

Military Participation and Economic Development in LDCs: New Evidence*

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This paper uses data from 31 Less Developed Countries (LDCs) and employs a five equation simultaneous model to investigate the relationship between military participation ratio on the one hand and economic growth and income distribution on the other. We find a weak support for the hypothesis that high military participation ratio is associated with equitable distribution of income. However, we also find that high military participation ratio is associated with slow economic growth. This makes it impossible to use military employment as a long term strategy for income distribution in LDCs.

I. Introduction

Research into the relationship between defense resources and economic development in Less Developed Countries (LDCs) has yielded mixed results. Following Benoit's study that found a positive relationship between defense spending/GDP ratio (defense burden) and economic growth rate, several critics (Deger and Smith (1983), Deger (1985), Faini, Annez and Taylor (1984) and Libovich and Ishaq (1986)) have found a negative relationship between defense burden and economic growth rate. Other researchers (Frederickson and Looney (1983)), have found evidence to support Benoit's results. Still other researchers (Biswas and Ram (1986))

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have found no relationship between defense burden and economic growth.

Researchers who have found a positive relationship between defense burden and economic growth stress technological spinoffs from defense spending, modernization of attitudes, and discipline the military brings to civilian life, resource mobilization efforts that increased defense burden requires, as well as increased demand bringing about a Keynesian-type multiplier effect. Those who have found a negative relationship between defense burden and growth stress the negative effects of defense burden on savings and investment, structural changes, and resource allocation in general. They argue that these negative effects outweigh any positive benefits that defense burden might have on growth.

The differences in research results are paralleled by differences in research designs. While a large number of researchers have estimated single equation models, others have estimated simultaneous equation models. The relationship between defense burden, economic growth, and investment or savings is likely to be a simultaneous one (Joerding (1986)). By nature, single equation models cannot explore the relationship among these variables: hence such models produce biased results.

All the studies mentioned above use defense burden as the measure of defense resources. However, Weede (1986), and Weede and Tiefenbach (1981) have used the military participation rate (the ratio of military force to total population) as the measure of defense resources. In this regard, their studies are unique in that they analyse the defense/development relationship in terms of the most important resource-human resource. Using data from 31 LDCs, Weede (1986) found that military participation rate (force ratio) is positively related to economic growth rate as well as the share of national income going to the poorest 40 percent of the population.¹ Weede and Tiefenbach (1981) found that increased force ratio is associated with equitable distribution of income.

Weede (1986) and Weede and Tiefenbach (1981) used single equation models to study the relationship between force ratio and economic development. This assumes that the force ratio is exogenously determined. However, there are reasons to believe that this is not the case. First, the civilian economy competes with the military for available labor. In high growth economies, wages will be bid up in both sectors. With high wage rates, the military may substitute capital (military hardware) for labor. Growth rate will therefore influence the decision to have a

¹ The force ratio is the same as the military participation ratio in this paper.

mechanized or a nonmechanized armed force and hence the force ratio. As an example, ACDA figures show that the force ratios of OPEC countries — where defense spending grew rapidly because of oil boom — were consistently lower than those of LDCs as a whole during the 1973/83 period even though OPEC's defense burden was about one and a half to two times that of the Developing World as a whole.

Second, since soldiers have to be fed, housed, trained, and equipped, a large armed force translates into a large defense burden. Many researchers (Deger (1985), Deger and Smith (1983), Joerding (1986)) have shown that the defense burden is related to growth rate. This means that even if the force ratio is not directly affected by growth rate, it is affected indirectly through defense burden.

The economic development literature is divided on whether fast growth improves or worsens income distribution. There is a consensus, however, that economic growth makes income redistribution possible. If so, income distribution depends on economic growth rate which in turn influences the force ratio. Therefore income distribution is not independent of other endogenous variables. The literature on income distribution in LDCs also argue that income distribution depends on growth rate as well as the *structure* of growth. Faini, Annez, and Taylor (1984) finds that military burden influences the structure of the economy. Could force ratio be picking up the effects of the excluded structural variables in Weede's distribution equation?

By using a single equation model, Weede (1986) and Weede and Tiefenbach (1981) are not able to account for the interrelationship among these variables. These studies account for the benefits of force ratio but not the cost of acquiring such a force ratio. At best, they estimate the partial rather than the total effects of force ratio on economic growth and income distribution.

Does higher force ratio cause faster economic growth after indirect effects are considered? Does income distribution in LDCs improve with the force ratio after allowance is made for the effects of economic growth and structural change? This paper investigates these two issues using data from a sample of 31 LDCs for the period 1973 to 1983.² We estimate a five equation — growth rate, investment, force ratio, defense burden, and

² Our sample countries are those used by Weede (1986). However, the time period differs from Weede's time frame. The sample countries are: Argentina, Bangladesh, Bolivia, Brazil, Cameroon, Chile, Colombia, Egypt, Ethiopia, Ghana, India, Indonesia, Ivory Coast, Jamaica, Kenya, Korea, Malawi, Malaysia, Mexico, Nigeria, Pakistan, Peru, Philippines, Senegal, Sri Lanka, Tanzania, Thailand, Tunisia, Turkey, Uruguay and Yugoslavia.

income share of the poorest 40 percent of the population — simultaneous system. This, allows us to take account of the simultaneity among the variables. It also makes it possible to investigate the mechanisms through which force ratio affects economic growth rate and income distribution. Though we estimate a five equation model, our prime interest is in the relationship between economic growth rate and income distribution on the one hand, and force ratio on the other. The results of this study have defense policy implications in LDCs.

We limit our sample to the 31 countries for two reasons. First, it is the sample countries for which the World Bank has data on price distortion, one of the variables we use. Second, it makes it possible to compare our results with those of earlier studies. We have chosen the 1973/1983 period because it coincides with the periodization of the World Bank data on income distribution and price distortion and also defense resources data are easily available for that period.

The paper is organized as follows: Section II presents the model while section III discusses the data. Section IV presents and discusses the statistical results and policy implications. Section V concludes the paper.

II. Model

Resources devoted to defense can influence economic growth in two possible ways: increased utilization of existing resources, increased demand, spillover of military technology, thus making existing resources more productive on the one hand, and the effects defense resources have on the supply of additional productive resources to the economy on the other. We refer to the first set of effects as direct effects and the second set of effects as indirect effects for want of a better terminology:

The direct effects work through increasing demand for labor (soldiers) as well as goods (equipment, construction etc.), thus employing resources that would otherwise go unemployed. The employment of these resources and the demand for construction and other purchases create additional spending which will in turn lead to the employment of more resources, hence economic growth. Also, it is argued that in LDCs, the military is the most modernized and disciplined institution: therefore increased military participation will make the labor force more productive thus increasing economic growth.

The indirect effects work through the changes defense resources have on the supply of productive resources to the economy. The acquisition of technical and managerial skills are part of the basic military training in

LDCs. Such skills are available to the economy when these soldiers complete their tours of duty. In LDCs, such technical and managerial skills are extremely scarce and constitute an effective growth bottleneck. By augmenting the supply of such skills, increased defense resources help to break this growth bottleneck. However, it is possible that increasing military participation ratio will increase the defense burden. This could decrease national expenditure on education, hence human capital formation in the civilian sector. Moreover, soldiers are recruited from the ranks of the educated people trained by civilian educational institutions. Under such conditions, it is not clear whether increasing the military participation ratio will increase the supply of skilled personnel to the economy. This is an empirical question not treated in this paper for lack of data.

Increased defense participation ratio implies increased defense burden since it requires large amounts of money to maintain a large army. Increased defense burden, all things equal, crowds out investment. For example, Deger (1985) finds that increased defense burden decreases the savings ratio in a sample of LDCs, thus reducing the resources available for investment. It is however possible that increasing defense resources will foster a sense of increased security among a nation's business people, leading them to increase investment. The net effect of these two opposing forces is an empirical question to be investigated below.

The interconnections between participation ratio, defense burden, investment, and economic growth are very complex. These interconnections cannot be captured in a single equation model. Because of the endogeneity of some of the explanatory variables, parameter estimates from single equation models will be biased. The appropriate modeling approach is a simultaneous equation system that accounts for the endogeneity of variables and also sheds some light on the interconnections between the variables. We provide such a model below.

The theoretical foundation of this work is provided by the results of previous research and growth accounting.³ In light of the arguments above, we start from a production function framework. We assume that output (GDP) is a function of capital, labor, technology, and security:

$$(1) \text{ GDP} = Y(K, L, S, T)$$

$$\partial \text{GDP} / \partial K, \partial \text{GDP} / \partial L, \partial \text{GDP} / \partial S, \partial \text{GDP} / \partial T > 0$$

where GDP = gross domestic product, K = capital stock, L = labor,

³ See, for example, Deger and Sen (1983), Deger and Smith (1983), and Faini, Annez, and Taylor (1984).

S = security, and T = technology.

Security is hard to define and quantify. However, we assume that given the threat a nation faces, security is positively related to defense burden and the force ratio.⁴

$$(2) S = g(F, M)$$

where F = force ratio and M = defense burden. Substituting equation 2 into 1 and converting variables to growth rates, we obtain the growth rate of GDP as a function of the growth rates of the arguments of the GDP equation.

$$(3) g = g(k, l, m, f, t, Z_g)$$

where g = growth rate of GDP, and Z_g is a vector of control variables.

Capital formation is not independent of other variables. For one thing, Keynesian investment theory suggests that capital formation will depend on economic growth rate. Given that defense competes with other sectors for available resources, defense burden is expected to influence capital formation. If military participation influences resource mobilization through increased taxation or fosters increased security and thereby changing the time preference of the population, then force ratio will influence capital formation. Putting these together, the capital formation equation is given as:

$$(4) k = k(g, m, f, Z_k)$$

where Z_k is a vector of control variables that influence capital formation.

While force ratio may at first appear to be exogenously determined, in reality, it is not. A nation cannot determine its force ratio without considering the labor needs of the civilian sector of the economy. The labor needs of the civilian sector will depend on, among other things, the growth rate of the economy. The higher the growth rate of the economy, the more the labor needs of the civilian sector, all things equal. This will raise the wage rate for both sectors. The increased relative cost of labor may cause policy makers to alter the capital/labor ratio in the military.⁵

⁴ Some authors make security a function of defense burden. However, Weede argues that force ratio provides a better measure of security than defense burden. We believe that a combination of both factors make more sense than either one of them separately.

⁵ This analysis is not applicable to countries that use conscription with short tours of duty in the military. It is wholly applicable to countries that rely on volunteer military enlistment. Most of the countries in our sample rely on voluntary career enrolment.

Finally, the force ratio will depend, in part, upon the financial resources available to the military, hence on the defense burden. This implies that the force ratio equation can be written as:

$$(5) \quad f = f(g, m, Z_f)$$

where Z_f is a vector of other variables that influence the force ratio. All other variables remain as defined above.

The military burden depends on force ratio because once a nation has decided on the size of its military, it has to find the money to train, equip, and maintain the soldiers. Therefore the higher the force ratio, all things equal, the higher will be the defense burden. The defense burden also depends on capital formation. The greater the share of resources devoted to capital formation, the less resources will be available for defense. The defense burden equation therefore is written as:

$$(6) \quad m = m(f, k, Z_m)$$

where Z_m is a vector of exogenous variables that influence defense burden.

While very little has been written on the relationship between force ratio and income distribution, Weede (1986) and Weede and Tiefenbach (1981) have argued that the income share of the poorest 40 percent of the population (L40) increases with force ratio. There are some reasons to believe that this is a reasonable proposition. First, one can consider the military as a public sector employment program, and like all public sector employment programs, it tends to redistribute income towards the poor. Second, the extended family system in LDCs makes it possible for relative of soldiers to benefit from their kin's employment in the military—food ration, medical benefits, even free military outfits are shared with relatives. Of course, remittances by soldiers to their relatives also tend to redistribute income towards the poor. The income share of the poorest 40 percent of the population is also dependent on the growth rate of the economy. While there is a debate as to whether fast economic growth is associated with equitable income distribution, the consensus in the development literature is that economic growth makes redistribution possible.⁶ We therefore specify the L40 equation as a function of economic growth rate, the force ratio, and other exogenous variables.

$$(7) \quad L40 = L(f, g, W_f)$$

⁶ See, for example, Chenery, et al.

where W_i is a vector of exogenous variables that influence income distribution. Equations (3)-(7) form the system to be estimated.

To estimate the system of equations, specific functional forms must be provided and the variables in each equation defined. We specify linear (in parameters and variables) regression equations. The system of equations to be estimated is specified below:

$$(3b) \quad g = a_0 + a_1k + a_2f + a_3m + a_4gdp + a_5XGROW \\ + a_6DISTORT + a_7p$$

$$(4b) \quad k = b_0 + b_1g + b_2m + b_3f + b_4FLOWS$$

$$(5b) \quad f = c_0 + c_1m + c_2g + c_3THRT + c_4WAR$$

$$(6b) \quad m = d_0 + d_1k + d_2f + d_3WAR + d_4THRT + d_5gdp$$

$$(7b) \quad L40 = e_0 + e_1f + e_2g + e_3DISTORT + e_4gdp + e_5AGPRO$$

where k = investment/GDP ratio of a nation, f = force ratio, m = defense burden, gdp = per capita real GDP in 1975 prices, $XGROW$ = the average annual growth rate of export earning, $DISTORT$ = index of price distortion, $FLOWS$ = net foreign capital inflow/GDP ratio, WAR = Dummy variable for war economy, = 1 if country was engaged in a war during the period under study, 0 otherwise, p = annual growth rate of population, $THRT$ = Threat dummy, = 1 if country borders on another country with which it has or has had hostilities, and $AGPRO$ = an index of agricultural sector's relative income. All other variables are as defined in the text.

The growth equation has gdp , $XGROW$, p , and $DISTORT$ as well as the three endogenous variables as arguments. It is possible that high income LDCs are better able to mobilize and utilize resources than their low income counterparts. On the other hand, low income countries have the advantage of borrowing technology for growth while their high income counterparts will have to invest in Research and Development to develop new growth technologies; hence low per capita income will be correlated with high growth rate. Whatever the relationship between growth rate and per capita income, it is reasonable to assume that the relationship between defense resources and economic growth will not be the same for low and high income LDCs. We have therefore introduced gdp as a scale variable in the economic growth rate equation.

We could not get reliable data for the growth rate of labor force. We assume that if the labor participation ratio remains stable, the growth rate of labor will be proportional to the growth rate of population. We have therefore included p as a proxy for growth rate of labor.

With the exception of few countries, LDCs tend to be open economies whose growth rates tend to depend on revenues from a few export commodities. XGROW is introduced as a variable to account for this phenomenon. The coefficient of XGROW is expected to be positive. Price distortion leads to misallocation of resources, especially capital and labor. In LDCs, this frequently takes the form of establishing political and economic alliances to share in the economic rents created by distortion. This inevitably reduces economic growth. The World Bank (1983), Weede (1986), and Weede and Tiefenbach (1981) find empirical evidence to support this phenomenon. We therefore expect DISTORT to have a negative coefficient in the growth equation.

The k equation includes FLOWS in addition to g , m , and f . FLOWS is intended to measure a nation's ability to obtain capital from external sources. This variable, as well as g , is expected to have a positive coefficient, f and m cannot be signed a priori.

The f equation includes WAR, THRT, m and g as arguments. Nations at war or threatened by external aggression are expected to have higher force ratios than nations not so threatened. We expect WAR and THRT to have positive coefficient. g cannot be signed a priori in this equation.

We have included WAR, gdp , and THRT as arguments in the m equation. Countries that are engaged in a war or are threatened by a neighbor will tend to spend more on defense than nations that do not face such problems. These variables, together with the force ratio, are expected to have positive coefficients. gdp and k cannot be signed on theoretical grounds.

In addition to g and f , we have included gdp in the L40 equation as a scale variable. If the argument that increased economic growth makes it easier to redistribute income is correct, the coefficient of g is expected to be positive. We cannot sign gdp and f a priori in this equation. Serious price distortion in an economy prevents employment growth, especially those of low skilled labor, hence distortion decreases the income share of the poorest 40 percent of the population. DISTORT is therefore expected to have a negative coefficient.

Not only does income distribution depend on gdp and growth rate; it also depends upon the *character* of economic growth. In LDCs, poverty tends to be concentrated more in the agricultural sector. Income growth in the agricultural sector, relative to other sectors, improves income distribution. To take account of this structural effect, we have included a variable AGPRO, defined as the ratio of agriculture's share of GDP to the share of total labor force employed in agriculture. This variable measures the share

of agricultural income relative to average incomes in the entire economy. We expect this variable to have a positive coefficient.

The interest of this paper is in the effect force ratio has on economic growth rate and the share of income going to the poorest 40 percent of the population. The force ratio multipliers are given as:⁷

$$(8a) \quad dg/df = \partial g/\partial f + (\partial g/\partial k)(\partial k/\partial f) + (\partial g/\partial m)(\partial m/\partial f)$$

$$(8b) \quad dL40/df = \partial L40/\partial f + (\partial L40/\partial g)(\partial g/\partial f)$$

The first expressions on the right hand side of equations (8a) and (8b) are the direct effects of force ratio on growth and distribution respectively while the remaining expressions on the right hand side are the indirect effects. The indirect effects of force ratio on economic growth has two components: the indirect effect through changes in investment and the indirect effect through changes in the defense burden. The indirect effect of force ratio on income distribution works through changes in economic growth. Equations (8a) and (8b) cannot be signed on theoretical grounds. Even if the direct effects in both multipliers are positive, the indirect effects could be negative and swamp the positive direct effects, or positive and reinforce the direct effect. The total effects are therefore empirical questions that can only be answered using appropriate data.

III. Data

Defense data in LDCs tend to be notoriously unreliable. Ball (1981) and Bzroska (1981) have shown that defense spending data for the same country in one year differs considerably among sources: even within one source, there tends to be considerable inconsistencies for a country over time. Part of the problem has to do with national governments' desire to conceal their military strengths. Second, defense expenditures are measured in domestic currencies. To make these expenditures comparable across countries, reporting agencies use official exchange rates to convert defense expenditures to common currency units. However, official exchange rates in LDCs tend to overvalue the domestic currencies. There are wide variations in the degree of currency overvaluation among LDCs; hence there tend to be biases imparted to the defense expenditure data by

⁷ The corresponding defense burden multipliers are:

$$dg/dm = \partial g/\partial m + (\partial g/\partial k)(\partial k/\partial m) + (\partial g/\partial f)(\partial f/\partial m)$$

or

$$dL40/dm = (\partial L40/\partial g)(\partial g/\partial m) + (\partial L40/\partial f)(\partial f/\partial m)$$

the use of official exchange rates to convert to a common currency unit. Besides the reliability problem, different countries have different resources available to them. To take account of differences in resource base of countries and differences in the reliability of exchange rates, we have measured the force ratio and all monetary variables as ratios of GDP.

Our data pertains to 31 LDCs between 1973 and 1983. We could have conducted a time series cross-sectional analysis but, because of unreliability of defense data, we decided to take the averages of variables over the eleven-year period. Each data point is therefore an average of the observations over the eleven-year period. In averaging, we lose some information about our data. However, the information we lose is the price we pay for improved reliability.

A second reason for taking the averages for the period is that while we had data for each year for most of the variables, the World Bank data on DISTORT and L40 were averages for the 1970s and early 1980s. This transformation therefore made the data consistent with the World Bank data.

Data for f and m were obtained from *World Military Expenditures and Arms Transfer 1985*, (Washington D.C., US Arms Control and Disarmament Agency (ACDA), August 1985). k is measured as the investment rate (gross investment as a proportion of GDP) and g is the annual growth rate of real GDP between 1970 and 1981.⁸ Data on k , AGRO, and g were obtained from *World Development Report* (various years). Data for gdp and XGROW were obtained from *World Development Report* (various years), and the World Bank's *World Tables*, Third Edition (Johns Hopkins University Press, Baltimore), FLOWS is measured as net inflow of Foreign Capital including aid, private direct investment, and private sector loans as a proportion of GDP. Data for FLOWS were obtained from The International Monetary Fund's (IMF) *International Financial Statistics*, various years (Washington, D.C., IMF).

Distort is a composite measure of price distortion calculated by the World Bank in a background study for the 1983 *World Development Report*. Data for DISTORT and L40 were obtained from Agarwala (1983). Data on WAR and THRT were obtained from *Cross-National Time Series Data Archive*, Center for Social Analysis, State University of New York at Binghamton. Some summary statistics of the data are presented in Table

⁸ A better measure of capital formation is net investment, but lack of data for depreciation precluded us from using net investment in our estimation. We assume that depreciation is a constant proportion of gross investment.

1. From Table 1, we see that there is a lot of variation in the data even after averaging.

The sample of 31 countries are of various sizes and were in different stages of economic development during the sample period. They ranged in size from a small population of 2 million to a large population of 750 million; per capita GNP ranged from a low of 100 US dollars to a high of 2,900 dollars. The sample also include some petroleum exporting countries that did not have a serious foreign exchange constraint. However, most of the countries in the sample were oil importers and as such faced foreign exchange constraint and hence their abilities to import arms were constrained during the sample period as the period covered the two oil price shocks of the 1970s. With the exception of few countries with a sizable industrial base (eg. Korea and Brazil), most of the countries in the sample import almost all their military hardware. Of the 31 countries in the sample, 7 either engaged in cross border war with another country or had some form of armed conflict within their borders during some part of the period under consideration.

The period under consideration was characterized by slow economic growth throughout the world, especially in the oil importing IDCs. In spite of slow economic growth, defense spending grew rapidly in the countries in our sample countries. Table 2 shows averages of resources devoted to defense in our sample countries for selected years during the

Table 1
SUMMARY STATISTICS OF DATA

| Variable | Mean Value | Standard Error |
|--------------------------------|------------|----------------|
| Force ratio (per 1,000 people) | 4.868 | 4.338 |
| Defense burden (% of GDP) | 3.408 | 3.310 |
| Per capita GDP (1978 US\$) | 603.550 | 405.07 |
| L40 (% of GDP) | 14.26 | 4.385 |
| Growth rate | 4.732 | 2.699 |
| DISTORT | 1.990 | 0.412 |
| XGROW | 3.642 | 8.890 |
| INVESTMENT (% of GDP) | 19.890 | 4.584 |
| FLAWS (% of GDP) | 4.70 | 2.010 |
| P | 2.68 | 1.894 |

N = 31

Table 2
COMPARATIVE STATIC DATA OF DEFENSE
RESOURCES OF THE SAMPLE LDC'S*

| Year | Defense Exp. (M1982 US\$) | GNP (M1982 US\$) | Armed Forces (Million) | Defense Burden** (%) | Per Capita Defense Expenditure (1982 US\$) | Force Ratio** (per 1000 people) |
|------|------------------------------|---------------------|---------------------------|-------------------------|---|------------------------------------|
| 1973 | 26,025 | 918,046 | 6.055 | 3.24 (2.80) | 17.37 | 4.88 (4.04) |
| 1977 | 32,158 | 1,112,488 | 6.410 | 3.36 (2.89) | 19.52 | 6.63 (3.89) |
| 1980 | 33,783 | 1,310,846 | 6.050 | 3.38 (2.58) | 19.14 | 4.81 (3.43) |
| 1983 | 37,889 | 1,256,479 | 6.490 | 3.23 (3.02) | 20.14 | 4.91 (3.45) |

* Calculated from ACDA, *World Military Expenditures and Arms Transfers, 1985*.

** Unweighted averages. Weighted averages are in parentheses.

sample period. It provides some comparative static statistics for resources devoted to defense by the sample countries during the 1973-83 period. Between 1973 and 1983, total real defense spending in the 31 countries increased by 45.6 percent while total real GNP increased by 37 percent. Per capita defense spending increased by 15.9 percent. The weighted average defense burden increased by 7.8 percent during the period while the unweighted average defense burden increased until 1980 but declined in response to austerity caused by the world wide recession of the early 1980s.

Total number of people under arms increased by 7.2 percent during the period. However, because of faster population growth, the force ratio showed a slight decline, the rate of decline accelerating between 1977 and 1983. Part of the dramatic decline in force ratio after 1977 can be attributed to the ending of wars in some of these countries. Increased defense spending coupled with a reduction in force ratios may be interpreted to mean that these nations opted for smaller but well equipped and better trained defense forces.

IV. Econometric Results

We append stochastic error terms, assumed to be normally distributed

with zero means and constant variances, to each of the equations. All equations in the system are fully identified by the rank condition.

The model is not a completely simultaneous system. It consists of two blocks of equations with growth rate, force ratio, investment rate, and defense burden forming the first block while the L40 equation forms the second block. The estimated model is therefore a block recursive model in which the first block is estimated and the values of estimated variables from the first block used to estimate the second part of the system.

Because of the correlation of error terms across equations, we use three stage least square (3SLS) procedure to estimate the system. 3SLS estimators are efficient when all equations in the system are correctly specified. However, if any of the equations in the system is misspecified, the misspecification is distributed to all equations in the system, thus making all parameter estimates inconsistent. To guard against such a possibility, we used Hausman's specification test (Hausman (1978)) to check for misspecification.⁹

Parameter estimates, together with the associated Hausman statistics, for the system of equations are presented in Table 3. From Table 3, it is clear that the null hypothesis of correct specification of the system of equations cannot be rejected at the 0.01 or 0.05 significance level. We proceed to discuss the estimated equations.

Looking at the growth equation, we find that k , and XGROW have positive and significant coefficients. Growth is negatively and significantly related to m and DISTORT. The coefficients of gdp and p are negative but statistically insignificant. The positive coefficient of f is similar to the results obtained by Weede (1986), Table 2. These coefficients are of the same magnitude as those of Weede.

⁹ The Hausman specification test (Hausman (1978)) is based in the difference between two estimators, both consistent under the null hypothesis of correct specification but only one attains the Cramer-Rao bound; and the other, though not efficient, is consistent under the alternative hypothesis. Under the null hypothesis of correct specification, both two stage least squares estimators (b_{2SLS}) and three stage least squares estimators (b_{3SLS}) are consistent but only b_{3SLS} attains the Cramer-rao bound; while under the alternative hypothesis only b_{2SLS} is consistent. Defining

$$q = b_{2SLS} - b_{3SLS}$$

and

$$V = (V_2 - V_3)$$

where V_2 and V_3 are the variances of b_{2SLS} and b_{3SLS} respectively, Hausman's specification test is based on the statistic:

$$m = q'(V)^{-1}q$$

This statistic is asymptotically distributed as chi-squared with degrees of freedom equal to the number of parameters estimated.

Table 3

COEFFICIENT ESTIMATES OF THREE STAGE LEAST SQUARES REGRESSION

| | | | | | |
|-------|---|---------------------------------|----------------------------------|-----------------------------------|--------------------------------|
| g | = | 13.3842 + (1.247)* | 0.330 <i>k</i> + (1.369) | 1.2545 <i>f</i> - (1.339) | 0.8031 <i>m</i> (2.386) |
| | | -1.060 <i>gdp</i> + (0.911) | 0.0919 <i>XGROW</i> - (1.359) | -1.0167 <i>DISTORT</i> (1.405) | - 0.049 <i>p</i> (0.924) |
| | | Hausman statistic = 9.383 | | | |
| k | = | 29.5344 + (3.031) | 0.5843 <i>g</i> - (1.469) | 0.7209 <i>m</i> - (1.520) | 35.290 <i>FLOWS</i> (0.985) |
| | | + 1.370 <i>f</i> (0.943) | Hausman statistic = 4.8104 | | |
| f | = | -6.9855 + (21.753) | 0.0888 <i>m</i> - (2.054) | 0.4763 <i>WAR</i> (1.487) | + 0.1319 <i>g</i> (2.329) |
| | | + 1.0206 <i>THRT</i> (3.010) | Hausman statistic = 7.5091 | | |
| m | = | 28.243 - (2.965) | 0.0944 <i>k</i> (1.524) | + 2.666 <i>f</i> (3.279) | + 1.1411 <i>WAR</i> (1.830) |
| | | - 1.2997 <i>gdp</i> (1.172) | + 0.9587 <i>THRT</i> (4.143) | Hausman statistic = 8.922 | |
| $L40$ | = | 58.9092 - (3.511) | 5.7776 <i>DISTORT</i> (2.072) | + 1.8883 <i>f</i> (1.437) | - 3.019 <i>gdp</i> (2.378) |
| | | - 1.2141 <i>g</i> + (2.546) | 4.1227 <i>AGPRO</i> (1.882) | | |

* Absolute value of t statistics in parentheses

However, the negative coefficient we obtain for m is the opposite of what Weede finds; it is also different from the positive coefficient obtained by Deger and Smith (1983). We note, however, that Deger and Smith used a different sample, so the difference in results could be due to sample differences. It could also be due to modeling differences. While we estimated four equations, adding investment and force ratio equations to the growth and defense burden equations, they estimated a three-equation model, adding a savings, rather than an investment equation, to the growth and defense burden equations.

Why does our coefficient on m differ from that of Weede, even though we use the same sample? The single equation model used by Weede is not able to take account of the simultaneity among the variables and, more important, the correlation of error terms across equations. The 3SLS estimation procedure we employ takes account of the simultaneity and correlation of errors. In the k equation, g has a positive coefficient while m has a negative coefficient as expected. Both coefficients are significantly different from zero. The negative and significant coefficient of m in this equation indicates that there is a tradeoff between defense spending and capital formation. Both FLOWS and f have coefficients that are statistically insignificant.

m , g , and THRT have positive and significant coefficients in the f equation. The positive coefficient of g in this equation is unexpected since growing economies are expected to have labor shortages, and if the military hires labor in competitive labor markets, it will have to change the mix of inputs in favor of capital. It should be noted, however, that we could not adjust for the use of conscription. If high growth countries tend to use conscription while slow growth countries do not, growth rate will pick up the effects of conscription. The positive coefficient of g may also imply that growing economies are able to afford larger armed forces.

The coefficient on WAR is surprisingly negative and significant. It may mean that countries that fought wars in our sample concentrated on having small but better equipped forces rather than larger ones that are poorly equipped. This interpretation is aided by the positive and significant coefficient of WAR in the m equation.

In the m equation, f , WAR, and THRT have positive and significant coefficients as expected. k has a negative and significant coefficient, indicating that the two variables have a tradeoff relationship. gdp is negative but statistically insignificant.

In the L40 equation, f has a positive coefficient while g has a negative coefficient. The implication is that force ratio has equitable redistribution effect while growth rate has the opposite effect. DISTORT and gdp are negatively associated with the share of GDP going to the poorest 40 percent of the population. As to be expected, the share of the poorest 40 percent of the population increases with AGPRO.

Two important questions this paper investigates are what happens to economic growth rate and the income share of the poorest 40 percent of the population when the force ratio increases. The effects of the force ratio on growth rate and L40 are measured by the expressions dg/df and $dL40/df$ respectively.

$$dg/df = a_2 + a_1 b_3 + a_3 d_2$$

$$dL40/df = e_1 + e_2 a_2$$

Using the estimated coefficients to evaluate these expressions, we find that $dg/df = -0.4351$ while $dL40/df = 0.365$. These figures are significantly different from zero at the 0.05 significance level. While our calculations agree with Weede on the effects of force ratio on income distribution, we disagree with him on the effects that force ratio has on growth rate. While high force ratio tends to redistribute incomes towards the poorest 40 percent of the population, it does so at the expense of slowing economic growth. It is also interesting to note that the force ratio/L40 "multiplier" is relatively small compared to Weede's coefficient estimates. The negative effect of force ratio on growth is consistent with the results obtained by Deger and Smith (1983), Deger and Sen (1983), Faini, Annez and Taylor (1984), and Lobovic and Ishaq (1987), even though they all relate growth to the defense burden.¹⁰

That increased force ratio has a negative total effect on economic growth rate makes intuitive sense. The military drains manpower from the civilian sector. Contrary to the notion that the military employs unskilled and uneducated youth, trains them, and releases them to the civilian sector, modern armies require educated and skilled people who, most often, have been trained by civilian educational institutions. Except in countries that employ conscription, these young people are not released to the civilian sector. The so called "discipline" they learn in the military stays in the military.

Second, training, equipping, and maintaining soldiers drains resources from the productive sectors of the economy. The growth effect of such a resource drain is much larger than any positive effect that force ratio might have on growth.

Our results do have some policy implications. Though increased defense resources decrease economic growth, the evidence suggests that a labor intensive military has some positive distributional impact compared to one that is equipment intensive. In this regard, defense employment is no different from any other public sector employment program or, for that matter, employment policy in the private sector. Labor intensive production techniques have more egalitarian income distribution effects than capital intensive production techniques.

¹⁰ The corresponding figures for defense burden are: $dg/dm = -0.9296$ and $dL40/dm = 1.1427$.

The second implication is that if LDC governments attempt to improve income distribution through employment in the defense sector, the cost associated with such a strategy is decreased economic growth. Such a distribution strategy could be dangerous in the long run because with decreased growth, there would be nothing to distribute. This is borne out by the experiences of countries that have tried to use government employment to redistribute income.¹¹ This means that even though defense employment can be used to increase the income share of the poorest people in society, it is not a viable long run distribution strategy.

V. Conclusion

This paper set out to answer two questions relating to the resources LDCs devote to defense: (i) Does an increase in force ratio foster or hinder economic growth? (ii) Does an increase in force ratio increase the income share of the poor? We argued that single equation models may misrepresent the true effects force ratio has on these variables because single equation models cannot take into account the interrelationship between force ratio and the cost of increasing this force ratio.

Using data from 31 LDCs, we estimated a five equation model and found that contrary to the results obtained by Weede (1986), force ratio has a negative effect on economic growth rate. We, however, found that force ratio has a small positive effect on the income share of the poorest 40 percent of the population: a result that is consistent with those of Weede (1986) and Weede and Teifenbach (1981). This positive distribution effect is, however, attained at the cost of decreased economic growth. This implies that using defense employment to redistribute income towards the poor is not a sustainable policy. This result those obtained by other researchers should sound a note of caution to those who advocate the use of defense spending and employment as a means to achieve economic growth and equitable distribution of income.

¹¹ Examples are Ghana and Guinea.

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