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## **GEOGRAPHIC INFORMATION SYSTEM "PTOLEMEOS". USER MANUAL**

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## **PREFACE**

The Geographic Information System "Ptolemeos" was developed by the Office of Strategic Studies, Constantine Porphyrogenetus Int. Ass. and it was employed in the context of the following research projects:

1. "The social and economic gravity centers of E.U. and the Balkans", Research Unit, University of the Aegean, 2000
2. "The social and economic gravity centers of the Middle East", Laboratory of Environment and Planning, Athens University of Economics and Business, 2000

The "User Manual" of the System as well as a copy of the report of the second of the above research projects, in which the theoretical background of the System is analyzed, are attached.

I would like to thank my students in the University of the Aegean and in the Athens University of Economics and Business who were involved in the above projects and who helped me with ideas and suggestions in the development of the System.

*August 2000*

*John Karkazis  
President  
Constantine Porphyrogenetus Int.Ass.*

## 1. INTRODUCTION

The System is working in a Visual Basic environment.

The main facilities available to the user of the System are:

- 1a. Production of digitized maps containing key information for selected countries or group of countries.*
- 1b. Production of statistical tables of key social and economic indices for selected countries.*
- 1c. Evaluation and geographic representation of social and economic gravity centers for selected countries or group of countries.*
- 1d. Gravity centers trend analysis*
- 1e. Evaluation of specialized regional discrimination indices: Regional Discrimination Cost, Capital Displacement Factor and others.*

### *Production of maps*

The user has the option of loading digitized maps of all countries of E.U. and the Balkans as well as of loading maps of groups of countries (E.U., Balkans, E.U.+Balkans, own selection of up to 6 countries). The user has also the option of loading political (bitmap) maps of the Balkans and the Middle East containing graphical representation of the gravity center trends. The key information contained in the digitized maps are: state and regional capitals locations and names for E.U. countries and state capitals locations and names for Balkan countries.

### *Production of statistical tables*

Statistical data can be loaded from the following data sources: EUROSTAT and UNIDO.

EUROSTAT data consist of the following indices: population (in mil. of inhabitants) and Gross Value Added (GVA, in bil. ECU) of E.U. countries at a state and regional level for the years 1985, 1990 and 1994. UNIDO data consist of the following indices: Gross Domestic Product (GDP, in bil. 1990 \$), Manufacturing Value Added (MVA, in bil. 1990 \$) and population (in mil. of inhabitants) for E.U. and Balkan countries at a state level for the years 1980, 1985, 1990 and 1994.

### *Evaluation of gravity centers*

The conceptual contents of the term "gravity centers" are associated with their capacity to attract activities (facilities) of the public sector (social gravity centers) or of the private sector (economic gravity centers) through the minimization of relevant transport cost (this issue is analyzed in section 1 of the attached Report). For the case of UNIDO data two types of gravity centers are evaluated for relevant countries and years: social (population) and economic (GVA) gravity centers. For the case of EUROSTAT data three types of gravity centers are evaluated for relevant countries and years: social (population), economic (GDP) and industrial (MVA) gravity centers.

### *Gravity centers trend analysis*

In the short and medium term the knowledge of the wider area inside which gravity centers are located can offer valuable insight both for the public and private sectors as to where economic activity is expected to be directed and where this activity is more probable to produce the highest economic return. On the other hand, in long term strategic analysis, the knowledge of intra-time change in the location of gravity centers can offer equally important strategic insight both for the public sector in its effort to counter-balance regional development and make long term plans for the distribution of infrastructure investment and for the private sector in its effort to make in-time adjustments relating to the changing economic value of the space.

The System offers the option of having different types of gravity centers at different periods represented in the same map with the use of appropriate symbols. In order to facilitate the analysis in this dynamic environment, we introduce the notion of Gravity Center Velocity. The correct interpretation of this strategic index requires a normalization of the notion of distance so as the latter to take into account and balance the size of the country inside which it is evaluated. As an example, a change of the economic gravity center in a country of the size of U.S.A. by 50 kilometers in a two-years period would have practically no impact on regional development planning whereas the same change in a small country like Belgium will have a significant impact in the decision making of both the private and the public sector. In order to normalize the notion of distance we first introduce the notion of Area Radius of a geographical area A,  $ar(A)$ , which is defined as the radius of a circle the area of which is equal to the area of A. Next, we define the regionally balanced notion of distance,  $d_r(P1,P2)$ , between points P1 and P2 in a geographical area (country or region) A as the % ratio of the corresponding Euclidean distance  $d_e(P1,P2)$  to the corresponding Area Radius:

$$d_r(P1,P2) = \% d_e(P1,P2) / ar(A)$$

The Gravity Center Velocity over a period of n years,  $gcv(n)$ , is then defined as the ratio of the regionally balanced distance (change of location)  $d_r$  covered by the gravity center during the above period over n, that is  $gcv(n)$  is expressed in “%rad per year” units where rad corresponds to the Area Radius index.

### *Regional discrimination indices*

As we have already mentioned the gravity center location of an area is a point in this area where transportation cost (in a wide social or economic interpretation of it) is minimized. As we deviate from the gravity center location the corresponding transportation cost is increased in a non-linear and rather complex way. The main factors differentiating transportation cost from its minimum level at the gravity center location is of course the distance from this location but also the distribution of demand points (sites of regional or state capitals in our case) in the area under consideration (see chapter 1 of the attached report). In order to express the spatial differentiation of transportation cost in a way amenable to regional planning considerations we introduce the notion of Regional Discrimination Cost at a site P of an area A,  $rdc_A(P)$  as follows:

$$rdc_A(X) = f(P) / f(G)$$

where  $f(P)$  expresses the transportation cost (social or economic according to the type of gravity center) associated with site  $P$  and  $f(G)$  the minimum value of transportation cost occurring at the Gravity Center location of area  $A$ . It is evident from the above that the higher the Regional Discrimination Cost of a region  $R$  (in a country  $C$ ) is, the lower the relative attractiveness of  $R$  with respect to investment considerations is expected to be. This highlights an "in-built" weakness of the region which is very difficult to remove in the short or medium term leaving the logistic interventions such as regional incentives as possibly the only means of encountering the problem by counter-balancing high transportation costs.

Finally, we introduce the notion of Capital Displacement Factor,  $cdf(A)$ , in a country/region  $A$  to be the regionally balanced distance between the site of capital,  $Cap$ , of the country/region and the site,  $G$ , of the gravity center under consideration:

$$cdf(A) = d_r(Cap, G)$$

The Capital Displacement Factor is expressed in "%rad" units where  $rad$  refers to the Area Radius of the country/region. This index offers a crude measure of the relative vicinity of the capital to social and economic gravity centers and hence it can be used as a "thump rule" in determining capital's capacity to serve efficiently population and to attract economic activity.

## 2. THE USER COMMUNICATION SCREEN

The "User Communication Screen" (see figure 2.1) consists of the following parts:

- (a) The Main Picture Box (Map) in which mainly maps but also statistical tables are drawn.
- (b) The Secondary Picture Box (Table) which accommodates statistical tables and gravity center analysis data and results.
- (c) The Mouse Info zone which gives information on the coordinates and color code of the current location (bit) of the mouse on the Main Picture Box.
- (d) The Map and Table Design Area through which the user designs the maps (the position and scale of maps and the type of information presented in them) to be drawn in the Main Picture Box and the type of data (statistical or gravity center ones) to be presented in Secondary Picture Box.
- (e) The Data Selection Area through which the user selects the maps to be drawn and the statistical data to be processed and/or represented in the Main and Secondary Picture Box.
- (f) The Codes Info Area which gives the codes of all states and all the regions of selected by the user countries. Note that regional data are only available for E.U. countries.
- (g) The Gravity Center, Trend and Regional Discrimination Analysis Area which contains tools enabling the user to evaluate and present in the Map gravity centers of various types and at different periods of time, to present corresponding data in the Table and also to evaluate various regional discrimination indices.



The description of the various parts, command buttons and data boxes of the User Communication Screen (UCS) will follow the logical operational sequence.

To run the System we double-click on the file "GravityCenter.exe" and we get the UCS (see figure 2.1). Note that yellow boxes represent command buttons through which the user activates the various routines of the System.

To activate a routine of the System we make the "mouse" pointing on the corresponding command button and we press down the left key of the "mouse". The term "activation of command button" will thereon refer to the above process.

## 2.1. The "Mouse Info" Zone

<b>MOUSE INFO</b>	X=	Y=	Col=	Screen=
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By rolling the "active mouse" (we get an "active mouse" for as long as left key on it is kept pressed down) on Main Picture Box (Map) we get the coordinates x, y of the current position of it in data boxes "X", "Y" respectively. The color code of the current "mouse" position (bit) appears in data box "Screen".

**Warning:** An error is occurring whenever the rolling "active mouse" pass through the borders of the Map.

## 2.2. The "Data Selection Area"

In order to activate any routine of the System we shall first load all data and then each time select from among the loaded data a portion that will be used in a specific application. Thus 'data loading' is performed only once whereas 'data selection' as many times as applications demand. Data loading and data selection command buttons belong to the 'DATA SELECTION AREA'.

DATA SELECTION AREA				
DATA BASE	TYPE	YEAR	LEV	STAT
1: EuroStat, 2: UNIDO	EUROSTAT			1: state: state code: 2: region: indiv state based data: 52: EU
EuroStat contains population, GVA data at a regional and state level for years 1985, 90, 94 for all EU states.	1: GVA, 2: Pop	1: 85, 2: 90 R: 94		Load Data Select Own Choice
UNIDO contains population, GDP, MVA data at a state level for years 1980, 85, 90, 93 for all European states.	1: GDP 2: MVA, 3: Pop	1: 80, 2: 85 3: 90, 4: 93		1 2 3 4 5 6
	ECONOMIC CENTER			
	Balkans Ec. Grav. Cent.			
	MidEast Ec. Grav. Cent.			

Figure 2.2. Data Selection Area

To load the data we activate command button "Load Data" indicated in the above figure with the number 1 on the corresponding arrow. To select data we shall first introduce the appropriate codes in the data boxes "DATA BASE", "TYPE", "YEAR", "LEVEL" and "STATE" and then activate command button "Select" indicated in the above figure with the number 2 on the corresponding arrow.

Note that "DATA SELECTION AREA" and "CODES INFO AREA" offer information to help the user in the selection of appropriate codes.

Suppose for example that we want to get statistical data for Spain and then evaluate its economic (GVC) gravity center for 1985. A list of state codes are given in the data box "State Codes" (see figure 2.3) of "CODES INFO AREA" (bottom left of UCS). The contents of this list can roll on the "State Codes" data box by pressing the "up" and "down" arrows at the right of the box. Note that these arrows appear only after data have been loaded. To get the list of regions of Spain

The screenshot shows a window titled "CODES INFO AREA". It contains several data boxes and buttons. On the left, there are labels "State Codes:" and "Region Codes:". The "State Codes:" box contains the text "1: SPAIN". The "Region Codes:" box contains the text "1: MADRID (Madrid)". To the right of these boxes are two small buttons with up and down arrows. Further right is a "State Code" box containing the number "1". To the right of this box is a "RegList Update" button. An arrow points to the "RegList Update" button from the right side of the image.

Figure 2.3 Codes Info Area

we introduce the state code of Spain (1) in the data box "State Code" at the right of "CODES INFO AREA" and then we activate command button "RegListUpdate" indicated with the arrow in figure 2.3. The list of regions (with region capital names in parentheses) can roll on "Region Codes" data box by pressing the "up" and "down" arrows at the right of this data box. To select the data for the evaluation of the economic gravity center of Spain for 1985 (the evaluation will be based on regional data from Eurostat) we introduce the code 1 (for Eurostat Data Source) in the data box "DATA BASE". The data type code is introduced in the data box "TYPE". Eurostat source contains two types of data: GVA data (code=1) and population data (code=2). Number 1 is next introduced in data box "TYPE". Since the gravity center analysis refers to year 1985, which in Eurostat data has code 1, we introduce the number 1 in data box "YEAR". Note at this point that gravity center analysis can be performed at a state as well as at a regional base. In order to evaluate a gravity center for a specific country we need to have the appropriate regional data for this country. Regional data are only available for E.U. countries through Eurostat data source. Since the gravity center analysis will be based on regional data we introduce the number 2 in the data box "LEV" (code 1 characterizes state based evaluations of gravity centers whereas code 2 regional based evaluations). After we have introduced data selection codes we activate command button "Select" and the corresponding portion of data is isolated for the gravity center evaluation.

To further clarify the selection process we consider another problem. Suppose we want to evaluate the industrial (MVA) gravity centers for the Balkans for the years 1980 and 1990. Since the specific type of data (MVA data) can be found only in UNIDO data source, we introduce number 2 (the code of UNIDO data) in data box "DATA BASE". Next, we introduce number 2 (the code for the MVA type of data in UNIDO data source) in the data box "TYPE" and the



number 1 (the code of year 1980 for UNIDO data source) in data box "YEAR". Since UNIDO data source contains data only at a state level we introduce code 1 in data box "LEV". Finally, we introduce number 54 (the area code for the Balkans) in data box "STAT" and we activate command button "Select". After we have finished our analysis with year 1980 we just introduce number 3 (the code of the year 1990 for UNIDO data) in the data box "YEAR" and then activate command button "Select". The new portion of data (corresponding to year 1990) are now available for use by the gravity center evaluation routine.

The production of maps and statistical tables requires only the introduction of the area code in text box "STAT" and the activation of command button "Select" in "DATA SELECTION AREA". Maps can be produced for individual E.U. and Balkan countries (those appearing in the "State Codes" list) and for the following country groups: E.U. (area code=52), Europe (E.U.+Balkans, area code=53), the Balkans (area code=54) and Own Choice group (area code=60). The last option (with code=60) gives the user the capability of producing a map of up to 6 countries selected by himself/herself. Especially for this case the user, after entering the area code 60, should enter the number of selected countries in data box "StatNum" and the individual country codes in the relevant data boxes in the bottom right corner of "DATA SELECTION AREA" starting from the upper left data box in the sequence indicated in figure 2.2 (arrow number 3). Statistical tables can be produced only for individual countries and not for group of countries.

### 2.3 The "Map and Table Design Area"

MAP AND TABLE DESIGN AREA									
Draw	Clear	RCap	SCap	RCap	SCap	Isles	Zoom	0	
Map	Map	Symb	Symb	Names	Names	Names	Left 10		
Clear	Start	Show	Show	Next	ShowGC	Update	Top 10		
Tabl		Udat	Edat		Results				

Figure 2.4. Map and Table Design Area

After we have finished with the country (or group of countries) selection we turn our attention to the "MAP AND TABLE DESIGN AREA". Activation of command button "Draw Map" produces a map (without capital symbols and names) of the country/countries selected in blue back color. Activation of command button "Clear Map" clears the contents of Main Picture Box. A map in white back color can be produced as follows: (a) we introduce the number 1 in text box "Screen" in "MOUSE INFO" zone, (b) we activate command button "Start" and (c) we activate command button "Draw Map" in "MAP AND TABLE DESIGN AREA". Activation of "RCapSymb" command button produces on the map the symbol of location of regional capitals whereas activation of command button "RCapNames" produces on the map the names of regional capitals (make sure that the last two buttons are activated only for countries for which regional data are available). Activation of "SCapSymb" and "SCapNames" produces on the map the symbol of location and the names respectively of state capitals. Activation of command button "Isles Names" produces on the map the names of the main islands (if any). In order to produce statistical tables (for the case of individual countries) we introduce in the text box "Screen" ("MOUSE INFO" zone) the code of the Picture Box in which the tables will be produced (code 1 for Main Picture Box and code 2 for Secondary Picture Box) and then activate one of the two command buttons: "ShowUdat", "ShowEdat". The activation of the former button produces statistical tables from UNIDO data source whereas the activation of the latter one produces statistical tables from the Eurostat data source. Activation of command button

"ClearTabl" clears the contents of the Secondary Picture Box. Note that in the case of UNIDO data the selection of the Main Picture Box allows for some extra data (%change of MVA, manufacturing share etc) to be produced besides GDP, MVA and population for 1980,85,90 and 1993 that can be produced in the Secondary Picture Box. Figure 2.5 gives typical statistical data outputs for the Spain in the Main and Secondary Picture Box whereas figure 2.6 gives a typical map production for the same country. Note that in the case of map the "area" figure given in the bottom left of the Main Picture Box does not represent the actual (official) value but the area of covered by the digitized map appropriately scaled. Hence, this figure represents a measure of quality of the digitization process.

TABLE						
SPAIN		Data Source: EUROSTAT				
Abbrev.: POP=Population, MVA=Gross Value Added						
Notes: POP in mill., MVA and in bill. ECU						
REGION	POP85	MVA85	POP90	MVA90	POP94	MVA94
MADRID	4832	33.5	4878	60.6	5001	63.9
CASTILLA Y LEO	2612	14.4	2626	22.5	2522	23.1
CASTILLA LA MANA	1677	9.3	1714	14.8	168	14.9
EXTREMADURA	1085	4.3	1128	7.2	1069	7.7
CATALUNA	6042	40.9	6008	73.6	607	77.8
COMTAD VALENCIA	3724	23	3787	38.5	3893	40
ISLAS BALEARES	687	5.3	682	8.8	722	9.6
ANDALUCIA	6675	30.1	692	53.7	7065	55
MURCIA	991	5.4	1027	10	1071	10.3
GALICIA	2839	13.4	2804	21.9	273	22.8
ASTURIAS	1135	6.5	1126	9.9	1082	10.1
CANTABRIA	523	3.1	527	5.2	527	5.3
PAIS VASCO	218	16.2	2129	26	2084	26.9
NAVARRA	516	3.7	521	6.4	524	6.4
LARIONA	257	2.2	26	3.3	261	3.7
ARAGON	1205	7.8	1213	13.2	1184	13.6
SPAIN	38.51	227.1	38.95	391.5	39.14	408

MAP			
SPAIN		Data Source: UNIDO	
Abbrev.: POP=Population, MVA=Manufacturing Value Added			
Notes: POP in mill., GDP and MVA in bill.1990\$, Per Cap GDP in 1990\$			
POP 1980:	37.54	Changes %: 1980-93	
GDP 1980:	366	<u>POP</u> <u>GDP</u> <u>MVA</u>	
MVA 1980:	81.85	5.2 36.9 25.8	
POP 1985:	38.47		
GDP 1985:	394.9	Manufacturing Share %: MVA/GDP	
MVA 1985:	83.75	<u>1980</u> <u>1985</u> <u>1990</u> <u>1993</u>	
POP 1990:	39.27	22.4 21.2 22.4 20.6	
GDP 1990:	491.8	<u>Per Capita GDP, 1993</u>	
MVA 1990:	110.29	12678	
POP 1993:	39.51		
GDP 1993:	500.9		
MVA 1993:	102.97		

Figure 2.5. Typical statistical data output

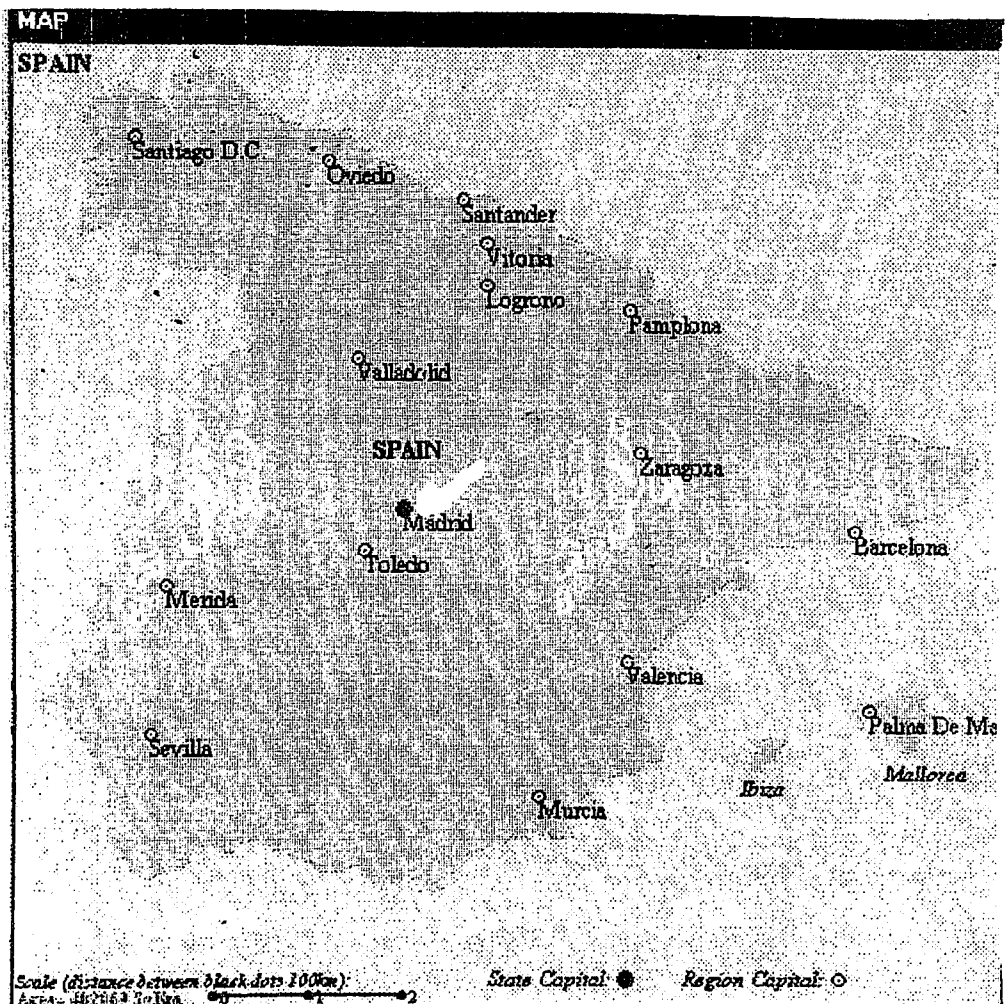


Figure 2.6. Typical map output

Finally, we activate command button "Next" in the "DATA SELECTION AREA" in the case of Eurostat statistical data of a country (such as France's) the volume of which is too big to be accommodated all in Secondary Picture Box. By activating this command button the remaining data are produced in this Box.

### Change in the scale and position of map output

Note that the contents of data boxes "Left" and "Top" (in the "MAP AND TABLE DESIGN AREA", figure 2.4) represent the coordinates of the upper left active Map area whereas the contents of data box "Zoom" represent the zoom level employed in order to adjust the map element coordinates to the size of the Main Picture Box. As an example, in the case of figure 2.1 the active upper left corner has coordinates  $x=10$ ,  $y=10$ . The corresponding zoom level is 1.2 which means that the digitized map elements have been expanded by 20% in order to adjust to the Main Picture Box. Suppose, next, that we have already produced the Eurostat statistical table

of Spain in the Main Picture Box (see figure 2.7) and we want to draw Spain's map (appropriately reduced in size) in the blank area. We first determine the upper left corner of the reduced map inside the Main Box and then the zoom level (level of reduction) to be employed. The upper left corner coordinates can be determined by making the "mouse" pointing at the desired point, and transfer the contents of "X" and "Y" data boxes (in "MOUSE INFO" zone) to the "Left" and "Top" data boxes (in the case of figure 2.7 the coordinates of the upper left corner are  $x=250$ ,  $y=250$  and correspond to the central point of the Main Picture Box. By optical examination it is determined that the original map should be roughly reduced by 40% in order to vertically adjust to the blank area. This means that the zoom level we have to employ is 40% of the original zoom level which is 1.2. Hence we introduce in the data box "Zoom" the value 0.5 (being roughly 40% of 1.2) and activate command button "Draw Map" and any other desired map design command button.

## 2.4. The "Gravity Center Trend and Regional Discrimination Analysis Area"

GRAV. CENTER TREND AND REG. DISCRIMINATION ANALYSIS AREA			
Draw Gr.Center	Keep First Center	State Radius (km)	Center Deviation (km)
Draw Trend	Keep Second Center	Grav. Center Velocity (%Stat/year)	Regional Discrim.
		Capital Displacement Factor (%Stat)	Code

### *Evaluation of a Gravity Center*

Suppose we want to evaluate the economic (GVA) gravity center of Germany in 1985 and also to evaluate the corresponding regional discrimination cost for Bavaria (Munich). We perform the following steps:

- Activate "Load Data" command button
- Introduce value 1 in "DATA BASE" data box (Eurostat data source), 1 in "TYPE" data box (GVA data), 1 in "YEAR" data box (year 1985), 2 in "LEV" data box (regional data) and 7 in "STAT" data box (the code for Germany)
- Activate "Select" command button
- Activate "Draw Map", "RCapSymb", "SCapSymb" and "RcapNames" command buttons to get a map of Germany

Next, we activate "Draw Gr.Center" command button to get the gravity center position on the map (see figure 2.8) and "Show G.C. Results" command button (in "MAP AND TABLE DESIGN AREA") to get the numerical input and output of gravity center analysis in Secondary Picture Box. On the left vertical zone of the Table we get the coordinates of the gravity center (OptX and OptY) and the (minimum) value of transportation cost corresponding to it (OptValue). On the right vertical zone we get the GVA levels of all regions (demand points) of Germany as well as the coordinates of their capitals.

By activating command button "Keep First Center" to get the Area Radius of Germany in "State Radius" data box and the deviation of the gravity center from its capital in km ("Center Deviation" data box) and in "%rad" units ("Capital Displacement Factor" data box). To evaluate the regional discrimination cost at a site in Germany we just make "active mouse" point on this site and we get corresponding value in "Regional Discrim.Cost" data box. Note that regional discrimination cost at the gravity center is equal to 1.



If we want to evaluate the economic (GVA) gravity center for year 1985 and also the Gravity Center Velocity for the period 1985-1994 we perform the following steps:

- (a) Introduce value 3 in "YEAR" data box (the code of year 1985 in Eurostat data) and activate "Select" command button
- (b) Activate "Draw Gr.Center" command button to get the site of the new gravity center
- (c) Activate "Show G.C. Results" command button to get the corresponding numerical input and output
- (d) Activate "Keep Second Center" command button to get the values of Center Deviation and Capital Displacement Factor corresponding to the new gravity center
- (e) Activate "Draw Trend" command button to get the corresponding value for Gravity Center Velocity in "Grav.Center Velocity" data box

**Warning:** *The following sets of data are not available:*

- *Germany's 1985 GVA data for its eastern regions*
- *U.K.'s 1990 regional GVA data*
- *Italy's 1985 and 1990 regional GVA data*
- *Greece's 1985 and 1990 regional GVA data*

*An effort to perform gravity center and regional discrimination analysis for the above sets of data will produce an error.*

