TEXTO PARA DISCUSSÃO Nº 97

WHO PATENTS IN BRAZIL? A LOOK AT THE PERIOD 1990-1995

Eduardo da Motta e Albuquerque
Paulo Brígido Rocha Macedo

Março de 1996

UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE CIÊNCIAS ECONÔMICAS
CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

WHO PATENTS IN BRAZIL? A LOOK AT THE PERIOD 1990-1995

Eduardo da Motta e Albuquerque
Universidade Federal do Rio de Janeiro (UFRJ) and CEDEPLAR/UFMG

Paulo Brígido Rocha Macedo
Universidade Federal de Minas Gerais (UFMG) and CEDEPLAR/UFMG

CEDEPLAR/FACE/UFMG
Belo Horizonte
1996

Ficha Catalográfica

347.77(81) A345W 1996	Albuquerque, Eduardo da Motta. Who patents in Brazil? a look at the period 1990-1995 / Eduardo da Motta e Albuquerque. Belo Horizonte : UFMG/CEDEPLAR, 1996. 20p. (texto para discssão; 97) 1. Patentes - Brasil - 1990-1995. II. Macedo, Paulo Brígido Rocha. III. Universidade Federal de Minas Gerais. Centro de Desenvolvimento e Planejamento Regional. IV. Título. V. Série

SUMÁRIO

I INTRODUCTION

The study of patent statistics is an important means of analyzing the innovativeness of a country's economy. Patent data have been used in studies of innovation in developed economies, but are rarely seen in developing country studies. This work uses data on invention patents of Brazilian firms or individuals, issued by Brazil and by the United States from 1990 through 1995, to analyze Brazilian innovation activity. The two main sources of data are patent statistics of the Brazilian Instituto Nacional de Propriedade Industrial, INPI (National Institute of Industrial Property), and of the United States Patent and Trademark Office, USPTO.

This study analyzes patent owners by three categories: ownership structure:. manufacturing sector (for firms); patent classification code of the World Intellectual Property Organization (WIPO). It ranks patent owners by category, according to their number of patents, and investigates the stability of these rankings over the period. It also examines the relationship between R&D expenditures reported in the manufacturing census survey of 1985 and patenting activity in the period 1990-1995.

Among the results discussed in this paper are the following:

- The data show a very high share of patents granted to individuals in Brazil, compared to firms.
- The Brazilian INPI data for firms show a different distribution by ownership structure than the USPTO data.
- The statistical analysis shows a strong relationship between R&D expenditures and patenting activity across manufacturing sectors, and supports the conclusion that patents are a good indicator of the inventive output of the research units in those sectors.

II PATENT STATISTICS: U.S. AND OTHER COUNTRIES

Among standard references on the role of patents as an indicator of technological progress are Griliches et al. (1984), Pavitt (1988), and Griliches (1990). Although the number of patents granted does not reveal their technological heterogeneity, most authors agree that patent statistics contain information that is invaluable to an understanding of technological change as an endogenous element in economic growth. In the words of Freeman (1994), patents are a "gold mine" for empirical research on innovation activities.

Studies of innovation systems based on patent statistics must take into account the following considerations: a) patented innovations are only a subset of the total number of innovations (see, for example, Levin et al, 1987; Pavitt, 1982); b) the economic value of patents and their technological relevance are heterogeneous (Cohen and Levin, 1989; Griliches, 1990); c) the propensity to patent varies widely across industrial sectors (Levin et al, 1987; Cohen and Levin, 1989); d) differences in national legislation affect incentives to use the patent system (Ordover, 1991).

International comparisons of national patent statistics have a more solid ground if based on shares rather than absolute numbers. An indicator of the strength of national innovation systems which is frequently employed is the share of total patents of a national patent office which are granted to residents of that country. Table I, compiled by the World Intellectual Poperty Organization (WIPO), shows such shares for selected countries in 1991. Only the U.S. and Japan have more than 50% of their patents issued to residents.

TABLE I

Patent statistics, according to the status of the grantee (1991)

Country	Residents	Non-Resid.	Res./Total
United States	51,184	43,330	0.53
Japan	30,453	5,647	0.84
Germany, Fed. Rep.	16,756	26,434	0.39
France	9,221	26,360	0.26
United Kingdom	4,492	29,582	0.13
Switzerland	2,540	14,268	0.15
Sweden	1,713	15,054	0.10
Canada	1,109	14,364	0.07
Netherlands	926	16,684	0.05
Brazill	341	2,078	0.14
Italy	311	19,192	0.02

Source: WIPO (1993).

Comparisons of national patenting activity are also possible using data on United States patents issued to residents of foreign countries. Such numbers provide indicators of both the strength and degree of world integration of national innovation systems, evaluated by the same U.S. patent law. The annual record of each country's share of the total number of patents issued by the USPTO to non-U.S. residents shows the structural technological changes undergone by the major industrial countries. In the last century (1883 -1993), Japan's share of these patents increased from 0.16% to 47.87%, the share granted to the Federal Republic of Germany declined from 18.67% to 14.96%, and the share granted to the United Kingdom declined even more dramatically, from 34.55% to 5.14%..[1]

For the recent period 1990-1993, Table II shows yearly figures on patents issued by the USPTO to residents of selected countries. There is no definite tendency for most countries over this period, with the exception of a consistently impressive performance for both the Republic of Korea and Taiwan. The growth in patenting for these countries, which started in the early eighties, proceeds through the nineties.

[1] Data from USPTO.

TABLE II

Patents issued by the USPTO to residents of foreign countries (1990-1993) [2]

Country	1990	1991	1992	1993
Argentina	15	17	21	30
Belgium	340	356	382	351
Brazil	38	61	55	58
Canada	2,061	2,184	2,311	2,198
China (Taiwan)	807	1,000	1,195	1,1453
Germany, Fed. Rep.	7,727	7,548	7,960	7,172
Hong Kong	134	209	169	174
India	18	28	23	21
Italy	1,460	1,379	1,455	1,452
Japan	20,170	21,464	26,481	22,942
Korea, Rep. of	236	413	543	789
Mexico	30	44	44	44
Netherlands	1,049	1,043	1,019	961
Sweden	840	843	747	743
Switzerland	1,342	1,384	1,369	1,1932
United Kingdom	2,947	2,976	2,856	2,463
Totals	45,201	46,978	49,969	47,927

Source: USPTO (1993).

[2] Data include utility, design, plant and reissue applications.

Another statistic for comparison of national innovation systems is the ratio of a country's USPTO-granted patents to its nationally-issued patents. Table III shows these ratios for a number of countries in 1991.

TABLE III

USPTO Patents to Non-residents as Proportion of National Patent Office Total

Country	Uspto/Nat. Pat Office
Netherlands	1.33
Canada	1.32
United States	1.00
Sweden	0.73
Germany	0.68
Switzerland	0.64
Japan	0.59
United Kingdom	0.52
France	0.32
Mexico	0.22
Argentina	0.18
Brazil	0.17
Korea, Rep. of	0.15
India	0.06

Source: WIPO (1993), USPTO (1993)

The ratios provide no conclusive patterns on international integration, which would require a closer look at the distribution of the patents issued to their residents by both national patent offices and the USPTO. For example, Holland and Canada, well-integrated in the world trade of goods and services, have ratios greater than one, while Korea, also an active participant in world trade, has a ratio of only 0.15. On the other hand, Argentina, Brazil, India, Korea and Mexico have considerable differences in their innovation systems but all have ratios below 0.25. Korea has a ratio of 0.15, very close to Brazil's 0.17, but a very different level of

patenting activity, with seven times as many USPTO-issued patents (1991), and much greater efficiency in generating output from its R&D outlays. For example, Korea issued 2,553 to residents in 1989 and had an R&D outlay of US$1.53 billion , while Brazil issued 341 resident patents and had US$ 2.7 billion in R&D expenses (1990 data).

III BRAZILIAN PATENTING ACTIVITY

This work analyzes patenting activity in Brazil by examining data on invention patents issued to Brazilian individuals and firms by the Brazilian INPI and by the USPTO in the period 1990-1995. Patent grantees are analyzed in the four sections below according to ownership structure, leading firms in patenting activity, WIPO patent classifucation code, and manufacturing sector (major census group).

III-A) Ownership Structure

For purposes of analysis of ownership structure, patent grantees are divided into six groups: Individuals (IND), Domestic private capital ownership (DOM), Foreign capital ownership (FOR), State- owned Brazilian enterprise (STA), Research institute or university (RES), Governmental agency (GOV). Table IV presents the shares of patents issued to each group in the period 1990-1995, both by the INPI and the USPTO.

TABLE IV

Average annual shares of patents issued to Brazilian residents, by the INPI and by the USPTO, by ownership structure (1990-1995)

Ownership Structure	Average (%)	Standard-Deviation (%)	Coeficient of Variability (%)
INPI :			
DOM	36.84	1.23	3.300
IND	30.44	2.47	8.100
FOR	15.30	1.23	8.000
STA	12.46	2.07	16.600
RES	3.80	1.42	37.400
GOV	1.01	1.12	110.900
USPTO :			
DOM	39.87	7.51	19.300
IND	30.60	6.43	21.000
STA	21.24	6.29	29.600
FOR	7.96	5.48	68.800

Source: INPI, USPTO

Figures from the INPI for 1990-1995 show a more stable pattern than those of the USPTO, as indicated by the smaller coefficient of variability. The groups with the biggest shares in the two patent offices are Individuals and Domestic private capital ownership: the numbers are 36.84% (IND) and 30.44% (DOM) from the INPI record, and 39.87% (DOM) and 30.60% (IND) from the USPTO record. The INPI data show the next groups as Foreign capital ownership (FOR) with 15.30% and State-owned enterprises (STA) with 12.46% , whereas the USPTO data place the group STA with 21.24% , ahead of the group FOR with 7.96%.

The high share for Individuals is considered by the literature to be a characteristic of less developed countries.[3] Possible explanations for this outcome are: the proximity of individuals' design patents to utility models, which causes the overestimation of the actual number of the former in the patent office record; and/or the existence of a fuzzy borderline between public and private goods in Brazil, which makes it relatively easy for individual researchers in publicly- funded research centers to claim ownership of invention patents that should be ascribed to their institutions.[4]

Adaptive rather than substantive innovations seem to be the norm in the patents of the group Foreign capital ownership (FOR) in Brazil and, accordingly, their share in the INPI record is nearly double that shown in USPTO tally. Examples of firms of the group FOR which have patents issued by the USPTO to their branches in Brazil are Mercedes-Benz, Alcoa, and Rhodia (subsidiary of Rhone Poulenc). On the other hand, the firms Robert Bosch from Germany and Johnson & Johnson from the U.S. had innovations developed by their branches in Brazil and applied for patent rights first to the INPI and then to the USPTO, where those rights were granted to their respective headquarters.

State-owned enterprises (STA) have a USPTO share almost twice as large as the one recorded in the INPI. This outcome is due to the perfomance of the state owned oil company Petrobras, which is one of the two companies from Brazil with yearly patenting activity in the USPTO. Petrobras has been actively engaged in research related to offshore drilling in deep waters and the corresponding inventive output has been recorded in the patent offices of both Brazil and the U.S.

III-B) Leading Firms in Patenting Activity

Table V presents the leading Brazilian firms in the records of both INPI and USPTO. Ten firms have average INPI patents greater than 2.5 per year. Five firms average more than 0.5 USPTO patents per year.

---

[3] Penrose (1973).

[4] The INPI records some invention patents, ascribed to individual researchers of publicly funded research centers, whose complexity means that they have zero probability of being the output of household innovation activities.

TABLE V

Average annual shares of leading firms and institutions in patenting activities, by the INPI and by the USPTO (1990-1995)

Firm or Institution	Average	Standard-Deviation	Coeficient of Variability (%)	Average Firm /Aver. Total (%)
INPI :				
Petrobrás	23.67	17.14	72.4	6.51
Usiminas	8.83	2.32	26.3	2.43
Embraco	7.50	7.94	105.9	2.06
Cosipa	5.17	3.43	66.3	1.42
C.S.N.	4.83	2.93	60.7	1.33
Rhodia	4.67	3.23	70.0	1.29
I.P.T.	3.67	3.14	85.6	1.01
Telebrás	3.17	2.32	73.2	0.87
Souza Cruz	3.17	2.56	80.8	0.87
Vale Rio Doce	2.67	2.16	80.9	0.73
USPTO :				
Petrobrás	8.17	2.14	26.2	18.83
Embraco	5.00	4.43	88.6	11.54
Metal Leve	2.83	1.83	64.6	6.53
Metagal	1.00	1.26	126.0	2.31
Romi	0.67	1.21	180.6	1.55

Source: INPI, USPTO.

Regarding the regularity of patenting activity, only six firms or institutions have at least one patent every year issued by the INPI: Petrobrás (state-owned; oil company), Usiminas (state-owned until 1992, domestic private capital after that; steel), Cosipa (domestic private capital, formerly state-owned; steel), Rhodia (foreign capital, Rhone Poulenc; chemical), Oxigênio do Brasil (domestic private capital; chemical), Embrapa

(govermental agency; agricultural research center).[5] Two firms have at least one patent issued by the USPTO every year, Petrobrás and Metal Leve (domestic capital; auto parts). Petrobrás leads the patenting activity both in the INPI and in the USPTO.[6]

Petrobrás, Embraco, and Metal Leve[7] all have less variability in their USPTO patent figures. Metal Leve, which has production units in North America, also has higher patenting activity in the USPTO than In the INPI. It should be noted that Telebrás (state-owned; telecommunications) patenting activity is not fully represented in the table, given its status as holding company for local-level telecommunications companies. If Telebrás figures are added to those of Telemig (State of Minas Gerais telecommunications company), Telerj (State of Rio de Janeiro), Telepar (State of Parana), and Telesp (State of Sao Paulo), the group has a yearly average of 5.33 patents issued by the INPI (standard deviation of 3.67), which places it in fourth position.

III-C) WIPO Patent Classification Code

The highest level of aggregation of the WIPO patent classification code has eight sections:A) Human Necessities; B) Performing Operations, Transporting; C) Chemistry, Metallurgy; D) Textiles, Paper; E) Fixed Construction; F) Mechanical Engineering, Lighting, Heating, Weapons, Blasting; G) Physics; H) Electricity. This work uses the second-highest aggregation scheme, which has twenty-one subsections. Nineteen subsections in the INPI data show patenting activity every year, and nine subsections in the USPTO tally. The average yearly patents of these subsections have smaller coefficients of variability in the INPI record than in the USPTO studies.

Table VI ranks the subsections which have average yearly patent shares greater than 5% of the total patenting activity in both the INPI and the USPTO. None of the subsections under Section (D) Textiles-Paper have patent shares greater than 5%. Subsection (F1) Engines or Pumps, which leads the USPTO statistics rank, has a yearly average participation in the INPI records of only 4% (standard deviation of 1.12%) and therefore is not included in Table VI. Subsection (G1) Instruments, which ranks fourth in the INPI statistics, is in twelfth place in the USPTO records. The INPI and USPTO statistics also differ in regard to the leading subsections of Section (A) Human Necessities. Agriculture (A1) leads in the INPI ranking whereas Health and Amusement (A4) leads in the USPTO ranking.

---

[5] Embrapa has an average yearly number of patents less than 2.5 and it is not included in Table V.

[6] In spite of its good performance in terms of Brazilian firms, Petrobrás is not among the 20 firms in the world which do the most patenting activity in its sector. Those 20 firms are all from Europe, Japan, and the U.S. (See Pavel and Pavitt, 1994)

[7] Metal Leve has a coefficient of variability of 112.9% in the INPI record in contrast to 64.6% of the USPTO statistics.

TABLE VI:

Average annual shares of patents issued to residents of Brazil, by the INPI and by the USPTO, by sub-sections of the International Patent Classification (WIPO) (1990-1995)

Sub-Section	Average (%)	Standard- Deviation (%)	Coeficient of Variability (%)
INPI :			
Transporting	13.14	1.41	10.8
Electricity	10.12	1.92	18.9
Chemistry	9.00	3.02	33.6
Instruments	8.69	2.41	27.7
Engineering in general	8.63	1.11	12.9
Shaping	8.52	1.71	20.0
Agriculture	5.14	1.56	29.4
USPTO :			
Engines or pumps	15.02	13.67	91.0
Transporting	8.52	1.68	19.7
Shaping	8.40	5.75	68.5
Engineering in general	7.97	3.06	38.4
Electricity	7.62	1.80	22.8
Chemistry	6.82	4.81	70.5
Health and amusement	6.68	3.04	45.5
Building	6.01	2.31	38.3
Separating; Mixing	5.96	5.80	97.4
Earth drilling; Mining	5.32	3.49	65.5
Instruments	5.09	3.42	67.2

Source: INPI, USPTO.

The benchmark character of the WIPO patent classification code can be used as a basis for interesting comparative studies of innovation. One such possibility is to examine how much the distribution of patents across WIPO sections (or subsections) is different in the national patent statistics than in the USPTO statistics for non-residents. The way these distributions differ across countries conveys information that could be further applied to evaluate national innovation systems.

III-D) Brazilian Census of Manufacturing Major Groups

Table VII shows the yearly average participation (in percentage terms) of the Brazilian Census Manufacturing Major Groups with a higher than 15% share of the total patenting activity in the INPI and in the USPTO. Patents analyzed in this section are a subset of total patents because figures of individuals, governmental agencies and research institutes are excluded. For the twenty-two major groups, eight had patenting activity every year (1990-1995) in the INPI statistics and only two in the USPTO record.

Chemicals, Electronic-and-Other-Electric-Equipment, and Industrial-and-Commercial-Machinery meet the 15% share criterion in both patent offices but Metallurgy does not show up in the USPTO data. In tems of variability, Chemical is the exception to the rule that participations recorded in the INPI are less variable than those in the USPTO.

TABLE VII

Average annual shares of patents issued to Brazilian residents, by the INPI and by the USPTO, by Major Industrial Groups (IBGE) (1990-1995)

Major Group	Average (%)	Standard-Deviation (%)	Coeficient Of Variability (%)
INPI :			
Chemicals	20.20	5.76	28.5
Metallurgy	18.86	3.05	16.2
Eletrical equipment	18.82	3.88	20.6
Industrial machinery	17.03	1.71	10.0
USPTO:			
Chemicals	31.54	7.78	24.7
Electrical equipment	26.13	14.73	56.4
Industrial machinery	15.74	9.22	25.6

Source: INPI, USPTO.

Table VIII presents the 1985 R&D expenditures of the manufacturing major groups, and the total number of patents issued to them by the INPI from 1990 through 1995. R&D expenditures are expressed in CR$ millions and are derived from the 1985 Brazilian Manufacturing Census. Patents granted in the period 1990-1995 had their applications filed on average in 1985-1989 making them good candidates to be, at least partially, the output of R&D expenditures in 1985.

TABLE VIII

R&D expenditures (Cr$ millions, 1985), and patents issued to residents of Brazil by the INPI (1990-1995), by Major Industrial Groups

Major Group	R&D Expenditure (Cr$ millions, 1985)	Patents (1990-95)
Metal mining	251,000	20
Manufacturing of nonmetallic minerals	35,000	10
Metallurgy	270,000	247
Industrial and commercial machinery	79,000	220
Electrical and other electronical equipments	330,000	250
Transportation equipment	288,000	35
Lumber and wood products	14,000	8
Furniture	1,000	2
Paper and allied products	9,000	10
Rubber	1,000	8
Leather	0	0
Chemicals	467,000	262
Pharmaceutical products	23,000	4
Soap, detergents and cleaning products	7,000	1
Plastic products	3,000	36
Textile products	0	4
Apparel and footwear	7,000	9
Food products	37,000	17
Beverages	3,000	0
Tobacco products	14,000	22
Printing and publishing	1,000	3
Miscellaneous manufacturing industries	22,000	133

Source: IBGE, INPI .

Chemicals and Electronic-and-Other-Electric-Equipment rank first in both R&D expenditures and patenting activity; below that rank, the ordering is unique to each set of data. There are some differences in terms of output per unit of input which can be attributable to the technological heterogeneity. For example, the group Metallurgy spent almost the same amount on R&D as the group General Mining (CR$ 270 millions and CR$ 251 millions, respectively) but had nearly twelve times as many patents granted.

IV STATISTICAL ANALSYIS OF PATENTING ACTIVITY AND R&D

The statistical analysis below uses the standard double-log specification of a linear relationship between patenting activity and R&D expenditures. (Griliches and Pakes, 1980) From the 22 major manufacturing groups, three had zero observations in either R&D or patenting activity and are dropped from the sample to allow for the log-transformation.[8] The Miscellanous-Manufacturing-Idustries group is also dropped from the sample because it included patents from other groups (e.g. Electric-Services and Telecommunications) which were not included in the Brazilian 1985 Manufacturing Census, the source of the R&D data.

The log patents regression shows a strong relationship between R&D expenditures and patenting activity (numbers in brackets are standard errors):

$$\text{Log-Patents} = -2.81 + 0.58\ (\text{Log R\&D})$$
$$[1.32] \quad [0.13]$$

$$(R^2 = 0.55;\ n = 18;\ \text{mean of Log-Patents} = 2.90)^{(9)}$$

The cross-manufacturing group elasticity of patenting activity with respect to R&D expenditures is 0.58. In particular, the estimated elasticity is compatible with figures reported in the literature. For example, Bound et.al. (1984) mention an elasticity of 0.59 from a cross-sectional analysis of a sample of firms with non-zero patents and R&D. The regression fit seems also good enough to support the hypothesis that patenting activity is a good indicator of the inventive output of the research units of the major manufacturing groups.

V CONCLUSION

The analysis presented here shows that the patenting activity in Brazil has an unusually high share of patents granted to individuals. This finding is consistent with the prevailing hypothesis in the literature that such a pattern is characteristic of less developed countries.

---

[8] According to Hausman et.al. (1984), this is one of the possible "solutions"to the zero observations problem.

[9] White's heteroscedasticity test does not reject the hypothesis of homoscedasticity for the regression above: the chi-squared statistic is 1.36, less than the 95 percent critical value of 3.84 (one degree of freedom).

The comparison of leading patenting Brazilian resident firms in the INPI and in the USPTO shows a change in their distribution which supports the hypothesis that the USPTO grantees have higher technological capabilities. These different patterns at the firm level underly the changes in the distribution of shares according to the criteria of the WIPO patent classification code and by major manufacturing groups.

The statistical analysis suggests a strong relationship between R&D expenditures and patenting activity across major manufacturing groups, which is also consistent with the outcomes of other studies reported in the literature.

The universality of the WIPO code makes it possible to examine how the distribution of patents across classifications differs in the national patent office data from the corresponding non-resident data in the USPTO statistics.

This work supports the relevance of patent data in analyzing the innovativeness of the Brazilian economy. Similar analysis of patent data for other Latin American countries could provide the basis for interesting comparative studies of innovation. The analysis could be further applied to evaluate national innovation systems.

VI REFERENCES

BOUND, J.; CUMMINS, C.; GRILICHES, Z.; HALL, B.; JAFFE, A. Who does R&D and who patents ? In: GRILICHES, Z. *R&D, patents and productivity*, Chicago: The University of Chicago, 1984.

COHEN, W. M.; LEVIN, R. C. Empirical studies of innovation and market structure. In: SCHMALENSEE, R.; WILLIG, R. D. (eds). *Handbook of industrial organization*.Amsterdam: Elsevier Science, 1989, v.2, p. 1059-1107.

FREEMAN, C. The economics of technical change, *Cambridge Journal of Economics*, v. 18, 1994, p. 463-514.

GRILICHES, Z. Patent statistics as economic undicators: a survey. *Journal of Economic Literature*, v. 28, Dec. 1990.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). *Censo Industrial 1985*. Rio de Janeiro: IBGE, 1991.

LEVIN, R.; KLEVORICK, A.; NELSON, R.; WINTER, S. Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, v. 3, 1987, p. 783-832.

ORDOVER, J. A patent system for both diffusion and exclusion. *Journal of Economic Perspectives*, v. 5, n. 1, Winter 1991.

PATEL, P.; PAVITT, K. Uneven (and divergent) technological accumulation among advanced countries: evidence and a framework of explanation. *Industrial and Corporate Change*, v. 3, n. 3, 1994.

PAVITT, K. R&D, patenting and innovative activities. *Research Policy*, v. 11, 1982.

PENROSE, E. International patenting and the less-developed countries. *The Economic Journal*, v. 83, n. 331, 1973, p. 768-788.

WORLD INTELECTUAL PROPERTY ORGANIZATION (WIPO). *International property statisitcs*. Geneva: WIPO. (1993).