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Multipliers of the Peruvian Economy 2002

by

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Abstract

This article illustrates an application of the input-output model to estimate the multiplier effects of investments and exports of the Peruvian economy. One conclusion is that multipliers of services are greater than multipliers of industries while primary products exhibit intermediate multipliers. Another conclusion is that exports reflect a much higher multiplier effect than do investments. Employment and wage multipliers appear greater for service sectors than for modern exporting sectors, such as mining and metallurgy, and for modern urban sectors, such as electricity, insurance, construction, and beverages.

Keywords: input output, multipliers, Peruvian economy.

Multipliers of the Peruvian Economy 2002

The multiplier originated in the analysis of a British economist, John Maynard Keynes, in the 1930s. The original model comprised a study of the relationship between autonomous expenditures and the macrolevels of income and employment. The theory illustrates that a change in autonomous expenditures (public and private investment, exports, and public expenditure) generates a much bigger change, a *multiplied* change, in income and employment (Keynes, 1936).

Economists have improved income and employment models through input-output schemes. The schemes involve considering the relations among all types of final demand (consumption, public expenditure, investments, and exports) and all supply sources (domestic production and imports) at the sector level. Such consideration allows economists to differentiate the effects of projects. The results of projects would vary depending on the sector (e.g., agriculture, mining, or infrastructure). The technique enables stakeholders to distinguish the impacts of exports according to the exporting sector (mining, fishing, or nontraditional industrial sectors).

This article illustrates an application of the input-output model to estimate the investment multipliers and export multipliers for the Peruvian economy for the year 2002. The objective was to derive a set of multipliers and proportions to improve the knowledge of the relative importance of all economic sectors considered in the input-output matrix. The multipliers also allow for visual representation of the characteristics of the productive structure of the country (Torres Zorrilla, 1998).

Unfortunately, the most recent input-output table pertains to the year 1994 (Instituto Nacional de Estadística e Informática [INEI], 2001). Some economists believe that the 1994 matrix is already obsolete (15 years later). Such a belief is especially true when considering one indicator: the price of oil. A barrel of oil cost $16 in 1994 and reached $150 in 2008 (International Monetary Fund [IMF], 2007). We are counting on a new input-output table, updated for the year 2002 (Ministerio de Comercio Exterior y Turismo [MINCETUR], 2006), which is the input-output source used for this study.

The first next sections of the article indicate the sector multipliers and the aggregate multipliers of the Peruvian economy, classified according to national income

multipliers and employment multipliers. Conclusions of the study appear next along with suggestions for future research. The appendixes include the formal input-output model and the coefficients of the model.

Methodology of Estimation of the Multiplier

In theory, multipliers have numerical values, generally greater than 1. Multipliers represent the ratio of the total impact—the sum of the direct, indirect, and induced impacts—divided by the initial impact or direct impact. The input-output method allows for calculation of these ratios. Thus, we may determine the effect on income and employment of autonomous expenditures (investment or exports) for each of the economic sectors considered in the input-output matrix.

Discussions of the formal model for deriving sector multipliers are abundant in the literature (Chenery & Clark, 1959; Miller & Blair, 1985). The basic assumptions of the model include the knowledge of the technical coefficients of production and other additional parameters, such as the import coefficients, the consumption coefficients, and the marginal propensity to consume.

The analysis reflects the assumption of a certain constancy of technical production coefficients. However, we know today that these coefficients (input proportions by unit of output) evolve towards proportions more or less stable, but economists should not interpret that as rigid or unchanged coefficients. At a certain historic moment, given technological and institutional conditions, input coefficients exist that may be considered *normal*. If imposing new conditions, one would need to revise the coefficients appropriately. The technical coefficients for the calculations in this study appear in the updated 2002 input-output table (see Appendix A).

The definition of import coefficients reflects the ratio between imports and domestic production. Both are indicators related to the share of total demand of each input-output sector satisfied by imported products. The coefficients are generally more variable over time than the input-output coefficients because they do not depend on technical conditions of production but rather, among other things, on the production capacity of the economy in relation to demand, on the exchange-rate policy, and on the balance-of-payments situation. Nevertheless, one may assume that import coefficients exist that may be *representative* for a moment in time under certain conditions. This study involved using only total imports by sectors of origin from the updated 2002 input-output table.[1]

Calculation of consumption coefficients involved the information contained in the same input-output matrix. These coefficients are also variable because they depend on relative prices, income, the distribution of income, and tax policy. However, econometric researchers rather tend to prove empirically some constancy of the consumption coefficients. All input-output coefficients (technical, import, and consumption) appear in Appendix B.

Finally, an estimate of the marginal propensity to consume completes the model. Estimation of this parameter involves the series of gross domestic product (GDP) and private consumption of the national accounts. The result is that the marginal propensity to consume is 0.70.

Another important factor regarding multipliers is that their values vary over time because their basis is specific registries of different input-output tables. Thus, comparison of multipliers over time is risky. For this reason, a detailed comparison with previous estimates will produce only an approximation.[2] Nevertheless, Appendix D includes a comparison of the 1994 and 2002 multipliers.

The magnitude of the multiplier is an important indicator but not necessarily an integral measure of the impact of sector production or the relative importance of a given sector. Valuation of an industry should not be restricted to the importance of its interindustry relations but rather include effects on total production. Thus, an industry that generates a high level of income and value added and that requires technological inputs and highly qualified human resources may have a lower multiplier but may *produce* more economic and noneconomic impacts and externalities.

Expression of the impact of the multiplier often appears in incremental terms. In other words, for each unit of *increase* of the initial expenditure, the output for the entire economy will be *incremented* by a larger amount, represented by the value of the multiplier. However, the process also operates in reverse, creating a multiplied contraction in economic activity from an initial *shock,* such as the present international financial crisis.

Multipliers of the Peruvian Economy

This article illustrates the empirical results of estimated multipliers from the 2002 input-output matrix. The matrix includes 45 productive sectors, and the values in the table appear as producer prices. Producer prices reflect economic reality better because, in practice, enterprises value their sales at prices ex-factory, sales tax included. The equivalent concept for imports is cost, insurance, and freight (CIF) prices, import duty included.

Multipliers of the National Income

The model in Appendix C aided in calculating the sector multipliers, and the empirical results appear in Table 1.[3] As explained, these multipliers represent the total effect of an autonomous increase in final demand of each sector on national income, after considering the direct, indirect, and induced effects of the initial expenditure. The direct effect is the initial autonomous expenditure (after deducing direct imports generated). The indirect effects correspond to the internal demand generated by the need for inputs to produce the final goods initially demanded as well as the inputs of the inputs and so on. The induced effects correspond to the reasoning behind the traditional Keynesian multiplier: The

incomes generated by expansion of production of the final good, of its inputs, and of inputs of inputs are spent in new final goods that in turn generate new demands for inputs, new income, and so on.

Table 1
Income Multipliers of the Peruvian Economy

	Sector	Multiplier
1	Agriculture	2.090
2	Fishing	2.184
3	Petroleum, crude	1.154
4	Mining	2.207
5	Dairy products	1.883
6	Prepared fish	2.216
7	Fishmeal	2.288
8	Cereal grains, milled	2.125
9	Sugar	1.887
10	Other food	1.948
11	Beverages, tobacco	2.079
12	Textiles	1.841
13	Wearing apparel	1.999
14	Leather	1.617
15	Footwear	1.470
16	Wood products	1.920
17	Paper products	1.456
18	Publishing	1.865
19	Chemicals	1.434
20	Pharmaceuticals	1.121
21	Other chemicals	1.550
22	Petroleum, refined	1.158
23	Rubber, plastics	1.144
24	Nonmetals	2.050
25	Iron steel metals	1.005
26	Nonferrous metals	2.124
27	Metal products	1.758
28	Machinery NE	0.321
29	Machinery E	0.718
30	Transport equipment	0.594
31	Other manufactures	1.361
32	Electricity, water	2.297
33	Construction	2.143
34	Commerce	2.293
35	Transport	1.977
36	Services, financial	2.271
37	Insurance	1.794
38	Rental	2.391
39	Services, enterprises	2.026
40	Restaurants, hotels	2.097
41	Services, households	2.243
42	Services, households	2.120
43	Private health	2.203
44	Private education	2.152
45	Government	2.302

Note. From "2002 Input-Output Matrix," by MINCETUR (2006).

Figure 1 shows a ranking of the multipliers from Table 1. The first result of the analysis is that, in general, the multipliers of service sectors (Sectors 32 to 45 of the input-output table) are higher than the multipliers of industrial products (Sectors 5 to 31 of the table). All multipliers of the service sectors (the only exception is Sector 37: Insurance) are equal to or greater than 2, which means that an increase of 1 sol in the demand of these sectors generates value added across the national economy that is more than twice the initial demand.

With the exception of crude petroleum, the basic products (agriculture, fishing, and mining) reflect intermediate-level multipliers, near to or greater than 2. In the industrial sector, fishmeal, prepared fish, cereal grains milled, nonferrous metals, beverages and tobacco, nonmetal products, and wearing apparel exhibit relatively high multipliers. Finally, an interesting result is the much lower level of the multipliers of the machinery and equipment sectors (machinery NE, machinery E, and transport equipment). The multipliers are 0.32, 0.72, and 0.59 respectively (see Table 1). The result is a reflection of the import dependency level for this type of investment good. A multiplier of less than 1 means that an increase of 1 sol in final demand of these sectors is going to be satisfied basically by imported goods, and the rest (domestic origin) will generate a value added in the whole economy that is greater than the initial domestic demand, but less than 1.

Next, to obtain a global idea of the multiplier effect of the different types of final demand, the study involved computing multipliers of aggregated consumption, aggregated investment, and aggregated exports. The new calculation does not reflect a return to the aggregated macroeconomic model with all its well-known deficiencies. Such macromodels include setting up relations between *aggregated* autonomous expenditures and *aggregated* income and deriving Keynesian multipliers of investment, of exports, and of public expenditures. However, using these macrorelations in practice results in doubts as to their validity for policy design or impact analysis of new market situations.

The aggregated nature of the relations raises concerns as to whether an increase in investment has the same income effect if one were to study an agricultural project (e.g., Chavimochic irrigation system), a mining project (e.g., Yanacocha, Antamina, and Toromocho), the construction of a gas pipeline (e.g., Camisea), or the interoceanic highway. In addition, one would need to question whether an increase in exports has the same income effect when studying fish exports, mining exports, and nontraditional exports. Use of the input-output multiplier model resolves these doubts.

The objective of the following calculations was to present a general idea of the effects of different types of expenditures. However, because computing these aggregate multipliers involved a sector model, the

Figure 1. Ranking of multipliers of the Peruvian economy.

results will be more approximated to reality than those multipliers derived from a macromodel. The aggregate multipliers appear in Table 2. The multipliers represent the results of a unit increase in each type of expenditure, assuming distribution of the expenditure among the input-output sectors following the share structure of the base year of the input-output table. The expenditure shares of consumption, investment, and exports used in this exercise are evident in Appendix B.

Table 2
Aggregate Multipliers of the Peruvian Economy

Final demand	Multiplier
Consumption	2.031
Investment	1.743
Export	2.011

Note. From "2002 Input-Output Matrix," by MINCETUR (2006).

The multiplier of consumption expenditures is the largest of the three; the multiplier of exports is similar to the consumption multiplier, while the multiplier of investment is the smallest of the three, explained by associated-to-investment imports. Investment in new construction has a rather high multiplier and tends to compensate. The exports multiplier is close to the consumption multiplier, explained by the relative importance of fish, mining, and agriculture industries in exports and by the fact that these sectors have high multipliers. However, a huge variation is evident between the exports and investment multipliers, depending on the sector. A clear conclusion is that exports reflect a larger aggregate multiplier compared to investment.

Employment Multipliers in the Peruvian Economy

Employment multipliers are similar to income multipliers and are derived from the inverse input-output matrix. The difference is that obtaining the final effect of a unit increase of final demand of each sector of the economy involves using employment coefficients instead of value-added coefficients. Table 3 illustrates the employment multipliers along with the respective direct employment coefficients that may be interpreted as the initial impacts.

Note that two types of registries of the labor factor may exist in an input-output table. The first type refers to the value of wages and salaries, and the second refers to the number of jobs. Consequently, deriving two types of multipliers is possible: multipliers of wages and salaries in the different sectors of the economy and multipliers of the number of persons working in the different sectors of the economy. Table 3 includes the wages and salaries multipliers only because the information was available.

A ranking of the wages and salaries multipliers appears in Figure 2. The sectors of the economy with higher wages and salaries multipliers included six services sectors and mining: government; services, financial; services, households; health; mining; insurance; and electricity. The second level reflected five good-producing sectors: nonferrous metals, beverages, construction, sugar, and publishing. Following these 12 sectors were commerce; cereal grains, milled; education; services, enterprises; and transport with wages and salaries multipliers near 0.5. The subset of the first 17 positions in the ranking included all sectors with a greater than or near to 0.5 multiplier. The sectors that reflected lower wages and salaries multipliers are machinery and equipment due to the high import component.

Table 3
Multipliers of Wages and Salaries of the Peruvian Economy

	Sectors	Coefficient Wages & Salaries	Multiplier Wages & Salaries
1	Agriculture	0.119	0.443
2	Fishing	0.083	0.443
3	Petroleum, crude	0.158	0.279
4	Mining	0.244	0.615
5	Dairy products	0.068	0.439
6	Prepared fish	0.082	0.469
7	Fishmeal	0.065	0.443
8	Cereal grains, milled	0.083	0.489
9	Sugar	0.179	0.524
10	Other food	0.043	0.421
11	Beverages, tobacco	0.148	0.552
12	Textiles	0.085	0.432
13	Wearing apparel	0.092	0.454
14	Leather	0.09	0.408
15	Footwear	0.184	0.423
16	Wood products	0.132	0.520
17	Paper products	0.091	0.355
18	Publishing	0.171	0.509
19	Chemicals	0.114	0.341
20	Pharmaceuticals	0.178	0.295
21	Other chemicals	0.116	0.378
22	Petroleum, refined	0.062	0.274
23	Rubber, plastics	0.143	0.305
24	Nonmetals	0.081	0.472
25	Iron steel metals	0.153	0.282
26	Nonferrous metals	0.05	0.576
27	Metal products	0.136	0.448
28	Machinery NE	0.117	0.081
29	Machinery E	0.129	0.190
30	Transport equipment	0.104	0.155
31	Other manufactures	0.103	0.333
32	Electricity, water	0.228	0.595
33	Construction	0.138	0.527
34	Commerce	0.114	0.489
35	Transport	0.134	0.476
36	Services, financial	0.425	0.804
37	Insurance	0.234	0.599
38	Rental	0.009	0.342
39	Services, enterprises	0.156	0.478
40	Restaurants, hotels	0.047	0.414
41	Services, households	0.061	0.432
42	Services, households	0.284	0.708
43	Private health	0.255	0.625
44	Private education	0.157	0.480
45	Government	0.629	1.004

Note. Estimated from the input-output matrix.

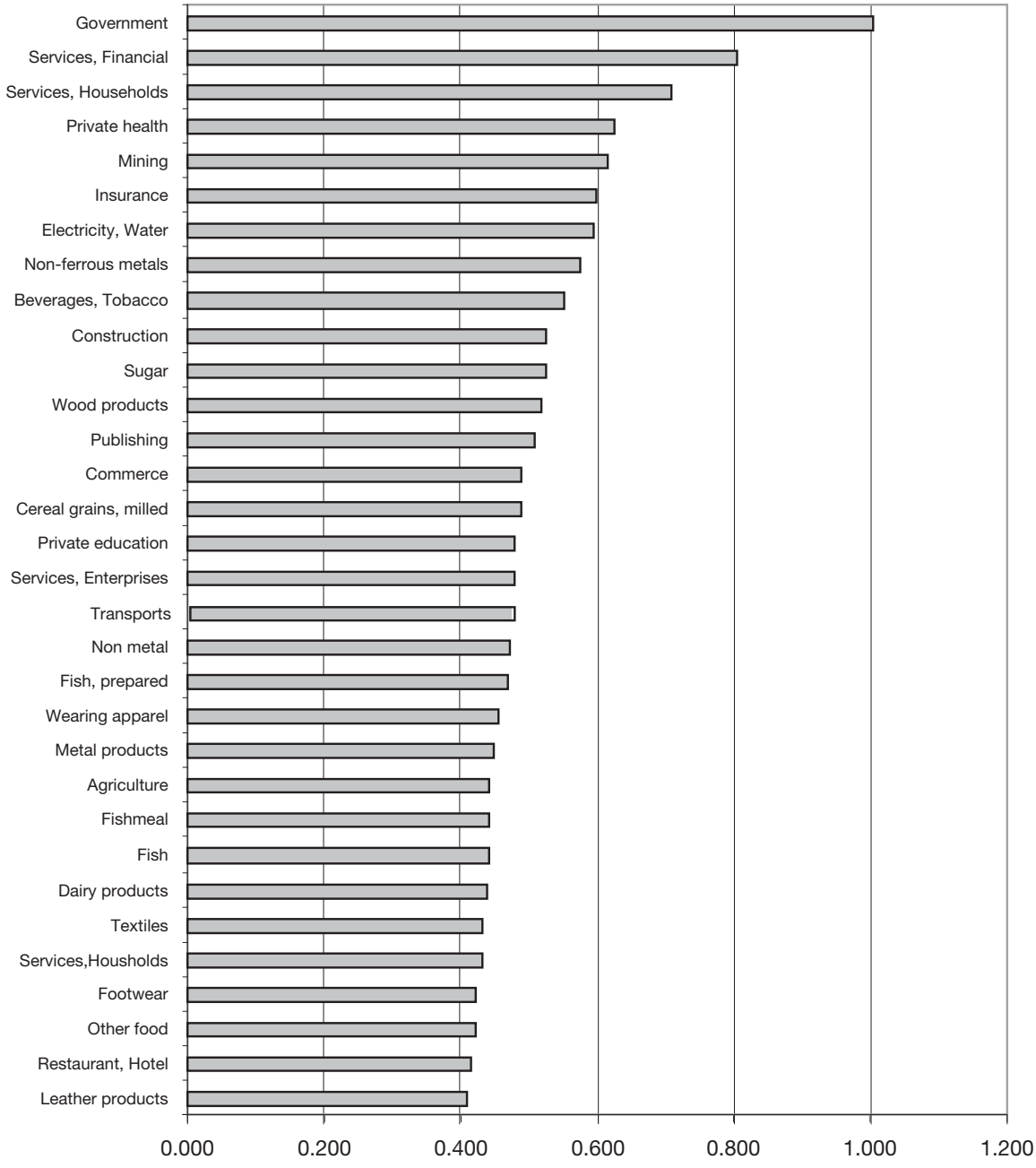

Figure 2. Ranking of employment multipliers of the Peruvian economy.

Finally, to establish a global idea of the multiplier effect of the different types of final demand, the study involved computing the wages and salaries multipliers of aggregated consumption, aggregated investment, and aggregated exports (see Table 4).

Table 4
Aggregate Multipliers of Wages and Salaries of the Peruvian Economy

Type	Multiplier
Consumption	0.461
Investment	0.426
Export	0.495

Note. Estimated from the 2002 input-output matrix.

Table 5
Multipliers of Imports of the Peruvian Economy

	Sectors	Coefficient	Multiplier
1	Agriculture	0.088	0.371
2	Fishing	0.026	0.361
3	Petroleum, crude	0.929	0.651
4	Mining	0.005	0.339
5	Dairy products	0.108	0.435
6	Fish products	0.013	0.337
7	Fishmeal	0.000	0.319
8	Cereal grains, milled	0.026	0.361
9	Sugar	0.137	0.436
10	Other food	0.109	0.414
11	Beverages, tobacco	0.033	0.374
12	Textiles	0.131	0.446
13	Wearing apparel	0.066	0.397
14	Leather	0.242	0.511
15	Footwear	0.354	0.559
16	Wood products	0.039	0.421
17	Paper products	0.375	0.563
18	Publishing	0.081	0.440
19	Chemicals	0.490	0.573
20	Pharmaceuticals	0.860	0.663
21	Other chemicals	0.332	0.534
22	Petroleum, refined	0.301	0.651
23	Rubber, plastics	0.727	0.656
24	Nonmetals	0.068	0.392
25	Iron steel metals	0.964	0.700
26	Nonferrous metals	0.026	0.366
27	Metal products	0.110	0.472
28	Machinery NE	5.174	0.903
29	Machinery E	1.813	0.783
30	Transport equipment	2.218	0.820
31	Other manufactures	0.568	0.591
32	Electricity, water	0.000	0.314
33	Construction	0.000	0.357
34	Commerce	0.000	0.309
35	Transport	0.101	0.414
36	Services, financial	0.000	0.314
37	Insurance	0.175	0.454
38	Rental	0.000	0.281
39	Services, enterprises	0.108	0.382
40	Restaurants, hotels	0.076	0.369
41	Services, households	0.017	0.321
42	Services, households	0.000	0.361
43	Private health	0.000	0.330
44	Private education	0.066	0.351
45	Government	0.000	0.308

Note. Estimated from the 2002 input-output matrix.

An expectation of this study was that consumption expenditures would generate more wages and salaries than investment expenditures. A surprising result was that exports generated more wages and salaries than consumption expenditures.

Further, in analogy to income multipliers, defining import multipliers is possible. These multipliers represent the effect of a unit increase in final demand of each sector on imports after considering the direct, indirect, and induced effects of the initial expenditure. The import multipliers appear in Table 5 along with their respective import coefficients, which may be interpreted as the initial impacts.

Analysis of import multipliers indicates that they are greater for the machinery sectors (nonelectrical and electrical), transport equipment, and chemicals. The range of the multiplier extends from 0.28 (rental) to 0.90 (machinery NE). The high import dependency explains the high multipliers for the machinery sectors.

To promote a global idea of the multiplier effect of the different types of final demand, the study involved computing import multipliers of aggregated consumption, aggregated investment, and aggregated exports (see Table 6).

Table 6
Aggregate Multipliers of Imports of the Peruvian Economy

Type	Multiplier (import)
Consumption	0.389
Investment	0.477
Export	0.398

Note. Estimated from the 2002 input-output matrix.

As expected, the effect of investment expenditures on imports was greater than the corresponding effect of consumption expenditures. However, the relative high effect (0.398) of export expenditures is noteworthy. For every dollar exported, spending of 39.8 cents on imports occurs to sustain that export.

Conclusions

The objective of the study was to present the multipliers and coefficients that synthesize the relationship between final demand in the different sectors and the national income of Peru. The multipliers permit a better knowledge of the relative importance of all economic sectors considered in the input-output matrix. Such multipliers also allow for visual representation of the characteristics of the productive structure of the country. A presentation of the main conclusions of the analysis appears in this section.

A statistically significant difference is apparent between the effects on national income generated by a unit increase of demand in the different sectors. A corollary is

the need to use better schemes than the macroeconomic models for this type of impact analysis. Particularly, input-output models are useful.

Multipliers of service sectors are higher than multipliers of industrial products. The basic products (agriculture, fishing, and mining) show intermediate-level multipliers. A clear conclusion is that the consumption multiplier is similar in magnitude to the export multiplier while the investment multiplier is the lowest of the three.

Wages and salaries multipliers are higher for the service sectors and for some modern export sectors, such as mining and metal products, and modern urban sectors, such as electricity, insurance, construction, and beverages. An expectation of the study was that consumption expenditures generate more wages and salaries than investment expenditures. A surprising result was that exports generate more wages and salaries than consumption expenditures.

Regarding import multipliers, as expected, the effect of investment expenditures on imports is greater than the corresponding effect of consumption expenditures. However, the relatively high effect of export expenditures is noteworthy. For every dollar exported, spending of 39.8 cents on imports occurs to sustain that export.

Finally, future researchers should consider two issues: the analysis of the interindustry linkages and the study of productive clusters. The pioneer study by Hirschman (1958) and his now famous backward and forward linkages represent the origin of the theory of linkages. The linkages of an industry are the indirect effects of changes in the industry. The effects are the impacts of a given industry on other connected industries, regarding production, income, employment, taxes, natural resources, and the environment.

Identifying the main productive clusters in the Peruvian economy is another suggestion for future researchers. The concept of a cluster comes from the pioneer work of Porter (1990). A cluster is a net of activities that naturally tends to develop around the exploitation of natural resources, such as fishing, mining, natural gas, and petroleum. Enterprises form the cluster in the main activity (nucleus of the cluster) by processing activities and by providing activities of inputs, equipment, and services.

Many authors today believe that these two topics, linkages and clusters, are key to understand the process of development of new competitive industries in emerging economies (Porter, 1990).

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Footnotes

1 Note that the 1994 input-output table included an entire matrix of imports by sector of origin and sector of destination.

2 Extending comparison to situations in neighboring and similar countries may be useful. Departamento Administrativo Nacional de Estadísticas (2008) and Banco Central de Chile (2008) illustrated linkage analysis and multiplier analysis.

3 The formula to calculate the values in Table 1 is $K = (I + M - A - C)^{-1} d$. In the equation, K is the vector of multipliers; M is the diagonal matrix of import coefficients; A is the matrix of input-output coefficients; C is the square matrix of consumption coefficients; and d is the vector of final demand (see Appendix C).

4 Note that the import coefficient is the ratio of imports (m) with respect to gross output (x) at the sector level (see Appendix C). For some sectors, imports are much greater than the value of domestic output, and the import coefficient is greater than 1. This is the case for machinery (electric and nonelectric) and transport equipment, which explains why the multipliers for these sectors are less than 1.

5 The A matrix of coefficients is derived from the input-output table in Appendix A. All coefficients in the table are positive and less than 1 because a coefficient a_{ij} is the ratio between X_{ij} and X_j, and we will always see (by construction) that $X_{ij} < X_j$.

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Appendix A

Table 7

Input-Output Table of the Peruvian Economy 2002 (Million Soles)

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 Agriculture	2485	0	0	25	395	0	1	1422	719	4134	89	343	0	0	0	147	0	0	6	1	6	0	70	3
2 Fishing	0	1	0	0	0	188	1078	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Petroleum, crude	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3216	0	0
4 Mining	6	0	1	68	0	0	7	0	0	3	0	0	0	0	0	0	0	0	20	3	6	0	0	392
5 Dairy products	0	0	0	1	286	0	0	29	0	40	0	0	0	0	0	0	0	0	0	1	0	0	0	0
6 Prepared fish	0	3	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Fishmeal	0	0	0	0	0	0	0	5	0	683	0	0	0	0	0	0	0	0	4	0	70	0	0	0
8 Cereal grains, milled	0	0	0	3	1	0	0	288	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Sugar	0	0	0	2	6	0	0	118	19	114	117	0	0	0	0	3	226	0	0	2	0	0	0	0
10 Other food	764	2	0	82	10	14	4	185	0	1190	257	1	0	117	0	0	4	0	3	6	11	0	0	0
11 Beverages, tobacco	4	1	0	11	0	0	1	0	0	2	332	0	0	0	0	0	0	0	0	8	11	0	0	0
12 Textiles	42	110	0	6	0	0	3	51	0	171	31	2358	1813	8	28	82	2	0	0	1	2	0	70	10
13 Wearing apparel	1	10	4	28	2	9	9	9	2	6	5	4	17	1	1	4	15	5	3	4	7	0	10	10
14 Leather	0	0	0	7	0	0	0	0	0	0	0	2	24	10	84	22	0	1	0	0	5	0	1	1
15 Footwear	1	3	0	2	0	2	2	0	0	0	0	0	0	0	9	9	0	0	0	0	0	0	0	0
16 Wood products	41	3	0	4	0	0	2	1	0	1	1	0	0	0	1	200	0	1	0	0	2	0	0	10
17 Paper products	46	1	0	26	77	11	1	164	25	86	68	24	17	2	8	1	668	666	17	24	96	0	30	70
18 Publishing	0	0	0	10	38	1	11	12	0	23	7	17	1	1	2	7	2	78	45	3	31	0	5	8
19 Chemicals	780	0	3	181	6	2	16	20	19	80	30	126	45	12	13	199	30	9	185	73	336	1	603	184
20 Pharmaceuticals	54	0	0	4	0	1	0	0	0	9	6	0	0	0	0	6	0	0	0	121	27	0	0	3
21 Other chemicals	1	50	22	243	5	1	1	4	0	24	36	33	2	8	13	130	43	115	124	23	287	5	122	67
22 Petroleum, refined	34	212	30	256	14	7	30	38	23	36	41	22	7	1	1	18	27	10	49	1	15	7	22	155
23 Rubber, plastics	37	18	2	123	20	4	42	41	0	112	40	20	22	0	44	56	22	4	57	29	155	0	139	23
24 Nonmetals	4	0	3	68	3	0	1	1	0	20	153	2	0	0	0	6	1	0	93	35	154	0	19	679
25 Iron steel metals	5	8	35	530	0	1	8	0	0	13	0	0	0	0	2	130	7	2	19	9	6	2	3	32
26 Nonferrous metals	0	0	2	73	1	0	0	0	0	0	0	0	0	0	0	1	0	3	14	0	107	0	9	0
27 Metal products	73	16	42	48	116	84	2	1	7	76	65	3	4	1	1	55	13	4	21	4	52	1	15	24
28 Machinery NE	7	2	4	17	1	1	3	4	1	3	7	5	5	0	0	3	5	2	6	1	4	0	3	24
29 Machinery E	0	9	12	12	3	2	16	0	4	0	3	0	4	0	0	1	3	2	1	1	1	0	3	2
30 Transport equipment	1	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Other manufactures	2	6	8	39	1	2	8	2	0	6	3	1	6	1	1	0	0	1	0	2	1	0	0	0
32 Electricity, water	13	0	20	592	8	6	23	76	9	79	92	90	37	4	3	44	113	36	136	6	45	3	70	330
33 Construction	0	0	50	1	0	0	0	1	1	1	2	5	4	0	0	0	3	1	1	1	2	1	0	0
34 Commerce	935	195	89	612	147	145	168	744	33	1659	287	340	309	22	55	266	170	206	184	108	300	5	236	518
35 Transport	280	30	168	1035	95	66	115	240	50	352	419	113	205	12	18	166	44	44	70	91	51	37	48	147
36 Services, financial	154	81	38	156	35	18	52	111	24	188	82	53	42	6	9	54	61	48	55	30	63	9	62	115
37 Insurance	3	25	42	162	2	3	4	16	3	22	15	11	5	1	4	3	6	4	4	4	17	2	11	27
38 Rental	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Services, enterprises	637	156	360	885	54	27	40	197	24	234	345	152	231	8	12	197	105	56	90	19	171	9	179	158
40 Restaurants, hotels	0	8	32	28	1	1	1	1	16	3	11	2	0	0	1	2	2	7	1	3	9	0	6	11
41 Services, households	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42 Services, households	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43 Private health	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44 Private education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45 Government	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total input	6428	906	976	5325	1326	595	1642	3780	974	9379	2549	3729	2809	216	310	1818	1571	1305	1197	615	2052	3298	1737	2968
VA 2002	12705	1745	1528	9239	504	614	2282	1901	366	2986	1534	1926	2240	48	181	738	927	957	1126	666	1524	1204	941	2191
VBP 2002	19132	2651	2504	14564	1829	1209	3924	5681	1340	12365	4084	5654	5049	264	491	2555	2498	2262	2323	1282	3576	4503	2678	5159
Importation CIF	1678	69	2327	76	197	16	0	148	183	1353	133	738	334	64	174	100	937	184	1139	1102	1186	1355	1947	351

Table continued

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	DI	C	I	Ex	DF	OT
1	0	4	0	0	0	0	0	0	20	1	0	1	0	0	1	184	2	134	3	0	117	10313	6642	1962	1728	10332	21236
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	6	0	0	6	1317	857		517	1374	2721
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3216	0		1638	1638	5366
4	91	3237	0	0	1	0	171	1	557	1	0	0	0	10	1	0	0	0	1	0	1	4578	0		9072	9072	14642
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	12	2	0	46	477	1860		48	1907	2396
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	31	2	0	67	177	981		89	1071	1252
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	763	0		3143	3143	3924
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	48	1	0	22	424	5969		124	6093	6526
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	5	0	0	15	668	981		70	1051	1734
10	0	14	0	0	0	0	5	0	0	69	0	6	0	0	0	1644	22	260	11	0	178	4859	9320		651	9971	14939
11	0	0	0	0	0	0	0	0	4	0	0	11	0	0	0	2488	81	43	1	0	49	3047	3173		65	3238	6354
12	0	0	4	6	0	0	29	1	12	33	0	106	4	0	50	19	0	99	135	7	166	5456	570		517	1087	6665
13	4	7	3	0	0	0	0	1	67	26	41	24	3	0	264	17	141	301	128	1	179	1375	2297		1873	4170	5763
14	1	1	0	0	0	0	7	2	0	0	0	3	0	0	1	0	0	1	0	0	2	176	83		76	159	338
15	0	0	0	0	0	0	0	0	2	1	0	4	0	0	5	0	1	72	0	0	16	130	601		8	608	741
16	0	1	5	0	1	1	5	1	500	13	3	25	1	5	6	1	8	30	11	40	22	945	1401	421	363	2185	2745
17	4	1	7	6	14	9	26	1	8	178	48	36	7	0	264	22	37	47	46	127	125	3139	386		95	481	3691
18	0	0	10	4	6	4	14	42	12	167	52	58	9	0	163	28	38	43	31	300	146	1429	1008		128	1136	2597
19	7	47	41	5	23	4	37	21	0	7	5	0	0	0	86	1	30	13	58	5	24	3363	0		185	185	3624
20	2	0	0	0	0	0	0	0	5	5	4	0	0	0	3	0	2	39	241	18	27	580	1918		128	2046	2639
21	2	30	41	8	30	25	165	3	444	25	22	56	3	31	201	43	107	32	44	109	115	2895	2038		227	2265	5226
22	60	65	14	8	10	4	11	158	217	102	2029	8	3	0	88	58	12	18	10	59	199	4188	2849		1107	5096	8214
23	1	18	17	6	60	11	19	7	562	235	729	40	0	4	138	44	28	41	4	58	51	3084	1460		353	1813	4968
24	8	14	7	6	9	7	16	97	3098	14	94	26	0	55	42	10	2	1	23	48	46	4864	537		144	681	5655
25	363	113	604	89	52	106	13	35	1076	1	20	0	0	5	35	0	0	4	7	29	10	3374	0		174	174	3625
26	69	1628	73	12	161	12	134	3	41	0	0	0	0	0	6	0	0	0	0	0	11	2361	0		4867	4867	7281
27	2	8	72	20	32	22	21	7	425	17	29	8	1	4	66	14	12	19	20	12	77	1616	301	926	14	1241	2894
28	2	1	3	8	7	1	3	5	10	9	7	8	0	0	15	1	1	1	1	9	11	213	179	4045	158	4383	4601
29	0	2	1	17	47	12	3	83	157	8	122	18	0	5	76	6	102	9	3	20	44	819	1947	2275	76	4298	3814
30	0	0	0	0	0	12	0	0	3	2	59	1	0	0	4	0	0	1	0	2	6	99	958	1354	92	2404	2506
31	1	1	2	1	4	3	17	9	4	48	40	8	2	1	73	11	12	29	63	47	89	556	2316	841	96	3253	3240
32	71	252	31	8	20	12	33	128	30	464	164	111	4	0	284	127	57	37	84	135	244	4133	2220			2220	6448
33	1	1	1	0	1	5	0	125	29	11	87	44	1	65	14	2	1	0	11	2	232	708	217	22126		22343	23067
34	174	105	199	92	153	106	121	231	2041	325	1662	167	11	39	582	1125	176	327	278	323	549	16519	20434		1641	22075	38969
35	35	204	96	50	52	45	102	151	794	5559	2579	352	16	31	686	188	320	328	104	201	632	16420	13873		2403	16276	33074
36	33	96	33	14	21	19	28	172	142	1135	694	139	107	11	359	35	480	176	41	17	874	6172	462		176	638	6951
37	8	42	5	2	5	5	7	27	30	115	293	327	906	0	72	4	12	9	28	32	173	2494	292		59	351	2901
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5571			5571	5775
39	206	60	80	71	94	58	79	260	1087	2377	5171	474	209	133	5094	401	1052	236	923	690	952	24050	2939	1178	234	4351	28973
40	3	0	17	4	6	3	8	29	65	62	422	106	3	0	148	5	106	39	9	1	268	1450	13660		1172	14832	16315
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10447		176	10623	10078
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4077			4077	3759
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6211			6211	6090
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10827			10827	10494
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	745			21448	20712
INS	1140	5937	1366	438	813	488	1075	1572	11436	11096	14068	2187	1301	404	9040	6733	2887	2497	2367	2309	5783	142446	142606	35128	33688	232125	375520
VA	595	1148	1159	252	436	191	776	4398	10744	26885	15426	4764	1012	5371	16422	8152	6648	1262	3723	7441	14929	181804	20703				
VBP	1735	7085	2525	690	1249	680	1851	5970	22180	37981	29494	6951	2312	5775	25462	14886	9535	3759	6090	9750	20712	324250					
IMP	1672	187	277	3570	2264	1508	1051	0	0	0	2990	0	404	0	2748	1131	162	0	0	646	0	34403					

Appendix B

Table 8
Coefficients of the Input-Output Model

	Sector	Value Added	Coefficient (Consumption)	Coefficient (Investment)	Coefficient (Export)	Coefficient (Import[4])
1	Agriculture	0.664	0.047	0.056	0.051	0.088
2	Fishing	0.658	0.006	0.000	0.015	0.026
3	Petroleum, crude	0.610	0.000	0.000	0.049	0.929
4	Mining	0.634	0.000	0.000	0.269	0.005
5	Dairy products	0.276	0.013	0.000	0.001	0.108
6	Prepared fish	0.508	0.007	0.000	0.003	0.013
7	Fishmeal	0.582	0.000	0.000	0.093	0.000
8	Cereal grains, milled	0.335	0.042	0.000	0.004	0.026
9	Sugar	0.273	0.007	0.000	0.002	0.137
10	Other food	0.241	0.065	0.000	0.019	0.109
11	Beverages, tobacco	0.376	0.022	0.000	0.002	0.033
12	Textiles	0.341	0.004	0.000	0.015	0.131
13	Wearing apparel	0.444	0.016	0.000	0.056	0.066
14	Leather	0.182	0.001	0.000	0.002	0.242
15	Footwear	0.369	0.004	0.000	0.000	0.354
16	Wood products	0.289	0.010	0.012	0.011	0.039
17	Paper products	0.371	0.003	0.000	0.003	0.375
18	Publishing	0.423	0.007	0.000	0.004	0.081
19	Chemicals	0.485	0.000	0.000	0.005	0.490
20	Pharmaceuticals	0.520	0.013	0.000	0.004	0.860
21	Other chemicals	0.426	0.014	0.000	0.007	0.332
22	Petroleum, refined	0.267	0.020	0.000	0.033	0.301
23	Rubber, plastics	0.351	0.010	0.000	0.010	0.727
24	Nonmetals	0.425	0.004	0.000	0.004	0.068
25	Iron steel metals	0.343	0.000	0.000	0.005	0.964
26	Nonferrous metals	0.162	0.000	0.000	0.144	0.026
27	Metal products	0.459	0.002	0.026	0.000	0.110
28	Machinery NE	0.365	0.001	0.115	0.005	5.174
29	Machinery E	0.349	0.014	0.065	0.002	1.813
30	Transport equipment	0.281	0.007	0.039	0.003	2.218
31	Other manufactures	0.419	0.016	0.024	0.003	0.568
32	Electricity, water	0.737	0.016	0.000	0.000	0.000
33	Construction	0.484	0.002	0.630	0.000	0.000
34	Commerce	0.708	0.143	0.000	0.049	0.000
35	Transport	0.523	0.097	0.000	0.071	0.101
36	Services, financial	0.685	0.003	0.000	0.005	0.000
37	Insurance	0.438	0.002	0.000	0.002	0.175
38	Rental	0.930	0.039	0.000	0.000	0.000
39	Services, enterprises	0.645	0.021	0.034	0.007	0.108
40	Restaurant, hotel	0.548	0.096	0.000	0.035	0.076
41	Services, households	0.697	0.073	0.000	0.005	0.017
42	Services, households	0.336	0.029	0.000	0.000	0.000
43	Private health	0.611	0.044	0.000	0.000	0.000
44	Private education	0.763	0.076	0.000	0.000	0.066
45	Government	0.721	0.005	0.000	0.000	0.000

Appendix C

The Input-Output Model

The basic input-output model begins with the supply-demand balance equation:

$$x + m = Ax + d$$

where x is the vector of production by sector, m is the vector of imports by sector, d is the final demand vector, and A is the input-output coefficients matrix.[5] Generally, we assume that imports represent a given share of domestic output in each sector:

$$m = Mx$$

where M is the diagonal matrix of import coefficients.

The first solution of the model involves substituting the second equation in the balance equation and solving as follows:

$$x = (I + M - A)^{-1} d$$

The multiplier formula requires that the final demand vector be disaggregated in the following terms:

$$d = c + k + e + g$$

where c is the consumption vector, k is the investment vector, e is the exports vector, and g is the government vector.

The key assumption is that the national income GDP determines consumption and that investment, exports, and government expenditures are exogenous. Because GDP = v′x (where v′ is the value-added coefficients vector), we can write the consumption vector as follows:

$$c = \beta c^* v' x$$

where β is the marginal propensity to consume, and c* is the vector of proportions of consumption. Note that $\beta c^* v'$ is a square matrix that may be represented by C. Replacing and solving, we have the following:

$$x = (I + M - A - C)^{-1} d$$

We may interpret the inverse matrix as the matrix of Keynesian multipliers. Mathematically, the vector K of Keynesian multipliers is given by the following:

$$K = v'(I + M - A - C)^{-1}$$

This is the formula used to estimate the multipliers in this essay.

Total employment (E) in the input-output model is a function of the output vector x

$$E = l'x$$

where l′ is the row vector of employment coefficients, and E is a number. Substituting x into this equation, we have the following:

$$E = l'(I + M - A)^{-1} d$$

From here, we may deduct that the row vector of sectoral employment multipliers (L) appears as follows:

$$L = l'(I + M - A)^{-1}$$

Finally, on the assumptions of the model, a more explicit statement follows. First, imports are endogenous and determined by the model, while, on the other hand, exports are exogenous to the model. That is to say, imports and

exports are independent. Therefore, the model is a short-run model, and the implicit assumption is that the balance of payments will not be in perfect equilibrium. The corresponding variations in the foreign-exchange reserves of the Central Bank of Peru will aid in financing the deficit/surplus.

Second, government expenditure (consumption and investment) is exogenous while taxes are endogenous. That is to say, government expenditures and taxes are independent. Therefore, the model is a short-run model, and the implicit assumption is that the government accounts will not be in perfect equilibrium. Achieving the financing of the fiscal deficit/surplus will involve the corresponding variations in government debt.

Regarding consumption, the assumption in this study was that consumption is endogenous because it depends on production and on generated income. The model is a Keynesian model, and the multiplier is a Keynesian concept. Some authors internalize private consumption in the input-output matrix, but for clarity in the exposition, we did not. Of course, a part of the consumption may be assumed exogenous.

Appendix D

Comparison of 1994 and 2002 Multipliers

Table 9
Comparison of 1994 and 2002 Multipliers

	Sectores	Multiplier 1994	Multiplier 2002
1	Agriculture	2.176	2.090
2	Fishing	2.211	2.184
3	Crude petroleum	1.935	1.154
4	Mining	2.223	2.207
5	Dairy	1.653	1.883
6	Prepared fish	2.246	2.216
7	Fishmeal	2.296	2.288
8	Cereal grains, milled	2.089	2.125
9	Sugar	1.509	1.887
10	Other food	2.043	1.948
11	Beverages, tobacco	2.052	2.079
12	Textiles	1.825	1.841
13	Wearing apparel	2.125	1.999
14	Leather	1.958	1.617
15	Footwear	1.908	1.470
16	Wood products	2.028	1.920
17	Paper products	1.383	1.456
18	Publishing	1.922	1.865
19	Chemicals	0.891	1.434
20	Pharmaceuticals	1.610	1.121
21	Other chemicals	1.544	1.550
22	Petroleum, refined	1.718	1.158
23	Rubber, plastics	1.337	1.144
24	Non metals	1.965	2.050
25	Iron steel metals	1.363	1.005
26	Non ferrous metals	2.183	2.124
27	Metal products	1.632	1.758
28	Machinery NE	0.553	0.321
29	Machinery E	0.666	0.718
30	Transport equipment	0.575	0.594
31	Other manufactures	1.532	1.361
32	Electricity water	2.367	2.297
33	Construction	2.244	2.143
34	Commerce	2.444	2.293
35	Transports	2.172	1.977
36	Services, financial	2.397	2.271
37	Insurance	1.805	1.794
38	Rental	2.525	2.391
39	Services enterprises	2.251	2.026
40	Restaurant, hotels	2.272	2.097
41	Services households	2.411	2.243
42	Services households	2.221	2.120
43	Private health	2.354	2.203
44	Private education	2.324	2.152
45	Government	2.397	2.302

Note. 1994 multipliers from *Multiplicadores de la Economia Peruana,* by INEI (2001)

A comparison between the multipliers of the Peruvian economy for the year 1994 and the multipliers of the Peruvian economy for the year 2002 follows. An assumption of the comparison is that most relationships between variables of the input-output model are constant. The assumption is only approximate for the following reasons: First, the structure of industries may have changed between 1994 and 2002; for instance, the mining industry was biased towards gold in 2002 than in 1994 because the big mining Yanacocha project was not fully operative in 1994. Second, the importance of imports may have increased between 1994 and 2002 because of the globalization of world markets and the opening of the Peruvian economy to trade and investment.

Nevertheless, the following figures illustrate the comparison of 1994 multipliers to 2002 multipliers. The simple average multiplier in 1994 was 1.896, which decreased slightly to 1.797 in 2002 (a 5% decrease). Figures 3 and 4 show the sector-by-sector comparison.

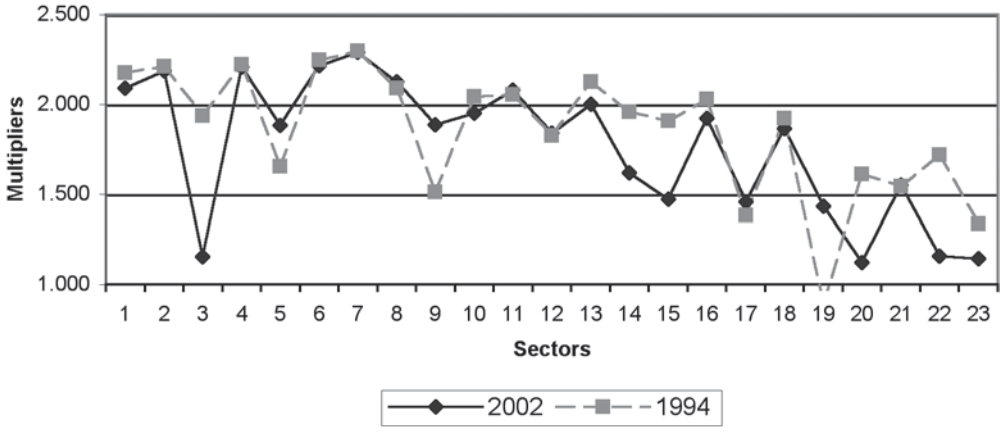

Figure 3. Comparison of 1994 and 2002 Multipliers (Sectors 1-23)

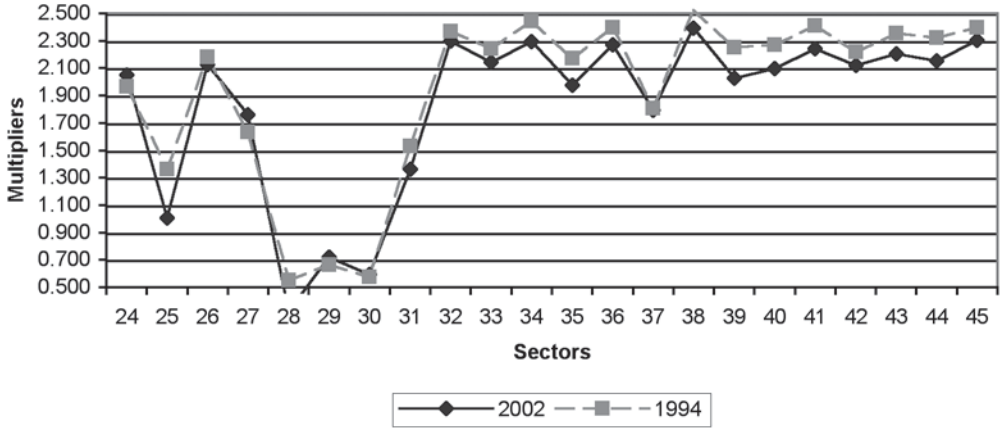

Figure 4. Comparison of 1994 and 2002 Multipliers (Sectors 24-45)

Finally, Table 10 illustrates a comparison of the aggregate multipliers for investment and exports for the years 1994 and 2002.

Table 10
Comparison of Aggregate Multipliers (2002 and 1994)

	2002 Multipliers	1994 Multipliers
Investment	1.743	1.812
Export	2.011	2.156

The result is that, in the aggregate, investment and export multipliers were higher in 1994 than in 2002. The investment multiplier was 4% higher while the export multiplier was 7% higher in 1994. The reasons behind the decline of the absolute values of the multipliers were advanced above. The main reason may be that the opening of the Peruvian economy to trade and investment in the 1990s led to an increase in import coefficients at the sector level, which tends to have a negative effect on the value of the sector multipliers.