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Telecommunications and the location of Portugal in global information space 1950-85

Jorge Gaspar & Chris Jensen-Butler

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Changes in the location of Portugal in global and European information space are examined using data on telephone, telex and telegram traffic. Multivariate analysis is used to identify causes of change. The results are related to social and economic change inside and outside Portugal.

Keywords: Information space, telecommunications, Portugal, multivariate analysis.

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This study examines, for the period 1950-85, the location of Portugal in the information space constituted by telecommunications flows between Portugal and the rest of the world. During this period Portugal experienced major internal and external social, economic and political changes which included transformation from a relatively closed agrarian economy to an open industrialized economy. These transformations are reflected in changes in Portugal's position in global and European information space. However, information flows are not passive reflectors of such change, they are simultaneously agents of change. For example, the relationship between level of development of telecommunications and GDP/inhabitant (Gillespie et al., 1985; Jecquier, 1984) is well documented.

Investment in telecommunications is an important factor in creating conditions for rapid growth (Gaspar, Jensen-Butler & Jeppesen, 1986). Rapid growth generates new patterns of information transfer. If Portugal is to close the development gap in relation to northern Europe (Gillespie et al., 1985), considerable investment in telecommunications is implied. In this light the development of information transfers between Portugal and the rest of the world since 1950 is examined both within and outside Portugal. The analysis is, however, only exploratory in nature.

Defining information space

Types of flow

Information is transferred within networks, which can have different structures. A number of analyses of network development have been undertaken in recent years (eg. Thorngren, 1970; Goddard & Gillespie, 1986); within these networks information can be analyzed in both quantitative (which is the case here) and qualitative terms (Goddard, 1979; Pye, 1979).

A multidimensional space can be defined for any set of objects which have identifiable inter-object distance relations. A common measure of proximity in multidimensional space is the magnitude of flows between objects in that space: Large flows imply proximity, whilst small flows imply distance. Information flows and economic flows can be used to define one type of space and flows of factors of production another. Both commodity and factor flows generate financial flows. In the case of commodity flows the corresponding pattern of financial flows will often be a close mirror image of the pattern of commodity flows, though this type of flow is developing a more complex structure. In the case of factor markets, the underlying financial flows are more complex and difficult to model.

Information plays a complex role in relation to these three types of flow. Information transfers can be analyzed at three different levels: (1) those occurring before initiation of economic activity, (2) those occurring during the activity, and (3) those occurring after completion of the activity, such as accounting and evaluation. This classification has, at different time scales, clear relations to the product-cycle model (Vernon, 1979).

Other types of information transfer occur. Social and recreational activity also generates information flows, though in the context of this study we consider information transfer related to economic activity to be fundamental at the international level, even when there is a social component in the generation of information flows, such as in the case of information transfers between migrants and their families. International transfers of administrative information will also increase as a consequence of increasing international political and administrative integration and cooperation.

Geographical studies of information transfer have usually been based upon simple characteristics, such as population and distance. More recent interest in network economies (eg. Grøn, 1985) has indicated the need for inclusion of information transfer. As information transfer related to economic activity is the core of the present analysis we identify the following types of activity-related information flow:

1. Commodity-related flows

- a. trade related information flows
 - b. tourism-related information flows, particularly financial transfers
2. Factor-related information flows
 - a. related to labor migration
 - b. related to capital migration
 - c. related to transfers of factor incomes.

These information flows are the central elements of the present study.

Information space

Ideally, an analysis of information space at global level should treat the individual country as an object located in an n-dimensional space. The quantity of information transfer between each pair of countries can be used as a measure of distance between the objects in a space of unknown dimensionality. Standard multidimensional scaling (MDS) techniques (see for example Jensen-Butler & Petersen, 1973; Shepard et al., 1972) can be employed to determine the dimensionality of the space generated by the inter-object distances and the resulting dimensions can be interpreted using the coordinates of the objects on each dimension. The location of the individual country and changes in location over time can be analyzed. This type of analysis requires a full information flow matrix between all objects (countries).

Unfortunately, the only available data relating to Portugal is quantitative data on incoming and outgoing traffic by origin and destination for telephone, telex and telegrams, for the period 1950-85. This corresponds to one row and one column in the complete global flow matrix, a fact which places severe theoretical and methodological limitations on the analysis.

Portugal: External relations since 1950

Portugal's economic relations with the rest of the world have undergone profound transformations since 1950, transformations which have both political and social aspects.

In 1950 Portugal was a relatively closed agricultural economy, except for the African colonies, which had very close ties to Portugal. Trade with the rest of the world was limited and concentrated in traditional products, except for energy import. In the early 1960's the colonial wars started, the long-term effects of which proved to be quite dramatic. Portugal became a member of EFTA in 1960, which represented a major change in a largely isolationist economic policy. Reorientation of trade patterns towards Europe and an influx of foreign capital, particularly in the industrial sector, in branches such as chemicals, electronics and vehicles, followed.

In 1960 the most important destination for Portuguese emigrants was South America – principally Brazil and

Venezuela. During the 1960's this pattern changed markedly, with a major reorientation towards Europe, especially France, and also BRD, Luxembourg and Switzerland. Estimates of total emigration, including illegal emigration, suggest a peak in 1970 with over 173,000 emigrants. Emigration to North America also increased during the 1960's though not at the same rate as emigration to Europe. After 1974 these patterns changed markedly. Emigration was reduced to a trickle and return migration grew in importance. 600,000 *retornados* (former settlers) returned from the former colonies. An event of major importance for Portuguese external relations was the revolution of 1974. This set the scene for European integration and decline in relations with the colonies, which gained independence in 1975. The revolution cemented the opening of the Portuguese economy towards Europe. For a brief period in 1974-75 some orientation towards socialist countries was observable, which was, however, short-lived. Once again in the latter half of the 1970's economic relations with the west grew in strength. In 1986 Portugal became a full member of the EEC after many years of negotiation. These changes in Portuguese external relations are associated with internal socio-economic transformations of the country (Ferrao & Jensen-Butler, 1986). The changes are in turn reflected in the development of the telecommunications sector within Portugal (Gaspar & Porto, 1984; Gaspar, Jensen-Butler & Jeppesen, 1986).

Data problems

The basic data utilized in this study is for telephone, telex and telegram traffic for the period 1950-85, published annually by the Portuguese teleadministration, PTT. The use of this data involves a number of serious theoretical problems described below, which cannot be fully overcome.

First, information transfer depends upon the level of network development in the countries involved. As the level of network development changes over time, this will affect the pattern of information transfer. On the other hand, the problem can be inverted and the combined effect of increasing information transfer and network development itself can be taken to indicate the level of development of economic relations between the countries or regions involved. Increasing informational proximity resulting from expansion of telecommunications coverage in any given country is of as much significance as simple increases in telecommunications traffic.

Table 1 shows the geographical units employed in the following analyses and the development of telephone coverage in each area between 1971 and 1985. Related to network development are different rates of provision of new services in different countries. Second, substitution between types of communication occurs, depending upon access, level of technological development and pricing.

Areal unit	1971	1985	Notes
Y. America	78959	109887	1
USA	71150	941905	3
Canada	6812	11403	3
S. America	4485	12371	1
Brasil	na	628	3
Venezuela	1908	1214	3
Europe	61804	136686	1
EEC 12	41237	112229	
BRD	9658	25588	2,3
France	4653	23032	2,3
Italy	6989	17396	2,3
Luxemburg	87	154)2, 3
Belgium	1441	3061) 3
Holland	2471	5822	2,3
UK	10114	21661) 2,3
Ireland	248	703) 3
Denmark	1316	2543	2,3
Greece	1045	2927	2,3
Spain	3265	9340	2,3
EFTA 5	7678	13068	
Austria	1058	2729	2,3
Switzerland	2061	3297	2,3
Norway	774	1716	2,3
Sweden	3725	5242	2,3
Socialist & other	2889	11390	1,3
Asia & Oceania	29855	77604	1,3
Africa	1849	4981	1
Angola	na	3	
Mozambique	26	38	3
C. Verde	na	2	3
S. Tome	na	2	3
G. Bissau	na	na	3
S. Africa	959	2298	3

Notes:

- 1 : Units employed at global level analysis
- 2 : Units employed at European level analysis
- 3 : Units employed in multivariate analysis

Table 1. Areal units used in the analysis and numbers of telephone lines (10^3) in 1971 and 1985.

Tabel 1. Arealmassige enheder anvendt i denne analyse af antal telefonforbindelser (10^3 i 1971 og 1985. Noter: 1: på verdensplan; 2: på europæisk niveau; 3: i multivariat analysen.

The development of new services, such as data transmission and telefax enhances substitution possibilities. Thus a relative decline in importance of information transfer by telephone to and from a country need not imply decline in information transfer when all types of communication are considered. Third, the available data allows no qualitative evaluation of content. Finally, substitution between postal services and telecommunication cannot be evaluated because of lack of data. Despite these serious data problems some meaningful interpretation can be given to the results of the ensuing analysis, which is accordingly presented with all possible reservations.

Portugal and information space: The global level

Total traffic

The growth of Portuguese external telephone traffic in the period 1950-85 was considerable, from $1,395 \cdot 10^3$ mi-

minutes in 1950 to 181,329.10³ minutes in 1985. The period of most rapid growth was 1970-80. The balance between incoming and outgoing traffic was generally constant, at around 30-33 % outgoing. Some authors (eg. Nystuen & Dacey, 1961) have argued that patterns of domination and subordination can be identified by examination of the balance of incoming and outgoing traffic. As will be seen later, this is generally unreliable.

External telex traffic has grown even faster than telephone traffic, from 104,10³ minutes in 1955 to 38,247.10³ minutes in 1985. The period 1955-65 experienced most rapid growth and the relationship between incoming and outgoing traffic changes throughout the period from 36.5 % outgoing to 53 % in 1985.

External telegram traffic declined from 18,113.10³ words in 1950 to 8,215.10³ words in 1985. The period of most rapid growth was 1955-65 and since 1970 there has been an absolute decline in traffic. In 1950 44.5 % of traffic was outgoing and in 1985 38 %.

Substitution has been occurring throughout the period, from telegram to telex to telephone. After 1980 growth rates slow down for all types of telecommunication.

Global patterns

Figure 1 shows the 5-yearly growth rates in telephone traffic for major global regions. In general, all regions follow the same overall pattern as the total trend for Portugal, though Africa is a major deviation, with a marked relative decline after 1975-80, in the aftermath of decolonization and exodus to Portugal. After 1980 both Africa and Asia pick up in terms of growth rates relative to the rest of the world; these changes are related to a number of factors, including technological improvements, closer economic links with Japan and Macau and the use of Portuguese labor in the construction industry in the Persian Gulf and Israel.

In 1950 Europe dominated telephone traffic with 97 % of total traffic. By 1985 this was reduced to 75 %, reflecting increasing telephone coverage in less developed parts of the world and improved access to North America and other parts of the more developed world. North America has experienced a major increase in share of total traffic, from under 1 % in 1950 to 11.4 % in 1985. Likewise, South America has also increased its share, from under 1 % in 1950 to 4.6 % in 1985. Asia increases its share from almost nothing to 4.6 % in 1985. Africa exhibits an interesting pattern: From 1.4 % in 1950 through 14.2 % in 1965 to a maximum of 18.1 % in 1975, followed by a decline to about 6 % in the 1980's. This clearly reflects the changing relations with the African territories, principally Angola and Mozambique, and also demonstrates that changing shares are not a simple function of telephone coverage. Telephone traffic between Portugal and the socialist countries peaked around 1975.

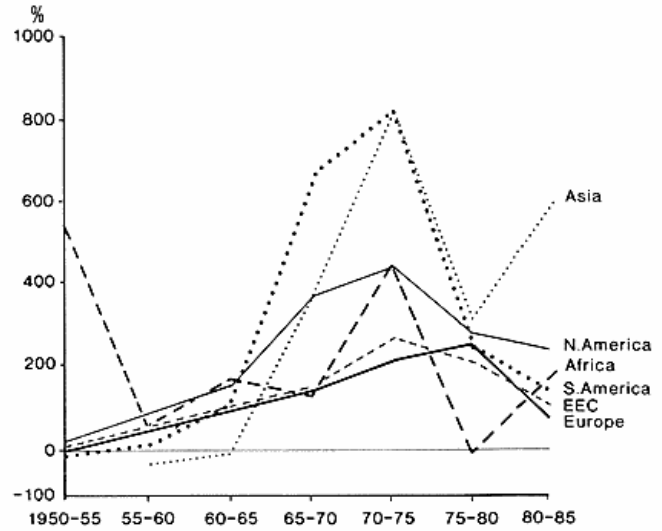


Fig. 1. 5-yearly growth rates for Portuguese telephone traffic by continent 1950-85.

Fig. 1. 5-årige vækstrater for den portugisiske telefontrafik til og fra kontinenterne 1950-85.

All major global regions generate more incoming traffic to Portugal than they receive, in every period. If we choose to interpret this as reflecting external dominance over the Portuguese economy, then we are left with the paradox of the African colonies, which were unquestionably dominated by Portugal, having throughout the entire period greater telephone traffic to Portugal than from Portugal. Thus patterns of incoming and outgoing telephone traffic do not reflect patterns of dominance. The relatively greater telephone density in Portugal as compared with Angola and Mozambique could perhaps explain this pattern of traffic, but this in turn should indicate that Portugal would have more outgoing traffic to richer countries in Europe and the rest of the world, which is not the case.

Examination of 5-yearly growth rates in figure 2 for telex traffic again reveals that all major regions follow the same pattern as the total pattern for Portugal. Asia, Africa and North America have high initial growth rates, reflecting network development, and Africa exhibits marked decline after 1975. Europe has a declining share of telex traffic from 97 % in 1960 to 82 % in 1985. North America has continuously increasing shares, from 1 % in 1960 to 6.4 % in 1985. Asia follows a similar pattern, from 0.1 % in 1960 to 2.7 % in 1985. Africa's share rises to 7.5 % in 1975 followed by a moderate fall, though considerably less than with the telephone. The pattern of incoming and outgoing traffic changes from a predominance of incoming traffic in 1960 to a predominance of outgoing traffic in 1985 for nearly all regions.

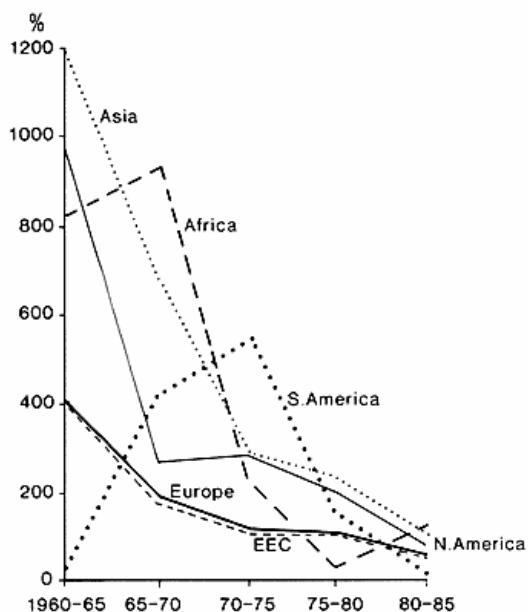


Fig. 2. 5-yearly growth rates for Portuguese telex traffic by continent 1950-85.

Fig. 2. 5-årige vækstrater for den portugisiske telextrafik til og fra kontinenterne 1950-85.

5-yearly growth rates for telegram traffic shown in figure 3 have a stable pattern, except for Asia where growth rates vary considerably. The pattern for Africa again shows a small peak around 1975. Clearly after 1965 telegrams are being replaced by other communication media. North and South America have slowly increasing shares. In 1950 distant regions had larger shares of telegram traffic than they had for telephone and telex traffic, for technological reasons. In 1985 Africa had almost 24 % of total telegram traffic. Incoming traffic is always greater than outgoing, for all regions and for all years.

Patterns of growth and relative shares: The global level

A number of tentative conclusions can be drawn from this analysis. These rapid growth rates indicate in absolute terms a general increase in proximity between Portugal and the rest of the world, reflected in the enormous increases in exchange of information. In what follows the *relative* changes in location will be considered. Throughout the period North America has increased its share of information transfer with respect to Portugal. In this sense North America has moved closer to Portugal in global information space. The same is the case, though less strongly, for South America. Likewise, Asia and Oceania have moved closer to Portugal, though in 1950 they were very distant and remain so today. It would appear that in relative terms Europe has become more distant.

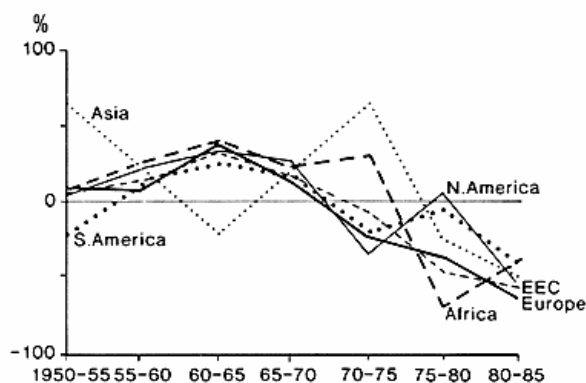


Fig. 3. 5-yearly growth rates for Portuguese telegram traffic by continent 1950-85.

Fig. 3. 5-årige vækstrater for den portugisiske telegramtrafik til og fra kontinenterne 1950-85.

Portugal's economy, in relative terms, would seem to become progressively more internationalized at the global rather than the European level. Furthermore, informational proximity to North America would seem to be increasing.

These findings seem a little paradoxical, as throughout the period Europe's share of Portuguese trade, both imports and exports, has been growing. Europe has also increased its share of Portuguese emigrant labour throughout the period - very markedly during the 1960's and 1970's. North American exports to Portugal have exhibited relative increases and some direct investment has occurred. To the extent that informational proximity represents a dynamic for economic development, the influence of North America may grow, despite increasing economic links with Europe.

Portugal and information space: The European level

Portugal in European information space

Figure 4 shows the 5-yearly growth rates for selected European countries and the EEC for telephone traffic. The overall pattern of growth is similar for all countries, with a peak around 1980, but divergences in growth rates in any one period are to be found. There is an explosion in growth rates for traffic to Luxembourg (L) after 1970 and France (F), and BRD (D) also exhibit above average growth rates. It is clearly emigration to these countries which is the cause of the observed patterns. Spain (E) has, interestingly, much lower growth rates for telephone traffic than other European countries and growth rates for traffic to and from the UK exhibit fluctuating values. Growth rates for EEC traffic are higher after the early 1970's than for Europe as a whole.

In terms of relative shares shown in figure 5, in 1985

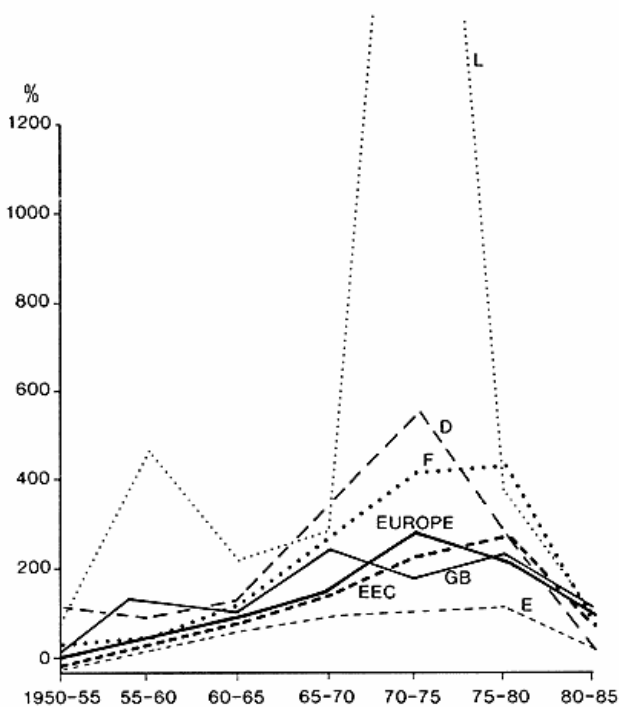


Fig. 4. 5-yearly growth rates for Portuguese telephone traffic in Europe.

Fig. 4. 5-årige vækstrater for den portugisiske telefontrafik til og fra Europa 1950-85.

France clearly dominates with over 40% of all traffic, with a marked increase throughout the period. This suggests that France and Portugal have become closer in relative information space. This is also the case, though to a lesser degree, for BRD, Switzerland (CH) and Belgium-Luxembourg (B+L). The most dramatic change is the rapid and continuous decline of Spain, suggesting – again in relative terms – a more distant location. After 1970 the British share exhibits fluctuations, suggesting a weakening of information relations between Portugal and Britain – again in relative terms. Italy (I) seems to become more distant, whilst the most distant countries (not shown in the figure) remain the Scandinavian countries (where Norway (N) is the most distant and Sweden (S) the least), Greece, Ireland and Austria (A).

5-yearly growth rates for telex traffic to and from European countries reveal a remarkably uniform growth pattern, with declining growth rates throughout the period as shown in figure 6. The increase in traffic with Spain 1975-80 is to be noted as is the generally superior British growth rate until 1970.

Some interesting comparisons with telephone traffic can be made. As can be seen in figure 7 Spain, Italy and Denmark (DK) have increasing shares of telex traffic, whilst BRD, Switzerland and Norway have decreasing

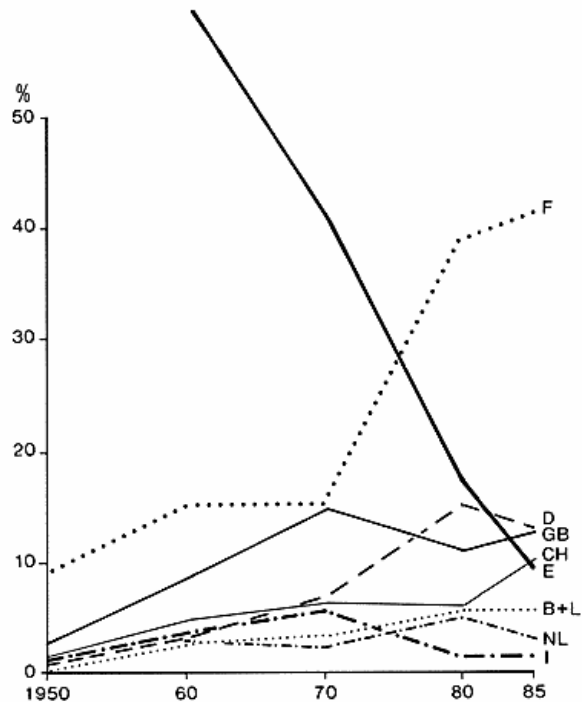


Fig. 5. Relative shares for Portuguese telephone traffic in Europe 1950-85.

Fig. 5. De europæiske landes relative andele af den portugisiske telefontrafik 1950-85.

shares. The UK, France and Belgium-Luxembourg have stagnating shares. In terms of the information space generated by telex traffic, Spain, Italy and Denmark have moved relatively closer, whilst BRD, Switzerland and Norway have become more distant. Norway and Austria remain throughout the period the most distant European countries (together with Greece and Ireland which are not shown in the figure), whilst the UK, BRD and France are the closest.

The pattern for 5-year growth rates for telegram traffic shown in figure 6 reveals that most countries conform to the overall growth pattern, where growth rates become negative after 1970, the decline in traffic to and from the UK being most marked and for Spain less so.

France has an increasing share of a declining traffic as do Belgium-Luxembourg and Switzerland. The UK has a markedly declining share. It would seem that in the commodity and capital markets telegrams are being increasingly substituted by other means of telecommunication, whilst the decline in the use of telegrams by emigrants is much slower, which is logical enough, as a substantial part of the Portuguese emigrant labour force originates from regions where telephone coverage is low and they tend to belong to social groups where the rate of telephone ownership is low.

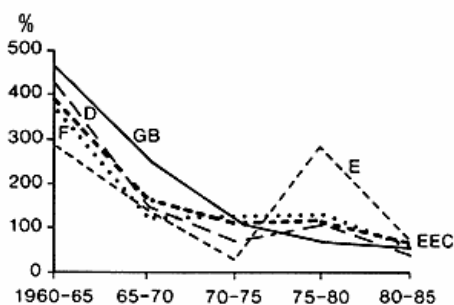


Fig. 6. 5-yearly growth rates for Portuguese telex traffic in Europe 1960-85.

Fig. 6. 5-årige vækstrater for den portugisiske telextrafik til og fra Europa 1960-85.

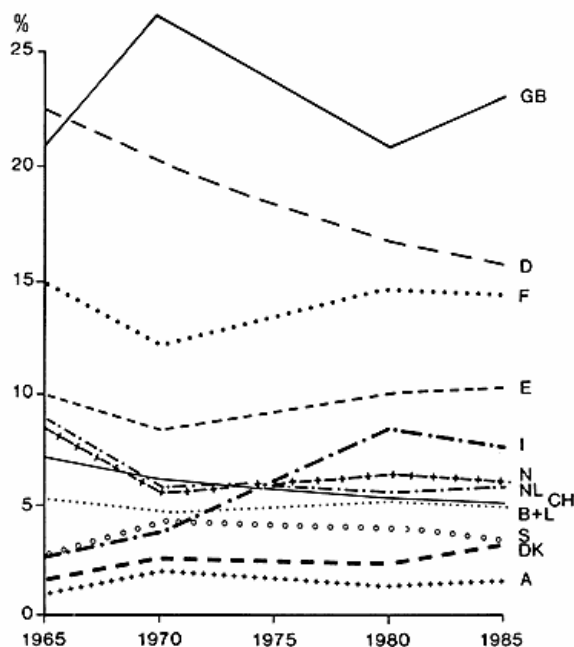


Fig. 7. Relative shares of Portuguese telex traffic in Europe 1965-85.

Fig. 7. De europæiske landes relative andele af den portugisiske telextrafik 1965-85.

Patterns of growth and relative shares: The European level

Some tentative conclusions can be drawn from this analysis. The marked general absolute increase in proximity to all European countries is clear, as witnessed by the enormous growth in information exchange. When the relative growth patterns and traffic shares are considered, there is overall stability in the structure of information space with respect to Portugal. France, UK and BRD

remain the closest countries throughout the period, and Greece, Ireland, Norway and Austria the most distant. France, BRD, Holland and Switzerland have increased their relative proximity to Portugal, whilst distances to Spain, Italy and the UK have increased, again in relative terms. For telex, BRD, Holland and Switzerland have become more distant and Italy and Spain closer.

Adding the two types of information transfer and giving them equal weight, the UK has become more distant, BRD closer, France has not moved, Spain has become more distant and Italy closer. The remaining countries have more or less stationary positions.

Changes in relative location in information space are different for telephone and for telex. The main reason for this would seem to lie in the different functions which telephone and telex play in the international economy. Telex is more clearly related to the commodity markets than the telephone, whilst the telephone is more clearly related to inter-personal communication and the international labour market. Information transfer between enterprises and capital owners is more difficult to assess, but the influence of Spanish capital is growing, whilst the British influence is declining.

In order to investigate this hypothesis further, a statistical analysis was made. The 13 European countries were ranked according to their share of Portuguese exports and imports by value in 1970, 1980 and 1985. Likewise rankings were made of the 13 countries' shares in telephone and telex traffic. Ordinal data was used because of the sensitivity of the basic data to relative price changes. Spearman's rank correlation coefficient r^2 was calculated for each year between the telecommunications data and the trade data. The results can be seen in table 2. For each year the rank order of telex traffic by country was closer to the rank order of both exports to and imports from the respective countries than is the case for telephone traffic, which suggests that the above hypothesis is valid.

It may be the case that information transfers develop ahead of trade flows in the commodity and capital markets, whilst the reverse is perhaps the case in the international labour markets. It is possible to speculate tentatively that economic links with Spain and even Italy will be strengthened in the future, whilst economic links to Germanic and Anglo-Saxon Europe may weaken, all in relative terms. The position of France will remain largely unchanged.

The analysis also indicates that renewed emigration will create stronger or even new information flows, particularly by telephone. Other things being equal, it is reasonable to expect that emigration will tend to go to countries where a large Portuguese population already exists.

Tourism also generates information flows. Here the most marked changes during the period 1970-84 have been a strengthening of European tourism, marked reduc-

Imports			
	1970	1980	1985
Telephone	.8736	.9382	.8846
Telex	.8901	.9636	.9478
Exports			
	1970	1980	1985
Telephone	.6236	.7761	.8462
Telex	.7582	.9107	.9505

Table 2. Spearman rank correlation coefficients between patterns of imports, exports, telephone, and telex, by country and region.

Tabel 2. Spearman rang korrelationskoefficienter mellem landenes fordeling af import, eksport, telefon- og telextrafik.

tions in the relative importance of France and Britain as countries of origin, and an explosive growth in tourism from Spain.

Locational change: A causal analysis

Identifying causal relations

It is clear from the preceding analysis that changes in the location of Portugal in information space are caused by a number of factors. Different factors lie behind the changes observable in the three types of information flow considered. Also, different factors play different roles at different points of time. In order to attempt to identify these causes and their changing roles, two different types of multivariate analysis have been applied to the data.

First, a stepwise multiple regression analysis has been made, where the dependent variable in four separate analyses is parentage shares of telephone and telex traffic for the 27 countries and regions shown in table 1, for two years, 1970 and 1980. This type of analysis assumes, however, hypotheses concerning causality and raises problems of multicollinearity amongst the independent variables.

Second, in order to examine the data more closely for underlying relationships, a principal components analysis was made using 16 variables (8 for 1980 and 8 for 1970). This type of analysis permits the data to generate factors which can be used to explain both temporal and locational change and problems of multicollinearity are also solved.

Both analyses produce results of interest.

Stepwise multiple regression

For the 27 countries and regions identified, a stepwise multiple regression analysis has been made for telephone and for telex traffic, treating 1970 and 1980 separately.

The dependent variables are % share of total traffic for telephone and for telex, considered separately. Six independent variables were used as explanatory variables:

1. Export, by value, % share.
2. Imports, by value, % share.
3. Number of tourists by country of origin, % share.
4. Portuguese emigrants, stock, by country/region.
5. Distance to economic centre of gravity from Portugal.
6. Distance² to economic centre of gravity from Portugal.

The results of the four regression analyses (telephone and telex traffic for 1970 and 1980, respectively) can be seen in table 3. The regression is stepwise, where the variable which gives the greatest increase in multiple r^2 is chosen automatically.

For telephone traffic in 1970, the pattern of tourist origins explains 86.7 % of the variance. A word of caution is, however, necessary in interpreting this variable. Tourism is measured by numbers of foreign residents entering Portugal. In 1970 Spain dominated the pattern of entries and was also the most important telephone partner. Not all Spanish entries were by tourists. The relative importance of Spanish entry to Portugal has since been reduced and the pattern of telephone contact has also changed markedly. The next variable entering the regression is the pattern of emigration, and the third, though only with a small contribution to r^2 , is distance², bringing r^2 up to 0.918. Examination of simple and partial correlation coefficients suggests that there is little interaction between the independent variables.

By 1980 the situation has changed. Emigration is the single most important causal variable, though this only explains 49 % of the variance in the pattern of telephone traffic. The pattern of exports adds 10 % to the explanation, followed by the pattern of origins of tourists. The influence of distance appears to diminish in relation to 1970, with decreases in both simple and partial correlation coefficients between distance and telephone traffic. Examination of the pattern of correlation reveals that emigration is not related to other variables, whilst there is some relationship between the pattern of imports and exports in 1980 ($r = .69$).

62.2 % of the variance in the pattern of telex flows in 1970 is explained by the pattern of Portuguese imports, followed by distance, which contributes a further 20 %. At the third step tourism enters raising r^2 to 0.980. Examination of simple and partial correlation coefficients reveals that there is some relationship between the pattern of exports and imports, but that imports are more clearly related to the pattern of telex flows than are exports.

By 1980 the picture has changed. The pattern of exports now explains 88.2 % of the variance in the pattern of telex traffic. Inclusion of distance raises the multiple r^2 to

Step	Equation	Mult R ²	R
TELEPHONE TRAFFIC 1970			
1.	VAR10=.65VAR13+13.6 (12.8)	.931	86.7
2.	VAR10=.65VAR13+.12VAR14+6.7 (14.8) (3.1)	.951	90.5
3.	VAR10=.63VAR13+.13VAR14-0.03VAR16+12.2 (15.1) (3.4) (-1.8)	.954	93.5
TELEPHONE TRAFFIC 1980			
1.	VAR2=.43VAR6+8.8 (4.9)	.700	49.0
2.	VAR2=.37VAR6+.53VAR3-6.7 (4.4) (2.3)	.764	58.4
3.	VAR2=.37VAR6+.48VAR3+.13VAR5-9.6 (4.7) (2.3) (2.2)	.810	65.5
TELEX TRAFFIC 1970			
1.	VAR9=1.0VAR12-.57 (6.4)	.788	62.2
2.	VAR9=1.1VAR12-.12VAR16+14.5 (9.8) (-5.1)	.904	81.8
3.	VAR9=1.1VAR12-.10VAR16+.05VAR13+13.1 (9.1) (-4.8) (.94)	.908	82.5
TELEX TRAFFIC 1980			
1.	VAR1=1.1VAR3-2.9 (13.7)	.939	88.2
2.	VAR1=1.1VAR3-.04VAR8+4.5 (16.3) (-3.6)	.960	92.4
3.	VAR1=1.2VAR3-.03VAR8+.06VAR5+2.3 (19.2) (-3.8) (3.4)	.975	95.0

Key:

VAR1:Telex traffic 1980(%share)
 VAR2:Telef Traffic 1980(%share)
 VAR3:Exports 1980(%share)
 VAR4:Imports 1970(%share)
 VAR5:Tourist orig.1980(%share)
 VAR6:Emigrant stock 1980
 VAR7:Distance c. gravity 1980
 VAR8:VAR7 squared
 VAR9:Telex traffic 1970(%share)
 VAR10:Telef traffic 1970(%share)
 VAR11:Exports 1970(%share)
 VAR12:Imports 1970(%share)
 VAR13:Tourist orig.1970(%share)
 VAR14:Emigrant stock 1970
 VAR15:Distance c. gravity 1970
 VAR16:VAR15 squared

The figures in parentheses are values of t.

Table 3. Stepwise multiple regression analysis for telecommunications data.

Tabel 3. Resultater af en trinvis multipel regressionsanalyse for en række variable vedr. telekommunikation i Portugal.

0.924. Tourism enters at the third step. As noted above, the patterns of imports and exports are related, but examination of the correlation coefficients confirms that the change from imports to exports as the most important explanatory variable is real enough.

Principal components analysis

Observations for each of the 27 countries/regions on each of the 16 variables identified in table 3 were used as input data for an R-mode principal components analysis. Both

Factor Loadings after Varimax rotation				
VAR1	.8710	-.2952	.2620	.1945
VAR2	.3087	-.1903	.3677	.7320
VAR3	.9531	-.1001	.0923	.1824
VAR4	.6968	.5091	.2068	-.0107
VAR5	.0143	-.0887	.9873	-.0138
VAR6	.1120	.1087	.0714	.9419
VAR7	-.1955	.9550	-.0729	.1602
VAR8	.0378	.9850	-.0657	-.0246
VAR9	.8771	-.3249	.1952	.1246
VAR10	.2868	-.1822	.8949	.2267
VAR11	.7948	.0013	-.0415	.0598
VAR12	.9362	.1630	.1073	.1015
VAR13	.1530	-.0749	.9705	.0447
VAR14	.1053	.1244	-.0534	.9002
VAR15	-.0777	.9551	-.1981	.0368
VAR16	.0324	.9851	-.0695	-.0296
Sum of loadings squared	4.7017	3.6282	3.0854	2.4160

Table 4. Factor loadings after principal components analysis and Varimax rotation of 16 variables. See table 3 for variable listing.

Tabel 4. Faktor loadings fra en principal komponentanalyse med Varimax rotation. Der indgår 16 variable. Tabel 3 identificerer disse variable.

1970 and 1980 data enter the analysis simultaneously. From a 16x16 matrix of correlation coefficients between the variables a number of factors have been extracted and interpreted. Varimax rotation has been applied. Examination of the factor loadings for each of the 16 variables permits reasonably clear interpretation (see table 4).

Factor 1 has high loadings for telex traffic in both 1970 and 1980 together with high loadings for shares of exports and imports in both 1970 and 1980. This factor can be interpreted as a stable telex-commerce dimension.

Factor 2 has high loadings alone for the four distance variables and a single moderately high loading for % share of imports in 1980. Both telex and telephone traffic correlate negatively (as would be expected) with this dimension.

Factor 3 is related to tourist traffic in both 1970 and 1980, but only telephone traffic in 1970. This is a tourism-telephone dimension.

Factor 4 has high loadings for emigrant stock in both 1970 and 1980 and telephone traffic in 1980. The differences in factor loadings between factor 3 and factor 4 indicate the transition in the use of the telephone noted earlier.

Conclusions

The multivariate analyses confirm earlier findings: Telex flows are related to the development of commerce, this relation increasing in strength during the 1970's, whilst telephone flows are related to movements of people, where tourism has been replaced by emigration as a principal telephone traffic generator during the 1970's. The

influence of distance diminished between 1970 and 1980 for both types of traffic.

Prospects for the future

Telecommunications is a rapidly expanding sector and the consequences for Portugal of this expansion will be manifold.

In comparison with other EEC countries, Portugal will experience rapid increases in internal telecommunications traffic as telephone density increases from the present low level. Development of new services will play an important role in generation of internal and external telecommunications flows, notably data transmission, videotex and perhaps also videoconferencing in a country with a weakly developed transport infra-structure and major island populations on the Azores and Madeira. Portuguese communities living abroad will also be an important source of traffic.

Portuguese emigration may well again increase in the future, after restrictions on emigration to other EEC countries are lifted in 1992, which will increase external telephone traffic, as suggested above, to France, BRD, Switzerland and Luxembourg. New types of emigration may emerge: Whilst the emigrant of the 1970's was typically a male with low income and poor educational qualifications, coming from rural areas in the north and interior of Portugal, a new urban middle class higher income emigration will probably emerge, causing even greater increases in external telephone traffic.

Improved telecommunications linkages and new services will, for small and medium sized enterprises, simultaneously give better contact to the world market and benefit information-rich sectors where Portugal has some comparative advantage, such as fashion clothing, printing, ceramics and glass, fresh food and agricultural products. Certainly better access to the European agricultural market data systems will constitute major informational gains for Portuguese agriculture. At the same time, improved telecommunications access can increase the importance of foreign control over capital invested in Portugal. One potential danger is the geographical separation of design, planning, research and administrative functions from production units established in Portugal, and relocation of these functions in other countries or continents, such as the USA. The main foreign exploiters of improvements in telecommunications will probably be Spain, whose investment in Portugal is increasing rapidly, and the USA, where Portuguese firms often have specific and well developed linkages. Improvements in telecommunications will clearly have the effect of shrinking distance relations, thus giving new advantages to remoter locations. It seems probable that pricing systems for new tele services will be less distance-dependent than earlier, which will further reinforce this tendency.

Developments in the transport sector will also affect the development of telecommunications traffic. For a country such as Portugal, in relative geographical isolation, the present rapid growth in air links, the construction of new motorway links from the north of Portugal to Europe and the proposals for express train connections to Madrid and Europe will clearly have generative effects with respect to telecommunications. Likewise improvements in telecommunications will have both a generative and a substitution effect with respect to the transport sector. Inside Portugal three main axes of increase in telecommunications traffic will develop: Increasing traffic along the coast, particularly between Lisbon and Porto, where the substitution effect of improvements in telecommunication will perhaps be more limited, increases in traffic between north Portugal and through northern Spain to Europe, and a strengthening of the Lisbon-Madrid information axis. The triangle Lisbon-Porto-Madrid will become important in informational terms, as it will for movement of goods and people. The problem of access to information for the poorer Portuguese regions of the interior is apparent. Investment in telecommunications access can increase these regions' development potential substantially (Gaspar, Jensen-Butler & Jeppesen, 1986).

In geographical terms a number of developments in the structure of information patterns with respect to Portugal will probably occur. First, the Portuguese economy will be drawn increasingly into the growing economic integration at a global scale. This implies relative increases in importance of information flows to Asia, notably Japan, Singapore, Hong Kong and Macau and also to North America. Our evidence suggests that to the extent that information flows precede economic flows, a possible scenario is that the importance of economic linkages to the US will grow, both in terms of trade, and also in terms of direct investment in Portugal. These developments will contrast and even conflict with increasing European integration, depending upon the nature of European economic development. The European economy itself may well be subject to increasing dominance from the US.

Inside Europe, our evidence suggests closer economic linkages with Spain and with Italy, which raises the question of potential economic domination by Spain. An important factor in future informational linkages with Europe is the future pattern of Portuguese emigration. Here France, Switzerland and BRD, as noted above, are the most likely destinations.

Telecommunications developments will reduce the effects of distance. Portugal will, in both economic and cultural terms, once again be opened to a more global perspective and may even forge stronger links with the Pacific area. At the same time European integration will tend to subordinate the Portuguese economy to one or

more European economies, particularly Spain. Whilst telecommunications improvements play an important role in economic development, particularly for countries with a weakly developed telecommunications sector, a certain internal economic threshold must be reached to reap the full benefits of investment in telecommunications, otherwise increased external economic domination, rather than internally generated growth, can become the main consequence of telecommunications improvements. Portugal will have difficulty in reaching this threshold level, which can, however, be supplied at the European level, or even by Spanish capital. This new type of dependency may be the price which Portugal has to pay for economic development based upon modern technology.

Finally, at the global scale, other developments will be important. The future performance of the economies of the former colonies in Africa can have marked effects on Portuguese trade and information flows. Likewise, the future economic performance of Brazil and Venezuela can cause both economic and informational realignments.

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Sammenfatning

Ændringer i Portugals placering i global og europæisk informationsrum undersøges ved anvendelse af data om telefon-, telex- og telegramtrafik. Multivariat analyse anvendes til identifikation af årsagerne til disse ændringer, og resultaterne relateres til samfundsmæssige og økonomiske forandringer i og udenfor Portugal.

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