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FOREIGN DIRECT INVESTMENT AND SPILLOVER EFFICIENCY IN THE DEVELOPING COUNTRIES

Key Words

Foreign Investment; Spillover of Efficiency; Effect of FDI; FDI in Developing Countries; Production Function; Technical Efficiency.

Abstract

This paper examines, within a new growth theory framework, the efficiency effect of foreign direct investment (FDI) for forty-four developing countries. The paper tests an interesting hypothesis advanced by many writers in international investment theory, such as Bhagwati and Das, who suggests a positive relationship between the level of FDI and technical efficiency. The model used to test the hypothesis is derived, in conventional manner, from a production function. Application of the stochastic frontier function and the distribution-free model makes this study one of the most sophisticated empirical tests of the efficiency effect of FDI in the literature. The empirical results, ceteris paribus, confirm the relative technical efficiency of developing countries that have high FDI exposure.

Introduction

Although the role of FDI in improving the technical efficiency of developing countries' economies has long been a topic of intense debate, there is very little empirical analysis of the issue. Almost all econometric studies, new and old, analyze linkages between foreign investment and technical efficiency in the context of developed countries (see Mohen [1990] and Griliches [1992] for recent review). The most recent empirical test of the efficiency effect of FDI in the developing countries is the 1995 study by Kholdy, in which he examined the spillover efficiency effect for five developing countries. In addition, several case studies have investigated the effect of FDI on the economic efficiency of a host developing country. These studies include Blomstrom and Persson (1983), Blomstrom (1986), Willmore (1986), Ferrantino (1992), and

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Athukorala and Menon (1995). The findings of these studies are not conclusive, possibly due to lack of a conceptual design and a succinct, testable hypothesis. However, recent developments in growth theory, styled endogenous growth theory, and the recent advancement in efficiency measures provide such a conceptual framework for analyzing the impact of FDI on the technical efficiency of the developing countries' economies.

What policy measures should a developing country adopt regarding FDI? Should a developing country liberalize its foreign trade to attract more FDI, or should it rely more heavily on its indigenous capabilities to achieve high economic growth? These questions deserve a more thorough analysis at a time when multinationals have become one of the most important means of transferring resources across national boundaries, and when it is generally agreed that technology is a key determinant of economic growth, international competitiveness, and trade performance.

The purpose of this empirical study is to analyze the relationship between the levels of FDI exposure and the magnitude of technical efficiency in the developing countries in the context of new growth theory. An interesting hypothesis proposed by Bhagwati (1978) and Das (1987) captures the essence of the efficiency effect of FDI. The hypothesis relates the volume of FDI to the magnitude of the economic efficiency of the host developing countries. Both Bhagwati and Das concluded that the rate of increase in economic efficiency is positively related to the level of FDI.

The empirical measurement of efficiency is derived from the concept of the frontier production function, first introduced by Farrell (1957) and more rigorously developed in recent years by Haung (1984) and Al-Obaidan and Scully (1995). In this paper a maximum likelihood stochastic frontier function and a distribution-free model are estimated. A theoretical analysis is presented in Section II. Technical efficiency is defined as producing a given output with the cost-minimizing input ratio. The gain from FDI inflows is conceived of as increased technical efficiency of the resources in the economy. Data and variable construction are discussed in detail in Section III. The empirical results, which are discussed in Section IV, suggest, ceteris paribus, that technical efficiency is approximately 9 percent greater in developing countries with high levels of FDI as opposed to developing countries with low FDI exposure.

Theoretical Paradigm of the Efficiency Effect of FDI

The new growth theory as presented by Pack (1994) has significant implications for hypotheses concerning the economic effect of FDI. The various forms of growth-promoting factors identified by the new growth theory can be utilized to promote economic efficiency and growth through FDI. The theory suggests that growth-promoting factors embodied in knowledge/externality of FDI inflows of both human and physical assets can be used to enhance the technical efficiency of resources in a host developing country. Consequently, the increase in production factors, in the aggregate, may not be subject to diminishing return. Thus, the new growth theory suggests that domestic physical and human assets of a host developing country may grow beyond the level suggested by the neoclassical model (the Solow model). Hence, the theory utilizes FDI flows of knowledge/externalities to expel the assumption of diminishing return to scale of aggregate inputs that the neoclassical model emphasizes. Accordingly, the increase in domestic production factors of a host developing country, in the aggregate, enhances technical efficiency and therefore increases gross domestic product (GDP) growth. However, the new growth-theory argument implies that returns to a single private investment may diminish. Therefore, the theory proposes that the diversion between social and private returns is attributed to the enhanced technical efficiency that results from the accumulation of new knowledge brought by FDI inflows. Thus, endogenous growth theory provides compelling reasons to link knowledge, investment in human resources, and scale economies to economic efficiency and growth.

It is well known that the principal gains from FDI stem from the potential benefits resulting from the inflow of productive investment and improved technological and managerial capabilities. Those inflows may increase the international competitiveness of the human assets and capital stocks of the host developing countries. Thus, writers in international investment theory such as MacDougall (1960), Hood and Young (1979), Globerman (1979), Dunning (1981), Caves and Jones (1981), and Caves (1982), suggest that direct investment can make considerable contributions to the host economy through the supply of capital, technology, and management. To the extent that such inputs are scarce locally, foreign investment may make it possible to enhance labor and capital productivity. The presence of efficient firms that are competitive on world markets can provide a potentially important channel for transferring technological and managerial skills to host countries.

On the other hand, multinational corporations (MNCs) are reluctant to share their advanced technology and / or intellectual property with a local partner in the host country. This is because they have invested heavily to obtain such intangible assets. Several empirical studies (Caves 1974, Wolf 1977, Dunning1980, and Morck and Yeung (1992) are examples) have included measures of advertising and research and development expenditures in regression analysis as proxies for intangible assets. Furthermore, Morck and Yeung (1991) used advertising expenditures as a proxy for consumer goodwill and research and development expenditures as a proxy for a firm's technical expertise. Those empirical studies found that advertising expenditures and research and development expenditures are all positively related to a firm's FDI activities. The transaction cost theory (Coase, 1937) suggests that firms establish foreign subsidiaries abroad because of the inadequacy of the market as a device in placing value on tangible or intangible assets produced by the firm. This results from the existence of opportunism, bounded rationality, and information impactedness, which may make a contingent-claims contract that is aimed at benefiting from ownership-specific advantages by transmitting tangible or intangible assets through subcontracting agreement difficult to draft, monitor, and enforce. Thus, MNCs have a vested interest in maintaining complete control over their products. This is done through product differentiation and FDI via an affiliate rather than a joint venture or licensing arrangements. However, although MNCs exhibit those characteristics they may facilitate the technology transfer to developing countries. This can take place within a particular industry, where suppliers of inputs to a foreign affiliate, domestic users of an affiliate's output, and competitors may be induced to adopt more efficient techniques. The FDI benefits may also spill over more generally within the economy. This may be accomplished through an eventual improvement in level of training and the technical know-how of the labor force, and through the possible encouragement of new arrangements of various financial, commercial, and service support industries that can lower all industrial costs. Furthermore, FDI by multinational enterprises may make a contribution to filling the resource gap in the host economy between desired investment and domestic savings. This is because multinational enterprises, by virtue of their large average size, have access to enormous financial resources for investment. Moreover, FDI may mobilize local savings by offering attractive investment opportunities in host countries' capital markets; without such foreign investment, these sources may remain idle or be utilized in less productive ventures. Furthermore, FDI may stimulate additional foreign investment from other foreign entities, which enables the host developing countries to reduce the resource gap further.

Koizumi and Kopecky (1977), Bhagwati (1978), Findlay (1978), Das (1987), Wang (1990), and Wang and Blomstrom (1992) also investigate the theoretical literature on technology transfer through FDI. In this framework, the level of knowledge is itself a productive factor that depends on levels of investment. Moreover, each firm learns from the investment activity of other firms as well as its own investment behavior. The technical efficiency of a host developing county's economy is thus assumed to be an increasing function of the cumulative aggregate of the level of FDI. MNCs are assumed to possess superior technological knowledge, and the technologies transferred are "public goods" in nature. Bhagwati adds that the exploitation of the potential knowledge provided by FDI requires a conducive economic climate. He suggests that the principal virtue of the export-promoting (EP) strategy, with its emphasis on neutrality of policy between the import and the export sectors of the economy, is that it permits the allocation of national resources to their highest attainable utility function. Therefore, Bhagwati argues that a liberal trade regime (EP), as opposed to a projectionist regime (a regime that adopts import substitution policies), is likely to provide an appropriate environment for a greater volume of FDI flows, greater technical efficiency, and hence greater economic growth. Therefore, the theoretical research on FDI suggests that there is a positive relationship among the level of FDI, trade policy, and the magnitude of the technical efficiency of a host developing country's economy. Thus, developing countries that liberalize their foreign trade may achieve the following: (1) attract a higher level of FDI flows and (2) enjoy greater technical efficiency. The first of these two dimensions has received empirical support (see Balasubramanyam and Salisu, 1991). In this paper I test the second component, namely, technical efficiency is greater in countries with high levels of FDI.

Data and Variable Construction

Stochastic Specification

Technical inefficiency is the result of the systematic choice of a suboptimal production plan. Empirical measurement of technical inefficiencies hinges on the ability to separate random errors from the systematic error component. This can be accomplished by specifying a particular distribution for the systematic error term. The stochastic frontier function utilizes a half-normal distribution under the assumption that technical inefficiency is an asymmetric and increasing, but never decreasing, cost component. In contrast, the distribution-free model notes that random errors should average out over time, leaving a systematic component assumed to be time-independent. Both measures of inefficiencies were estimated with no difference in the conclusion.

Stochastic Frontier Function

A stochastic frontier function, as proposed by Aigner *et al* (1977), assumes that the observed frontier deviates from the efficient frontier by a random noise, v_i, and an inefficiency component, u_i . Thus, the observed frontier function is:

$$\ln Q_i = f(Ki, Li) + \varepsilon_i \qquad (1)$$

where

$\varepsilon_i = u_i + v_i$

v_i = Statistical noise; distribution normal $(0, \sigma^2)$

u_i = one-sided inefficiency measure, distributed half-normally.

Q_i = output

K_i = capital stock

L_i = number of labor

The log-likelihood function is given by :

$$\ln L = \tfrac{N}{2}\ln\tfrac{2}{\pi} - N\ln\sigma - \tfrac{1}{2\sigma^2}\sum_{i=1}^{N}\varepsilon_i^2 + \sum_{i=1}^{N}\ln\left[\phi\left(\tfrac{\varepsilon_i\lambda}{\sigma}\right)\right]$$

where N = number of countries. Jondrow *et al.* (1982) shows that the ratio of variability,σ, can be used to measure a country's mean inefficiency, where $\sigma = \left[\sigma_u^2 + \sigma_\nu^2\right], \lambda = \sigma_u/\sigma_\nu, \phi(\bullet)$ is the standard normal density function and Φ is the standard normal cumulative distribution. Inefficiency measures are derived for all years for the complete sample as follows:

$$E(u_i \setminus \varepsilon_i) = \left[\tfrac{\sigma\lambda}{1+\lambda^2}\right]\left[\frac{\phi(\frac{\varepsilon_i\lambda}{\sigma})}{\Phi(\frac{\varepsilon_i\lambda}{\sigma})} + \frac{\varepsilon_i\lambda}{\sigma}\right]$$

Distribution-Free Model

Berger (1993) avoids the strong distribution assumptions of the stochastic frontier function by introducing a distribution-free model. An advantage of this method is that it allows the coefficient to vary over time. The observed frontier equation is :

$$Q_{it} = f(K_{it}, L_{it})\ ut\ \nu_t \qquad t = 1...T; \qquad (2)$$

Thus, in this equation, u_t, the systematic error component, is a multiplicative inefficiency factor. Taking the logs, we obtain:

$$\ln Q_{it} = \ln f(K_{it}, L_{it}) + \ln u_t + \ln \nu_t \quad (3)$$

where the variables are similar to those defined for equation (1). Only the u_t remains fixed over time, while the rest of the coefficients and variables vary. For each country and time period, t, an average of the residuals for all periods is estimated, denoted $\ln u_i$. This average is an estimate of $\ln u_t$, assuming that random errors will cancel out over the covered periods. The estimated average residual is then transformed into a measure of inefficiency as follows:

$$INEFF_{it} = \exp(\min(\ln u_t) - \ln u_{it})$$

Where $\min(\ln u_t)$ is the minimum $\ln u_{it}$ for the period of estimation t.

Functional Specification

Economies can be thought of as large firms. Just as the efficiency of firms is affected by the introduction of advanced technology, so is the efficiency of economies. Economies or nations determine the level of FDI through a wide range of trade and investment incentives and/or regulations in which individual economic actors seek to utilize the prevailing investment opportunities. The increased FDI has consequences for the allocation of resources (efficiency) in the economy.

The effect of an increase in the productivity of inputs depends on how resources are utilized in the economy. For equal rates of capital and labor formation, economies that are able to utilize the prevailing FDI opportunities will enhance the productivity of their capital stocks and human assets. On the other hand, reduction or elimination of FDI opportunities may lead to under-utilization of the nations' capital stocks and human assets, which will lead to transforming inputs into output relatively inefficiently. One or more of the economies in the sample will have values of labor inputs that are less than those of other economies with similar values of the input ratio. These economies are the most technically efficient in transforming inputs into output.

Most empirical studies in this literature postulate a simple neoclassical production function, homogeneous and of degree one in inputs [see, for example, Goldar (1986), Ahluwalia (1991), Basant and Fikkert (1993), and Al-Obaidan and Scully (1995)]. Thus, following Al-Obaidan and Scully [1995] let the economy be described by the homothetic production fubction1,

$$Qe^{f(Q)} = AK^{\alpha} L^{1-\alpha} = A\beta^{\alpha} L, A > 0, 1 > \alpha > 0, \beta = K/L, \quad (4)$$

where Q represents output; K and L, respectively, represent the amounts of capital and labor inputs, and A and

α are parameters. The function $f(Q)$ is assumed to be a continuous convex function of Q with a minimum point for some positive Q^*. Therefore, the function exhibits economies of scale up to Q^* followed by a range of diseconomies of scale. By dividing both sides of equation (4) by Q and rearranging, the production function can be written as a unit output function:

$$l = F(Q)k^b, \qquad (5)$$

where $l = L/Q$, $k = K/Q$, $F(Q) = Ae^{-f(Q)}$, and, $b = \alpha/(1-\alpha)$.

Cost minimization requires that the marginal rate of technical substitution, given as the ratio of the marginal products of the inputs, equals the factor price ratio, r/w. Thus, the cost minimizing input ratio is given as:

$$\beta^* = \alpha\, w/(1-\alpha)r. \qquad (6)$$

Consider an observation (Q_1, β_1, L_1) of an economy producing subject to the frontier production function given by equation (4). While cost minimization requires output of Q^* and an input ratio of β^* and while frontier production technology requires a labor input of $L^*(Q^*, \beta^*)$, where $L^*(\bullet)$ satisfies equation (4) for Q^* and β^*, the economy produces output Q_1 using input ratio β_1 and labor input L_1. To the extent that these observations differ from the ideal values (Q^*, β^*, L^*), inefficiencies arise.

Technical (or managerial) inefficiency occurs whenever the observed labor input, L_1, exceeds the minimum required for output Q_1 and input ratio β_1. Technical inefficiency, TE, is measured as the ratio of the average cost of producing Q_1, using β_1 and $L^*(Q_1,\beta_1)$ to the average cost of producing Q_1, using β_1 and L_1.

$$TE(Q_1,\beta_1,L_1) = [(w + r\beta_1)L^*(Q_1,\beta_1)/Q_1]/[(w + r\beta_1)\ (L_1/Q_1] = L^*(Q_1,\beta_1)/L_1 \qquad (7)$$

Thus, technical efficiency is that fraction of all inputs utilized (expressed as labor inputs, since β is constant), if the best practice management is employed. When $L_1 = L^*(Q_1,\beta_1)$, technical efficiency is at a maximum, equal to unity. As managerial efficiency declines, L_1 rises relative to $L^*(Q_1,\beta_1)$, and TE falls below unity.

Data and Variables

The cross-country economic data employed in this study comes mainly from four sources. First, Glen and Sumlinski, the World Bank, and International Finance Corporation published "Trends in Private Investment in Developing Countries 1995." The manuscript provides internationally comparable time series economic data over the period 1982-1993. Data on GDP and domestic investment as share of GDP was obtained from "Trends in Private Investment in Developing Countries 1995." Second data on population and the national currencies of the countries in the sample per U.S.

dollars was obtained from the Statistical Yearbook. Third, data on net FDI in U.S. dollars for each country in the sample was obtained from "World Debt Tables." Forth, data on total labor force for each country in the sample was obtained from The EUROPA World Yearbook."

The status of FDI exposure for every country in the sample is determined after a thorough investigation of the nature and the characteristics of the economies of the countries included in the sample. First, net FDI data over the period 1982-1993 is examined. Naturally, the data reflects levels of net FDI for every country in the sample. Countries that encourage FDI have relatively high and positive net foreign investment values; countries that discourage FDI have low or zero or negative (divestment) net foreign investment values. Second, the criterion of the status of foreign investment exposure variable is determined. The mean value of the net FDI investment variable is calculated for each country in the sample for the period 1982-1993. A country is judged to have relatively high FDI exposure if the net FDI variable of the country is greater than its calculated mean value. Therefore, a high status of FDI exposure is based on a relatively higher growth rate of net FDI follows than is a low status of FDI exposure. Accordingly, a dummy variable is used to reflect the country's FDI exposure status. The variable is equal to unity for economies that have high FDI exposure status and zero for economies that have low or zero or negative FDI exposure status. Moreover, the use of the variance of the net FDI flows variable, as a proxy for the country's FDI level does not materially change the empirical results. Thus to conserve space, only the results of the dummy variable are reported.

The annual data series on GDP, and the percentage of GDP devoted to domestic investment provide the basic data for the construction of the capital stock series. The annual series of GDP is the output variable used in this empirical study. The country's population is used as a proxy for the economically active population. Furthermore, the use of total labor force as a proxy for the economically active population does not materially change the empirical results. Thus, to conserve space, only the results of the population variable are reported.

A pooled cross-country and time series sample of 44 economies for the period 1982-1993 (complete N = 465) is utilized in this study (see Table 1). The sample included all the developing countries contained in the manuscript published by the World Bank and International Finance Corporation. Using the mean value of the net FDI variable as a cut-off point, 182 cases are judged to have high FDI levels, and 286 cases are judged to

Table 1
Developing Countries in the Sample, 1982-1993.

Countries	
1. Argentina	23. Madagascar
2. Bangladesh	24. Malawi
3. Belize	25. Malaysia
4. Bolivia	26. Mali
5. Brazil	27. Mauritius
6. Chile	28. Mexico
7. Colombia	29. Morocco
8. Costa Rica	30. Namibia
9. Cote d'Ivoire	31. Nepal
10. Dominican Republic	32. Nigeria
11. Ecuador	33. Pakistan
12. Egypt	34. Panama
13. El Salvador	35. Papua New Guinea
14. Fiji	36. Paraguay
15. Ghana	37. Peru
16. Guatemala	38. Philippines
17. Guinea	39. Sri Lanka
18. India	40. Thailand
19. Indonesia	41. Tunisia
20. Iran	42. Turkey
21. Kenya	43. Uruguay
22. Korea	44. Venezuela

have low or zero or negative FDI levels.

Finally, the construction of a disaggregated production function containing variables that reflect economic factors that may influence the efficiency of the allocated national resources within the developing countries in the sample (such as the appropriateness of the investment incentive packages designed to attract FDI, the level of local competition, the level of local technical skills, and the relative input and output prices in the host developing countries) may be more appropriate than the aggregated production function (capital stock and labor) used here. However, micro-quantitative data of this sort is simply not available, and we proceed with caveats with the data that is available.

Empirical Results

The estimated distribution-free frontier and the stochastic frontier function appear in Table 2. The dependent variable is labor divided by output (GDP in U.S. dollars). The independent variable is capital stock in U.S. dollars (GDP * percentage of GDP devoted to domestic investment) per output. The estimated frontier functions are statistically highly significant.

The frontier functions in Table 2 are the basis for the estimates of technical efficiency (TE). Technical efficiency is the dependent variable in the test of the effect of FDI on efficiency in Table 3. The independent variable in the regression in Table 3 is a dummy variable that is equal to unity for economies that have high FDI exposure status and zero for economies that have low or zero or negative FDI exposure status. Thus, the parameter may be interpreted as the changes in technical efficiency resulting from having a high growth rate relative to a low and/or a negative growth rate of FDI flows. In both the distribution-free frontier approach, and the stochastic frontier approach the FDI coefficient is positive and statistically highly significant. The statistical results suggest that technical efficiency is 0.072 points higher in the economies that have high FDI exposure status than in the economies that have low or zero or negative FDI exposure status for the distribution-free approach, and 0.073 points higher for the stochastic approach. Comparison of the average technical efficiency of the economies that have high FDI exposure status with the economies that have low or zero or negative FDI exposure status reveals that the economies that have high FDI exposure status are about 109 percent ([0.781 + 0.072]/0.0.781 = 1.092); ([0.781 + 0.073]/0.791 = 1.093) as efficient as the economies that have low or zero or negative FDI exposure status. Thus, ceteris paribus, developing countries can increase the utility of their human assets and capital stocks by approximately 9 percent simply by promoting FDI flows.

Summary and Conclusion

Attitudes toward FDI in less developed countries have changed dramatically over the past two decades. While the policies during the 1970s generally aimed at discouraging foreign capital inflows, in recent years many developing countries have been actively seeking FDI. Various methods have been used to attract FDI flows. Those methods include redirecting development strategies, liberalizing international trade, and setting up a range of new investment incentive packages. FDI can make considerable contributions to the host economy through the supply of capital, technology, and management. To the extent that such inputs are scarce locally, foreign investment may make it possible to enhance labor and capital productivity. The empirical results provide quantitative measures of the

Table 2
Estimated Frontier Functions

Dependent Variable a Summary	Independent Variable[a] Statistics			
	Constant Capital Stock/Output			
	(t-statistics)	(t-statistics)	F-value	
Distribution-Free Model Labor/Output	5.546 (14.037)	-1.193 (-5.130)	26.322	Adj R-sq 0.21
Stochastic Frontier Labor/Output	5.546 (14.036)	-1.149 (-5.099)	26.001	Scale 1.716

[a] Variables are in Logarithms.
Numbers in parentheses are t-vales

Table 3
Estimates of the Effect of Foreign Direct Investment on Technical Efficiency

Stochastic Specification	Statistics		
	Constant (t-statistics)	FDI (t-statistics)	F-value (Prob > F)
Distribution-Free Model	0.781 (40.107)	0.072 (2.416)	5.837 (0.009)
Stochastic Frontier	0.781 (40.108)	0.073 (2.362)	5.579 (0.018)

Numbers in parentheses are t-vales

relationship between the level of FDI and the magnitude of the technical efficiency. It is estimated, ceteris paribus, that technical efficiency is approximately 9 percent greater in developing countries with high levels of FDI as opposed to developing countries with low or zero or negative (divestment) FDI exposure.

Although the sample used in this empirical study includes only developing countries, it is admitted that the use of cross-county data without controlling the country-specific economic factors that may have some effects on the efficiency of allocated national resources within the countries in the sample requires well-known caveats. Therefore, the lack of internationally comparable time-series micro-data that can be utilized to neutralize country-specific economic factors leads us to suggest that the results of this empirical study should be viewed as suggestive, not definitive.

Endnots

1. The assumption is testable. A flexible production function was estimated. An F-test on the unrestricted model versus the restriction of unity for the sum of the coefficient yielded F = 0.20, which is insignificant.

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الملخص

الاستثمار الأجنبي المباشر وفيض الكفاءة في الدول النامية

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يناقش هذا البحث من خلال الإطار الذي تعرضه نظرية النمو الحديثة تأثير الاستثمار الأجنبي المباشر في الكفاءة لأربع وأربعين دولة نامية. وتختبر الدراسة فرضية مشوقة أثارها العديد من الكتاب المهتمين بنظرية الاستثمار العالمي. وفحوى الفرضية يدور حول وجود علاقة قوية بين مستوى الاستثمار الأجنبي المباشر والكفاءة الفنية. وقد تم اشتقاق النموذج المستخدم بالطريقة المعهودة والمستمدة من دالة منحنى الإنتاج. وتشير نتائج الدراسة إلى ارتفاع الكفاءة الفنية في الدول النامية التي تتصف بارتفاع مستوى الاستثمار الأجنبي فيها.

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