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ARIMA Modelling of Foreign Direct Investment Inflows: A Case Study of Services Sector in India

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ABSTRACT

This study dives into the FDI inflow's scenario in the country over the next decade. The time frame of this analysis is from 2000 to 2023. Results of the analysis showed that the time series became stationary at the first difference using Philips Perron Unit Root Test. Employing ARIMA model methodology the diagnostic test revealed that ARIMA model order (1, 0, 2) is the most appropriate and suitable model as the Akaike's Information Criterion (AIC) is the lowest. A 10 year forecast was made in this study from 2023 to 2033, the result of the analysis showed that the FDI inflow in Services sector in India will continue to grow in the predicted period. Due to the government's timely intervention there was a significant change in the volume of the foreign direct investment and particularly into services sector. Which has contributed greatly in the country's GDP. Further in future the government needs to formulate proper policies which will work as force to sustain the upward flow of FDI into the services sector.

KEYWORDS: *FDI, Services Sector, India, ARIMA*

INTRODUCTION

Foreign direct investment is a major pathway in making an economy global. Foreign direct investment being a significant source of external financing which opens up many doors of opportunities for the host countries as most of them lack necessary financial and technical assistance as FDI not only brings in capital but also required technology and modernization by which they are able to utilize their resources to the optimal level. India after the liberalization saw an huge influx of Foreign direct investment in various sectors. However, according to the RBI Manual 2010 the services sector saw a 7% share of total FDI in the first decade i.e. 1991 to 2000 but this sector attracted the highest FDI equity inflow of 16.33% from April 2000 to June 2024. This amounts to US$113.49 billion.

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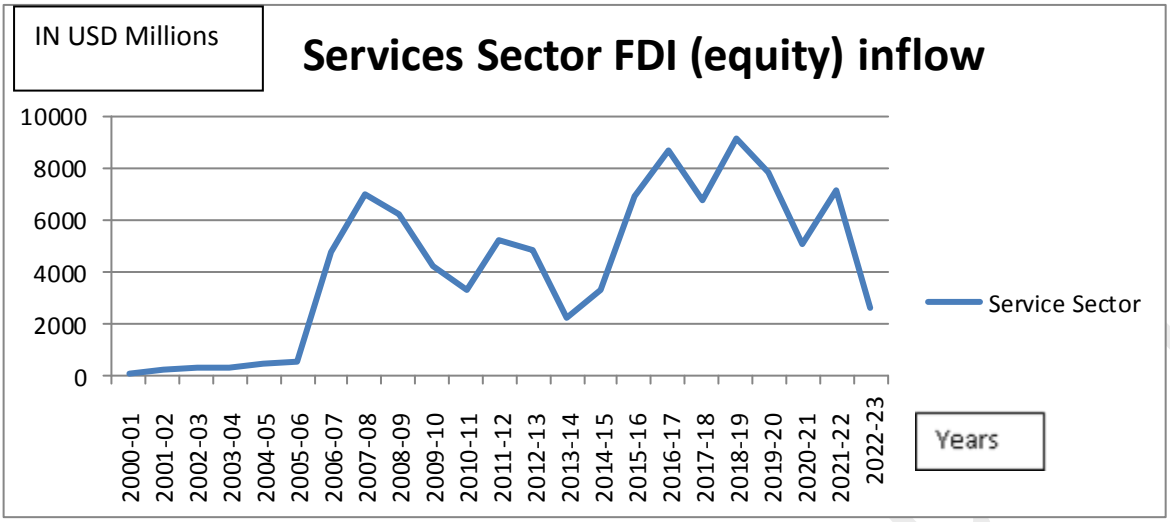
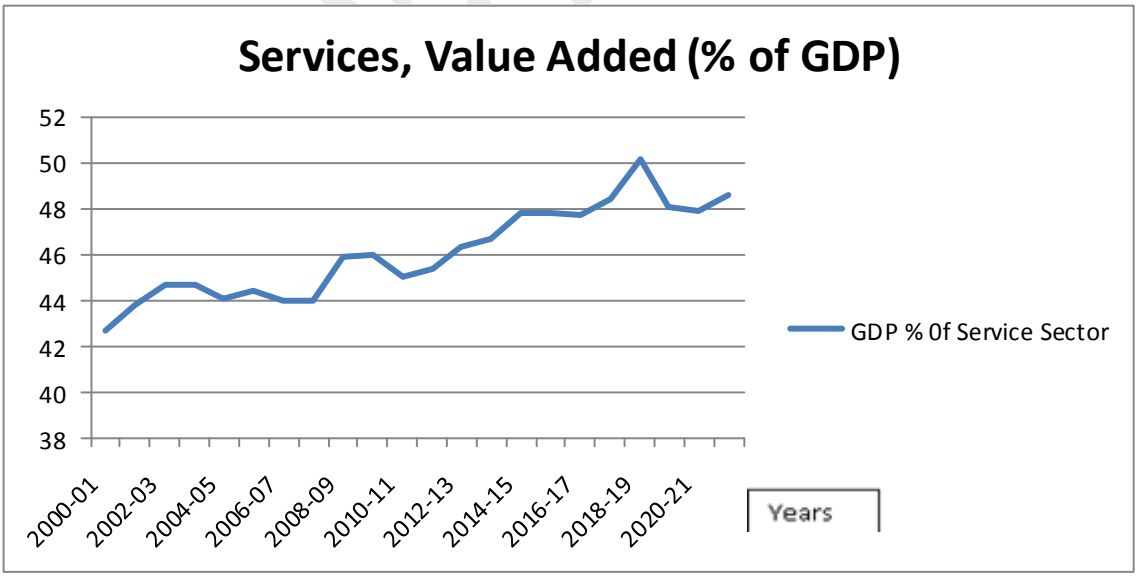
Chart 1: FDI equity inflows in service sector



Note: Service sector including Fin., Banking, Insurance, Non-Fin./Business, Outsourcing, R&D, Courier, Tech, Testing and Analysis, other
Source: DPIIT, Factsheet of DPIIT

The Contribution of FDI in services is significant as, this sector has a large share in the growth of GDP of India. In return India's rank in service export in the world stands at 6th rank and it provides employment around 30.7% of the total work force in the country. The number of sub-sectors under services sector in India are Construction, trade, hotels, transport, restaurant, communication and storage, social and personal services, community, insurance, financing, business services and real estate.

The services sector has taken up the centre stage in the growth story of our country.
Chart 2: Contribution of services in terms of GDP



Source: World Bank

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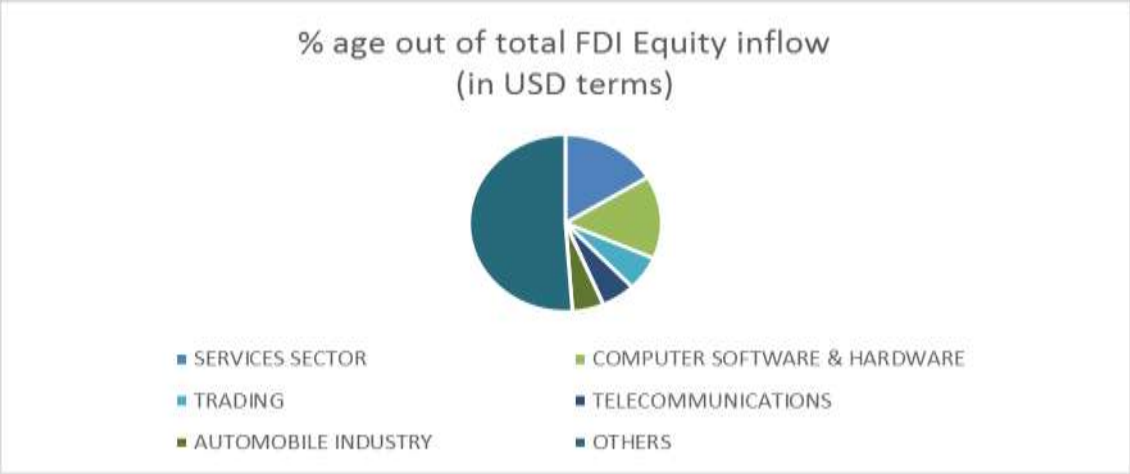
The above graph shows the significance and the role played by the services sector in pushing up the GDP of our country.

Chart 3: Percentage out of total FDI Equity inflow



Source: DPIIT Fact Sheet Foreign Direct Investment (FDI) Inflow

Thus a substantial part of FDI inflow goes into this sector and its crucial part in the growth of our economy, it's future prospects and trends are needed to be studied for a better policy framework.

LITERATURE REVIEW

Biswas (2015)"Forecasting Net FDI Inflows in India: Box Jenkins ARIMA Model" This paper employs Box-Jenkins ARIMA Model and focuses on the time period of 1992-2014. The findings of this study is that the total volume of FDI is expected for years 2015-2034 is □ 2,76,130 crores in INR. There will be a smooth increase in FDI inflows.

Kala k., et.al.(2018) "Forecasting FDI inflows in India using ARIMA Model" This paper focuses on 17 years of monthly FDI inflows data from India. The study showed total inflow value during July 2017 to July 2018 is US$163899.64 million and average inflow value during above periods was US$12607.66 million. The forecasted average percentage increase in the inflow will be 7.69%.

Henry., et.al.(2019) " Time series ARIMA Model for predicting Nigeria Net foreign direct investment (FDI)" In this paper the researcher has done an empirical study of modelling and forecasting time series data of Nigeria net foreign direct investments. The year's data has been collected from 1972 to 2018. The paper concluded with a positive note that Nigeria will continue to grow it's Net FDI investments in the forecasted next 30 years.

Patel and Patel (2023) "Determining FDI inflows in India using Box Jenkins ARIMA Approach"

This paper estimated the FDI inflow over the next 9 years i.e 2022 to 2030 is US$ 907131 million. Used the time series data for FDI inflow from the year 1991 to 2021.

K.Y. Ingale., et.al.(2023) "Time series ARIMA forecasting of FDI inflow in India" The FDI inflow in India has been forecasted using ARIMA model from 1950-2020. This paper showcases the exponential growth of FDI inflows and what decisions can be made in the case of foreign policy.

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Thus due to better forecasting of FDI inflows, the policies would contribute in a better way in overcoming the unbalanced market viability.

DATA AND METHODOLOGY

This paper focuses on the Foreign Direct Investments into the services sector of India in the past two decades i.e. from 2000 till 2023 the data has been taken from DPIIT factsheet . ARIMA or Autoregressive Integrated Moving Average Model has been used, which is one of the most popular technique for forecasting and predicting the future events which are backed by statistical data.
This technique is made with three notations which are AR(p) order , Integrated(d) and MR(q) which are explained below:

Autoregressive Process AR (p)

The Autoregressive model of p order refers to a model that shows a changing variable that regresses on its own lagged or prior values.

Autoregression AR (p) Equation:

$$\mathbf{Y_t = c + \varphi_1 * Y_{(t-1)} + \varphi_2 * Y_{(t-2)} + \ldots + \varphi_p * Y_{(t-p)} + \varepsilon_t} \quad \text{...}(1)$$

Y_t is the value of the time series at time t, c is a constant term, φ_1, φ_2, φ_p are taken as AR(p) parameters to be estimated, $Y_{(t-1)}$, $Y_{(t-p)}$ are the lagged values of the time series, ε_t is taken as error term at time t and p is considered as order of the AR model.

Moving Average Process MA (q)

The Moving Average model incorporates the dependency between an observation and an form a Moving Average model applied to lagged observation. Basically it tells about the dependency of its residual factor of yesterday.

Moving Average MA(q) Equation:

$$\mathbf{Yt = \mu + \varepsilon t + \theta 1 * \varepsilon(t-1) + \theta 2 * \varepsilon(t-2) + \ldots + \theta q * \varepsilon(t-q)} \quad \text{..................................... (2)}$$

Y_t is considered as value of the time series at time t, μ is taken as constant term, ε_t as error term θ_1 ,θ_2, θ_q as MA(q) parameters ,$\varepsilon_{(t-1)}$, $\varepsilon_{(t-2)}$...., $\varepsilon_{(t-q)}$ and q as order of the MA model.

Autoregressive Integrated Moving Average

Autoregressive Integrated Moving Average (ARIMA) model is a univariate model which is expressed in a time series form which is based on the past values of itself(the autoregressive component) with it's lagged terms or values of an error term (moving average component). ARIMA model has both AR(p) and MA(q) order with is held together by order of Integration(d). In simpler words, ARIMA model is a model in which the value of a variable in current period is related to its own value in the previous period as well as values of the residuals in the previous period i.e. ARIMA is a combination of both Autoregressive term (p) , Integration (d) and Moving Average (q) terms.

It is therefore denoted as ARIMA (p,d,q). The model can be written as :

ARIMA(p, d, q) Model Equation:

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$Y_t = c + \varphi_1 * Y_{(t-1)} + \varphi_2 * Y_{(t-2)} + \ldots + \varphi_p * Y_{(t-p)} + \theta_1 * \varepsilon_{(t-1)} + \theta_2 * \varepsilon_{(t-2)} + \ldots + \theta_q + \varepsilon_t$ .....(3)

Yt is the value of time series at time t, c is taken as constant, $\phi_1, \phi_2, \ldots \phi_p$ are autoregressive parameters, $\theta_1, \theta_2, \ldots \theta_p$ is considered as moving average parameters, ε_t is the error term and $\varepsilon_{(t-1)}$, $\varepsilon_{(t-2)} \ldots\ldots \varepsilon_{(t-q)}$ are lagged values.

RESULT AND DISCUSSION

The first thing in order to start with the analysis is to determine if the data taken is stationary. There are three kinds of Unit Root Test which provide us with more formal approach to the degree of differencing required such as Phillips-Perron Unit Root Test, Augmented Dickey fuller Test(ADF), and Kwiat-Kowski-Phillips-Schmidt-Shin(KPSS) as listed by Henry(2019) for Predicting Nigeria Net Foreign direct investment (FDI).But for the purpose of this study we used Phillips Perron Unit Root Test and the data came out to be stationary after the first difference itself.

Table 1: Stationarity Results

Phillips-Perron Unit Root Test	
At level (p-value)	At First Difference (p-value)
0.443	0.02278

Source: Author's Own Calculation

Next step in this study is to select the best suited model for the forecast, in the given evaluation there has been three sets of model combinations and out of which the one which has the lowest Akaike Information Criterion has been selected.

Table 2: Akaike Information Criteria for various models

Combinations	**AIC**
1,0,2	423.18
3,0,2	425.41
2,0,2	424.07

Source: Author's Own Calculation

As from the above table it is clear that combinations (1, 0, 2) has the lowest AIC so that one model has been chosen for formulating the model which means that the model is most appropriate as it is robust and is free from any autocorrelation which significantly affect the forecasted result.

Table 3: specifications obtained from model (1,0,2)

Coefficients				
	ar1	ma1	ma2	Intercept
	0.7412	0.3914	-0.4397	3698.409
s.e.	0.2824	0.3529	0.3420	1342.303

Source: Author's Own Calculation

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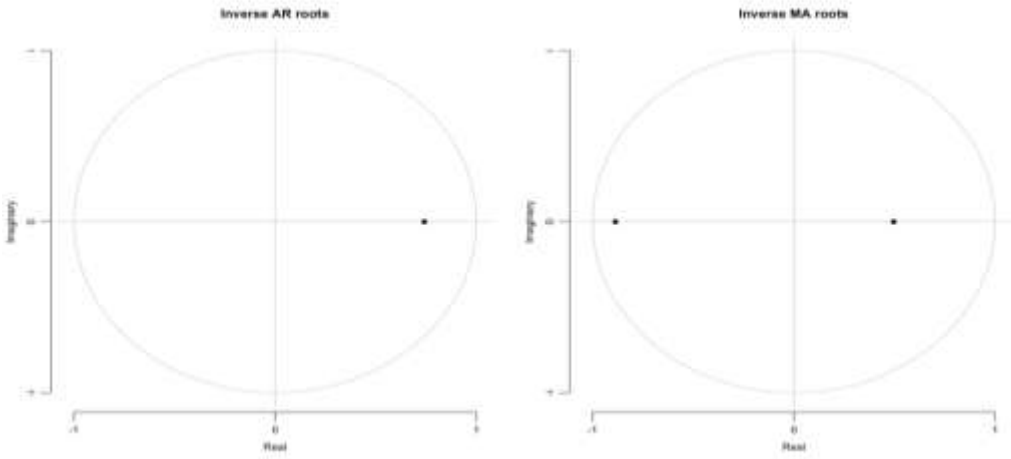
The below equation is formed using the specifications of (1, 0, 2) model is:

$InFDI = 3698.409 + 0.7412InFDI_{(t-1)} + 0.3914(et-1) + (-0.4397)et-2$

Figure 1: Inverse AR and MA roots

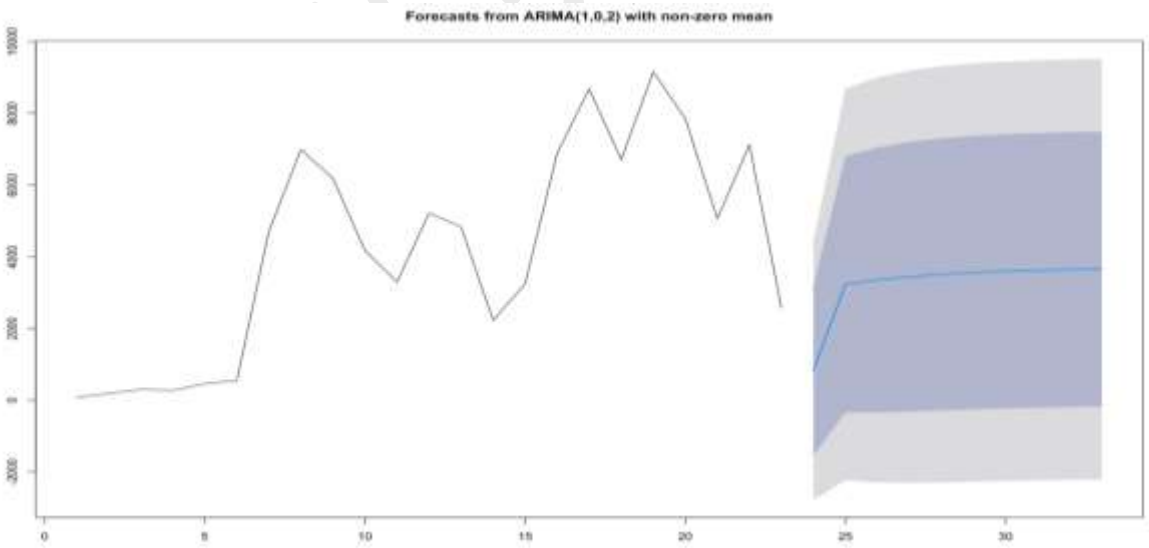


Source: Author's Own Calculation

The model chosen (1, 0, 2) is stating the future trend of foreign direct investment in services sector depends on the past trends and the volume of data considered in the study is FDI in services sector from the year 2000 to 2023, this means there is no strong seasonality in the previous trends depending on which the future trend could be predicted. A gap which can be seen in the forecasted trend in given diagram below for that the reason has been stated above. The trend is significantly random and irregular.

After the model selection and evaluation, the forecast results obtained are :-

Figure 2: ARIMA(1, 0, 2) Forecast Results



Source: Author's Own Calculation

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The given chart is the graphical representation of the forecast of next 10 years, the upper and the lower limits at 80% and 95% each.

Table 4: Forecast results with high and low limits of 80% and 95%

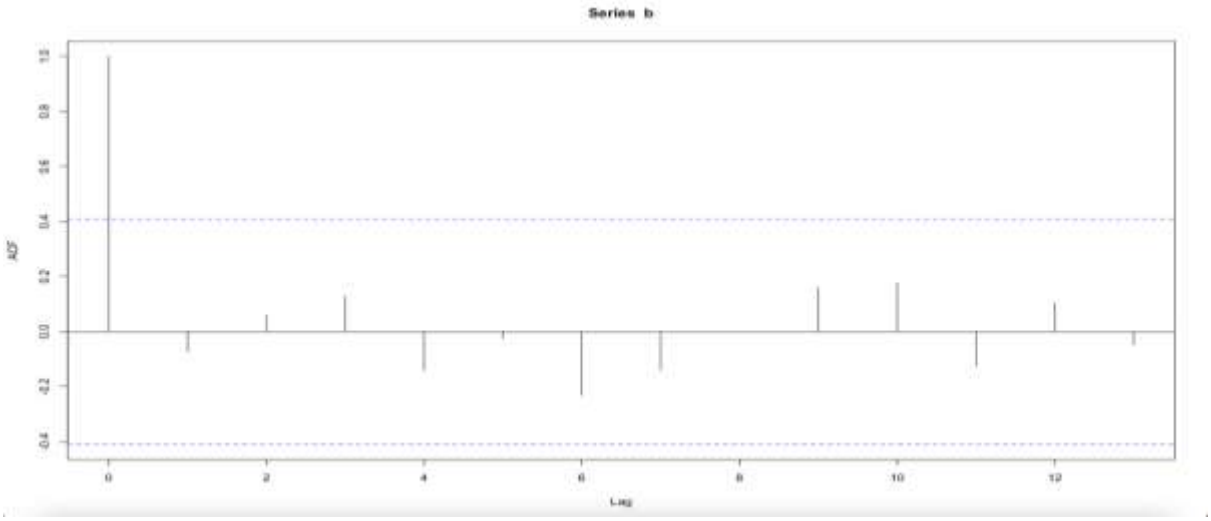
	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
24	834.866	-1530.0557	3199.788	-2781.97	4451.702
25	3230.351	-341.492	6802.195	-2232.312	8693.015
26	3351.507	-343.2127	7046.227	-2299.079	9002.094
27	3441.302	-319.2066	7201.811	-2309.9	9192.504
28	3507.854	-288.308	7304.016	-2297.875	9313.582
29	3557.179	-258.4258	7372.783	-2278.285	9392.642
30	3593.736	-232.5065	7419.978	-2257.997	9445.469
31	3620.83	-211.243	7452.904	-2239.82	9481.481
32	3640.911	-194.3611	7476.184	-2224.632	9506.454
33	3655.795	-181.2342	7492.823	-2212.434	9524.023

Source: Author's Own Calculation

As from the above stated results of the forecast that the FDI may be seen that there is a consistent increasing trend from year 2024 till the year 2033 and a smooth upward trajectory can be predicted till the year 2033.

Certain diagnostic checks are done for the assessing the stability of the stated model has been employed, firstly all the residual has been checked to find any correlation among them. If there is any correlation among them then it would mean that there is certain information that has been left out unrecognized in the process.

Figure 3: ACF Result



Source: Author's Own Calculation

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As per the above graph it can be seen that the residuals are well within the upper and the lower limits and not correlated so there is no significant information left out that has not been included in the study. Further the accuracy has been checked with the help of Box-Pierce Test.

Table 5: Box-Pierce test

Box-Pierce test		
X-squared = 4.063	df = 7	p-value = 0.7725

Source: Author's Own Calculation

As seen in the above table the p-value obtained is more than 0.05 level of significance which means that the residuals are independent and are not correlated. So the above taken model is proper for tracking the forecast for the next ten years.

CONCLUSION

On the basis of this study it can be concluded that the FDI inflow in the Indian services sector is one of the major reason for increased GDP growth and it's contribution in providing employment to the Indian youth is undeniable. There is important point to be noted that predicting the economic variables that is FDI inflow is not an easy task as the results of such analysis can easily be affected by structural breaks in the economy. Thus results of such estimated model remains relevant as long as there are no structural breaks as mentioned by Henry(2019).

The model (1, 0, 2) is the most suitable one for forecasting FDI inflows in services sector in India. This study has considered a time frame from 2000 to 2023 and inflow of FDI in services sector can be seen in all the phases. The study is predicting the trend of FDI Inflow in services sector from the period of 2023 to 2033. The trend that has been observed in the analysis is that there is an upward trajectory of the inflow of FDI into services sector. This is due to a drastic strategic shift in the national policies in the early nineties and by removing restrictions it liberalized the Indian economy. The study is predicting that FDI into services sector will keep coming in at an increasing rate and now the government had to formulate policies which will form a proper framework for the service sector to grow and these policies should be employed effectively in order to fully utilized the existing human resource in the country.

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