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A Study on the Impacts of FDI on Inequality – Using the Spatial Econometric Approach

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Abstract: This study examines the impact of foreign direct investment (FDI) on inequality at the provincial level in Vietnam. The provincial Atkinson inequality index is calculated based on the Vietnam Household Living Standards Survey. Measures of provincial FDI are compiled from the Enterprise Survey dataset. The study finds that FDI can help improve income equality if it takes the form of labor-intensive investment; in contrast, if it takes the form of capital-intensive investment, it is likely to increase inequality. In addition, the study shows that spatial autocorrelation exists in the relationship between FDI and income inequality; therefore, a spatial econometric approach is required to obtain reliable estimates.

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I. INTRODUCTION

Foreign direct investment (FDI) is often pointed out to have a positive impact on growth and to help improve productivity in the host country; however, its effect on income inequality within society has not been much addressed. Many studies argue that globalization—of which the increasing flows of FDI among countries, particularly from developed to developing countries—will further exacerbate income disparities in developing nations. This has been a controversial topic in numerous economic and political debates among countries during negotiations on free trade and investment.

The impact of FDI on inequality is evident not only between countries but also across regions within a single country. However, when examining the impact across regions within a given space, due to the geographical proximity of regions, there may be spillover effects between them in terms of inequality indicator or FDI itself—an interaction less likely to occur when comparing countries. If such correlation among provincial observations does indeed exist, the classical regression method becomes inappropriate, as the assumption of independence among observations is violated. In such cases, it is argued that spatial econometric approaches should be adopted instead to ensure the reliability of estimated coefficients. In this paper, we we will examine the impacts of foreign direct investment on the level of inequality measured by the Atkinson index.

II. THEORETICAL FRAMEWORK

In this section, we will examine issues related to the measurement of variables, or the selection of representative variables that reflect the target of our analysis, and explain the mechanism through which foreign direct investment affects measures of income inequality.

A. Measurements of Inequality

Inequality is a multidimensional concept. This multidimensional nature is reflected in a highly general definition: *"it is a fundamental inequality, whereby one person is given the right to choose while another is not granted the same choices."* These choices, and the factors that allow or prevent them, are multidimensional variables. Such dimensions have been identified in poverty studies, including education, health and nutrition, welfare, power, social status, income or consumption, and assets (Thomas et al., 2001; Deaton, 1999).

This definition also reflects the view that both inequality of opportunity and inequality of outcomes should be considered (Lefranc & Trannoy, 2008). Although many studies focus on inequality of outcomes (since it is more easily observable), it is equally important to understand the underlying factors and processes driving such inequality. Inequality of outcomes is an inherent feature of a market economy—for instance, differences in how individuals seize available opportunities—and uncertainty may also play a significant role. However, a critical component contributing to overall inequality stems from inequality of opportunity, where some individuals are more advantaged or disadvantaged depending on where they live, their parents' circumstances, and other factors.

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The relative importance of these causes of inequality is crucial when considering policy responses. It is also necessary to understand the processes underlying inequality, particularly those that are long-term or intergenerational. Inequality can be measured in several ways.

➢ *Decile Dispersion Ratio*

A simple and widely used measure is the decile dispersion ratio, which is defined as the ratio of the average consumption (income) of the richest 10% to that of the poorest 10%. This ratio can also be calculated for other percentile thresholds (for example, the richest 5% compared to the poorest 5%).

This percentile ratio is relatively easy to interpret, as it shows how many times higher the income of the richest group is compared to that of the poorest group. However, its limitation is that it overlooks information about the income levels of the middle groups in the distribution, and it also ignores the income distribution within the richest and poorest groups themselves.

➢ *Lorenz Curve and Gini Coefficient*

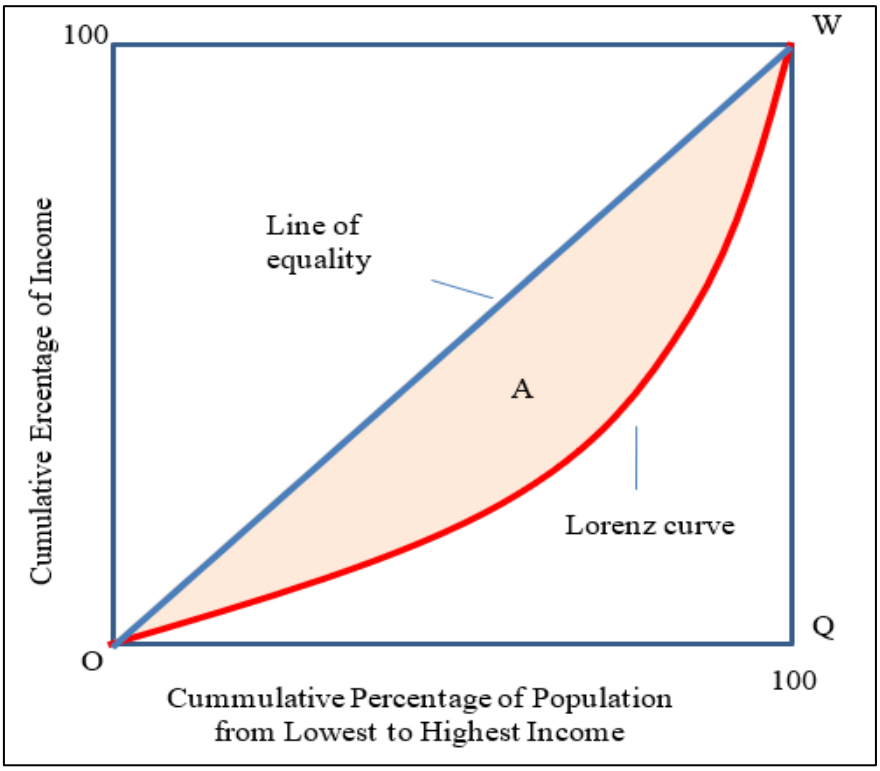

Fig 1: The Lorenz curve

The most commonly used measure of inequality is the Gini coefficient (Gini, 1912). It is based on the Lorenz curve. To calculate the ***Gini*** coefficient, we plot on the horizontal axis x the cumulative percentage of households (from poorest to richest), and on the vertical axis y the cumulative percentage of expenditure (or income). If the Lorenz curve is a diagonal line, the population as a whole has perfect equality.

The Gini coefficient is calculated as the ratio of area A to the area of triangle OQW, and therefore takes values in the interval [0,1]. A Gini coefficient of 0 indicates perfect equality, while a value of 1 indicates absolute inequality.

The formula of the Gini coefficient can be writen as follows:

$$\text{Gini} = 1 - \sum_{i=1}^{N}\left(x_i - x_{i-1}\right)\left(y_i + y_{i-1}\right)$$

In which, x_i denotes the coordinate on the cumulative population percentage axis, and y_i is the corresponding coordinate on the cumulative income percentage axis. In the case where we divide the cumulative population percentage axis into N equal intervals, i.e., $x_i - x_{i-1}$ is the same for all i, and equal to 1/N, then the Gini coefficient can be simplified as follows:

$$\text{Gini} = 1 - \frac{1}{N}\sum_{i=1}^{N}\left(y_i + y_{i-1}\right)$$

➢ *Atkinson Index*

Atkinson (1970) developed another class of inequality measures. This class of measures includes a weighting parameter ε (reflecting the degree of inequality aversion), and some of its theoretical properties are similar to those of the Gini index. The Atkinson measure is calculated using the following formula:

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$$A_\varepsilon = \begin{cases} 1-\left[\dfrac{1}{N}\sum_{i=1}^{N}\left(\dfrac{y_i}{\bar{y}}\right)^{1-\varepsilon}\right]^{1/1-\varepsilon}, \varepsilon \neq 1 \\ 1-\dfrac{\prod_{i=1}^{N}\left(y_i^{(1/N)}\right)}{\bar{y}}, \varepsilon = 1 \end{cases}$$

The Atkinson index is directly related to the social welfare function, that is:

$$W = \frac{1}{N}\sum_{i=1}^{n} U(y_i)$$

Theo Atkinson, the social welfare functions has this form:

$$U(y_i) = \frac{1}{1-\varepsilon} y_i^{1-\varepsilon}, \qquad \varepsilon \neq 1$$
$$U(y_i) = \log y_i, \qquad \varepsilon = 1$$

In which, as mentioned above, ε is the parameter reflecting the aversion to inequality. When ε = 0, we have $U(y_i) = y_i$, that is, the social welfare function is exactly equal to the average income, and therefore any increase in average income will lead to an increase in social welfare.

As the value of ε increases, increases in the income of lower-income groups are assigned greater weight in the social welfare function. Specifically, if we take the first derivative of the social welfare function with respect to y_i, we obtain:

$$\frac{\partial W}{\partial y_i} = \frac{1}{N}\frac{1-\varepsilon}{1-\varepsilon} y_i^{1-1-\varepsilon} = \frac{y_i^{-\varepsilon}}{N}$$

This value is always positive, implying that when a person has a higher income, social welfare increases, and vice versa. Taking the second derivative, however, yields a negative value, suggesting that the increase in welfare diminishes as the income recipient is a higher-income individual, and conversely.

The Atkinson index captures this characteristic. The magnitude of ε determines whether the increase in social welfare is large or small.

The Atkinson index also allows us to identify a threshold income such that, if everyone were to have this same income level, it would generate a level of social welfare equivalent to the current actual income distribution.

For example, in the diagram below, there are two individuals with incomes y_1 and y_2, respectively. Suppose the current income distribution is at point A, with $y_2 > y_1$. If we set ε = 0, meaning no aversion to inequality, then the social welfare function takes a linear form, and point B—where both individuals have equal income—would yield the same level of social welfare. In this case, redistributing income between the two individuals would have no effect on overall social welfare.

However, when inequality aversion is taken into account (ε > 0), the social welfare function becomes convex toward the origin, as shown in the figure. In this case, the average income required to generate the same level of social welfare as at point A corresponds to the income at point C, which is lower than at point B. Equalizing incomes therefore increases social welfare, and thus society may accept a reduction in average income.

The Atkinson inequality index is constructed based on this idea:

$$Atkinson(\varepsilon) = 1 - \frac{OC}{OB} = 1 - \frac{y_C}{y_B}$$

The Atkinson index tells us how much income society would need to forgo in order to maintain the same level of social welfare if everyone had equal income.

Let the average income that yields an equivalent level of social welfare be denoted by y_E. Then, social welfare can be expressed as follows:

$$U(y_E) = \frac{1}{1-\varepsilon}(y_E)^{1-\varepsilon}$$

Because the level of social welfare in the two cases is equal, we have:

$$W = \frac{1}{n}\sum_i \frac{y_i^{1-\varepsilon}}{1-\varepsilon} = \frac{(y_E)^{1-\varepsilon}}{1-\varepsilon}$$

We can determine this equivalent income level y_E.

$$y_E = \left[\frac{1}{n}\sum_i y_i^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

In the case of ε equal 1, we have:

$$y_E = \prod_i (y_i)^{\frac{1}{n}}$$

Thus, the Atkinson index allows us to directly calculate the equivalent mean income y_E corresponding to different values of ε. When ε>0 , the income level y_E decreases and the Atkinson index increases. With ε=2 and an Atkinson index of 0.4, we can interpret this as society being willing to accept a 40% reduction in total income in order to equally distribute income among everyone while still maintaining the same level of social welfare as before. When we know the

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average income and the value of the Atkinson index A(ε), we can determine both the level of welfare and the equivalent income y_E.

$$y_E = \bar{y}(1 - A(\varepsilon)) = W$$

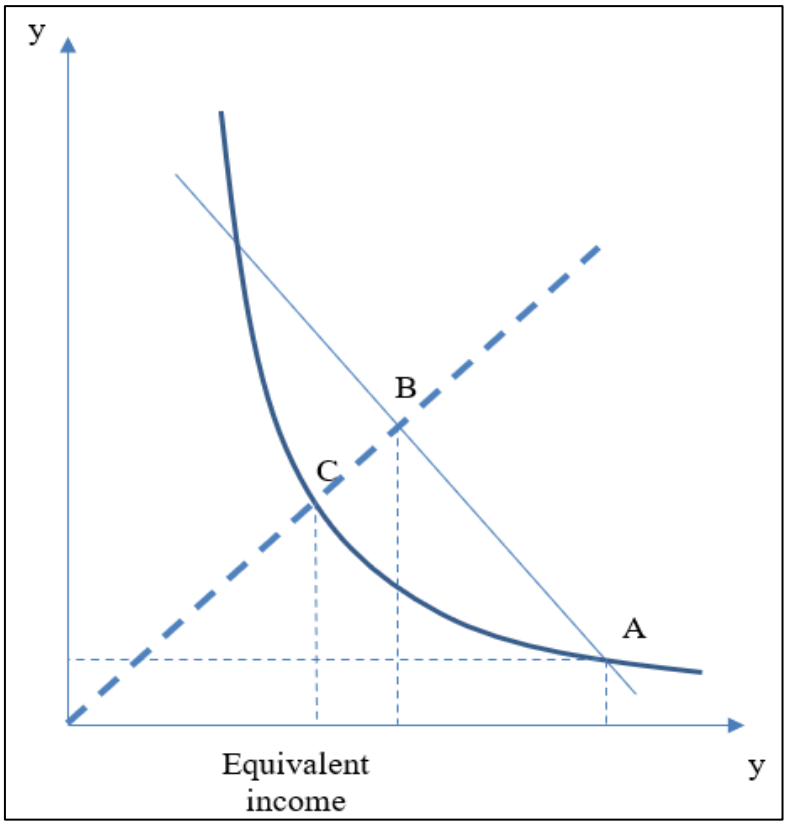

Fig 2: The Social Welfare Function and the Equivalent Income

B. Measurement of FDI

Provincial-level FDI data published by the National Statistics Office only include registered capital and the number of projects, which are not very useful when assessing their impact on socio-economic indicators in the corresponding year. Moreover, foreign direct investment data, even when referring to implemented capital, do not provide insights into the multidimensional effects of this capital on the economy. Instead, we will compile data from wholly foreign-owned enterprises in each locality, thereby identifying the scale of assets, equity, labor force, revenue, and so forth of these enterprises, based on the Enterprise Survey dataset. This approach will allow us to evaluate the impact of foreign direct investment in a more accurate and multidimensional manner.

C. Spatial Econometric Model

In spatial econometrics, it is assumed that geographically proximate observations may influence one another, leading to the phenomenon of spatial autocorrelation (LeSage, 1999). Spatial autocorrelation is classified into two types: (i) spatial autocorrelation of the dependent variable itself, and (ii) spatial autocorrelation of the error term. Consequently, traditional estimation methods are no longer appropriate because the assumptions are violated. Two corresponding spatial econometric models have been proposed to address this issue: the Spatial Autoregressive Model (SAR) and the Spatial Error Model (SEM).

The general form of the Spatial Autoregressive Model is as follows:

$$(I - \rho W)y = x\beta + e$$

The spatial error model takes the following form:

$$(I - \lambda W)y = (I - \lambda W)x\beta + u$$

in which, y is the dependent variable, x represents the independent variables, W is the spatial weight matrix, and the coefficients λ and ρ are the spatial autoregressive parameters, indicating the effect arising from spatial autocorrelation. The error term ε follows a normal distribution with constant variance and no autocorrelation, whereas the error term u in the spatial error model follows a distribution with spatial autocorrelation, that is $u = \lambda W + \varepsilon$.

III. DATA AND EMPIRICAL RESULTS

We use the Enterprise Survey dataset conducted and published by the National Statistics Office (NSO) to calculate indicators on revenue, assets, equity, and labor of wholly foreign-owned enterprises aggregated at the provincial level.

We use the indicator of industrial output value as a measure reflecting provincial production activities. From this, in order to show the relative scale of foreign direct

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investment (FDI), we calculate the ratios of revenue, assets, etc. of foreign enterprises in each province to the industrial output value. In addition, we can also calculate the ratios of these indicators to the provincial population size. Data on industrial output and population size are taken from the Statistical Yearbook published by the NSO.

Inequality data are calculated based on the Vietnam Living Standards Survey (VLSS) dataset, which is conducted biennially by the NSO. Here, the measure of inequality is the Atkinson coefficient.

Data reflecting the capacity and quality of provincial government management are taken from the Provincial Competitiveness Index (PCI), which is surveyed and published by the Vietnam Chamber of Commerce and Industry (VCCI).

In the model assessing the impact of foreign direct investment (FDI) on inequality, the dependent variable is the Atkinson coefficient of inequality. The explanatory independent variables includes: (i) the ratio of equity capital of wholly foreign-owned enterprises to the province's industrial output / the ratio of employment in wholly foreign-owned enterprises to the province's industrial output, (ii) the Provincial Competitiveness Index (PCI), and (iii) the ratio of provincial output per capita.

The first variable illustrates the impact of FDI on inequality. Here, we employ two measures to represent FDI: the relative size of equity capital and the scale of employment of foreign enterprises in the province. This distinction is made because the author assumes that FDI can follow two tendencies: capital-intensive and labor-intensive. In the case of labor-intensive FDI, the potential to promote greater equality within the province is higher, whereas capital-intensive FDI is more likely to exacerbate inequality.

The Provincial Competitiveness Index variable reflects the quality of local government management. If the local government has better governance capacity, it may pay greater attention to promoting equality within the province. The provincial per capita output variable indicates the province's economic performance and may exert certain effects on inequality.

The descriptive statistics of the variables used in the model are summarized in the following table.

Table 1: A Descriptive Statistic of Variables in the Model

Variables	Observations	Mean	Standard Deviation	Min	Max
Atkinson	63	0.211525	0.037496	0.14678	0.32697
pci	63	57.01764	4.145726	45.11707	63.79096
output_per_cap	63	41227.54	67294.11	1950	414255
fdi_output	63	0.052664	0.060889	0.001138	0.334375
vieclam_output	63	1701.956	4779.091	1.329414	32944.32

Source: National Statistic Office and Chamber of Industry and Commerce (2024)

Table 2: The Estimation Results of the Impact of FDI on Inequality

Dependent Variable: Atkinson Inequality Index	OLS		SAR		SEM	
output_per_cap	0.628 (6.921)		-0.363 (6.705)		-0.662 (6.698)	
pci	-.0005375 (.0011226)		-.0004827 (.0010876)		-.0004688 (.0011211)	
vieclam_output	-39.12948** (10.39865)		-38.58454** (10.08088)		-38.96721** (10.14165)	
fdi_output		-.0286941 (0.140359)		-.0291732 (.108984)		-.0293817 (.0947644)
_cons	.3568029 (.0634778)		.2711619 (.170929)		.3608382 (.0635219)	
λ					0.2067905 (.4663193)	
ρ			.2394616 (.4462247)			
SEM Moran's I SAR Lagrange multiplier	p-value 0.180 0.652					

Source: The author's calculations

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In the model assessing the impact of foreign direct investment on inequality, we have two options for variables representing foreign direct investment: the ratio of employment in the foreign-invested enterprise sector to the province's industrial output (indicating the labor intensity of foreign direct investment), and the ratio of equity capital of foreign-invested enterprises to the province's industrial output. In both models, although the accompanying variables have the expected signs, they are not statistically significant at the 5% level. The coefficient of provincial per capita industrial output carries a positive sign, implying that provinces with larger economic activity tend to have higher levels of inequality. This is considered consistent with the early stages of economic growth. The coefficient of PCI carries a negative sign, suggesting that better governance quality reduces inequality, since governments with higher governance quality usually place greater emphasis on social issues, including equality.

For the foreign direct investment variable, with two different specifications considered here, the results differ slightly. The employment ratio variable carries a negative sign and is statistically significant at the 1% level, implying that provinces where foreign enterprises generate more employment relative to industrial output tend to experience lower inequality. This is entirely reasonable, since labor-intensive industries bring relatively higher income to low-income workers, thereby improving equality.

In contrast, the equity capital ratio variable, although also negative, is no longer statistically significant at the 5% level. This suggests that while the share of foreign capital may be higher, it is distributed across both capital-intensive and labor-intensive industries. Whereas the former may increase inequality and the latter may reduce it, their combined effect becomes indistinct.

The test for spatial autocorrelation shows the existence of spatial effects in this model (both the Moran's index and the Lagrange multipliers in the SEM and SAR models are statistically significant). This implies that the inequality index across provinces are correlated with each other; therefore, a spatial econometric regression model should be employed in this case.

IV. CONCLUSIONS

This paper examines the impact of foreign direct investment on inequality. After calculating the Atkinson inequality index of provinces in Vietnam using the Vietnam Household Living Standards Survey (VHLSS), the author investigates the effect of FDI on this indicator. Instead of using the realized or committed investment capital figures published by the National Statistics Office, the author employs the Enterprise Survey dataset to measure the scale of equity capital and the number of jobs that foreign enterprises use/create in each province. The estimation results lead to the following conclusions.

First, labor-intensive FDI has a positive impact on reducing local inequality, while capital-intensive FDI is more likely to increase provincial inequality.

Second, in the model assessing the impact on inequality, spatial autocorrelation is present; therefore, it is appropriate to employ a spatial regression model.

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