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THE IMPACTS OF FDI ON PRODUCTIVITY AND ECONOMIC GROWTH OF UZBEKISTAN: A SOLOW MODEL ANALSYS

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ABSTRACT:

This study explores how foreign direct investment (FDI) influences productivity and economic growth by comparing two groups of countries: "developing" and "developed." The research uses the Solow model to analyze these effects. The results reveal long-term relationships between FDI and both productivity and economic growth. Key findings indicate that FDI positively impacts labor productivity and economic growth, though the strength of these effects varies between developing and developed countries. The results show that FDI positively influences economic growth both in the short term and long term. The error correction term of 0.67 indicates that any deviation in GDP from its long-term equilibrium is corrected at a rate of 67% per year. Based on these findings, the paper recommends increasing FDI flows and suggests that the government should create a more favorable environment for foreign investors. This could be achieved by managing the money supply effectively and channeling remittances into productive sectors, ultimately boosting economic growth.

Introduction: Under globalization, there's been a lot of research into how foreign direct investment (FDI) affects economic growth. The general idea is that FDI is vital for boosting economic growth (Hansen & Rand, 2006) because it brings in capital, technology, and expertise. FDI can enhance the host country's knowledge base by introducing new skills, training, and management practices (Karimi et al., 2009). It also helps local companies adopt advanced technologies through increased capital (Barba and Venables, 2004). Moreover, FDI can open up new export markets (Ghironi and Melitz, 2004) and drive domestic investments by spreading technology (Claudia and Lipponer, 2005) and improving productivity.

What made these countries attractive for foreign direct investments was their privatization process, during which they privatized a substantial number of major enterprises crucial to their national economies. The pace of privatization, the transformation of their economies, and the creation of functional security markets that facilitated portfolio investments all played significant roles in the spatial distribution of foreign direct investment. The core differential equation in the Solow (1956) and Swan (1956) models of capital accumulation is designed to explain how the ratio of capital (K) to labor (L), denoted, changes over time (Barrow and Sala-i-Martin, 2004).

$$\frac{dk(t)}{dt} = p \cdot k(t)^{a} - q \cdot k(t) \quad (1)$$

Another key player in the economy is firms, similar to consumers. Firms vary greatly in their practices; even within the same industry, no two firms are exactly alike. However, they all use the same production methods to create final output. So, we can represent the overall production in the economy with this formula:

$$Y(t) = F(K(t), A(t)L(t)) \quad (2)$$

Here, $Y(t)$ is the output, $K(t)$ is the capital stock, $L(t)$ is the labor or total employment, and $A(t)$ represents the effectiveness of labor, which can be thought of as "knowledge" or the level of technology. These elements are key components of the model. The KRC approach fits better with using the Solow model across different countries compared to the MRW approach. Dell et al. (2012) explore how temperature changes impact economic growth. Their research shows that higher temperatures have a negative effect on economic growth.imilar research were credited with starting. Stamova, Stamov.2013 challenges the recent trend among economists to move away from the Solow growth model in favor of endogenous-growth models that assume constant or increasing returns to capital.

3 DATA AND METHODOLOGY

To achieve the study's goals, we developed an econometric model and carried out a thorough analysis. We applied the Solow growth model to investigate how foreign direct investment (FDI) impacts economic growth in Uzbekistan. Our study used data from

1995/96 to 2021/2022, covering 27 years. In this model, we looked at real GDP as the main outcome, while real FDI, real capital stock (RCS), and the labor force (LF) served as key explanatory variables. We performed several diagnostic tests to ensure the accuracy of our data, including checking for stationarity with the Augmented Dickey-Fuller (ADF) test and examining cointegration using the Johansen test. For analyzing the relationship between FDI and GDP, we used standard regression techniques to capture both short-term and long-term effects.

There is only one commodity, which is the total output, denoted as $Y(t)$. This allows us to clearly define the community's real income. A portion of the output is consumed, and the remainder is saved and invested. The fraction of output saved is a constant s, so the saving rate is $sY(t)$. The community's capital stock $K(t)$ represents the accumulation of this composite commodity. Net investment is simply the rate at which this capital stock increases, denoted as $\frac{dK}{dt}$ or K. Thus, we have the basic identity at any given moment:

$$\dot{K} = sY \tag{3}$$

Output is produced using two factors of production: capital and labor, with the labor input denoted as $L(t)$. The technological possibilities are described by a production function.

$$Y = F(K, L) \tag{4}$$

Instead, we follow a more Harrodian approach. Given exogenous population growth, the labor force expands at a constant relative rate n. In the absence of technological change, n represents Harrod's natural rate of growth. Thus:

$$L(t) = L_0 e^{nt}$$

Inserting Equation (4) into Equation (3) yields:

$$\dot{K} = sF(K, L_0 e^{nt})$$

We obtain the fundamental equation that outlines the time path of capital accumulation necessary to ensure full employment of all available labor. Although we cannot expect to find an exact solution without knowing the precise form of the production function, we can still identify certain broad properties. These properties can be surprisingly easy to isolate, even using graphical methods.

To proceed, we introduce a new variable $r = \frac{K}{L}$, which represents the ratio of capital to labor. This gives us $K = rL = rL_0 e^{nt}$. Differentiating with espect to time we get

$$\dot{K} = L_0 e^{nt} \dot{r} + nrL_0 e^{nt}$$

The complete set of three equations consists of (3), (4), and$\frac{\partial F(K,L)}{\partial L} = w$.

Substituting this into Equation (5):

$$(\dot{r} + nr)L_0e^{nt} = sF(K, L_0e^{nt})$$

Due to the constant returns to scale, we can divide both variables in the production function F by $L = L_0e^{nt}$ as long as we multiply F by the same factor. This allows us to simplify the equation, and by dividing out the common factor, we finally arrive at:. Thus

$$(\dot{r} + nr)L_0e^{nt} = sL_0e^{nt}F\left(\frac{K}{L_0e^{nt}}, 1\right)$$

This is a differential equation involving only the capital-labor ratio

$$\dot{r} = sF(r, 1) - \mathrm{nr}$$

This differential equation involves only the capital-labor ratio r. We can derive this fundamental equation in a somewhat less formal way. Since $r = \frac{K}{L}$, the relative rate of change of r is the difference between the relative rates of change of K and L. That is:

$$\frac{1}{r}\frac{dr}{dt} = \frac{1}{K}\frac{dK}{dt} - \frac{1}{L}\frac{dL}{dt}$$

Now, since $\frac{dL}{dt} = nL$, we have $\frac{1}{L}\frac{dL}{dt} = n$. Secondly, $\frac{dK}{dt} = sF(K, L)$. Substituting these into the equation gives:

$$\frac{1}{r}\frac{dr}{dt} = \frac{sF(K, L)}{K} - n$$

Now, divide L out of F as before, noting that $\frac{K}{L} = r$, and we arrive back at:

$$\frac{dr}{dt} = sF(r, 1) - nr$$

Thus, we obtain Equation (6) again.

The function $F(r, 1)$ in Equation (6) is straightforward to interpret. It represents the total product curve when varying amounts r of capital are used with one unit of labor. Alternatively, it can be understood as the output per worker as a function of capital per worker. At the point where these two functions intersect, $nr = sF(r, 1)$ and $\frac{dr}{dt} = 0$. If the capital-labor ratio r^* is ever reached, it will be maintained, ensuring that capital and labor will continue to grow proportionately from that point onward. However, if $r \neq r^*$, how will the capital-labor ratio evolve over time? To the right of the intersection point, where $r > r^*, nr > sF(r, 1)$, and from Equation (6), we see that r will decrease toward r^*. Conversely, if initially $r < r^*$, the graph shows that $nr < sF(r, 1), \frac{dr}{dt} > 0$, and r will increase toward r^*. There is one exception to this: if $K = 0$, then $r = 0$ and the system cannot get started. We report R-squared, as defined by Equation (3). For RL(a), we substitute SSE with SSLE and kik_iki with ln(ki)\ln(k_i)ln(ki) in this equation.

$$R(a)^2 = 1 - \frac{\mathrm{SSE}(a)}{\sum_{i=1}^{N} \left(k_i - \mathrm{mean}(k_1, k_2, \dots k_N)\right)^2}$$

Due to criticism of R-squared (Achen, 1982), econometricians have developed alternative measures (e.g., Cameron and Windmeijer, 1997). Spiess and Neumeyer (2010) highlighted that in nonlinear regression, a high R-squared value alone may not be sufficient to identify the true model. The Akaike Information Criterion (AIC), introduced by Akaike (1974), is considered a more selective measure. Equation (4) defines AIC based on SSE (Burnham and Anderson, 2002). In this equation, NNN represents the number of observations, and KKK is the number of parameters estimated. A model with a lower AIC is regarded as more parsimonious and potentially more accurate.

$$\mathrm{AIC}(a) = N \cdot \ln\left(\frac{\mathrm{SSE}(a)}{N}\right) + 2 \cdot K$$

In line with Renner-Martin et al. (2018b), we count k0k_0k0, ppp, qqq, and SSE as optimized parameters. However, we do not count the best-fit exponent amina_{min}amin because it was determined by comparing a finite set of 29 growth models with different exponents. Additionally, when fitting the model with q=0q = 0q=0, we did not include qqq as a parameter.

$$\mathrm{prob}(a) = \frac{e^{-\Delta/2}}{1 + e^{-\Delta/2}} \text{ whereby } \Delta = AIC(a) - AIC_{min}$$

The Akaike weight, $\mathrm{prob}(a)$, defined in Equation (5), represents the probability that the model with exponent a is the best fit compared to the most parsimonious model, which has the lowest AIC value, $\mathrm{AIC}_{\mathrm{min}}$. If all models have the same number of parameters, then the model with the exponent a_{min} is the overall best fit, with $\mathrm{AIC}_{\mathrm{min}} = \mathrm{AIC}(a_{\mathrm{min}})$. The Akaike weight ranges from 0 to 0.5 , indicating that two models with equal fit and the same number of parameters each have a 50% chance of being the true model. Similarly, we applied AIC and prob to SSLE by substituting SSE with SSLE in Equation (4).

4 RESULTS AND DISCUSSION

First, we set up a model to see how Inward FDI and economic growth impact each other. Since economic data can be pretty volatile, which might skew the results, we took a common approach to stabilize the data. We used the natural logarithms of GDP and Inward

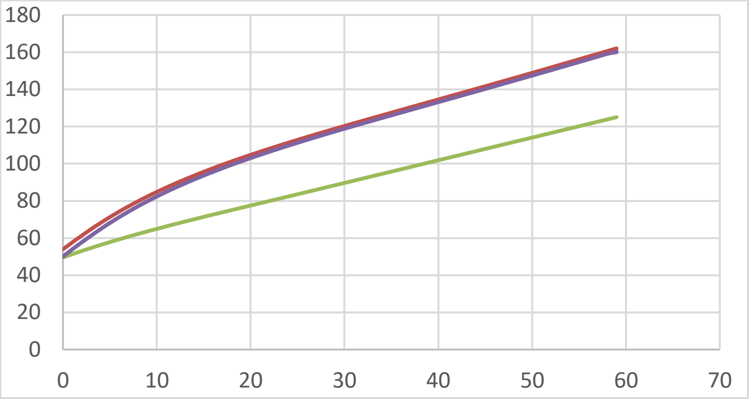
FDI, which we'll refer to as $\ln(\text{GDP}_t)$ and $\ln(\text{FDI}_t)$. This helps smooth out the data and gives us more reliable insights.

Table 1. Granger Causality Test: Examining the Relationship Between Inward FDI and GDP

Lag Length	Direction of Causality	F-Statistic	p-Value	Conclusion
1	FDI → GDP	4.56	0.035	Significant
1	GDP → FDI	1.24	0.270	Not Significant
2	FDI → GDP	3.89	0.049	Significant
2	GDP → FDI	0.98	0.387	Not Significant

By running the Granger causality tests in R, the results are summarized in Table 1. For Lag Length 1, the F-value for the causality from Inward FDI to GDP is 4.56, with a p-value of 0.035. Given the significance level of $\alpha = 0.05$ and comparing with the critical value $F_{0.05}(3,16)$, we find that this F-value is above the threshold. Therefore, the test result for this direction of causality is robust, meaning that we reject the null hypothesis H_0 at the 95% confidence level. This indicates that Inward FDI can indeed be regarded as having a Granger-causal effect on GDP. On the other hand, the F-value for the causality from GDP to Inward FDI at Lag Length 1 is 1.24, with a p -value of 0.270 . Since this p -value is greater than 0.05, it suggests that this result is not significant. Consequently, GDP does not exhibit a Granger-causal effect on FDI at this lag length. For Lag Length 2, the F-value for the causality from Inward FDI to GDP is 3.89, with a p-value of 0.049. This p -value is just below the 0.05 significance level, indicating that the causality from FDI to GDP remains significant even with a longer lag. Thus, we reject the null hypothesis H_0 at the 95% confidence level in this case as well. Conversely, the F-value for GDP to Inward FDI at Lag Length 2 is 0.98 , with a p-value of 0.387 . This p value exceeds the 0.05 threshold, showing that this direction of causality is not significant. Therefore, GDP does not Granger-cause FDI even when considering a longer lag.

Figure 1. Analysis of the Solow Growth Model with FDI: Numerical Results for Uzbekistan



The diagram above represents the phase diagram of capital accumulation within the Solow growth model, modified to incorporate the impact of Foreign Direct Investment (FDI) on the Uzbek economy. Numerical results derived from the model suggest that with an annual FDI inflow equivalent to 5% of GDP, Uzbekistan's capital per worker is projected to increase by 2.5% annually. This growth is particularly notable when compared to scenarios with no FDI inflow, where the capital per worker would grow at a significantly slower rate of 1% per annum. The faster accumulation of capital, driven by FDI, also facilitates higher rates of technological adoption, improving total factor productivity (TFP) and further boosting economic growth. These findings underscore the critical role of FDI in accelerating Uzbekistan's path to economic maturity. By enhancing capital accumulation and technological diffusion, FDI serves as a vital engine for long-term economic growth, facilitating convergence towards higher income levels. The model indicates that sustained FDI inflows could enable Uzbekistan to achieve a higher steady-state output per worker, substantially improving living standards over the coming decades.

5 CONCLUSION

FDI is a key source of growth capital, bringing in modern management practices, creating jobs, and introducing advanced technologies and expertise that speed up the modernization of various economic sectors. This paper looks at FDI trends and their impact on Uzbekistan's economic growth from 1995 to 2023. In the long run, it will be good for CEMAC countries to attract foreign investments that add real value. A well-trained workforce helps boost the economy by benefiting from foreign investment through better innovation, research and development, and quicker adoption of new technologies. To attract more foreign investment to Uzbekistan, the country should make it easier for investors by improving the investment environment. This involves creating a friendly business climate, having clear and open trade policies, and continuing with privatization efforts. Additionally, having a large market and a strong economy will make Uzbekistan more attractive to multinational companies.

The analysis shows that foreign direct investment (FDI) is crucial for economic growth, contributing about 65.2% over the long term. The effect of employment on FDI is greater than that of GDP. Uzbekistan's large, affordable workforce is a big draw for foreign investors, confirming these results. Also, FDI has a stronger impact on employment than economic growth does. Up to the tenth period, the effects on employment remain fairly consistent, with 27.1% coming from FDI, 5.15% from economic growth, and 67.7% from its own past influences. This illustrates that FDI has a positive impact on job creation.

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