterprise's businesses and promoting labor restructuring.

## APPENDIX

| VSIC | Industry description | VSIC | Industry description |
|---|---|---|---|
| 10 | Manufacture and processing of food | 22 | Manufacture of rubber and plastics products |
| 11 | Manufacture of drinks | 23 | Manufacture of other non-metallic mineral products |
| 12 | Processing of tobacco product | 24 | Manufacture of basic metals |
| 13 | Manufacture of textiles | 25 | Manufacture of fabricated metal products |
| 14 | Manufacture of wearing apparel | 26 | Manufacture of computer, electronic and optical products |
| 15 | Manufacture and processing of leather and related products | 27 | Manufacture of electrical equipment |
| 16 | Manufacture of wood products except furniture | 28 | Manufacture of machinery and equipment n.e.c. |

| VSIC | Industry description | VSIC | Industry description |
|---|---|---|---|
| 17 | Manufacture of paper and paper products | 29 | Manufacture of Motor vehicles, Trailers, and Semi-trailers |
| 18 | Printing and reproduction of recorded media | 30 | Manufacture of other transport equipment |
| 19 | Manufacture of coke and refined petroleum products | 31 | Manufacture of furniture |
| 20 | Manufacture of chemicals and chemical products | 32 | Other manufacturing and processing industry |
| 21 | Manufacture of pharmaceutical, medical and botanical products | 33 | repair, maintenance, installation of machinery and equipment |

Source: Author's compilation based on technology classification from UNSTATS, UN of OECD

## REFERENCES


1. Acemoglu, D & Autor, D (2011), 'Skills, Tasks and Technologies: Implications for Employment and Earnings', In Handbook of Labor Economics, Vol. 4B, edited by David Card and Orley Ashenfelter, 1043-1171, Amsterdam: Elsevier.
2. Ando, S. & Nassar, K. (2017), 'Indexing Structural Distortion: Sectoral Productivity, Structural Change and Growth', IMF Working Paper.
3. Charles, K.K, Hurst, E & Notowidigdo, M.J (2013), 'Manufacturing decline, housing booms, and non-employment: Technical report', NBER Working Paper, No. 18949, National Bureau of Economic Research.
4. Cho, D. H., & Yu, P. I. (2000), 'Influential factors in the choice of technology acquisition mode an empirical analysis of small and medium size firms in the Korean telecommunication industry', Technovation, 20(12), 691–704.
5. Duarte, M., and D. Restuccia. 2010. "The Role of the Structural Transformation in Aggregate Productivity." Quarterly Journal of Economics 125 (1): 129–73.
6. Fourastié, J. (1949) Le Grand Espoir du XXème siècle. Paris: PUF.
7. Herrendorf, Berthold, Richard Rogerson, and Akos Valentinyi. ´ 2014. "Growth and Structural Transformation." In Handbook of Economic Growth. Vol. 2, , ed. Philippe Aghion and Steven N. Durlauf, 855–941. Elsevier.
8. Hoang Manh Hung, Nguyen Khac Minh (2018), 'The impact of factors on the imbalance of labor structure', National Workshop, (10), 2018.
9. Jae-Seung Han and Sang-Yong Tom Lee (2012), 'The impact of technology transfer contract on a firm's market value in Korea', Springer Science Business Media, LLC2012, pp.651-674.
10. Jagoda, K. B., Maheshwari, B., & Lonseth, R. (2010), 'Key issues in managing technology transfer projects: Experiences from a Canadian SME', Management Decision, Vol 48, No. 3, pp. 366–382.
11. Jaimovich, N. & Siu, H.E., (2012), 'The trend is the cycle: job polarization and jobless recoveries', Technical Report, NBER Working Paper, No. 18334, National Bureau of Economic Research.
12. Jones, G.K., Lanctot Jr., A., Teegen, H.J., (2001), 'Determinants and performance impacts of external technology acquisition', Journal of Business Venturing, 16 (3), 255–283.

13. Jones, M. and Jain, R. (2002), ‘Technology transferfor SMEs: challenges and barriers’, International Journal of Technology Transfer and Commercialization, Vol. 1 Nos 1/2, pp. 146-162.
14. Ki H. Kang, Gil S. Jo & Jina Kang (2015), ‘External technology acquisition: a double-edged sword’, Asian Journal of Technology Innovation, 23:1, 35-52.
15. McMillan, M., and D. Rodrik. 2011. Globalization, Structural Change, and Productivity Growth. NBER Working Paper 17143. Cambridge, MA: National Bureau of Economic Research
16. McMillan, J. M., & Renzaglia, A. (2014). Supporting Speech Generating Device Use in the Classroom. Part Two: Student Communication Outcomes, Journal of Special Education Technology 29(3)
17. Tambunan, T. (2009), ‘Promoting innovation through transfer of technology’, Asia Pacific Tech Monitor, Vol. 26 No. 4, pp. 30-36. Williamson, O.E. (1985), The Economic Institutions of Capitalism, New York: Free Press.
18. Timmer, Marcel P., Erik Dietzenbacher, Bart Los, Robert Stehrer, and Gaaitzen J. de Vries. 2014. “The World Input-Output Database (WIOD): Contents, Concepts and Applications.” GGDC Research Memorandum 144, Groningen Growth and Development Centre.
19. de Vries, G. J, M. P. Timmer, and K. de Vries. 2015. “Structural Transformation in Africa: Static Gains, Dynamic Losses.” The Journal of Development Studies 51(6): 674–88.
20. Whangthomkum, N., Igel, B., & Speece, M. (2006), ‘An empirical study of the relationship between absorptive capacity and technology transfer effectiveness’, International Journal of Technology Transfer and Commercialisation, Vol 5, pp. 31–55.
21. Williamson, O.E. (1985), The Economic Institutions of Capitalism, New York: Free Press.
22. Zahra, S.A., 1996b, ‘Technology strategy and new venture performance: a study of corporate-sponsored and independent biotechnology ventures’, Journal of Business Venturing, 11 (4), 289-321.