

Multipliers, Linkages and Key Sectors For Algerian Economy, 1989

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Abstract

The developpement strategy for the Algerian economy in the 1980s was based on the establishment of small- and medium-scale industrial units. The effectiveness of this policy is assessed, using multiplier and linkage analysis. It is concluded that the strategy was not effective, largely because only 19.2 % of total intermediate production was associated with strong forward and backward linkages.

1. INTRODUCTION

The Algerian economy in the 1970s was in many ways untypical of many other developing. It passed through a period of behaving as a socialist command economy, and has suffered gluts and shortages resultant from the inherent inabilities of any government to regulate the economy efficiently. In the 1980s Algeria looks to be in a transition period towards a more international, capitalistic economic framework. That is, the aim of the development strategy was a shift from capital intensive industrial units to more labour intensive small- and medium-scale industrial units [1]. The point to be assessed in this

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paper is whether such a policy would aid intergration of the national economy.

The subsequent four sections of this paper are structured as follows. Section 2 deals with the theory of input-output multipliers and linkages. Section 3 contains an input-output analysis of the results and their policy implications for Algerian development. In Section 4 some concluding remarks are offered.

2. THEORY OF MULTILIERS AND LINKAGES

2.1. The Input- Output Multiliers

The input-output multipliers, as defined by Burdekin and Al-Ali [2]

Give a detailed picture of changes in final demand on output, and employment throughout the economy. They are now well established as indicators of the importance of particular sectors and the interdependence of the industrial structure (p 13)

The following notation is used throughout this paper (Miller & Blair)[3]. A is a square matrix describing the technical relation of production. x is a vector of total output, y is a vector of final demand, $(I-A)^{-1}$ is the leontief inverse matrix. These satisfy the usual basic input-output equation

$$(1) \quad x = (I-A)^{-1} y$$

2.1.1 The Output Multipliers

An output multiplier is defined as the change in gross output resulting from a unit change in final demand in a given sector. As we are assuming constant returns to scale, the effect on the economy is seen by multiplying $(I-A)^{-1}$ by a final demand vector that has unity in the sector. This is defined as $i'(I-A)^{-1}$. This is just the column sum of the Leontief inverse. Here i is the unit vector and a prime indicates the transpose.

2.1.2 The Income Multiplier

The income generated in the economy by a change of 1 Algerian dinar (AD) in final demand is defined as $w'(I-A)^{-1}$. Here each element

of u is the of wages and salaries to gross output for each sector (i.e. the labour income coefficient). However, a more useful measure of the interdependence of the economy is to look at the total direct and indirect income generated for every 1 AD of direct income generated. Thus the income multiplier for industry j has the indirect income effect as numerator and direct income as denominator (Miller & Blair, p.107). We write this as

$$(2) \quad u'(I-A)^{-1} \hat{W}^{-1}$$

Here $\hat{W}$ is the 'diagonalised' matrix, with vector u on the principal diagonal, zeros elsewhere.

2.1.3 The Labour Multiplier

Let us assume that the vector of non-produced input, v , is related to the total output x by

$$(3) \quad v_i = x_i r_i$$

Here r is the vector of non-produced input coefficients. Substituting for x in the input-output equation gives

$$(4) \quad v = \hat{r} (I-A)^{-1} y$$

So the effect of a unit change in any element of final demand will simply be the sum of the corresponding column of the matrix $\hat{r} (I-A)^{-1}$.

Therefore, the vector of all these effects can be found by multiplying this matrix on the left by r' , i.e. $r' \hat{r} (I-A)^{-1}$. So the multiplier in this case is

$$(5) \quad r'(I-A)^{-1}$$

The effect on total employment of increasing final demand by sufficient to require one extra direct unit of non-produced input would require that final demand in sector i increase by $1/r_i$ units. So we would need

to multiply the above matrix by $\hat{f}^{-1}$ i.e the non- produced input multipliers is

$$(6) \quad r' (I-A)^{-1} \hat{f}^{-1}$$

2.2 Linkages

In developing planning it is obviously important to know how closely 'linked' sector are with each other. Of course, the direct linkages are shown in the A matrix, and the direct plus the indirect linkages are revealed $(I-A)^{-1}$ [4]. However, we need to distinguish between 'backward' linkages and 'forward' linkages.

Backward linkages are the relationship between the activity in a sector and its purchases. Forward linkages are the relationship between the activity in a sector and its output. The output multipliers, defined as the column sum of the Leontief inverse, obviously indicate backward linkages. Using the row sums of the Leontief inverse, obviously indicate forward linkages.

3. RESULTS AND POLICY IMPLICATIONS

3.1. Multiplier Results

For Algeria the input output for 1989 have been analysed (Tableau des Entrées-Sorties, 1994) [5]. These have been aggregated to a consistent 16 sector structure, and the various multipliers and linkage measures discussed above have been calculated.

* The original data for this table contained 94 producing sectors, being aggregated down to 16 sectors.

The value multipliers for each sector enable the estimation of the total direct and indirect effects of a unit change in activity in each sector. The higher the multiplier the greater the impact on inter-related domestic industries of a sectoral output change. The industrial sectors in the top quartile of industries ranked by the size of domestic value multiplier hydrocarbon services, food and drink and transport and communication.

The relatively high value multipliers for these industries are indicative of economic linkage of these industries with other industries.

Industries with very low value multipliers in the bottom quartile, have little or no connection with other Algerian industry, i.e. any multiplier effects produced by these sectors, therefore, occur outside Algeria. These industries are other industries, iron and steel, mining and quarrying and agriculture.

Overall, the value multipliers are low as would be expected of an economy with a high propensity to import. The industry with the highest value multiplier, hydrocarbon and public works, generates only some 0.86 AD worth of extra output in Algeria for each 1 AD increase in the gross output of the public works industry.

By summing the rows in the Leontief inverse a multiplier is derived which estimates the impact of 1 Algerian dinar (AD) change in gross output in all domestic industrial sectors upon each sector. The higher the value of these 'row' multipliers the greater the change induced by 1 AD change in gross output in all industries. These multipliers which indicate the relative sensitivity of industries to the

general level of economic activity in Algeria, are listed in column 2 of Table 1

TABLE 1
ALGERIAN VALUE MULTIPLIERS, 1989

Industrial Sector	Impact of 1 AD change in Sector Gross Output on All Other Sectors (1)		Impact of 1 AD change in Gross Output in All Sectors on Each Sector (2)	
	Value	Rank	Value	Rank
1 Agriculture forestry and fishing	1.207	16	1.539	5
2 Energy and Water	1.465	9	1.208	11
3 Hydrocarbon	1.530	7	2.110	1
4 Hydro. Services & Public Works	1.858	1	1.238	10
5 Mining and Quarrying	1.201	15	1.127	14
6 Iron and Steel	1.258	14	1.759	3
7 Porcelain and Glass	1.313	12	1.195	12
8 Cement and building materials	1.524	8	1.071	15
9 Chemicals, rubber and Plastics	1.558	5	1.722	4
10 Food, Drink and Tobacco	1.684	3	1.343	7
11 Textiles and Clothing	1.328	11	1.305	8
12 Leather and Footwear	1.532	6	1.133	13
13 Timber, Furnitures and Paper	1.338	10	1.351	6
14 Other industries	1.280	13	1.051	16
15 Transport and Communication	1.592	4	1.302	9
16 Services	1.749	2	1.857	2

Source : Computed based on [5], equation (1)

The industrial sectors whose output is most sensitive to changes in the general level unit of economic activity are hydrocarbon, services, chemicals and plastics and iron and steel

Industrial sectors whose output is least sensitive to activity in the rest of the Algerian economy are leather and footwear, mining and quarrying, cement and building materials and other industries

Income multipliers for 1989 (Table 2) range between 2.964 for the hydrocarbon industry to 1.224 for mining and quarrying. These multipliers can be used to assess the importance of income generated in each industry. For example, if the increase in final demand in 1989 is such that 1000 AD of income is created directly in Algeria, making a total income change of 2964 AD. The reason for the high income multipliers in the hydrocarbon industry is not only because of its low direct coefficients, capital intensive industry, but also because of its significant domestic inter-industry linkages.

TABLE 2
ALGERIAN INCOME MULTIPLIERS, 1989

Industrial Sector	Value	Rank
1. Agriculture, forestry and fishing	1.377	10
2. Energy and Water	1.394	8
3. Hydrocarbon	2.964	1
4. Hydro Services & Public Works	1.716	4
5. Mining and Quarrying	1.224	16
6. Iron and Steel	1.361	11
7. Porcelain and Glass	1.264	14
8. Cement and building materials	1.246	15
9. Chemicals, rubber and Plastics	1.713	5
10. Food, Drink and Tobacco	1.085	2
11. Textiles and Clothing	1.392	9
12. Leather and Footwear	1.558	6
13. Timber, Furnitures and Paper	1.395	7
14. Other industries	1.728	3
15. Transport and Communication	1.349	12
16. Services	1.322	13
Average	1.568	

Source : Computed based on [5], equation (2)

By using employment data for each industry, the effective full-time work force of each industry can be calculated [6]. These effective employment figures are then combined with the Leontief inverse matrix to give the labour multipliers for each sector: the labour multipliers in terms of the effect of an extra person employed in each sector on employment in all other sectors are shown in Table 3.

The labour multiplier for food, drink and tobacco is 6.92 which signifies for every one extra person employed in food, drink and tobacco it is necessary for 5.92 persons to be employed elsewhere in the Algerian economy.

A comparison of the value multipliers and the labour multipliers shows considerable differences in the industrial ranking although the Spearman's rank correlation coefficient of 0.58 is significantly different from zero at the 1% significance level.

Analogous to the output multiplier analysis, there are also multipliers which show the sensitivity of each sector to a change in employment by one person in all of the sectors in the economy: these employment sensitivity multipliers are shown in Table 3.

The industrial sector in the top quartile of sensitivity multipliers are agriculture, services, chemicals and iron and steel. The sensitivity of employment in the agriculture sector to change in the level of employment in Algeria suggests that employment in agriculture can be used as an economic indicator of cyclical changes in the local economy.

Industrial sectors in the bottom quartile indicating sector employment insensitivity to employment changes in the rest of Algerian

economy are mining and quarrying, leather and footwear, cement and building materials, and other industries.

TABLE 3
ALGERIAN LABOUR MULTIPLIERS, 1989

Industrial Sector	Labour Multiplier		Sensitivity Multiplier	
	Value	Rank	Value	Rank
1. Agriculture forestry and fishing	1.087	16	7.930	1
2. Energy and Water	1.269	14	1.533	6
3. Hydrocarbon	2.943	3	1.506	9
4. Hydro Services & Public Works	1.669	3	1.512	8
5. Mining and Quarrying	1.183	15	1.215	13
6. Iron and Steel	1.293	12	2.158	4
7. Porcelain and Glass	1.285	13	1.310	11
8. Cement and building materials	1.602	7	1.135	15
9. Chemicals, rubber and Plastics	1.786	4	3.125	3
10. Food, Drink and Tobacco	6.920	1	1.265	12
11. Textiles and Clothing	1.392	11	1.311	10
12. Leather and Footwear	1.617	6	1.151	14
13. Timber, Furnitures and Paper	1.499	8	1.615	5
14. Other industries	4.192	2	1.006	16
15. Transport and Communication	1.484	9	1.515	7
16. Services	1.478	10	3.448	2

Source : Computed based on [5], [6], equation (6)

By combining the labour multiplier with the total employment, 'the column headed the total effect of a 1% change in sector employment' is derived. Consider, for example, the agriculture sector with a labour multiplier of 1.087 and total employment of 975110 (i.e. 54% of total Algerian employment), the effect of a 1% change in

agriculture employment would generate a change in employment in Algeria of 10596.5 employees. In contrast the food, drink and tobacco sector with a high labour multiplier in food, drink and tobacco would change total employment in Algeria by only 4937.3 jobs (Table 4).

There are obviously significant differences in the ranking of sector by the size of the labour multiplier and the size total employment impact of a 1% change in sector employment. This can be seen by comparing the sectoral rankings in Table 4.

Table 4 shows clearly that the sector with the largest total employment effects are those with the greatest employment and not those with largest labour multipliers.

The spearman rank correlation coefficient between the ranking of the total employment effect and the labour multiplier the coefficient is -0.04 which is not significantly different from zero.

TABLE 4
TOTAL EFFECT OF 1% CHANGE IN SECTOR
EMPLOYMENT

Sector number	Labour		Total employment(E)		Total effect of 1% Change in Sector		
	Multiplier (LM)		Employment (E)		Employment E/100 (LM)		
	Value	Rank	Employment	% of the Total	E effect	Rank	% of 1 Effects
1	1.087	16	975110	53.5	10596.5	1	38.7
2	1.269	14	30640	1.7	388.8	12	1.4
3	2.943	3	45000	1.9	1031.6	7	3.8
4	1.669	5	25411	1.4	431.8	11	1.6
5	1.183	15	10434	0.6	123.5	14	0.5
6	1.293	12	136212	7.5	1760.8	5	6.4
7	1.285	13	29280	1.6	376.4	13	1.3
8	1.602	7	160120	8.8	2565.8	3	9.4
9	1.786	4	26786	1.5	478.5	9	1.7
10	6.920	1	71352	3.9	4937.3	2	18.1
11	1.392	11	43044	2.4	599.3	8	2.2
12	1.617	6	11982	0.7	193.8	15	0.7
13	1.499	8	30260	1.6	453.5	10	1.6
14	4.192	2	945	0.1	39.6	16	0.1
15	1.484	9	77733	4.3	1153.7	6	0.2
16	1.478	10	154643	8.5	2285.7	4	8.3

Source : Computed based on [5], [6]

3.2 Linkage Results

Before examining the linkage results, it should be noted that the ranking of the sector is commonly used as a criterion here. Further, an index can be constructed to measure the relative strength of the forward and backward linkages by dividing each of the sector's forward and backward linkages by their respective averages for the whole economy. Using z_{ij} as an element of $(I-A)^{-1}$ and q_{ij} as element of $(I-B)^{-1}$ we can define

$$(7) \quad \text{backward linkage} = n \sum z_{ij} / \sum \sum z_{ij}$$

$$(8) \quad \text{forward linkage} = n \sum q_{ij} / \sum \sum q_{ij}$$

here n refers to the number of economy sector. Jones's [7] measurement of forward linkages is used in this analysis, is the intermediate flows are supply led than demand led.

In Table 5 are listed the for forward and backward linkages and rankings for 1989. Key sectors, according to Hirschman [8], are sectors with both backward and forward indices greater than unity.

	Backward		Forward	
Industrial Sector	Index	Rank	Index	Rank
1 Agriculture forestry and fishing	0.825	15	0.943	9
2 Energy and Water	1.001	19	1.066	6
3 Hydrocarbon	1.045	7	0.982	8
4 Hydro Services & Public Works	1.270	7	1.023	7
5 Mining and Quarrying	0.820	16	1.517	7
6 Iron and Steel	0.859	14	0.930	10
7 Porcelain and Glass	0.897	12	1.255	3
8 Cement and Building materials	1.042	8	0.637	16
9 Chemicals, rubber and Plastics	1.065	5	1.384	2
10 Food, Drink and Tobacco	1.150	3	0.776	14
11 Textiles and Clothing	0.908	11	0.806	13
12 Leather and Footwear	1.047	6	0.716	15
13 Timber, Furnitures and Paper	0.914	10	1.172	4
14 Other industries	0.874	13	0.858	11
15 Transport and Communication	1.088	4	0.852	12
16 Services	1.195	2	1.0083	5

Source : Computed based on [5], equation (7) & (8)

The results in Table 5 can be summarized by defining 'strong'

strong linkages index ≥ 1

Intermediate 1 > linkages index ≥ 0.9

Weak $0.9 > \text{linkages index}$

A study Table 6 indicates that energy and water, hydrocarbon

services and public works, chemicals, rubber and plastics and services

are key sectors. That the services sector qualifies as key sector

underscores the limitation of the method, the 'supply led' assumption

Table 6
SECTOR CHARACTERISTICS FOR 1989

		Forward linkage		
		Strong	Intermediate	Weak
Backward linkage	Strong	2, 4, 9, 16	3	8, 10, 12, 15
	Intermediate	13		11
	Weak	5, 7	1, 6	14

source: Table 5.

Sectors possessing weak forward linkage indices are cement and building materials, food, textiles, other industries and transport. This is because these industries sell their output mostly to final demand and hence do not figure significantly in the measures as they depend on intermediate flows.

Sectors possessing weak backward linkage indices are agriculture, mining, iron and steel, porcelain and glass and other industries. Their dependence on other sectors for their inputs is comparatively very low. This happens because the principal input to agriculture is labour, while for iron and steel input are provided mainly by imports.

Having determined the ranking of the sectors, a word on the general pattern of linkages during this period is useful.

As revealed in Table 7, in 1989 as much as 19.2% of total intermediate production is associated with sectors with strong forward and weak backward linkages.

TABLE 7
LINKAGES ASSOCIATED WITH THE PERCENTAGE OF
INTERMEDIATE PRODUCTION, 1989

		Forward linkage		
		Strong	Intermate	Weak
Backward linkage	Strong	19.2	22.7	11.8
	Intermediate	5.1		3.2
	Weak	8.1	29.3	0.0

Source: Computed based on [5], Table 6

4. CONCLUSION

4.1 Intersectoral Linkages

A summary of the results of the various multiplier analysis showed the importance of the food, drink and tobacco and hydrocarbon industries in terms of capacity to stimulate output, income and employment in the rest of the economy. One interesting feature of the output multipliers in particular was the grouping of a large industries is likely to be sensitive to future changes and also any policies aimed at increasing demand in all or some of industries is likely

to prove almost equally effective in terms of stimulating the rest the economy.

The key sectors in the Algerian economy were found to be energy and, public works, chemicals and plastics and services. However, the most interesting aspect to emerge is the appearance of sectors (hydrocarbon and timber, furniture and paper) that 'nearly' qualified as key sectors. In particular, the hydrocarbon sector, compared with pother sector, had a much greater role in relation to the traded sector than it does to the domestic economy, and thus offered considerable potential in any growth strategy.

4.2. General Pattern of Linkages

In the late 1980s the Algerian development strategy (i.e. transition towards a more international, capitalistic economic framework) did not generate extensive linkages or act as a stimulus to the base. That is, only 19.2% of total intermediate production was associated with strong forward and backward linkages. This is because the majority of the projects undertaken which tend to create linkages were delayed following the collapse in oil prices in the mid 1980s.