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Defense expenditures and economic growth in Pakistan and India: An augmented Feder-type model

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CASE STUDY

DEFENSE EXPENDITURES AND ECONOMIC GROWTH IN PAKISTAN AND INDIA: AN AUGMENTED FEDER-TYPE MODEL

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Abstract

To discover defense-growth nexus, this study has used Feder type model to capture the supply-side impacts for Pakistan and India. In Feder-type model, this study has used four sectors to find out total effects of defense spending on growth by using OLS technique. The findings of the study show that there is positive association between the total effect of defense and growth in all the sectors for both the countries. In augmented Feder-type model, the total effects along with externality effects and productivity differential have been re-estimated. The sign of the total effects of defense sector remain the same for both the countries whereas externality effects of defense sector have been observed negative for both the countries except in four-sector for Pakistan. The results of productivity differential of defense sector appear with negative sign throughout the analysis.

Key Words: Defense Expenditures, Economic Growth, Pakistan, India, Feder Model
JEL Codes: H56, O40, B23

Introduction

The contentious issue of defense expenditures and economic growth is a fundamental issue of defense economics since the pristine study of Benoit (1973,1978). This work has paved the way for researchers to explore unploughed field of defense-growth relationship. There has been a divergence of opinions regarding the effects of defense expenditures on growth. Owning to their persistence confrontation, this issue has gained prominence in the case of Pakistan and India. In order to probe the defense-growth nexus, the several empirical studies[1] have used Feder's model. This study employs Feder-type and augmented Feder-type framework (comprising civilian, defense, non-defense government and export sectors) to examine the defense growth relationship in both the neighboring countries over the period 1972-2010.

A range of authors have used different variants of Feder-type model by introducing a number of sectors and set of externalities in the model. Atesoglu and Mueller (1990) have used two sectors i.e. defense and civilian sectors. Huang and Mintz (1990,1991) bifurcated the economy into three sectors: non-defense sector, defense sector and civilian sector in their studies. Alexander (1990) includes export sector and externalities by making four-sector model.

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[1]See Biswas and Ram,1986; Hartley and Sandler, 1990; Atesoglu and Mueller, 1990; Alexander,1990; Mintz and Huang, 1990; Huang and Mintz, 1991; Ward et al.,1991; Brauer,1991; Mueller and Atesoglu, 1993; Linden,1992.

The three types of effects are analyzed in the model:

1) size (overall) effects of each sector on economic growth
2) externality effects and
3) relative factor productivity differentials

The total effect is decomposed into externality and relative productivity effect.

Although this model has many pitfalls[2] but still it is used to explain the supply-side effects of defense spending on economic growth. None of the previous studies has used the four sector Feder-type model simultaneously for Pakistan and India to figure out the defense growth relationship. It is the contribution of this study to analyze the defense growth relationship by making a cross country analysis of Pakistan and India and including the new sectors in Feder-type model to observe its sensitivity. It estimates the externality effects and productivity differentials of each sector with respect to the civilian sector (base sector).

The rest of the study has been structured as follows: In the next section, we have described the review of previous studies. The subsequent sections present the model specifications, data sources, methodology, description of variables, empirical results and conclusions respectively.

Review of Previous Studies

In order to analyze the impact of defense outlays on growth many empirical studies based on supply-side models have employed the aggregate production function. The export-growth model by Feder (1982) provided the base for investigating the defense-growth relation in supply side framework. Feder (1982) using the production function, investigated the exports-growth relationship with externalities occurring between export and non-export sectors in developing countries. For observing the association between government and non-government sectors, Ram (1986) used the Feder (1982) model. In the realm of cross national studies, Biswas and Ram (1986) were the pioneers who used the Feder model (1982) for the defense sector. The authors scrutinized the link between the defense and non-defense sectors along with the externality effect and relative factor productivity differential between the sectors. The study considered the two time periods 1960-1970 and 1970-1977 for fifty eight less developed countries. The outcomes revealed that defense spending did not affect the economic growth. The defense-civilian externality effect and relative factor productivity between the sectors were found statistically insignificant in their study. After this study, many studies [see for instance, Huang and Mintz, 1990,1991; Ward et al., 1991; Atesoalou and Mueller, 1990; Ward and Davis, 1992; Ward et al.,1993] have used the Feder-type models with different assumptions for developing and developed countries.

Alexander (1990) used a multi-sector Feder-type model with complex forms of externalities for nine industrial countries covering the period 1974-84. The author considered that economy is comprised of four mutually exclusive and exhaustive sectors. Alexander (1990) found the insignificant overall effect of defense expenditures on growth and concluded that defense sector is less productive than the other sectors. Although this study was the major development in Feder-type model but it has been criticized due to the misspecification and complex set of externalities.

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[2] See Alexander and Hansen (2004).

Linden (1992) applied the Feder-type model with two sectors. The study included thirteen countries for the period 1974-1985. The author found negative defense-growth association. Relating to 30 developing countries for the period of 1981-1989, a study by Biswas (1993) noticed a positive correlation between defense and growth. Similar results have been found by Macnair et al. (1995) using the Feder-type model.

Using the augmented Feder-type model for three-sector, Mintz and Stevenson (1995) suggested that non-defense sector influenced the economic growth positively and significantly while defense sector had insignificant effects for many countries. Moreover, no externality effects were observed. Alexander (1995) adopted the four-sector Feder-type model with growth of real non-defense output as dependent variable instead of growth of real defense output. The author inferred that defense sector has no significant effect on growth of real non-defense output for eleven OECD countries.

Murdoch et al. (1997) used the three-sector Feder-type model for two groups of Asian and Latin American economies. The authors conducted cross section and pooled time series estimation for the period 1954-1988. They concluded that in addition to other forms of government spending, defense expenditures promoted the economic growth in the Asian and Latin American countries. Yildirim et al. (2005) analyzed the two-sector Feder model by applying static and dynamic panel data techniques and explored the positive association between defense outlays and economic growth for the countries of the Middle East and Turkey ranging the period 1989-1999.

Turning to the national studies, Huang and Mintz (1990, 1991) employed the ridge regression to avoid the multicollinearity in augmented Feder model. In both studies, they have used the three-sector Feder model for USA for the period 1952-88. In their first study (1990), they estimated only the overall effect in their subsequent study (1991), they considered the externality and productivity effects as well. Owing to the use of ridge regression, multicollinearity reduced in the models. The authors reported both the OLS and ridge regression estimates. The results the first study indicated that the overall, externality and productivity effects of defense spending were insignificant in USA.

Using Feder-type model for three sectors over the period of 1950-87, Ward et al. (1991) revealed a positive link between defense expenditures and economic growth for India whereas effects of the non-defense sector were found negative. The civilian sector appeared with larger marginal productivity than the non-defense sectors. Moreover, the defense sector had no positive externalities for other sectors.

For USA over the period 1948-90, Ward and Davis (1992) used Feder-type model for the three-sector and found negative size effect of defense spending in USA with positive externalities and negative factor productivity. Another study by Ward et al. (1993) found the positive overall effect of defense sector with negative externalities for Taiwan. The authors used the same model for the period 1961-1988. Additionally, Ward et al. (1995) explored a negative size effect of defense for USA but positive for Japan for the period 1889-1991.

In order to asses the defense-growth nexus in Turkey for the period of 1950-1993, Sezgin (1997) used the two-sector Feder-type model. The findings of this study revealed that overall effects of defense are positively significant with negative externalities and defense sector is found to be less prolific than the civilian sector. The author contributed in the Feder model by adding the education expenditure as a proxy of human capital.

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Antonakis (1997a) adopted the same model with two sectors and discovered a reciprocal relationship between defense expenditures and growth during 1958-1991. The author found misspecification problems and removed it by introducing the lags in the model. Another study for Greece for the period 1960-1993 by Antonakis (1999) applied the four sector Feder-type model. The study established negative effect of defense on growth by applying the ARDL approach.

Batchelor et al. (2000) applied two-sector Feder type model to observe the defense-growth relationship in South Africa for the period 1964 to 1995. The authors using the discrete equivalents estimated the model by the Autoregressive Distributed Lag (ARDL) method and explored no significant impact of defense sector on growth. Moreover, defense expenditures had negative and significant effect on the growth of manufacturing sector in South Africa.

Reitschuler and Loening (2004) applied the two-sector Feder type model to explore the defense growth relation for Guatemala by using longitudinal data over the period 1951-2001. The study found that defense spending affected the economic growth positively at low threshold level of GDP and negatively at higher threshold level of GDP. Further, the study explored that productivity in the civilian sector is evident than defense sector in Guatemala.

In a nutshell, we can infer that most of the supply-side or Feder-type empirical studies found positive impacts of defense spending but some studies exhibited the negative role of defense outlays as well.

Model Specifications

The premier approach to investigate the sectoral production function was presented by Feder[3] (1982) to evaluate the role of exports in economic growth. Biswas and Ram (1986) were the first who used the Feder-type model (supply-side model) to investigate role of defense sector for two sectors i.e. military and civilian under the neoclassical framework. A lot of editions of Feder-type model have been evolved enriched with more sectors and externalities. The model specified in this study is Feder-type model to consider defense-growth relation for both the neighboring countries. We have estimated Feder-type model for two, three and four sectors separately to evaluate the sensitivity and validity of the model.

While modeling the sectoral Feder-type approach, it is assumed that all these discrete sectors are mutually exclusive and exhaustive with respect to output. These sectors are:

- Civilian sector (C)
- Defense sector (D)
- Non-defense government sector (G)
- Export sector (X)

Assuming that D, G and X creates externalities for C. There is a difference of marginal productivities of factors of production across the sectors as well. Owing to the assumption of four sector economy model, total output constitutes the civilian output, defense output, non-defense government output and export output i.e.

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[3] Feder divides the economy into export and non-export sectors.

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$$Y = C + D + G + X \quad \textbf{(1)}$$

Two factors of production or inputs i.e. labor (L) and capital (K) are employed in all sectors:

$$L = L_c + L_d + L_g + L_x$$
$$K = K_c + K_d + K_g + K_x \qquad \textbf{(2 a,b)}$$

Here subscripts show the respective sectors. The aggregate production functions for the four sectors are:

$$D = f(L_d, K_d)$$
$$G = f(L_g, K_g)$$
$$X = f(L_x, K_x) \quad \textbf{(3 a,b,c)}$$

All three sectors i.e. the defense sector (D), the non-defense government sector (G) and the export sector (X) have assumed an externality effect on the civilian sector (C). So:

$$C = f(L_c, K_c, D, G, X) \quad \textbf{(3 d)}$$

The ratio of the particular marginal productivity of factors to base sector (civilian) deviates from unity by $\gamma_i \ \ i = d, g, x$. Therefore:

$$\frac{D_L}{C_L} = \frac{D_K}{C_K} = (1 + \gamma_d) \qquad \frac{G_L}{C_L} = \frac{G_K}{C_K} = (1 + \gamma_g) \qquad \frac{X_L}{C_L} = \frac{X_K}{C_K} = (1 + \gamma_x) \qquad \textbf{(4 a,b,c)}$$

The subscripts show the partial derivatives of D, G and X with respect to subscribed inputs i.e. labor (L) and capital (K) for example, $D_L = \dfrac{\partial D}{\partial L_d}$ and $D_K = \dfrac{\partial D}{\partial K_d}$ i.e. marginal productivity of inputs in defense sector.

Identifying the externality effects, we assume that the size of D, G, X have marginal externality effects on the civilian sector (C) so, we will have:

$$D_L = (1 + \gamma_d) C_L \text{ and } D_K = (1 + \gamma_d) C_K$$
$$G_L = (1 + \gamma_g) C_L \text{ and } G_K = (1 + \gamma_g) C_K$$
$$X_L = (1 + \gamma_x) C_L \text{ and } X_K = (1 + \gamma_x) C_K \qquad\qquad \textbf{(5 a,b,c)}$$

The productivity differential between the base and the rest of sectors is shown by γ_i.

If, for example, the value of relative input productivity index for defense sector γ_d is zero, it means that there is no input productivity difference between defense and civilian sectors. A

positive value[4] of γ_d represents that the productivity of defense sector is more than civilian one and negative value of γ_d suggests the vice versa. The same conclusions can be drawn for relative input productivity index for non-defense government sector (γ_g) and the relative input productivity index for the export sector (γ_x).

In view of the fact that the data on sectoral inputs are scarce or unavailable especially in developing countries, so we reformulate the Feder-type model in terms of aggregate inputs. Now differentiating equation (1) w.r.t. time:

$$Y^{'} = D^{'} + G^{'} + X^{'} + C^{'}$$

Taking total derivative

$$Y^{'} = [(D_k K_d^{'} + D_L L_d^{'}) + (G_k K_g^{'} + G_L L_g^{'}) + (X_k K_x^{'} + X_L L_x^{'}) + \{(C_k K_c^{'} + C_L L_c^{'}) + (C_d D^{'} + C_g G^{'} + C_x X^{'})\}]$$

Since $K^{'} = I_i$

$$Y^{'} = [(D_k I_d + D_L L_d^{'}) + (G_k I_g + G_L L_g^{'}) + (X_k I_x + X_L L_x^{'}) + \{(C_k I_c + C_L L_c^{'}) + (C_d D^{'} + C_g G^{'} + C_x X^{'})\}] \quad \textbf{(6)}$$

Putting the values of $D_K, D_L, G_k, G_L, X_K, X_L$ from equation (5 a,b,c) in equation (6) it follows:

$$= (1+\gamma_d)C_k I_d + (1+\gamma_d)C_L L_d^{'} + (1+\gamma_g)C_k I_g + (1+\gamma_g)C_L L_g^{'} + (1+\gamma_x)C_k I_x + (1+\gamma_x)C_L L_x^{'} + C_k I_c + C_L L_c^{'}$$
$$+ C_D D^{'} + C_g G^{'} + C_x X$$

$$= C_k I_d + C_k I_d \gamma_d + C_L L_d^{'} + C_L L_d^{'} \gamma_d + C_k I_g + C_k I_g \gamma_g + C_L L_g^{'} + C_L L_g^{'} \gamma_g + C_k I_x + C_k I_x \gamma_x + C_L L_x^{'} + C_L L_x^{'} \gamma_x$$
$$+ C_k I_c + C_L L_c^{'} + C_d D^{'} + C_g G^{'} + C_x X^{'}$$

$$= C_k(I_d + I_g + I_x + I_c) + C_L(L_d^{'} + L_g^{'} + L_x^{'} + L_c^{'}) + \gamma_d(C_k I_d + C_L L_d^{'}) + \gamma_g(C_k I_g + C_L L_g^{'}) + \gamma_x(C_k I_x + C_L L_x^{'})$$
$$+ C_d D^{'} + C_g G^{'} + C_x X^{'}$$

Using the fact that $I = I_d + I_g + I_x + I_c$ and equation (5 a,b,c), we know that

$$D_k = (1+\gamma_d)C_k \, , \; C_k = \frac{D_k}{1+\gamma_d}$$

Similarly $C_L = \dfrac{D_L}{1+\gamma_d}$

So,

$$Y^{'} = C_k I + C_L L^{'} + \frac{\gamma_d}{1+\gamma_d}\left[D_k I_d + D_L L_d^{'}\right] + \frac{\gamma_g}{1+\gamma_g}\left[G_k I_g + G_L L_g^{'}\right] + \frac{\gamma_x}{1+\gamma_x}\left[X_k I_x + X_L L_x^{'}\right] + C_d D^{'} + C_g G^{'} + C_x X^{'}$$

[4] It means that if the given inputs i.e. labor and capital are transferred to defense sector where they are more productive, it would enhance the economic growth by boosting total output. The opposite would be true if the value of γ_d is negative.

Using the definition of total derivation

$$Y' = C_k I + C_L L' + \left[\frac{\gamma_d}{1+\gamma_d} + C_d \right] D' + \left[\frac{\gamma_g}{1+\gamma_g} + C_g \right] G' + \left[\frac{\gamma_x}{1+\gamma_x} + C_x \right] X'$$

Dividing by Y

$$\frac{\dot{Y}}{Y} = C_k \left(\frac{I}{Y} \right) + C_L \left(\frac{\dot{L}}{L} \right) \left(\frac{L}{Y} \right) + \left[\left(\frac{\gamma_d}{1+\gamma_d} \right) + C_d \right] \left(\frac{\dot{D}}{D} \right) \left(\frac{D}{Y} \right) + \left[\left(\frac{\gamma_g}{1+\gamma_g} \right) + C_g \right] \left(\frac{\dot{G}}{G} \right) \left(\frac{G}{Y} \right) + \left[\left(\frac{\gamma_x}{1+\gamma_x} \right) + C_x \right] \left(\frac{\dot{X}}{X} \right) \left(\frac{X}{Y} \right)$$

(7)

After the inclusion of intercept and stochastic error term in equation (7), the total effect of each sector on growth can be estimated for both the countries.

In order to measure the constant elasticities i.e. ψ_d, ψ_g and ψ_x, we further assume that D, G and X affect the of civilian sector production. (see Feder,1982; Ram 1986 and 1989). Therefore:

C = f(L$_c$, K$_c$, D, G, X)
$$C = G^{\psi_g} . X^{\psi_x} . D^{\psi_d} \ f(\text{L}_c, \text{K}_c)$$

It can be shown that

$$\frac{\partial C}{\partial G} = C_g = \psi_g \left(\frac{C}{G} \right) \ \frac{\partial C}{\partial X} = C_x = \psi_x \left(\frac{C}{X} \right) \ \frac{\partial C}{\partial D} = C_d = \psi_d \left(\frac{C}{D} \right) \ \textbf{(8 a,b,c)}$$

By including intercept and substituting the values of C_d, C_g and C_x from equation (8 a,b,c) in equation (7), we get equation (9):

$$Y^* = \beta_0 + \beta_1\left(\frac{I}{Y}\right) + \beta_2 L^* + \left[\frac{\gamma_d}{1+\gamma_d} - \psi_d\left(\frac{C}{D}\right)\right]D^*\left(\frac{D}{Y}\right) + \left[\frac{\gamma_g}{1+\gamma_g} - \psi_g\left(\frac{C}{G}\right)\right]G^*\left(\frac{G}{Y}\right) + \left[\frac{\gamma_x}{1+\gamma_x} - \psi_x\left(\frac{C}{X}\right)\right]X^*\left(\frac{X}{Y}\right)$$

Simplifying the terms

$$Y^* = \beta_0 + \beta_1\left(\frac{I}{Y}\right) + \beta_2 L^* + \left(\frac{\gamma_d}{1+\gamma_d}\right)D^*\left(\frac{D}{Y}\right) + \psi_d\left(D^*\frac{C}{Y}\right) + \left(\frac{\gamma_g}{1+\gamma_g}\right)G^*\left(\frac{G}{Y}\right) + \psi_g\left(G^*\frac{C}{Y}\right) + \left(\frac{\gamma_x}{1+\gamma_x}\right)X^*\left(\frac{X}{Y}\right) + \psi_x\left(X^*\frac{C}{Y}\right) \tag{9}$$

We can find the separate externality effects of each sector along with productivity differentials from equation (9).

Several weaknesses of Feder-type models have been observed by (Alexander and Hansen, 2004) that are as follows:

- Misspecification biases in the estimated growth equations
- Observational equivalence of the estimated growth equations
- Incorrect methods of statistical inference with respect to productivity differentials
- The questionable legitimacy of aggregate production functions in general
- 'Factor' versus 'material' inputs to production
- Mistaking misspecified identities for growth equations
- Possible simultaneity bias in the estimated growth equations

Owning to problems of data and measurement, Ram (1995) criticized the Feder-type models are not a good estimate of externality and productivity effects. Further, Dunne (1996) pointed out that these models focus only supply side factors and pay no attention to military and political factors.

Even there are drawbacks in Feder-type models, but these models are the only possible way out available in the literature to evaluate the supply side impacts of defense expenditures on growth. These models have strong footings in economic theory and require relatively less data for estimation as compare to the complete demand and supply models. These models are appropriate for the developing counties dearth of quality data.

Both countries, Pakistan and India are caught in supply-side bottlenecks. Hence, Feder-type model can better explain the supply-side causality of defense and growth.

Data, Methodology and Description of Variables
Data and Methodology

The data on the variables used in this study are taken from various sources. Specifically, Table 1 shows the extract of data sources in brief:

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TABLE 1
DATA SOURCES

Variable	Source (For Pakistan)	Source (For India)
Dollar Exchange rate GDP at constant 2000US$ GDP at current 2000US$	World Development Indicators	World Development Indicators
Investment Exports Defense expenditures Non-defense government expenditures	Handbook of Statistics on Pakistan Economy,2010	Handbook of Statistics on the Indian Economy,2011
Labor force	Pakistan Economic Survey (various issues)	

All the variables (except labor force) have been converted in USD by the respective country's dollar exchange rate and after that these variables have been adjusted for inflation through the respective GDP deflator.

To measure the variable of 'investment', we have used gross fixed capital formation for both the countries. With respect to the variable 'non-defense government expenditures', defense expenditure are subtracted from the total central government expenditures. To find the value of civilian output or expenditures (C) in different sectors i.e. two, three and four sectors, we have used following formulas:

$C = Y – D$ for two sector model
$C = Y – D – G$ for three sector model and
$C = Y – D – G – X$ for four sector model

In order to test the stationarity of entire variables in equations (7) and (9), Augmented Dickey Fuller (ADF) test is applied. All the variables are found stationary in equations (7) and (9). Table 2 exhibits the results of ADF test.

TABLE 2: AUGMENTED DICKEY FULLER TEST FOR FEDER MODEL

Unit Root Test on Level (For Pakistan)							
Variables	**None**	**Lags**	**Intercept**	**Lags**	**Intercept & Trend**	**Lags**	**Conclusion**
$Y^* = \dfrac{\Delta Y}{Y}$	-19.3681	0	-4.4082	1	-4.8488	1	I(0)
$\dfrac{I}{Y}$	0.0374	0	-3.8213	0	-3.5106	0	I(0)
$L^* = \dfrac{\Delta L}{L}$	-0.3942	6	-9.5590	1	-9.6515	1	I(0)
$D^*\left(\dfrac{D}{Y}\right) = \dfrac{\Delta D}{D}\left(\dfrac{D}{Y}\right)$	-4.5102	2	-7.5624	1	-7.3894	1	I(0)
$G^*\left(\dfrac{G}{Y}\right) = \dfrac{\Delta G}{G}\left(\dfrac{G}{Y}\right)$	-6.8702	0	-7.6078	0	-7.7621	0	I(0)
$X^*\left(\dfrac{X}{Y}\right) = \dfrac{\Delta X}{X}\left(\dfrac{X}{Y}\right)$	-5.1305	0	-5.4240	0	-5.2212	0	I(0)
$D^*\left(\dfrac{C}{Y}\right) = \dfrac{\Delta D}{D}\left(\dfrac{C}{Y}\right)$	-9.2759	0	-9.1561	0	-8.8506	0	I(0)
$G^*\left(\dfrac{C}{Y}\right) = \dfrac{\Delta G}{G}\left(\dfrac{C}{Y}\right)$	-5.9917	1	-6.5611	1	-8.6140	0	I(0)
$X^*\left(\dfrac{C}{Y}\right) = \dfrac{\Delta X}{X}\left(\dfrac{C}{Y}\right)$	-8.5359	0	-8.6346	0	-8.0919	0	I(0)
Unit Root Test on Level (For India)							
Variables	**None**	**Lags**	**Intercept**	**Lags**	**Intercept & Trend**	**Lags**	**Conclusion**
$Y^* = \dfrac{\Delta Y}{Y}$	-1.8632	1	-6.3705	1	-7.6443	1	I(0)
$\dfrac{I}{Y}$	-1.5820	0	-4.3278	1	-4.0835	1	I(0)
$L^* = \dfrac{\Delta L}{L}$	0.2987	1	-8.9981	1	-7.4403	1	I(0)
$D^*\left(\dfrac{D}{Y}\right) = \dfrac{\Delta D}{D}\left(\dfrac{D}{Y}\right)$	-5.1190	1	-6.1256	1	-6.1225	1	I(0)
$G^*\left(\dfrac{G}{Y}\right) = \dfrac{\Delta G}{G}\left(\dfrac{G}{Y}\right)$	-1.2588	3	-13.6847	0	-13.2286	0	I(0)
$X^*\left(\dfrac{X}{Y}\right) = \dfrac{\Delta X}{X}\left(\dfrac{X}{Y}\right)$	-1.6673	1	-2.6372	1	-4.5748	1	I(0)
$D^*\left(\dfrac{C}{Y}\right) = \dfrac{\Delta D}{D}\left(\dfrac{C}{Y}\right)$	-14.0923	0	-15.4460	0	-14.9765	0	I(0)
$G^*\left(\dfrac{C}{Y}\right) = \dfrac{\Delta G}{G}\left(\dfrac{C}{Y}\right)$	-0.2979	8	-15.8383	0	-15.3057	0	I(0)
$X^*\left(\dfrac{C}{Y}\right) = \dfrac{\Delta X}{X}\left(\dfrac{C}{Y}\right)$	-1.7353	2	-2.7889	2	-2.9851	2	I(0)

Source: Author's Calculations

Therefore, OLS (Ordinary Least Square) technique is applied to estimate the equations (7) and (9).

Description of Variables

$$Y^* = \frac{\Delta Y}{Y} = \text{Real GDP growth rate}$$

$$\frac{I}{Y} = \text{Share of Investment in Real GDP}$$

$$L^* = \frac{\Delta L}{L} = \text{Labor force growth rate}$$

$$D^*\left(\frac{D}{Y}\right) = \frac{\Delta D}{D}\left(\frac{D}{Y}\right) = \text{Size or Total effect of defense sector}$$

$$G^*\left(\frac{G}{Y}\right) = \frac{\Delta G}{G}\left(\frac{G}{Y}\right) = \text{Size or Total effect of non-defense government sector}$$

$$X^*\left(\frac{X}{Y}\right) = \frac{\Delta X}{X}\left(\frac{X}{Y}\right) = \text{Size or Total effect of Export sector}$$

$$D^*\left(\frac{C}{Y}\right) = \frac{\Delta D}{D}\left(\frac{C}{Y}\right) = \text{Externality effect of defense sector}$$

$$G^*\left(\frac{C}{Y}\right) = \frac{\Delta G}{G}\left(\frac{C}{Y}\right) = \text{Externality effect of non-defense government sector}$$

$$X^*\left(\frac{C}{Y}\right) = \frac{\Delta X}{X}\left(\frac{C}{Y}\right) = \text{Externality effect of Export sector}$$

$\gamma_d = $ Relative input productivity index for defense sector with respect to civilian sector

$\gamma_g = $ Relative input productivity index for non-defense government sector

$\gamma_x = $ Relative input productivity index for export sector

and Y = GDP at constant 2000 US$ (in million)
    I = Total Investment at constant 2000 US$ (in million)
    L = Labor Force (in million)
    D = Defense Expenditures at constant 2000 US$ (in million)
    G = Non-defense Government Expenditures at constant 2000 US$ (in million)
    X = Exports at constant 2000 US$ (in million)

Empirical Results

OLS estimates of Feder-type model (equation 7) for Pakistan and India are displayed in Table 3 which shows the total (size) effects of each sector i.e. civilian, defense, non-defense and exports on economic growth. In Table 4, OLS estimates of Augmented Feder-

type model (equation 9) for both nations are demonstrated that also show the total (size) effects of each sector along with externality effects and relative productivity differential.

In every table, the first, second and third column show the results of two, three and four sectors models respectively.

Empirical Results for Total Effects of Each Sector

The model specified in equation 7 has six variables. Real GDP growth rate is dependent variable whereas investment, labor force, defense expenditures, non-defense government expenditures and exports are independent variables. The empirical results of equation 7 are shown in Table 3.

TABLE 3
OLS ESTIMATES OF FEDER-TYPE MODEL FOR PAKISTAN AND INDIA

Regressors	Dependent Variable: Real GDP Growth					
	Pakistan			India		
	Two Sector	Three Sector	Four Sector	Two Sector	Three Sector	Four Sector
Intercept	0.01 (0.41)	0.017 (0.42)	0.00762 (0.18)	-0.12 (-2.76)**	-0.11 (-2.69)**	-0.088 (-2.00)*
I/Y	0.04 (0.18)	0.05 (0.20)	0.09 (0.36)	0.61 (3.29)***	0.54 (3.04)***	0.36 (1.85)*
ΔL/L	0.74 (14.61)***	0.74 (14.58)***	0.76 (15.28)***	0.625 (6.03)***	0.58 (5.74)***	0.56 (5.80)***
ΔD/ D (D/Y)	3.27 (4.96)***	3.55 (4.81)***	2.59 (3.03)***	13.21 (3.84)***	8.63 (2.15)**	6.53 (1.64)
ΔG/ G(G/Y)	------	-0.19 (-0.84)	-0.22 (-1.00)	------	1.42 (2.01)**	1.50 (2.22)**
ΔX/ X(X/Y)	------	------	0.76 (1.99)*	------	------	2.01 (2.04)**
Diagnostic Tests						
R²	0.96	0.96	0.97	0.90	0.91	0.92
DW	1.98	1.95	2.03	1.89	1.79	2.23
BPG test	0.81	0.72	0.81	0.67	0.45	0.47
Jarque Berra	0.85	0.99	0.91	0.04	0.11	0.31
Prob F-statistic	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author's calculations
Level of significance represented: 1% by ***, 5% by **, 10% by *.

In Table 3, the values of coefficient of investment ratio (I/Y) in two, three and four sector models for Pakistan are 0.04, 0.05 and 0.09 respectively. Although the investment ratio is insignificant but has the correct sign according to the macro economic theory of investment multiplier which suggest the positive relationship between investment and national income. The reason of insignificant result in the case of Pakistan may be that it is related to civilian sector that is not performing well due to social overhead capital constraints. Our results are compatible with the studies conducted for Pakistan [See Reinhart and Khan, 1989 and Sial and Anwar, 2010]. So far as India is concerned, coefficient of investment ratio (I/Y) in two, three and four sector models is 0.61, 0.54 and 0.36 respectively. This variable has positive sign and highly significant in the case of India because India has constructed effective infrastructure that has added to its economic growth. India may receive benefits from the externalities of industrial infrastructure developed over the past decades. Accordingly,

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significantly positive changes in productivity are expected due to investment. Some specific studies especially for India have also discovered a positive correlation between investment and growth [See Ward et al 1991 and Mallick,2012].

Our results corroborate with the other empirical studies that also recommend the positive relationship between investment share and economic growth [See Huang and Mintz, 1991; Mueller and Atesoglu, 1993 and Alexander, 1995]. Some studies, however, find the negative relationship between investment ratio and economic growth which is counter intuitive or contrary to macro economic theory. [See Alexander, 1990; Fontanel, 1990b; Ward and Davis, 1991].

The second variable specified in the model is labor force growth ($\Delta L/L$) which is positive and strongly significant both for Pakistan and India. The values of regression coefficient of labor force growth in two, three and four sector for Pakistan are 0.74, 0.74 and 0.76 correspondingly. Similarly, for India, the values of regression coefficient of labor force growth in two, three and four sector are 0.62, 0.58 and 0.56 respectively. Various economic theories like Solow-Swan neoclassical growth model, endogenous growth theory, Robert Barro's growth model support the positive association between labor and economic growth. In fact, labor is the principal source for economic growth. It is a base of production and technological progress. The countries by investing in their people can create human capital which ultimately leads to economic growth. Our findings accord well to the theories of economic growth. The positive labor- growth relationship proposes that both the countries are diverting their resources towards education, health and training of human beings. Our results are in accordance with other empirical studies that also recommend the positive labor-growth relationship [Huang and Mintz, 1991; Mueller and Atesoglu, 1993; Alexander, 1990, 1995]. Since the theories on labor-growth nexus are not conclusive as some studies suggest the negative relationship between labor and growth [Ward et al. 1991; Antonakis 1997]. Therefore, the negative labor-growth relationship can not be ignored as well.

Now we turn to the variables that we have included in neo-classical model i.e. defense, non-defense and export sector variables. The major variable of interest in this study is the coefficient of defense sector which shows the size or total effect of defense sector. For both the countries, the parameter of defense outlays is highly significant and positive supporting the arguments of spin- off and modernization effects[5]. We observe that the values of coefficient of defense sector ($\Delta D/D)(D/Y)$ in two, three and four sector models for Pakistan are 3.27, 3.55 and 2.59 respectively. In the same way for India, the values of coefficient of defense sector in two, three and four sector models are 13.21, 8.63 and 6.53 correspondingly. Defense expenditures can generate higher economic growth through its spin off effects. Deger (1986a) points out these spin-off effects may be realized by two ways. Firstly, defense expenditures as a component of state expenditures that can enhance economic growth via effective demand/multiplier effects provided there is insufficient aggregate demand. So, inefficient aggregate demand relative to the potential aggregate supply can be met by defense spending generating the extra demand through boosting the capital stock

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[5] Deger (1986a) has given the concept of spin off and modernization effects of defense on growth. By spin-off and modernization effects, Deger (1986a) means that the effects of defense expenditures on physical and social infrastructure which are helpful in building civil society and stimulating economic growth.

utilization and employment of labor. Thus, the long-run growth can also be attained in addition to short-run multiplier effects. *An increase in demand results in increased capacity utilization, employment and profit rate that leads to enhance investment and growth* (Deger, 1986). Secondly, defense spending can also have the modernization effects. Numerous technological advancements and spin offs take place from the defense sector which is greatly engaged in Research and Development. These technological advancements and spin offs can generate more growth if applied to the civilian or non-military sector. Defense spending provides social infrastructure, training, technical skills and education to army. If these things can later be applied to non-military sector, economic growth would be the outcome in developing countries specifically. Our findings are compatible with the studies [Ram, 1986; Ward et al 1991; Atesoglu and Mueller, 1990; Biswas, 1993; Alexander, 1995; Macnair et al, 1995; Murdoch et al,1997]. However, it is worth mentioning that certain studies [i.e. Huang & Mintz, 1990,1991; Ward and Davis, 1992; Ward et al, 1995] discovered a negative size effect of defense on growth rejecting the spin-off and modernization effects.

The regression coefficient of non-defense government expenditures ($\Delta G/G)(G/Y$) indicates the size or total effect of non-defense government sector on growth. For Pakistan, the values of coefficient of non-defense government sector in three and four sector models are -0.19 and -0.22 respectively. This variable shows the negative but insignificant effect of non-defense government sector on economic growth. Economic theory is not conclusive regarding the impact of non-defense government sector. Depending upon the circumstances of the country, it can have either positive or negative effects on economic growth. As in the case of Pakistan, negative impacts suggest that non-defense government outlays are misallocated. In fact, non-defense government sector hinders the economic growth due to a variety of cost i.e. displacement cost, extraction cost, negative multiplier cost, market distortion cost, behavioral subsidy and penalty cost, stagnation cost and inefficiency cost. A further possible interpretation of this result may be that in Pakistan it is well known that productivity in the public sector is relatively low not only because of general lack of efficiency in the public sector. In addition, it transfers the goods and services rather than production. Our results for Pakistan corroborates with the studies [See Landau, 1983; Grier and Tullock, 1987; Grossman, 1988; Barro, 1990; Ward et al., 1991, Rehmen et al., 2010 and Rauf et al., 2012].

For India, the values of coefficient of non-defense government sector in three and four sector models are 1.42 and 1.50 respectively. This variable shows the significantly positive effect of non-defense government sector on economic growth. These findings exhibit that besides defense expenditures, non-defense government outlays are also growth promoting in India. The reason of this positive relationship may be that non-defense government sector is performing well and resources are well allocated to stabilize the economy. Another argument may be that government sector provides socially optimum direction by balancing the disagreement between private and social interests. Our results for India support the studies [See Ram, 1986; Alexander, 1990, 1995; Huang and Mintz, 1991; Tulsidharan, 2006 and Sharma, 2008].

Export sector is generally considered a catalyst of economic growth. Export sector is growth stimulating in the sense that due to an increase in exports, the demand and rewards of factors of production increase leading to expansion in output. This would promote the technological advancement and investment efforts. The export led growth based on comparative advantage is multi-pronged in its externalities leading to optimum resource

utilization, foreign exchange earnings and improved total factor productivity. The final regressor in the Feder-type model is export sector $(\Delta X/X)(X/Y)$ that shows the size or total effect of export sector on growth. For both the nations, positive and highly significant result is found. The values of regression coefficient of export sector for Pakistan and India are 0.76, 2.01 respectively. Our results for both the countries are consistent with the studies [See Emery,1967; Balassa, 1978,1985; Feder,1982; Jung and Marshall,1985; Chow, 1987; Krueger,1990; Shirazi and Manap,2004; Konya and Singh, 2006; Siddiqui et al., 2008 and Rahman & Shahbaz, 2011].

Now we discuss the diagnostic tests of the analysis. So for as the explanatory power of the model for Pakistan is concerned, it is satisfactory as the values of R^2 are 0.96, 0.96, and 0.97 for two, three and four sector models respectively. For India, the values of R^2 are also satisfactory being 0.90, 0.91 and 0.92 for two, three and four sector models correspondingly. There is no evidence of autocorrelation as the values of Durbin Watson (DW) statistic are around 2 for all two, three and four sector models in both the countries. To check the heteroskedasticity for both the nations, we have performed the Breusch-Pagan-Godfrey (BPG) Lagrange multiplier test. Owing to the constant variance of error term,the probability values of BPG imply that we are unable to reject the null hypothesis. The probability values of Jarque Berra are also more than 5 percent except the two sector model for India suggesting that the residuals are normally distributed for both the countries. The overall significance of Feder-type model is also well as recommended by probability values of F-statistic for the two neighboring countries.

Empirical Results for Total, Externality and Relative Factor Productivity Effects

The model specified in equation 9 is Augmented Feder-type model that demonstrates the total effect along with externality and relative productivity effects for two, three and four sector model in Pakistan and India. The dependent variable is again Real GDP growth rate. The empirical results of equation 9 are depicted in Table 4. First, we elucidate the results for the two-sector model (civilian and defense), where the variable related to civilian sector i.e. investment ratio (I/Y) and labor force growth rate ($\Delta L/L$) represents the total effect of civilian sector on economic growth while the variable $(\Delta D/D)(D/Y)$ related to defense sector shows the total effect of defense sector.

For Pakistan, the sign of the coefficient of investment ratio is positive but insignificant same as observed in Feder-type model. The coefficient of labor force growth rate is found significant and has the same positive sign as before. The size or overall effect of the defense sector is found to be positive and significant as before. The externality effect of the defense sector with respect to the civilian sector $(\Delta D/D)(C/Y)$ shows the negative but insignificant effect. The relative factor productivity index for defense sector with respect to civilian sector (γ_d) calculated from the coefficient of total effect of defense sector, is negative and demonstrating that the defense sector in Pakistan is less productive than the civilian sector. Since the coefficient of total effect of defense sector is significant, so relative factor productivity index for defense sector has its importance. The two-sector model performs well in terms of explanatory power with R^2 being 0.96. To check autocorrelation in the model, we have applied DW test. The value of DW is exactly 2 that indicate no problem of autocorrelation. The Breusch-Pagan-Godfrey (BPG) Lagrange multiplier test is performed to check the heteroskedasticity and the probability value of BPG found is more than 5 percent i.e. 0.84 implying that the variance of error is constant. The probability value of Jarque Berra is also more than 5 percent i.e. 0.81 suggesting that the residuals are normally distributed. The

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overall significance as recommended by probability value F-statistic for two-sector model is also good.

TABLE 4
OLS ESTIMATES OF AUGMENTED FEDER-TYPE MODEL
FOR PAKISTAN AND INDIA

	Dependent Variable: Real GDP Growth					
	Pakistan			India		
Regressors	**Two Sector**	**Three Sector**	**Four Sector**	**Two Sector**	**Three Sector**	**Four Sector**
Intercept	0.01 (0.25)	0.01 (0.40)	0.03 (0.80)	-0.13 (-3.01)[***]	-0.07 (-2.09)[**]	-0.08 (-2.34)[**]
I/Y	0.08 (0.31)	0.07 (0.27)	0.013 (0.05)	0.66 (3.67)[***]	0.45 (3.19)[***]	0.48 (2.97)[***]
ΔL/L	0.73 (14.20)[***]	0.67 (8.87)[***]	0.55 (6.52)[***]	0.54 (4.96)[***]	0.41 (4.75)[***]	0.35 (4.07)[***]
ΔD/ D (D/Y)	4.81 (2.59)[**]	3.96 (1.96)[**]	1.68 (0.84)	39.99 (2.68)[**]	22.39 (1.79)[**]	16.20 (1.33)
ΔG/ G (G/Y)	------	-1.41 (-1.29)	-0.52 (-0.53)	------	-11.74 (-4.35)[***]	-9.59 (-3.50)[***]
ΔX/ X (X/Y)	------	------	-3.02 (-2.36)[**]	------	------	-1.45 (-0.98)
ΔD/ D (C/Y)	-0.09 (-0.88)	-0.05 (-0.52)	0.01 (0.19)	-0.63 (-1.84)	-0.41 (-1.53)	-0.32 (-1.25)
ΔG/ G(C/Y)	------	0.27 (1.16)	0.06 (0.28)	------	2.05 (4.88)[***]	1.69 (3.96)[***]
ΔX/ X (C/Y)	------	------	0.64 (3.04)[***]	------	------	0.30 (1.94)[*]
γ_d	-1.26	-1.33	-2.45	-1.02	-1.04	-1.06
γ_g		-0.58	-0.34		-0.92	-0.90
γ_x			-0.75			-0.59
Diagnostic Tests						
R^2	0.96	0.97	0.97	0.91	0.95	0.96
DW	2.00	1.78	1.77	1.94	1.77	2.28
BPG test	0.84	0.84	0.97	0.46	0.43	0.66
Jarque Berra	0.81	0.98	0.85	0.00	0.88	0.82
Prob F-statistic	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author's calculations

Level of significance represented: 1% by [***], 5% by [**], 10% by [*].

For India, the signs of the both coefficients relating to civilian sector i.e. investment ratio and labor force growth rate are positive and strongly significant, same as observed before in Feder-type model. The size effect of defense sector is found positive and significant as observed before. Externality effect of the defense sector shows the negative sign and significant at 10 percent. The relative factor productivity index for defense sector is negative which shows that defense sector in India is less productive than the civilian sector, the same result as found in Pakistan's case. Owing to significant parameter of total effect of defense sector, the importance of relative factor productivity index for defense sector increases. So far as the values of R^2 and probability of F-statistic i.e. 0.91 and 0.00 are concerned, these show

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that model is better fit. The probability values of BPG test and Jarque Berra test are 0.46 and 0.00 respectively. As the probability values of BPG test is more than 5 percent, we are unable to reject the null hypothesis of no heteroskedasticity. Some problems regarding the normality are there as the probability value of Jarque Berra test is less than 5 percent and we are unable to accept the null hypothesis. DW statistic is 1.94 which is close to 2 indicating no evidence of autocorrelation.

Turning to the three-sector model (civilian, defense and non defense government) where the variable related to non-defense government sector i.e. **(ΔG/G) (G/Y)** illustrates the size effect of non-defense government sector on economic growth. For Pakistan, there is no change regarding the sign of all variables specified in Feder-type model and Augmented Feder-type model. The significance of non-defense government sector has improved from 0.40 to 0.20 but the other variables have almost the same significance.

The externality effects of the defense and non-defense government sectors are found negative and positive (although insignificant) respectively. The relative productivity indices for defense sector and non-defense sector are negative for Pakistan. The values of diagnostic tests are satisfactory to validate the model.

For India, while comparing the Feder-type model and Augmented Feder-type model, the signs of all variables are same except in non-defense government sector. The sign of coefficient for non-defense government sector turns out from positive to negative. The significance level has altered a little bit for all the variables but remained significant. The variable of defense sector has particularly varied from 5 percent to 10 percent level. Externality effect of the defense sector is found negative and insignificant while for non-defense government sector it is positive and significant. The relative productivity indices for defense and non-defense sectors for India are negative and same as in the case of Pakistan. The values of diagnostic tests are also good to authenticate the three-sector model.

Now, we discuss the results of four-sector model (civilian, defense, non defense government and export sector) where the variable related to export sector i.e. **(ΔX/X) (X/Y)** illustrates the size effect of export sector on growth. For Pakistan, all the variables demonstrate the same signs except the export sector while comparing with Feder-type model. There is a minor change in the significance level of all variables but the significance of defense sector variable is totally changed and this has become insignificant in augmented Feder-type model. The externality effect of all the sectors is positive and insignificant but significant in export sector. The relative productivity indices for all sectors are negative. Diagnostic tests for four-sector model show that there is no violation of OLS again.

For India, while comparing the Feder-type model and Augmented Feder-type model, the signs of all variables are same except for non-defense government sector and export sector. The signs of variables of non-defense government and export sectors changed from positive to negative along with their significance. The variable of defense sector has particularly varied in its significance from 10 percent to 19 percent level. Similarly, the variable of export has changed its significance from 4 percent to 33 percent level. Externality effect of the defense sector is negative but insignificant while it is positive and insignificant for Pakistan. For Pakistan and India, the externality effects of the non-defense and export sectors are similar i.e. positive and significant. The relative productivity indices for all sectors are negative for India and same as in the case of Pakistan. The values of diagnostic tests indicate that four-sector model for India authenticates well.

CONCLUSIONS

This study provides the empirical evidence on defense-growth nexus for Pakistan and India based on supply side model (Feder-type) for the period of 1972 to 2010. We have included four sectors in Feder-type model along with externalities and the productivity differentials. These results are in accordance with the theoretical underpinning. In two-sector model both for Pakistan and India, total effect of civilian and defense sector is positive on economic growth. There is no change in the sign of civilian and defense sectors' coefficients when either the non-defense government sector alone (three-sector model) or both the non-defense government and export sectors (four-sector model) are introduced. The total effect of non-defense sector is negative but insignificant for Pakistan in both the three and four-sector models while for India, the total effect of non-defense sector is positive and significant in the three and four-sector models. The total effect of export sector is positive and significant for both the countries. Moreover, the overall performance and the explanatory power of all the models have remained the same.

The same process has been replicated with the augmented Feder-type model. This model gives the total effects with externality effects and productivity differential. Again for Pakistan, the variables of civilian, defense and non-defense sectors give the same positive signs except export sector but in case of India the variables of civilian and defense sectors give the same positive signs except non-defense and export sectors. The externality effect of defense sector in Pakistan remains negative in two and three sector models and positive in four-sector model while in India the externality effect of defense sector continues to be negative in all the sectors. The relative productivity index for all variables is found to be negative in both the countries.

In brief, we can conclude from the study is that the Feder-type and Augmented Feder-type model suggests that the total effect of defense sector is positive on growth both for Pakistan and India. The externality effect of defense sector in Pakistan remains negative in two and three sector models and positive in four-sector model while in India the externality effect of defense sector continues to be negative in all the sectors. The relative productivity index for all variables is found to be negative in both the countries.

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Uncertainty is the very condition to impel man to unfold his powers. If he faces the truth without panic he will recognize that *there is no meaning to life except the meaning man gives his life by the unfolding of his powers, by living productively;* and that only constant vigilance, activity, and effort can keep us from failing in the one task that matters - the full development of our powers within the limitations set by the laws of our existence.

Erich Fromm, *Man for Himself* , p.53-54