Foreign Direct Investment and Technological Spillovers as Drivers of Firm-Level Productivity in Saudi Arabia: Evidence from a Dynamic GMM Approach

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Abstract: - In light of Saudi Arabia's economic diversification, this research investigate how Foreign Direct Investment (FDI) and technology spillovers can affect firm level productivity. It relies on panel data from 73 non-financial firms listed on the Tadawul Stock Exchange for the period of 2015-2024. Using the GGM method of moments, this study is conducted using a dynamic panel approach. Unit root and cointegration studies demonstrate that there is a consistent long-term connection between productivity, FDI, and various spillover effects. The research indicates that FDI, vertical spillovers, investment in R&D, stability of exchange rates, firm characteristics such as age and size, export intensity or leverage, all have a positive impact on Total Factor Productivity (TFP). The research highlights the distinction between TFP determinants and labor productivity, concluding that horizontal spillovers may enhance technological efficiency, but not overall output per worker. The combination of GMM estimation and cointegration analysis is a reliable method for resource-dependent economies, although alternative methods may be less effective. From a political perspective, the findings emphasize that expanding vertical relationships, building domestic R&D capabilities, and encouraging innovation to foster better utilization of FDI inflows are crucial.

Key-Words: - Foreign direct investment, technological spillovers, total factor productivity, labour productivity, sustainable development.

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1 Introduction

The rapid growth in global Foreign Direct Investment (FDI) flows over the past three decades is evident, rising from approximately USD 1.3 trillion in 2000 to nearly USD 2 trillion in 2023. Interestingly, developing countries now account for more than half of all these investment flows, [1]. Besides giving money, Foreign Direct Investment is also considered a key method for host countries to gain new technology, improved management techniques, and higher productivity, [2], [3]. Various Meta analyses provide evidence that Foreign Direct Investment can increase Total Factor Productivity through spillover effects, both within

the same industry and across industries, particularly if domestic firms have sufficient absorptive capacity, [4]. Not only does it serve as a source of financing and the primary channel for the transfer of technology between countries, but this trend also underscores that Foreign Direct Investment (FDI) serves not only as a source of financing but also as the primary channel for the transfer of technology between countries. In line with this, Saudi Araia has been actively leveraging the potential of FDI through its Vision 2030 diversification agenda, implementing various reforms since 2016, including policy simplification and the provision of investment incentives. The implementation of this policy resulted in a significant increase in annual FDI inflows, from approximately USD 1.4 billion in 2017 to over than USD 32 billion in 2022, the highest level in the Middle East and North Africa region, [4]. At the same time, sectors with strong technological orientation such as information and communications technology (ICT) and advanced manufacturing have taken on a larger role in newly established foreign investment projects, [5]. Despite this progress, growth in non-oil labor productivity has remained modest, averaging only about 1 percent annually between 2015 and 2023, [6], this indicates that the transmission of technology from foreign investors to domestic firms has not yet occurred evenly across the economy.

This raises a fundamental policy question: to what extent can inflows of Foreign Direct Investment generate meaningful technology spillovers that enhance the performance of domestic firms? A number of international studies have yielded inconsistent and varied results. Although certain research indicates that competition and labor mobility contribute to positive horizontal spillovers, host-country factors such as human capital, R&D intensity (intensity), or institutional quality contribute significantly. Saudi Arabia has limited empirical evidence on the mechanisms of technology diffusion among firms, which is due to research focusing on growth related to FDI at the aggregate or sectoral level. The lack of this gap makes it tough for policymakers to develop plans that utilize FDI's developmental benefits in their evidence-based basis. Knowledge of supplier linkages, labor mobility or competitive pressures is essential to make good policies about innovation and education. Why? Among the factors that make Saudi Arabia an attractive destination for studying theories of Foreign Direct Investment (FDI) spillovers is its high income levels, heavy dependence on the natural resource industry and quick institutional changes, particularly in relation to oil-exporting countries. This study focuses on the impact of Foreign Direct Investment (FDI) on technology spillovers in non-financial firms in Saudi Arabia, using panel data from 2015 to 2024. A dynamic panel data framework is employed to estimate the results, which are based on the GGM and address potential endogeneity, reverse causality (FDI), and unobserved heterogeneities in firm performance. This approach is known as Dynamic Panel Data Estimation.

2 Related Studies

2.1 Background Theories

Endogenous Growth Theory is based on the notion that long-term productivity growth is driven by knowledge accumulation within an economy, not solely by capital deepening. This theory underlies this concept.

The operation of a business, including developing new technology and producing or selling goods to improve its operations are all potential uses for Foreign Direct Investment. Many studies indicate that knowledge produces externalities that promote long-term growth, while [7] suggests that Foreign Direct Investment can be more effective in promoting growth if it supports a skilled workforce that understands foreign technology. Saudi Arabia is aligned with Vision 2030, which promotes increased productivity, economic growth and production efficiency, [8].

The Knowledge-Spillover Theory in FDI makes it clear that the benefits of foreign investment do not spread automatically, but rather through specific mechanisms. This forms the basis for H2a-H3b. Specifically, this approach identifies two main mechanisms through which horizontal spillovers occur within the same industry imitation, learning from other firm's practices, labor mobility, and competitive dynamics. Vertical spillovers that arise from the relationship between suppliers and buyers in the production [8] shows that vertical spillovers through backward linkages are often more robust than horizontal spillovers, [9], while later studies continue to show that horizontal effects can be mixed and vertical channels more consistently supportive of local upgrading. In Saudi Arabia, this distinction is especially important because the institutional environment increasingly emphasizes local content, domestic supplier development, and stronger participation of Saudi firms in foreign-led value chains under Vision 2030. Accordingly, H2a and H2b reflect the possibility that domestic firms learn from foreign rivals operating in the same

sector, whereas H3a and H3b are more strongly tied to Saudi Arabia's policy emphasis on supply-chain localization and structured industrial linkages with multinational enterprises, [10]. The theory of Absorptive Capacity is the most robust in terms of supporting H4a and H4. It also accounts for why FDI, and therefore spillover theories are not necessarily automatic. According to [10] the authors, firms benefit from external knowledge only when they have sufficient prior knowledge. Internal learning aptitude to recognize, absorb, and employ.
In [11], the authors highlight the significance of human capital in converting FDI into growth and [12] suggest that internal capability plays a role in how firms leverage foreign presence. The theory holds great significance because institutional reforms in Saudi Arabia are not solely focused on boosting Foreign Direct Investment, but also involve strengthening human capital, technological capacity, and the innovation system. H4a and H3b are not just conventional innovation theories, but also align with the Saudi expectation that R&D expenditure can improve firms' absorptive capacity and facilitate foreign technology conversion. Saudi companies benefit from R&D as it drives productivity and complements the Kingdom's efforts to diversify and upgrade its industries, [13].

2.2 Past Studies

Different global meta analyses indicate that Foreign Direct Investment can be beneficial for host research, but the impact varies depending on its level. A compilation of over a thousand empirical estimates reveals that countries with high-quality human capital and ample R&D investment tend to experience more favorable effects from FDI, [14]. Regional and sector-wise discrepancies also indicate that foreign direct investment opportunities can be advantageous for local businesses based on their learning capabilities.

By conducting research on the company level, we can gain a more comprehensive understanding of how these things operate. In [15], the authors analyzed microdata from emerging markets and demonstrated that technology transfer is most effective when multinational enterprises (MNEs) engage in joint ventures and research collaborations with local firms. This paper discusses the importance of this relationship. When dealing with endogeneity, a dynamic panel approach is necessary, which suggests that the extent of foreign ownership may not accurately reflect spillover effects if the nature of collaboration is excluded. A study on Chinese manufacturing found that vertical relationships between foreign investors and suppliers or buyers result in greater productivity gains than horizontal competition, which is dependent on local firms conducting their own research and training. Finally, it is important to push for domestic advancements and adopt appropriate econometric approaches, such as the GMM method, to determine causal relationships more accurately.'

In the Middle East and North Africa (MENA) region, a study using 'dynamic panel methodology' shows that factors such as education quality, infrastructure quality or institutional-level measures are highly predictive of productivity growth through Foreign Direct Investment. According to the study, technology is not always disseminated by high FDI inflows. In order to maximize foreign investment opportunities, host countries must enhance their ability to absorb new technologies.

The evidence from studies on developing nations with similar characteristics confirms this pattern. An investigation into the manufacturing sector in Vietnam reveals that continuous innovation and intellectual property protection are crucial for unlocking productivity gains from backward links. In Southeast Asia and elsewhere, the results in [16] indicate that the effectiveness of spillovers is primarily dependent on the quality of domestic supplier networks and the availability of a skilled workforce. Generally speaking, the presence of foreign investors does not bring benefits without the internal stability and support of the host country's internal circumstances.

Empirical evidence for Saudi Arabia's actions is limited to macro-level analyses. Why? According to several time series studies, FDI's impact on technological development is limited and heavily reliant on institutional reforms, although it does contribute to economic diversification. The manufacturing industry's research indicates that horizontal spillover effects are generally weak at the firm level, [17]. Domestic supplier networks are not well-developed and R&D is not very active, which is why this occurs. Further evidence from the GCC region indicates that the impact of Foreign Direct Investment (FDI) on productivity is highly correlated with the quality of human capital and innovation ecosystem. Overall, these results suggest that structural and institutional barriers may be present in the Saudi Arabian economy to make technology transfer less effective. Despite significant changes in empirical findings, the theory still maintains that horizontal spillovers are beneficial, [18]. Conversely meta analytic evidence indicates that these effects are not uniform rather, they are significantly affected by the characteristics of the host country the absorptive capacity of

domestic firms, and the nature of foreign investor presence. This implies that positive effects remain feasible if facilitated by appropriate institutional condition, [19]. Several recent studies suggest that the initially weak or even negative horizontal effects of competitive pressure may become positive over time, as domestic firms adapt and learn from foreign firms, [19]. The Vison 2030 policy framework in Saudi Arabia is making it easier for this learning process to happen. This is because it focuses on changing industries, improving technology, and developing people. Therefore H2a and H2b remain formulated as positive hypotheses because the mechanism of knowledge diffusion remains theoretically relevant, even though competitive effects may slow down or reduce its impact in the short term, [20].

The most recent empirical literature underscores three principal aspects pertinent to this study. First, absorptive capacity, which includes the quality of education, the amount of R&D activity, and the strength of institutions [20], has a big effect on the amount and direction of FDI inflows. Second, when foreign companies work with domestic suppliers and customers in a vertical way, they usually have an easier time sharing technology than when they just compete with each other, [20]. Third, the data's endogeneity and changing nature mean that strong dynamic panel methods like System GMM must be used to get more accurate analysis results, [21]. In the last few years, Saudi Arabia has seen a lot of Foreign Direct Investment, [21], but there still isn't enough real world proof at the company level that technology spillovers happen. The System GMM method requires a firm data driven approach to comprehend the impact of FDI on technological progress, particularly in light of Vision 2030. This is crucial. How does this work?

2.3 Hypothesis Development

The impact of Foreign Direct Investment on firm productivity through capital infusion and knowledge transfer has been acknowledged over an extended period. Evidence from across the globe indicates that Foreign Direct Investment (FDI) has a greater impact on economic growth when an economy has sufficient human capital to adopt advanced technologies, [22]. Through the Vision 2030 reforms, Saudi Arabia is attracting foreign investment however; the extent to which FDI can boost productivity remains an important empirical issue requiring further research. Based on existing studies, this research formulates several hypotheses. FDI is viewed as a channel for the inflow of advanced technology and organizational practices that have the potential to increase efficiency at the firm level. Numerous international studies demonstrate that Foreign Direct Investment (FDI) positively correlates with enhancements in Total Factor Productivity (TFP), especially exhibit adequate absorptive capacity, [22]. In the Gulf region, [23] empirical findings also indicate that FDI inflows can drive productivity growth when supported by policies that strengthen innovation. Considering Saudi Arabia's efforts to improve the quality of human resources and infrastructure, FDI is expected to contribute to increases in both TFP and the labor productivity of domestic firms, [23].

H1a: Foreign direct investment positively influences total factor productivity of Saudi firms.

H1b: Foreign direct investment has a positive effect on the productivity of Saudi companies workers.

Numerous global studies indicate a correlation between Foreign Direct Investment (FDI) and increased Total Factor Productivity (TFP), particularly when domestic firms possess sufficient absorptive capacity. However, empirical evidence is inconclusive certain studies indicate positive horizontal effects, whereas others demonstrate that competitive pressures may diminish productivity in the short term, [23]. Vertical spillovers, which are the sharing pf knowledge and quality standards form MNEs to local suppliers or customers, are more often good, [24]. In Saudi Arabia, supplier development programs and the government's push for local content suggest that vertical linkages are likely to be a key way for technology to be shared.

H2a: Horizontal spillovers from foreign-invested firms positively influence total factor productivity of domestic firms.

H2b: Horizontal spillovers from foreign-invested firms positively influence labour productivity of domestic firms.

H3a: Vertical spillovers from foreign-invested firms positively influence total factor productivity of domestic firms.

H3b: Vertical spillovers from foreign-invested firms positively influence labour productivity of domestic firms.

Domestic research and development (R&D) activities help companies improve their absorptive capacity, which is their ability to find, absorb, and use knowledge from outside sources, [24]. Different empirical studies show that companies that spend more on R&D tend to get more out of technology transfers that are caused by FDI, [25].So, R&D is expected to directly improve productivity and make the spillover effects of FDI even stronger.

H4a: R&D expenditure positively influences total factor productivity of Saudi firms.
H4b: R&D expenditure positively influences labour productivity of Saudi firms.

2.4 Exchange Rate Effects

Changing exchange rates have a significant impact on both the cost of imported goods and the competitiveness of exports, leading to changes in productivity levels. Maintaining a steady appreciation rate can actually promote investment and technology adoption, while simultaneously diminishing export competitiveness. Saudi Arabian exchange rate fluctuations impact corporate productivity, including both labor productivity and Total Factor Productivity (TFP). How does this work?
H5a: Stability in the exchange rate has a positive effect on the total factor productivity of Saudi companies.
H5b: Stability in the exchange rate has a positive effect on the productivity of Saudi firm's workers.
Conceptual Framework

Figure 1 presents the conceptual framework of the study, illustrating how firm productivity is influenced by both external knowledge flows and the firm's internal capacity for innovation. Within this framework, the dependent variables reflect overall production performance as well as the contribution labor to output. International investors are thought to be very important to the market because they ring in new technology and management skills and help local businesses learn more about the market. Horizontal and vertical are the divisions of spillover in this model. Horizontal spillover happens within the same industry when people copy each other, compete with each other, or move jobs. Vertical spillover, on the other hand, happens when foreign companies and local suppliers or customers are linked through their supply chains.

Internally, the spending on R&D is viewed as an important factor that contributes to both innovation and knowledge acquisition, helping companies utilize external resources more effectively. Macroeconomic factors, such as competitiveness, the cost of imported inputs (e.g. How will this affect our economic situation? The structure factors in a company's size and age, its export volume, and the debt it bear to demonstrate variations in scope, experience, global involvement or financial arrangement. As shown in Figure 1, a combination of foreign investment, internal technological efforts, and the firm's structural characteristics determines its productivity.

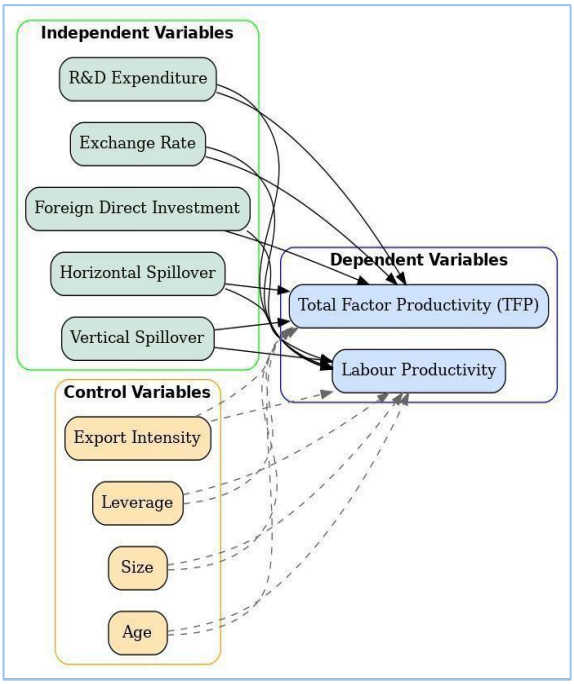

Fig. 1: Conceptual Framework
Source: Author's development

3 Data Source and Methodology

Consistency and reliability are maintained by utilizing secondary data from official Saudi Arabian sources and international databases in this study. Tadawul lists listed non-financial companies from 2015 to 2024, which are provided through the Capital Market Authority and annual reports. It provides financial information for measuring productivity and control variables. The Cobb Douglas production function is a tool for computing Total Factor Productivity (TFP), with output being the definition of output and labor and capital being considered as inputs. By utilizing company reports, the General Authority for Statistics (GASTAT) evaluates labor productivity and measures the value added per worker. The results are then analyzed using industry survey data, [25]. Firms' FDI, including the proportion of foreign equity ownership and annual inflows, are documented by CMA disclosures and the SAGIA database. Input-output tables from GASTAT and industry–level foreign ownership after [25] are used to calculate vertical spillovers, whereas horizontal spill overs correspond to the weighted average of foreign presence within each four-digit ISIC industry to identify their respective characteristics.

3.1 Description of Variables

This is the study of how firms convert inputs to output and captures technological advances that go beyond adding more labour and capital (Table 1).

By using Cobb Douglas production function, it is possible to determine Total Factor Productivity (TFP) from a range of firm data, including value added, capital stock, and employment. [26] propose the method of the estimation to solve for input endogeneity problems. Additionally, the assessment of human capital usage involves the utilization of labor productivity in relation to the actual value added per worker. The measurement is commonly employed to evaluate the utilization of technology and productivity among workers. This also considers several important independent factors of technology transfer.... FDI is the measure of foreign ownership or investment flows, which denotes access to financial resources and advanced knowledge. The weighted average of foreign presence within the four digit ISIC industry is used to calculate horizontal spillovers, which capture knowledge diffusion through competition, labor mobility, and imitation. By utilizing tables of national input output, vertical spillovers are calculated to determine the extent of foreign presence in both upstream and downstream industries. It also captures learning through links between suppliers and buyers, which often have a bigger impact on productivity than horizontal channels, [26]. The amount a company spends on research and development (R&D) shows how innovate it is on the inside and how well it can use and process knowledge from outside sources, [27]. Finally, the exchange rate is proxied by the real effective exchange rate of the Saudi riyal, which affects the cost of imported inputs and export competitiveness, thereby also impacting productivity levels, [27].

Control variables are employed to specify the factors that impact productivity within the firm. Since large firms are able to use economies of scale and easy access to finance for technology adoption, the size is often expressed as the natural logarithm of total assets. Age of a company, on the other hand, shows how much experience it has, which can be good or bad depending on how well the company can change, [28]. Export intensityis measured by the proportion of foreign sales to total sales, reflecting a company's engagement in the global market as well as the learning opportunities derived from export activities, [28]. Leverage, measured as the ratio of total debt to equity, reflects a company's capital structure. The use of a debt at a reasonable level can drive innovation, but if it is too high, it can actually limit investment, [29].

Table 1. Description of variables

Variables	Measurement	Expected Result
Dependent Variables		
Total Factor Productivity (TFP)	Estimated residual from a Cobb–Douglas production function using firm-level value added, capital, and labor.	?
Labour Productivity	Sales revenue divided by number of employees.	?
Independent Variables		
Foreign Direct Investment	Percentage of foreign equity ownership in the firm's total paid-up capital.	Positive: Higher foreign ownership is expected to raise productivity through technology transfer and better management practices.
Horizontal Spillover	Average foreign equity share of other firms within the same 2-digit industry and year (excluding the focal firm).	Positive: Greater foreign presence in the same industry is expected to generate knowledge diffusion and competition-driven efficiency.
Vertical Spillover	Weighted average of foreign ownership in upstream and downstream industries, using input–output tables to construct weights.	Positive: Stronger linkages with foreign-owned suppliers/customers promote technology and quality upgrading.
R&D expenditure	Firm's annual R&D spending as a percentage of total sales.	Positive: Higher R&D intensity fosters innovation and absorptive capacity.
Exchange rate	Annual average SAR per USD.	Ambiguous: Depreciation (higher SAR/USD) may raise export competitiveness (+) but can increase import costs (−).
Control Variables		
Size	Natural log of total assets.	Positive: Larger firms often enjoy economies of scale and more resources for technology adoption.
Age	Years since firm establishment.	Mixed: Older firms may benefit from experience (+) but could face structural inertia (−).
Export intensity	Export revenue divided by total sales.	Positive: Export-oriented firms tend to learn from international markets and improve efficiency.
Leverage	Total debt-to-equity ratio.	Negative or neutral: Excessive leverage may constrain investment in innovation and raise financial risk.

Source: Created by the authors

Together these variables form a comprehensive framework for understanding how FDI and related spillovers in driving technological advancement and corporate productivity in Saudi Arabia.

3.2 Method

Using the GMM system approach, we investigate how foreign direct investment is linked to technology spillovers and firm productivity in Saudi Arabia. System GMM, developed in [30], and refined in [31], is particularly suited for dynamic panel data, particularly when current performance is influenced by past conditions. Firm- level productivity, measured as total factor productivity (TFP) and labour productivity, typically exhibits persistence over time, and explanatory variables such as FDI and R&D expenditure may be jointly determined with productivity. The GMM approach addresses various potential biases by combining models in the form of differentiation and levels. This method also uses lagged values of endogenous variables as instruments to help with problems like multicollinearity, bias from unobserved variables, and measurement error in the estimates, [32]. This approach is particularly effective for dealing with unbalanced panels and heteroscedasticity, which are common issues with firm level data. By utilizing internal instruments, the GMM method is able to produce estimates that are more consistent and effective at capturing dynamic relationships. This step is essential to better understand how Foreign Direct Investment (FDI) and its spillover effects influence productivity in Saudi Arabia.

Before estimating the dynamic panel model, the Augmented Dickey Fuller and Phillips Perron tests were applied to examine the stationary of all variables in the same time series data. This procedure is important because non stationary data can produce unreliable or biased estimation results. The Augmented Dickey Fuller test is a modified version of the Dickey Fuller examination that employs higher order autocorrelation. However, the Phillips Perron test does not use parametric regression to examine autocorrelation and heteroscedasticity. Both tests are effective in revealing the correctness of stationarity a prerequisite for valid inference in panel estimations and cointegration analysis.

Given that some variables may be integrated of order one, the study also applies panel cointegration tests to examine whether a long-run equilibrium relationship exists among productivity, FDI, and technological spillover variables. Cointegration is essential because it ensures that the variables are stationary, despite each variable being non-stationary. This guarantees a steady relationship between the two variables, [33]. Detecting cointegration supports the use of a dynamic specification and justifies interpreting GMM results as capturing both short- and long-run effects of FDI and R&D on productivity.

The empirical specification is expressed as:

$$TFP_{it} = \alpha_0 + \beta_1 TFP_{it-1} + \beta_2 FDI_{it} + \beta_3 Horizontal\ Spillover_{it} + \beta_4 Vertical\ Spillover_{it} + \beta_5 R\&D_{it} + \beta_6 Exchange\ Rate_{it} + \beta_7 Size_{it} + \beta_8 Age_{it} + \beta_9 Export\ Intensity_{it} + \beta_{10} Leverage_{it} + \varepsilon_{it} \quad (1)$$

$$\text{Labour Productivity}_{it} = \alpha_0 + \beta_1 Labour\ Productivity_{it-1} + \beta_2 FDI_{it} + \beta_3 Horizontal\ Spillover_{it} + \beta_4 Vertical\ Spillover_{it} + \beta_5 R\&D_{it} + \beta_6 Exchange\ Rate_{it} + \beta_7 Size_{it} + \beta_8 Age_{it} + \beta_9 Export\ Intensity_{it} + \beta_{10} Leverage_{it} + \varepsilon_{it} \quad (2)$$

In the above models, α0 stands for intercept, i represents the firm, t stands for the time. TFPit-1 is the one period lagged for the dependent variable. ε indicates the error term in both models.

In Equation (1), the dependent variable is TFP, and in Equator (2), it is LP, which is also connected to Labour Productivity. The lagged dependent variable is used in each model to indicate the existence of persistence, where past behavior influences the present state. Transferring technology, management, and market knowledge through FDI is expected to enhance productivity. Horizontal spillovers reflect learning within the same industry through imitation, competition, and labour mobility, whereas vertical spillovers capture gains transmitted through supply-chain linkages with foreign-invested firms. R&D spending is treated as an internal factor that drives innovation while enhancing a company's ability to absorb external knowledge. Exchange rates show how the economy is doing on a large scale, which affects costs and competitiveness. This model includes control variables such as firm size and firm age, intensity of exports, and leverage to demonstrate differences based on business size, business experience, internationalization of the business, and financial structure. Lagged dependent variables are considered endogenous variables in GMM estimation. Variables such as foreign direct investment, horizontal and vertical spillovers, R&D, firm size, export intensity, and leverage are also considered endogenous or predetermined due to potential bidirectional relationships. Conversely, the exchange rate and firm age are treated as exogenous because they are not directly influenced by short term productivity fluctuations. Internal instruments are used starting from the second lag for endogenous variables, with a limit on the number of instruments to avoid overfitting.

4 Result and Analysis

Table 2 (Appendix) gives a brief summary of the most important variables for 730 firm–year observations. The average total factor productivity (TFP) is 1.56 (SD = 0.12) with a range from 1.23 to 1.91. The average labour productivity is 52.29 (SD = 6.51) and varies substantially between 28.36 and 71.98. The FDI has an average foreign equity stake in the FDI is 29.31% (SD=13.70), with a range of 2.56% to 77.62%. This means that the level of foreign ownership varies from one company to the next. The foreign presence in the industry is spread out fairly evenly, with horizontal spillovers averaging 29.31% (SD = 4.16) and vertical spillovers averaging 30.31% (SD = 2.49). Firms spend a relatively small amount on R&D, with an average of 1.34% of sales (SD = 1.19), but some firms spend as much as 6.58%. The exchange rate stays very stable, with a center point of 3.75 SAR/USD (SD = 0.02), which is in line with the currency of Saudi Arabia.

Control variables show different things that make conditions different between companies. Firm size is measured using the logarithm of total assets, with an average value of 7.77 (SD = 0.73) and a range between 5.12 and 8.75. The mean firm age is 34.35 years, reflecting a mix of relatively young and well established companies. Export intensity has an average of 0.31 (SD = 0.20), with values varying widely from 0.003 to 0.94. meanwhile, the average level of financial leverage is 1.02 (SD = 0.73), ranging from 0 to 3.50. The correlation matrix for all explanatory variables is presented in Table 3 (Appendix). The coefficients are all low and none are higher than 0.09, which means there are no problems with multicollinearity. Foreign direct investment (FDI) shows only weak positive associations with horizontal spillovers and R&D (r = 0.064 each) and negligible links with other variables. The highest negative correlation is between leverage and export intensity (r = –0.074), while firm size and age display a modest positive relationship (r = 0.068). A low correlation shows that the independent and control variables are different enough that the GMM system's estimates are more reliable.

The GMM estimates in Table 4 (Appendix) indicate that all main variables have a positive and significant effect on firm's TFP in Saudi Arabia. Foreign Direct Investment also has a strong impact, suggesting that foreign ownership enhances firms' technological capacity and efficiency, [34], [35]. Horizontal and vertical spillovers also show a positive and significant effect, indicating that domestic firms benefit from both intra industry competition and supply chain linkages, consistent with findings in various developing countries.

Absorptive capacity is crucial in translating external knowledge into productivity improvements, and internal innovation capacity through R&D expenditures drives TFP growth. Productivity is boosted by the exchange rate, which has been shown to have a positive impact on Total Factor Productivité (TFP) due to the stability of the Saudi riyal and macroeconomic factors. This is backed up by these findings. Larger companies' TFP is a crucial factor in their success due to their ability to adopt new technologies more efficiently and gain scale advantages. In addition, firm age is positively associated with TFP, meaning that older firms benefit from years of experience and ongoing education. Exporting TFP through intensity of exports indicates participation in international markets improves efficiency by increasing competitive pressure and expanding access to information, [33]. Also, in Saudi Arabia, TFP is positively linked to financial leverage, which suggests that appropriate debt utilization can promote productive investments like upgrading technology and equipment while minimizing performance impact. These findings suggest Saudi Arabia's private sector productivity growth is not primarily the result of foreign investment, but rather spillover effects, innovation capacity and firm-level resources. The results reinforce the view that Foreign Direct Investment can generate long-term productivity gains when supported by favorable conditions the host country, particularly in terms of innovation, supply chain integration, export participation, and access to financing.

Table 5 (Appendix) reports the results for labor productivity and highlights a limited number of significant factors. Horizontal spillovers are not statistically significant, suggesting that simply being exposed to foreign competitors within the same industry does not necessarily lead to improvements in worker level output.

In contrast, vertical linkages show a positive and significant effect on labor productivity. This implies that connections within the supply chain , especially with foreign firms facilitate the transfer or more advanced production techniques and management practices, ehich in turn enhance employee efficiency.

Firm level R&D spending is also found to have a positive and significant effect, highlighting the crucial role of internal innovation and absorptive capacity in improving individual productivity. Meanwhile, other control variables such as exchange rates, export intensity, and leverage do not

show statistical significance. This suggests that after accounting for technology diffusion, innovation activities, and key firm characteristics, broader macro financial factors and export exposure do not independently explain differences in worker level productivity within this sample. However, this does not mean that these factors are irrelevant in all contexts. Instead, it indicates that their direct influence on labor productivity is relatively weaker compared to factors likes supply chain based learning, investment in innovation, and firm size in the case of Saudi firms. In general, the results indicate that vertical technology spillovers, internal R&D efforts and organizational scale drive labor productivity improvements, but employee output level changes are not as important due to wider foreign presence within the same industry and general financial conditions.

5 Discussion

In Saudi Arabia, the positive impact of Foreign Direct Investment (FDI), technology spillovers, and firm specific characteristics is a major factor contributing to productivity growth. The positive and significant effects of FDI, horizontal and vertical spillovers, R&D investment, exchange rate stability, firm size and age, export intensity, and leverage are all linked to the total factor productivity. This underscores the significance of foreign investment and knowledge transfer in enhancing both managerial performance and technological proficiency. In contrast, labor productivity is influenced by a smaller number of variables. The positive impact of vertical spillovers, R&D, and firm size is limited by the fact that most macroeconomic variables are not analyzed statistically, while improvements in labor productivity are primarily determined by technology transfer or worker continuous learning. The distinction is evident in the findings. The outcomes are also in line with studies conducted in other countries, which indicate that FDI can boost productivity by facilitating the transfer of advanced technology and management practices. This vertical spillover effect is a positive example of how supply chain linkages can contribute to strengthening domestic capacity. In spite of this, the impact of horizontal spillover effects on labor productivity is not as substantial as observed in other areas. It is possible that this is due to the segmented nature of Saudi Arabia's labor market, which relies heavily on foreign workers. Limiting productive exchanges within the identical field as compared to those throughout the supply chain.' In addition, although experience is generally believed to enhance performance (although it may not be the case as long as other factors like organizational inertia are taken into account), the mixed relationship between firm age and labor productivity suggests that older firms may struggle to adopt new technologies.

Overall, the findings suggest that Saudi firms will experience significant productivity boosts if they can secure foreign direct investment through R&D investment, adequate firm size, and effective supply chain integration. In other words, the presence of foreign capital alone is not enough, domestic companies need to strengthen their absorption capacity and organizational flexibility to be able to transform external knowledge into long term efficiency. These results can be used to make a number of policy suggestions, such as making the innovation ecosystem stronger, encouraging Research and Development (R&D) cooperation between domestic and multinational companies, and training workers to be able to keep up with new technologies.

The results align well with the study's theoretical foundations. Findings that show innovation and the accumulation of knowledge are important for long term productivity support Endogenous Growth Theory. The positive impacts of vertical and horizontal spillovers affirm the Knowledge-Spillover Theory, illustrating how foreign participation generates industry- and supply-chain learning effects. Ultimately, the substantial amount of money spent on R&D lends credence to the Absorptive Capacity Theory, which asserts that firms must prioritize their own innovation potential in order to leverage external expertise.

6 Conclusion

6.1 Conclusion

The impact of Foreign Direct Investment (FDI) and technology spillovers on firm productivity in Saudi Arabia is explored through the use of a dynamic panel model using the GMM approach. According to the study, FDI's impact on TFP is significant and statistically significant. It also suggests that vertical linkages can enhance labor productivity through foreign ownership. The effects of spillovers (horizontal and vertical) are found to be significant in TFP, but only the vertical spill over demonstrate a significant impact on labor productivity. Furthermore, research and development expenditure is consistently more effective than other productivity-related factors, with the absorptive capacity serving as the primary factor in converting

external knowledge into quantifiable results. Additionally, The results also highlight the significance of firm-specific traits in determining productivity performance.

Generally, larger companies are better at exploiting economies of scale when adopting new technologies, while older firms tend to increase their Total Factor Productivity (TFP). Organizational rigidity can have a detrimental effect on their productivity due to labor imbalances. Firms' ability to compete is aided by stable exchange rates in TFP, while export intensity and leverage have narrower or less significant influence.

Utilizing firm-level data from a resource-based economy that is currently transitioning, this study provides primarily interdisciplinary analysis of how the spread of technology through foreign investment (FDI) affects both TFP and labor productivity. Many previous studies have focused on aggregate or sectoral data, but this study presents more intricate and nuanced patterns. While horizontal spillovers can improve technological efficiency, they do not directly impact labor productivity. The impact of firm age is influenced by the productivity level being examined. These findings provide further evidence for the importance of Endogenous Growth Theory, knowledge spillover theory, and absorptive capacity concept in Saudi Arabia. They propose that policy efforts should not solely focus on attracting Foreign Direct Investment, but also prioritize strengthening research and development collaboration and improving supply chain integration. Effective productivity enhancements can be achieved at both the firm and workforce levels through this approach.

6.2 Policy Recommendations

These findings have important implications from the theoretical, methodological and policy viewpoints. Based on Endogenous Growth Theory and knowledge spillovers, the results are supported by a distinct differentiation between their effects on TFP and labor productivity. Horizontal spillovers do not necessarily improve labor efficiency, as TFP can be improved but each productivity indicator depends on which channel of technology diffusion is used. Moreover, the idea of firm age as a measure of TFP (tame labor productivity) presents an alternative perspective on absorption capacity, where acquired experience does not necessarily guarantee equal privilege due to the amount of knowledge gained by individuals.

The development of diversified economies that heavily depend on oil industry data is made possible by the use of GMM-based system using firm level panel data. The use of dynamic GMM, unit root analysis, and cointegration tests provides a robust means of determining the short and long-term effects of foreign direct investment on various productivity measures. Resource-based economies may benefit from this method in future empirical research due to factors like endogeneity and persistence. The data indicates that attempting to attract Foreign Direct Investment alone won't result in substantial productivity increases. Instead, policies should focus on strengthening vertical links: such as developing local suppliers, integrating local content requirements with technology transfer, and supporting industry-focused research and development collaboration. The benefits of foreign investment can be shared among employees through these measures.. Foreign research and development requires tax incentives and innovation support to enable firms in absorbing new knowledge. Why? If organizations can be made more flexible, it is necessary to implement programs that enhance workforce skills, given the impact age has on productivity.

Both of these implications are closely tied to the success outlined in Goal 8 of the Sustainable Development Goals, which prioritizes economic growth and productive employment, and either (1) (GOG 9) prioritized infrastructure development, innovation, or industrial development. By aligning foreign investment with the 2030 development agenda, Saudi Arabia is demonstrating its ability to foster economic diversification through innovation and human capital growth for sustainable progress.

6.3 Limitations and Future Research Directions

The data collected for this study is based on firm level data obtained from publicly listed companies in Saudi Arabia, but it may not be indicative of small and medium sized enterprises (SMEs) or privately owned firms. There can be significant differences in technology transfer and the effects of Foreign Direct Investment (FDI) in these industries. The system GMM method can handle some problems, such as endogeneity and dynamic relationships, but it's challenging to identify the specific channels that technology is transferred, like labor mobility or joint ventures. Hence, it is not easy to comprehend the specific mechanisms responsible for these spillover effects.

Future studies can be developed from at least two perspectives. The inclusion of more extensive data from small and medium-sized (SMEs) and non-listed companies will enable us to better comprehend the impact of FDI on the economy.

Additional data regarding dissemination of knowledge and technology could be obtained through surveys conducted at the company level or matched information between firms/trained personnel.

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APPENDIX

Table 2. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
TFP	730	1.563	.117	1.226	1.912
Labour Productivity	730	52.292	6.51	28.36	71.98
Innovation Output	730	.584	.742	0	4
FDI	730	29.311	13.696	2.56	77.62
Horizontal Spillover	730	29.311	4.159	18.524	40.626
Vertical Spillover	730	30.314	2.492	25.36	35.581
R&D	730	1.344	1.189	0	6.584
Exchange Rate	730	3.749	.02	3.669	3.802
Size	730	7.772	.733	5.124	8.747
Age	730	34.349	16.545	1	69
Export Intensity	730	.307	.196	.003	.939
Leverage	730	1.016	.726	0	3.503

Source: Created by the authors

Table 3. Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FDI	1.000								
Horizontal Spillover	0.064	1.000							
Vertical Spillover	0.032	0.033	1.000						
R&D	0.064	0.087	-0.090	1.000					
Exchange Rate	-0.005	-0.033	-0.043	0.022	1.000				
Size	0.047	-0.022	-0.012	0.034	-0.009	1.000			
Age	-0.026	0.042	0.063	0.005	-0.023	0.068	1.000		
Export Intensity	-0.012	-0.060	0.004	0.012	-0.043	0.057	-0.037	1.000	
Leverage	-0.064	-0.058	-0.074	0.002	-0.042	-0.035	-0.018	-0.074	1.000

Source: Created by the authors

Table 4. Regression results of GMM

Total Factor Productivity	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
FDI	.005	0	23.73	0	.004	.005	***
Horizontal Spillover	.007	.001	8.82	0	.006	.009	***
Vertical Spillover	.007	.001	4.91	0	.004	.01	***
R&D	.026	.003	9.40	0	.021	.031	***
Exchange Rate	.312	.035	8.85	0	.243	.381	***
Size	-.035	.015	-2.30	.021	-.065	-.005	**
Age	.002	.001	3.61	0	.001	.003	***
Export Intensity	-.015	.009	-1.62	.105	-.033	.003	
Leverage	-.002	.003	-0.60	.551	-.008	.004	

Mean dependent var	1.557	SD dependent var	0.116
Number of obs.	657	Chi-square	137648.186
Number of Instruments	49		
Sargan	0.1588		
Hansen	0.2157		
AR (1)	0.0000		
AR (2)	0.8621		

**** p<.01, ** p<.05, * p<.1*
Source: Created by the authors

Table 5. Regression results of GMM

Labour Productivity	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
FDI	.062	.018	3.45	.001	.027	.097	***
Horizontal Spillover	.008	.069	0.12	.905	-.128	.144	
Vertical Spillover	.237	.108	2.20	.028	.026	.448	**
R&D	1.153	.201	5.72	0	.758	1.547	***
Exchange Rate	2.793	4.55	0.61	.539	-6.126	11.711	
Size	3.585	2.049	1.75	.08	-.431	7.602	*
Age	-.162	.049	-3.32	.001	-.257	-.066	***
Export Intensity	.961	1.032	0.93	.352	-1.063	2.984	
Leverage	.445	.276	1.61	.107	-.096	.986	

Mean dependent var	52.221	SD dependent var	6.479
Number of obs.	657	Chi-square	2333.735
Number of Instruments	49		
Sargan	0.3925		
Hansen	0.1392		
AR (1)	0.0000		
AR (2)	0.6467		

**** p<.01, ** p<.05, * p<.1*
Source: Created by the authors

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The authors equally contributed to the present research at all stages, from the problem formulation to the final findings and solution.

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Conflict of Interest

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