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Application of Dynamic Structural Model to Identify Factors That Influence Capital Adjustments in The National Manufacturing Industry

Iwan Harsono[1]✉, Jusatria[2], Rachmadi Indrapraja[3], Iwan Henri Kusnadi[4], Saeful Rohman[5]

[1]Universitas Mataram
[2]Universitas Islam Indragiri
[3]PT. Pupuk Kaltim
[4]Universitas Subang
[5]BRIN

iwanharsono@unram.ac.id

Abstract

This research aims to determine the costs of capital adjustments and company dynamics. Company panels comprise the database. The main advantage of analyzing the nature of adjustment costs at the plant level is that the data contain information for purchases and sales of capital goods. Panel data, including information from many plants and long periods, allows for a more comprehensive analysis of firms' investment behavior in the face of capital adjustment costs. The estimation results allow for the recovery of companies' frictions in adjusting their capital stock. The estimation results for capital adjustment costs are consistent with other studies using similar methodologies. Estimates show that there are significant, unchangeable fixed costs, as well as moderate quadratic costs. Researchers then use the estimated parameters in a counterfactual simulation to analyze the impact of a decline in average firm profitability on the labor market. The results show a significant labor market response to the shock, with the transition to the new stable state being slow and taking several years to complete the adjustment. The simulations highlight the importance of not only modeling capital mobility but also considering and estimating its frictions to evaluate the impact of policies or shocks on the economy. The mobility and capital adjustment costs influence the speed of the economy's adjustment to shocks and their effects on factor allocation and remuneration in the short and long term.

Keywords: Capital Costs, Investment, Market, Economy.

1. Introduction

Changes in political policies and market conditions significantly impact the distribution of resources in an economy. For example, tax or trade reform can change the allocation of resources across different sectors of the economy. Changes in trade policy, for example, can affect demand for imported and local products, which can then influence the reallocation of labor and other resources in related sectors. Policy changes can also affect demand for production factors such as labor, capital, and natural resources [1]. The impact of these changes often creates distributional conflicts between various groups in society because the parties who benefit and lose can be different. Distributional disputes like this can create social and political tensions in society. Changes in resource distribution can have a long-term impact on economic growth and stability. Therefore, understanding the consequences of political reforms and changing market conditions is essential for designing effective policies to achieve desired economic and social goals. A comprehensive analysis of policy changes' social, financial, and political impacts and market conditions can help design more inclusive and sustainable policies [2].

The role of capital will be analyzed with a focus on understanding the nature of capital adjustment costs and their implications for the response of the economic system to shocks. The analysis will also consider these factors' influence on demand and the resulting distributional effects. Both capital and labor have adjustment costs [2]. Although estimating job adjustment costs is beyond the scope of this study, our results highlight the importance of assumptions about the functioning of the labor market for understanding the impact of shocks on the variables of interest. We estimate employment adjustment costs using a structural model and Argentinian data, revealing high mobility costs and a slow adjustment of variables in response to commercial and technological shocks [3].

On the other hand, previous studies combined mobility costs for work and capital adjustment costs. This latest research highlights the importance of modeling joint frictions in labor and capital markets to understand the impact of trade shocks in developing countries. This analysis will provide a deeper understanding of how capital and labor adjustment costs affect an economic system's response to shocks and the implications for resource distribution [4].

Various factors can cause friction in the capital allocation process at the company level. For example, reallocating factors or resources due to the installation or replacement of capital may result in product losses because such changes may require additional time and resources to adjust the production process [5]. Furthermore, installing new production structures often necessitates additional costs, such as employee retraining, installation, and testing, to ensure that the structure functions appropriately and meets established standards [6]. These costs are not only financial but can also affect a company's productivity and efficiency over some time. Thus, companies must carefully consider the capital adjustment process to reduce the negative impact on the company's operations and finances [7]. Changes in production structure or capital investment can also directly impact the workforce. For example, using new technology or more advanced equipment may require employees to retrain or develop new skills. This can incur additional costs for the company, and it will need time to adjust to the changes [8].

The absence or imperfection of a secondary market for certain capital goods can also give rise to adjustment costs due to the irreversible nature (wholly or partially) of such capital investment in the factory. Traditionally, the literature has analyzed the structure and magnitude of adjustment costs, assuming a convex functional form. However, in recent years, the literature has highlighted the role of non-convexities and irreversibility at the firm or plant level in the investment process [9]. Evidence at the production plant level indicates a non-linear relationship between the investment level and certain relevant moments, underscoring the importance of these cost structures. More precisely, in the absence of adjustment costs, investments tend to overreact to shocks, leading to a negative serial correlation if the shocks exhibit some degree of persistence, a phenomenon not seen in plant-level data. In this case, the role of adjustment costs is to moderate the investment response and create a positive serial correlation in the variable [10]. However, although convex adjustment costs can produce a positive serial correlation in investment levels, they fail to reproduce other characteristics observed in the data, such as significant investment episodes, disinvestment, or inertia zero investment level. Adding non-convex and irreversible parts to the functional form of adjustment costs tries to fix this problem by getting more accurate estimates of adjustment costs. It is critical to understand how capital adjustment costs impact a firm's investment response to shocks and how this can affect the distribution of resources in the economy as a whole [11].

We will estimate parameters related to capital adjustment costs using a dynamic structural model, considering various components of the cost function discussed in the literature, including convexity, non-convexity, and irreversibility [12]. The estimation strategy will compare the model's predicted investment levels with the investment dynamics observed in panel data for manufacturing plants. To accomplish this, we will use the simulated moment method, which minimizes the weighted distance between the moments observed in the data and those predicted by the model [13]. This method will assist in more accurately estimating parameters related to capital adjustment costs, which will provide a better understanding of how firms respond to shocks and how this affects the distribution of resources in the economy. Using panel data from manufacturing plants, we can analyze the impact of various factors on capital adjustment costs and their implications for firm investment [14].

Model parameter estimates will be used to conduct counterfactual simulations regarding the impact of a decrease in average company profitability on allocating capital, labor, and wages [14]. The results obtained from this study highlight the relevance of convexity, non-convexity, and irreversibility in cost structure adjustments at the factory level. The estimated parameters indicate the presence of significant and irreversible fixed costs and the movement of derived quadratic costs [15]. Additionally, the simulation exercise highlights the importance of jointly modeling corporate investment decisions and frictions in capital mobility to analyze the impact of shocks on factor markets [16]. The research results show that economic adjustments in response to shocks are slow in the face of capital adjustment costs, in contrast to the results obtained after assuming no adjustment costs or capital immobility. The impact of shocks on wages, employment, and aggregate capital is quite significant, exceeding the effect obtained under the assumption of capital immobility. This research provides valuable insights into how shocks affect factor markets and economic resource allocation.

2. Research Methods

The database used consists of a balanced panel of companies. The main advantage of analyzing the nature of adjustment costs at the plant level is that the data contain information for purchases and sales of capital goods. In particular, it makes it possible to analyze positive and negative adjustments in the capital stock, thereby enabling an analysis of the role of partial irreversibility and transaction costs, which would otherwise be impossible. Panel data, including information from many plants and long periods, allows for a more comprehensive analysis of firms' investment behavior in the face of capital adjustment costs. With this data, research can identify investment patterns in different situations and measure the impact of various economic factors that influence a company's investment decisions. Analyzing this data can provide deeper insight into how companies respond to capital adjustment costs and how this influences their investment behavior. The results of this research could have significant implications for designing economic policies aimed at increasing investment and overall economic growth.

3. Results and Discussion

Econometricians do not observe the state of factory profitability, which poses challenges in estimating parameters related to the factory production function. Least squares estimate in this context contain simultaneity bias because variable factors are correlated with unobserved productivity. For example, if plants with greater productivity or profitability require more significant inputs, then least squares coefficient estimates will tend to have an upward bias. This estimator allows controlling for simultaneity problems by using investment as a proxy for unobservable and time-varying productivity shocks. Despite the absence of direct observation of state variables, this approach enables researchers to estimate more accurate parameters related to the factory production function. In this estimation, we use investment as a proxy to mitigate simultaneity issues caused by unobserved state variables. Investment is used as a proxy because it is assumed to react to actual profitability conditions and reflect changes in these unobserved conditions. By using investment as a proxy to overcome the simultaneity problem, researchers can more accurately estimate parameters related to the factory's production function. Although these estimates can still have some uncertainty, this approach can better estimate the relationship between input and output in factory production.

The estimation method can influence the coefficient estimation results related to the production function. We performed estimates in this case using ordinary least squares, fixed effects, and the estimator. In the least squares estimation, coefficients associated with variable factors such as employment and materials tend to suffer from upward bias. This bias may be more significant in factors that are easier to adjust for. The estimates made with the Olley-Pakes estimator for the labor, material, and capital variables are different from those made with fixed effects estimators and ordinary least squares.

Regarding capital-related coefficients, the estimation results using the estimator are lower than the results obtained with ordinary least squares but higher than those obtained with fixed effects. This shows that the Olley-Pakes approach can provide more accurate results in controlling simultaneity bias in estimating production function parameters. This approach enhances the ability to adjust for factors not directly observed, like factory profitability conditions, which can impact the coefficient estimates for other variables.

When you use fixed effects estimators instead of ordinary least squares or the method to estimate coefficients, you tend to get lower estimates, especially for the capital factor. The nature of fixed effects estimators, which account for intertemporal variation and increase measurement error in the forecast, explains this difference. This shows that methods considering inter-time variations can provide more accurate estimates when analyzing the relationship between production factors. These findings are consistent with research results in other developing country contexts, indicating that the observed patterns may be a general characteristic of developing economies. This research makes an essential contribution to the understanding of the dynamics of production and resource allocation in the context of a developing economy and shows the relevance of considering inter-temporal variations in the estimation of production function coefficients.

The level of investment has a significant impact on company behavior and the economy as a whole. Parameters related to the level of investment, such as substantial investment episodes or inaction, have an essential role in determining the risks a company faces. Higher levels of autocorrelation and lower innovation variance allow firms to make more accurate predictions about future profitability shocks. This influences the company's decision to adjust cost structures and allocate production factors. At the macro level, these parameters also influence total factor productivity and can impact the dynamics of the economic cycle. For example, high and consistent levels of investment can increase overall productivity, accelerating economic growth.

Conversely, uncertainty in investment levels or unexpectedly large investment episodes can cause financial instability and disrupt long-term growth. By paying attention to these parameters, companies can make more informed decisions about adjusting cost structures and managing risks. Governments and policymakers can also use this information to design policies that support stable investment and sustainable economic growth.

After calculating the distinctive components of profitability shocks, the next step is to estimate the desired parameters using the ordinary least squares method. Both a single plant and an entire industry exhibit a high correlation with specific shocks at the plant level. Furthermore, we find a high variation in innovation associated with the characteristic component of the shock, accompanied by a standard deviation of that component's innovation. These results indicate that the distinct components of profitability shocks have significant effects and considerable variation across industries. This shows the complexity of economic dynamics that must be considered in policy analysis. By considering these factors, policy analysis can be more accurate and effective in responding to economic changes. In this context, parameter identification and the estimator's efficiency depend heavily on selecting the right moments. For estimation purposes, the selected moment should provide insights into changes in the structural parameters. The literature recommends selecting a combination of moments that accurately depict the behavior of investment levels over time and within a specific period. We selected four moments for this analysis based on observations. First, choose the investment-level serial correlation as the first moment. The second moment consists of the correlation between the level of investment and (logarithmic) profitability shocks. These two moments have been used repeatedly in empirical research on adjustment costs because they are sensitive to the cost structure. Additionally, the moments include the fraction of observations with more excellent investment rates and those with less than -5%, capturing the asymmetry and right tail of the investment rate distribution at the plant level. We hope that by considering these moments, the parameter estimates and estimator efficiency in this analysis can offer a more precise representation of investment dynamics within the context of adjustment costs.

Parameter estimates for the three components of capital adjustment costs, along with their standard errors, indicate significant fixed costs, representing the average capital stock at the plant level. In addition, there are also enormous irreplaceable costs, although specific values are not included, as well as quadratic costs, which have an estimated coefficient of 0.05, which indicates a moderate level. All of the estimated parameters are also statistically significant. We report observed and simulated moments in this analysis to minimize the distance between them and describe the measures of model fit. We can enhance our understanding of the performed estimation analysis by providing a more comprehensive explanation of the model parameterization and its implications, along with additional details about observed and simulated moments. The optimal decision analysis for different versions of the estimation model reveals differences in investment response based on the cost structure used. Models with fixed costs and partial irreversibility produce different investment decisions than frictionless models. A frictionless model eliminates the need for capital stock adjustments, allowing for frictionless investment decisions. However, more extensive and less frequent capital adjustments are required in a fixed-cost model to offset fixed costs to make investment decisions more prudent. In addition, quadratic adjustment costs in the model also reduce investment response and create a positive serial correlation in investment levels. This shows that different cost structures can result in different investment decisions. Decision analysis for unconstrained models, which incorporate three types of costs in an adjustment function, can provide additional insight into how adjustment costs influence investment decisions in the long run.

A decline in corporate profitability has varying effects depending on the economic model's labor supply elasticity. When there is a highly elastic labor supply, the impact of profitability shocks tends to be greater on the economy's aggregate capital. This is due to the dependence of capital on other technologically complementary factors of production and the difficulty of transferring profitability losses to wages. Conversely, in cases where the labor supply remains fixed, a decline in profitability may lead to a corresponding drop in wages. However, this wage reduction can mitigate the shock's negative impact by increasing the company's profitability. The evolution of aggregate employment after profitability shocks to firms shows a slow and significant decline in employment levels. The simulation results show that the impact of these shocks on the labor market is very influential, with employment adjustments occurring slowly between the initial and final stable conditions. A decline in corporate profitability, assuming a highly elastic labor supply, significantly impacts the economy's aggregate capital and labor markets.

After the profitability shock, the economy took nine years to reach a new stable condition. Labor market outcomes assuming a constant labor supply significantly impact the labor market, with a decrease in the equilibrium wage compared to its initial value. The economic recovery process took five years to reach a new stable condition after the shock. The evolution of aggregate capital shows different capital adjustment dynamics depending on assumptions about the labor market. Models assuming an infinitely elastic labor supply have more excellent adjustments between steady states than models assuming a fixed labor supply. This demonstrates the importance of considering mobility costs and labor factors constraints when evaluating the impact of policies or shocks on the economy. Evaluation of the robustness of the simulations to varying shock magnitudes shows that larger shocks not only have more significant effects on these variables but also have more persistent impacts. This highlights the complexity of managing economic shocks and the need for appropriate policies to accelerate economic recovery following shocks.

Economic models strongly influence the evolution of employment, wages, and aggregate capital with assumptions about capital mobility. First, capital mobility magnifies the impact of shocks on the labor market. Changes in employment levels and wages will be more significant in the model with capital mobility than in the model without. For example, in a model with capital mobility, the decline in the aggregate employment rate will be more significant than in a model without capital mobility. Similarly, wage reductions in models with capital mobility would be more important. Second, capital adjustment costs influence the speed of labor market adjustment. Although the magnitude of long-term changes is the same in models with expensive and inexpensive capital adjustment costs, the dynamics will differ. In a model with expensive capital adjustment costs, labor market adjustment will be slower than in a model without expensive capital adjustment costs. In a frictional model with significant capital adjustment costs, it will take the firm five or nine years to complete the adjustment, depending on the assumptions made about the labor market. This shows the importance of considering capital mobility and adjustment costs in economic analysis better to understand the impact of shocks on the labor market.

4. Conclusion

The estimated capital adjustment costs results indicate the friction companies face in adjusting their capital stock. These estimates are consistent with the findings of previous studies using similar methodologies. Estimates indicate enormous, unchangeable fixed costs and moderate quadratic costs. We then use the estimated parameters in a counterfactual simulation to analyze the impact of a decline in average firm profitability on the labor market. The simulation results show a significant labor market response to the shock. The transition to a new stable state was slow, and it took several years to complete the adjustment. These simulations highlight the importance of modeling not only capital mobility but also considering and estimating the frictions associated with it. Evaluating the impact of policies or shocks on the economy is essential. Capital mobility and adjustment costs influence the speed of an economy's adjustment to shocks and their effects on factor allocation and remuneration in the short and long term. By considering frictions in capital adjustments, economic policy analysis can be more comprehensive and accurate in predicting the consequences of financial shocks.

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