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Small Country Size and Returns to Scale in Manufacturing

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Summary. — This paper tests the hypothesis that small country size is associated with constraints relating to economies of scale in manufacturing. The study adopts a production function approach, utilizing data from 43 differently sized countries. The results, confirming the hypothesis, lend empirical support to the presumption that small countries face serious disadvantages in terms of production cost per unit in their manufacturing sectors, suggesting that such countries are, as a result, seriously disadvantaged in terms of international competitiveness in manufacturing trade. © 1998 Elsevier Science Ltd. All rights reserved

Key words — small country size, economies of scale, manufacturing

1. INTRODUCTION

During the last three decades, there has been a growing interest in the economic characteristics and economic performance of small countries. Initially, concern centered on economic survival and viability of small economies [see discussion in Schaffer (1975)], but following the decolonization process, and the economic success of a number of small states, attention focused more on economic performance [see, for example, Robinson (1960), Selwyn (1975), Banerjee (1982), Blazic-Metzner and Hughes (1982), Persaud (1982, 1989), Thomas (1982), Gayle (1986), Milner and Westaway (1993) and Armstrong and Read (1995)].

One reason that could explain the growing interest in small states could be the fact that since the 1960s, many states with a population of about one million or less, have become members of the United Nations.[1] Another reason could be related to improved statistics on the economic performance of small countries in recent decades, enabling scholars to find it increasingly possible to carry out studies on small economies. A third reason could be the relatively good economic performance of many small states, such as, to mention a few, Malta, Cyprus, Barbados, Singapore and Mauritius, prompting analysts to attempt to explain the paradox of small size and economic success.

Small countries are associated with a number of special characteristics, including a relatively large foreign sector, dependence on a very narrow range of exports and a relatively large public sector. These characteristics are well known, and arise from the small size of the domestic market, lack of natural resources and indivisibilities in public administration.

A presumption often made with regard to small countries relates to economies of scale constraints. It is hypothesized that small country size is associated with high per-unit costs due to such constraints (Bhaduri *et al*., 1982) and that therefore small countries face disadvantages in this regard.

It is, however, known that small countries do not, in general, register low GNP per capita and low Human Development Index scores (Briguglio, 1995), leading some analysts to argue that being small is not a disadvantage after all. This line of argument may of course contain an element of truth in that smallness has its advantages. Some authors have referred to economic factors to explain this reality. Blazic-Metzner and Hughes (1982), Ashoff (1989) and Armstrong and Read (1995) consider the relatively high dependence on international trade by small counties as an important factor in this regard. Others give importance to social considerations in addition to economic ones, including the high degree of flexibility in the face of changing circumstances and social cohesion in small states (Streeten, 1993, pp. 199–200).

This paper presents the view that small country size is indeed disadvantageous since it imposes constraints with regard to economies of scale, and that therefore, the relatively good

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performance of some small countries has occurred in spite of, and not because of, small economic size.

This approach taken in this paper is based on the estimation of production function coefficients, including the returns to scale parameter, with data derived from the manufacturing across countries. Although the hypothesis that small countries experience economies of scale constraints in manufacturing has been discussed at a theoretical level in earlier work [see, for example, Bhaduri *et al.* (1982)], the approach adopted in this study is innovative in that it lends empirical support to this hypothesis.

2. THE SIZE OF COUNTRIES: ECONOMIC IMPLICATIONS

The size of a country can be measured in terms of its population, its land area or its gross national product. Some studies prefer to use population as an index of size, whereas others take a composite index of the three variables (Jalan, 1982; Downes, 1988; Briguglio, 1993, appendix 1).

There are many reasons why small size should be associated with economic disadvantage.

(a) *Limited possibilities for economies of scale*

Small size limits the possibilities for economies of scale, mostly due to indivisibilities and limited scope for specialization. In turn, this gives rise to, among other things, high per-unit costs of production. This constraint is especially relevant to the manufacturing sector, where a critical minimum size is important.

(b) *Limited possibilities for the development of endogenous technology*

Small size leads to a high degree of dependence on imported technologies, since it is often not feasible, due to financial and other limitations, to invest in research and development. In addition, small countries tend to face technological mismatches, because imported technologies are not always suitable for small production runs and for the special conditions prevailing in small countries.

(c) *Limited natural resource endowments and high import content*

Small size often implies poor natural resource endowment and low interindustry linkages, which result in a relatively high import content of total final expenditure (Briguglio, 1995). This makes the economy highly dependent on foreign exchange earnings. In addition, the small size of the domestic market severely limits import substitution possibilities (Worrell, 1992, pp. 9–10).

(d) *Small domestic market and dependence of export markets*

The small domestic market, coupled with the need for a relatively large amount of foreign exchange to pay for the large import bill, gives rise to a relatively high dependence on exports (Briguglio, 1995) and therefore on economic conditions in the rest of the world. In addition, small size restricts the country's ability to diversify its exports, and this renders the country dependent on a very narrow range of goods and services (Briguglio, 1993, appendix 5). This carries with it the disadvantage associated with having too many eggs in one basket, and intensifies the problems associated with dependence on international trade.

(e) *Problems of public administration*

Small size creates problems associated with public administration, the most important of which is probably the small manpower resource base from which to draw experienced and efficient administrators (Jacobs, 1989). Very often, specialists can only be trained overseas in larger countries, without a guarantee that their services will be needed on their return. For this reason, many specialists originating from small countries emigrate to larger countries where their services are better utilized and where remuneration for their services is better.

A related problem is that many government functions tend to be very expensive per capita when the population is small, due to the fact that certain expenses are not divisible in proportion to the number of users.

(f) *Transport costs and insularity*

The majority of small countries are also islands, and transport costs associated with the international trade tend to be relatively higher per unit of export than in other countries (Briguglio, 1995). The main reason for this is that islands are separated by sea and are therefore constrained to use air and sea transport only for their imports and exports. Land transport is of course out of the question, and this reduces the options available for the movement of goods and of people.

Apart from this, a small economy tends to require relatively small and fragmented cargoes, leading to high per unit costs. Moreover, small size often excludes the countries involved from the major sea and air transport routes, which give rise to delays. Insularity and remoteness from the main commercial centers may also give rise to additional problems such as time delays and unreliability in transport services. An additional problem that arises when transport is not frequent and/or regular is that enterprises have to keep large stocks to meet sudden changes in demand, implying additional costs of production, associated with tied up capital, rent of warehousing and wages of storekeepers.

3. ECONOMIES OF SCALE

This paper focuses on one disadvantage of small country size, namely constraints relating to economies of scale in manufactures, and one particular approach, namely the estimation of a labor demand function derived from a production function.

The basic assumption underlying a production function is that output depends on labor and capital, given the state of technology. The variable representing capital is often difficult to measure, and data on this variable are generally not readily available (Dean, 1964). In addition, there is the problem of measuring capital utilization. Some researchers use an index of energy utilized for production as an indicator of capital services—an index that is supposed to capture the stock of capital and its utilization. In general, however, models utilizing data for capital services tend to leave a question mark as to the reliability of the estimates that they produce.[2]

One way of circumventing this problem is by deriving and using the marginal productivity condition from the production function, which is the approach adopted in this study. The underlying production function that will be utilized is of the CES type, allowing for the possibility of efficiency changes and non-constant returns to scale.

(a) *The underlying production function*

It is assumed that the underlying production function explaining the relation between labor, capital, technology and output has the following specification:

$$Y = T[bL^{-p} + (1-b)K^{-p}]^{-v/p} \qquad (1)$$

where the upper-case variables have the following meanings:

- Y represents the value-added produced by the productive unit;
- L represents the labor services used to produce Y;
- K represents the capital services used to produce Y;
- T captures shifts in the production function, due, for example, to technological change (when the function is based on time series data, the variable T is often represented by a time trend expression, such as e^{rt}).

The coefficients of equation (1) can be interpreted as follows:

- b represents the distribution parameter. It can be shown that under certain conditions b measures the share of output that accrues to the labor input and $(1-b)$ the share of the other inputs, collectively considered as capital;
- p represents the substitution parameter, from which the elasticity of substitution $\sigma = 1/(1+p)$ can be derived. In the Cobb–Douglas production function, the value of σ is restricted to unity, implying that p takes a value of zero. By using the CES production function, we are implicitly allowing for the possibility that a certain percentage decrease in factor prices need not generate a corresponding percentage increase in factor demand;
- v is the homogeneity parameter, which measures the degree of returns to scale, and would indicate constant returns if its value is unity, decreasing returns if its value is a positive fraction and increasing returns if its value is higher than unity.

When time-series data are used, the efficiency term of the production function is often interpreted as capturing Hicks-neutral technological change. Alternatively, one can allow for a non-neutral type of technological change (David and Van de Klundert, 1965) in the sense that the factor augmenting efficiency changes are not assumed to be the same for labor and capital.

Although the technical change parameter is usually applied to time-series data, we shall use the concept of efficiency in our cross-section analysis to allow for shifts in the production function due to differing factor enhancing endowments across countries.

(b) *Deriving a labor demand equation*

The labor demand equation is derived by first specifying the marginal productivity condition, and assuming that the marginal product of labor is equal to the wage rate[3] as shown in equation (2):

$$\partial Y/\partial L = W. \quad (2)$$

Applying this condition to equation (1), we obtain:

$$\partial Y/\partial L = vbT^{-p/v}L^{-(p+1)}Y^{(1+p/v)}. \quad (3)$$

Combining equations (2) and (3), re-arranging, and expressing the resultant equation in log form, the following equation is obtained:

$$\ln L = \sigma \ln(vb) - \sigma \ln W + [1 + \sigma(v-1)]/v \ln Y - (1-\sigma)/v \ln T, \quad (4)$$

where $\sigma = 1/(1+p)$, which can be interpreted as representing the elasticity of substitution between labor and capital.

Equation (4) can therefore be expressed as follows:

$$\ln L = \alpha_1 + \alpha_2 \ln W + \alpha_3 \ln Y + \alpha_4 \ln T, \quad (5)$$

where the α coefficients have a number of interesting properties, namely:

α_2 takes a value of $-\sigma$, that is the elasticity of substitution with a negative sign, indicating the extent to which labor replaces capital as wage rates become lower in relation to the rental value of capital.

α_3 represents the elasticity of employment with respect to output. As already explained, this coefficient will, under certain conditions, take a value of a positive fraction if increasing returns to scale are assumed.[4]

α_4 captures, among other things, shifts in the production function due to technological change. It is expected to have a negative sign, indicating that with technological advance, the number of employees per unit of output would decrease.

4. THE DATA

The estimation of equation (5) requires data on labor (L), wage rates (W) and output (Y). The sources and method of computation of the data are given in Appendix B. In brief, Y is measured by value-added (US$ million) of the manufacturing sector in each country, W is measured by the monthly wage rates (US$) and L is measured by employment (thousand persons) in the manufacturing sector in the respective country. Various variables were utilized to capture the effect of the state of technological advance in each country, but the best results were produced by a dummy variable distinguishing between developing and developed countries.

The choice of 43 countries was conditioned by the availability and reliability of data. It turned out, however, that the sample contains a good representation of differently sized countries, as shown in Table 1, which summarizes the data given in Appendix A.[5]

As expected, the size of the manufacturing sector of each country, measured by its value added, was found to be positively correlated with the population size of the respective country.[6]

Wage rates across countries varied considerably, with the developed countries of Western Europe, North America, Oceania and Japan registering the highest rates. Country size and wage rates were, however, not correlated.

GNP per capita, which in this study will be used as a shift variable, was uncorrelated with country size, but again the countries of Western Europe, North America, Oceania and Japan registered the highest rates.

5. ESTIMATION RESULTS

The following equation was used for the purpose of estimation:

$$L_i = \alpha_1 + \alpha_2 W_i + \alpha_3 Y_i + \alpha_4 T_i + e_i, \quad (6)$$

Table 1. *Size distribution of the sample of countries*

Population size	Sample of countries		All countries	
	Number	Percentage	Number	Percentage
0–1 million	8	19%	37	20%
1–5 million	9	21%	46	24%
5–20 million	12	28%	61	32%
20–100 million	11	25%	35	19%
100 million and over	3	7%	10	5%
Total	43	100%	189	100%

where the variables have the same meaning as in equation (5), except that they are measured in natural logarithms. The subscript i refers to the ith country, and e is an error term.

The coefficients of equation (6) were estimated by the Ordinary Least Squares (OLS) Method using data for the manufacturing sector of 43 countries of different size. It was tested first without the efficiency variable. The results are as follows:

$$L_i = 2.024 - \underset{(-7.369)}{0.656W_i} + \underset{(20.630)}{0.922Y_i}$$

$$N = 43 \quad R^2 = 0.961 \quad \text{Adj } R^2 = 0.919. \qquad (6')$$

The estimated coefficients possess the right signs and have plausible magnitudes. The t-statistics indicate that the estimates are statistically different from zero at the 95% level, whereas the correlation coefficient is on the high side. A t-statistic test on the coefficient on Y indicated that it is statistically lower than unity.

The coefficients on W take a value of -0.656, indicating that as wage rates increase, employment decreases, as hypothesized. This would seem to suggest that as countries experience higher wage rates, they tend to substitute capital with labor. The elasticity of substitution between labor and capital, as measured by the coefficient on W, suggests that a given percentage wage rate increase brings about a much lower percentage decrease in employment, everything else remaining constant. This does not carry direct implications regarding the size of countries because, as stated, country size and wage rates are not correlated. It does, however, provide an insight into the possible labor output ratio changes of countries as their wage rates increase.

The estimated coefficient on Y takes a value of 0.922. This would seem to suggest that as the manufacturing sector expands, the cost per unit of output decreases, since the coefficient on Y implies that the returns to scale parameter v in the underlying CES production takes a value of 1.29. In other words, a 1% change in labor and capital would, according to this estimate, increase output by 1.29%.

This finding has important implications for the size of countries. It suggests that larger countries, which employ more labor and capital than small countries, are able to enjoy increasing returns to scale. This is in line with the hypothesis that the small countries tend to face higher cost per unit when compared to large countries.

The equation was augmented to include shifts caused by technological advance. As stated, the sample contains countries in different stages of development. Various variables were included in the equation to allow for such shifts, including the Human Development Index, a Years of Schooling Index and a GNP per Capita Index. None of these produced plausible statistical results. The reason for this could be attributed to several factors, including that the shift variable was incorrectly measured or that the shift occurs after a certain threshold is reached.

A further attempt to allow for technological shifts was made by introducing a dummy variable, taking a value of zero for countries with a 1993 GNP per capita less than US$8000 and one for countries with a 1993 GNP per capita higher than US$8000 (which countries can be considered as the more developed countries in the sample). The results of this experiment are as follows:

$$L_i = 1.031 - \underset{(-4.519)}{0.472W_i} + \underset{(22.568)}{0.932Y_i} - \underset{(-2.859)}{0.678T_i}$$

$$N = 43 \quad R^2 = 0.968 \quad Adj\ R^2 = 0.932, \qquad (6'')$$

where L, W and Y have the same meaning as before, and T is a dummy variable as just explained. Again, the estimated coefficients possess the right signs and have plausible magnitudes. The t-statistics pertaining to W, Y and T indicate that the estimates are statistically different from zero, and the coefficient on Y is statistically different from unity, at the 95% level.

The result shown in equation (6″) would seem to suggest that, as expected, more developed countries tend to economize on factor inputs due to technological advance relating to capital and improvements in human resource endowments, although it is not possible to distinguish between the two factor enhancing effects from the results.

The augmented equation indicates that the elasticity of labor demand with respect to wage rates is lower than that found in the case of equation (6′), suggesting more limited factor substitution possibilities.

The estimates of the equation, as augmented by the dummy variable, suggest that the returns to scale coefficient v takes a value of 1.16, again confirming the presence of increasing returns to scale in manufacturing.

6. CONCLUSION

In this paper, it has been argued that small size is likely to be associated with a higher cost per unit, due among other things, to constraints on the ability enjoying economies of scale. This hypothesis was tested using a production function approach, utilizing the marginal productivity condition of the CES production function.[7]

The results indicate, among other things, that a percentage change in factor employment brings about a higher percentage change in output, thereby suggesting that as countries become larger, they would be able to produce output at a lower cost per unit.

The finding has an important implication for small countries, namely that small size is a disadvantage in terms of cost per unit, and therefore it adversely affects the international competitiveness of small countries, everything else remaining constant.

Given that small countries tend to have a very large foreign sector, it is suggested that this could be a major disadvantage that small countries have to overcome.

One escape route for small countries is not to rely too much on manufacturing production and instead seek forms of production that are not generally subject to increasing returns. The services sector is often singled out in this regard (Bhaduri *et al.*, 1982, p. 63; Blazic-Metzner and Hughes, 1982, p. 96; Seers, 1982, p. 80; Thomas, 1982, p. 117).

The estimation results indicate also that wage rates have an important influence on labor demand, everything else remaining constant. Although this relationship is not directly related to size, it could be of relevance to a number of rapidly growing small countries, such as Malta and Cyprus, which are experiencing rising wage rates, with a possible negative impact on aggregate employment and foreign exchange earnings. This is, of course, a *ceteris paribus* conclusion, and, as is well known, it need not mean that economic growth, which often leads to wage rate increases, leads to loss of employment, since the positive impact of the income variable could outweigh the negative impact of the wage variable.

The finding of increasing returns to scale in terms of country size is not a surprising one, and confirms what is generally assumed. However, the empirical confirmation of the hypothesis that small states face this major constraint lends support to the arguments that small countries tend to be economically successful not because they are small, but in spite of this fact. This phenomenon can be compared to the case of small firms that tend to experience limitations in terms of economies of scale, but manage to overcome this deficiency through other means, such as being more flexible to sudden changes and seeking niche markets for their products.

NOTES

1. Many of these small states are members of AOSIS, the Alliance of Small Island States, a pressure group within the United Nations. AOSIS has had an important voice on a number of global issues affecting small island states, notably the Convention on Climate Change.

2. For literature on this subject see Gaude (1975) and Briguglio (1982).

3. A great number of works based on the labor demand equation derived from the marginal productivity condition have been produced. For literature on this subject, see Briguglio (1984).

4. It should be noted that $\alpha_3 = [1+\sigma(v-1)]/v$, which means that the labor demand elasticity with respect to output is not uniquely related to v but also to σ. It can be shown that $v = (1-\sigma)/(\alpha_3-\sigma)$, so that if $\sigma < \alpha_3 < 1$, v would be higher than unity, implying increasing returns to scale.

5. The 189 independent states, representing the total country population, are included in table 6.1 of the UNCTAD, *Handbook of International Trade and Development Statistics* (UNCTAD, various years). The 20 to 100 million category in the sample is somewhat overrepresented, partially due to the fact that it was easier to obtain data for such countries. The set of small countries in the sample is, however, approximately equal to the percentage of the total country population.

6. The correlation coefficient between population size and the size of the manufacturing sector in the sample of countries was 0.85.

7. It would have been desirable to estimate the production function directly, in which case the estimation results would have yielded additional information regarding the expansion path and other factors relating to the capital input. It was not, however, found possible to obtain reliable data on capital, and this approach was not utilized.

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Appendices — *overleaf*

APPENDIX A
Countries in the sample classified by population size

Country	Population	Area	GDP	GDP per capita
Seychelles	0.07	450	443	6153
Barbados	0.26	430	1631	6273
Malta	0.36	320	2454	6798
Luxembourg	0.40	2586	12,504	31,656
Bahrain	0.54	680	4548	8501
Cyprus	0.73	9250	6486	8934
Fiji	0.76	10,270	2222	2931
Swaziland	0.81	17,360	1039	1284
Mauritius	1.09	2040	3112	2852
Botswana	1.40	581,730	3813	2724
Estonia	1.52	45,100	5092	3350
Jamaica	2.41	10,990	3839	1593
Singapore	2.79	620	55,086	19,723
New Zealand	3.49	270,990	43,699	12,539
Norway	4.30	323,900	103,419	24,057
Paraguay	4.70	406,750	6825	1452
Jordan	4.94	89,210	5189	1051
Finland	5.06	338,130	83,794	16,567
Denmark	5.17	43,090	135,999	26,331
Austria	7.86	83,850	182,067	23,155
Sweden	8.69	449,960	185,289	21,312
Belgium	10.05	30,514	210,576	20,961
Belarus	10.19	207,600	27,545	2704
Hungary	10.21	93,030	38,099	3732
Greece	10.38	131,990	73,182	7052
Equador	10.98	283,560	14,421	1313
Chile	13.82	756,950	43,684	3160
Netherlands	15.29	37,330	309,227	20,231
Australia	17.62	7,713,358	281,853	15,999
Peru	22.89	1,285,220	41,061	1794
Canada	28.82	9,976,136	18,959	18,959
Spain	39.50	504,780	478,581	12,115
South Africa	39.66	1,221,040	117,228	2956
Korea	44.13	99,020	332,822	7542
France	57.51	551,500	1,251,696	21,766
Thailand	57.59	513,130	124,857	2168
UK	57.92	244,880	941,424	2923
Turkey	59.60	779,450	174,187	16,253
Germany	80.86	356,910	1,910,760	23,631
Mexico	90.03	1,958,200	343,472	3815
Japan	124.54	377,800	4,214,125	33,839
Brazil	156.49	8,511,968	436,304	2788
USA	257.93	9,809,426	6,259,898	24,270

Note on the data. All data pertain to 1993. The units of measurement are: population in millions; land area in square kilometers; GDP in US$ million; GDP per Capita in US$.
Source: UNCTAD, *Handbook of International Trade and Development Statistics* (UNCTAD, various years).

APPENDIX B

The data

The data used for estimating equation (6) refer to the most recent year for which statistics were available for the three variables, which, for most countries, was 1993. However, in some cases, the most recent year for which data were available was 1992, 1991 or 1990.

The definition and the sources of the data are as follows:

Labor (L)

Definition: Employment in Manufacturing Industries (thousand persons).

Source: *United Nations Statistical Yearbook* (40th Issue).

Wage Rates (W)

Definition: Average monthly wage rate in manufacturing ($US).

Source: *Yearbook of Labor Statistics, 1995.* Geneva: ILO.

Comments: The data on wage rates are given in national currencies in the *Yearbook of Labor Statistics*, and were converted into $US using yearly average exchange rates, as given in the IMF *International Financial Statistics*. In addition, the *Yearbook of Labor Statistics* does not supply homogenous data on wage rates, since they are not always given as monthly rates. The figures were adjusted to render them comparable as much as possible across countries.

Output (Y)

Definition: Value added in Manufacturing Industries (Million $US)

Source: *United Nations Statistical Yearbook* (40th Issue).