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Land Use and Water Management in a Sustainable Network Society
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Gravitational Attraction Fields for Population in Turkey

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Abstract

Inspired by the gravitational attraction of the masses in Physics, the gravitational pull between the settlements has been proven to be an important phenomenon in explaining potentials that arise among towns. Again inspired by the Electro-magnetic fields in Physics, in this paper, the gravitational attraction between the cities is assumed to be exerted on a city with a certain “charge” on a map of superimposing “charges” of different cities. Following this line, an attraction field has been presented for different census years on city basis in Turkey and possible implications have been evaluated. The values for the year 2000 on the other hand have been tested with other factors including the GNP per head, population and the literacy rate to see the impact of these forces on the tendencies to move in and out of the cities, that is the migratory effects. The study is as well done separating the country into a West and an East to see if there are striking differences in between.

Magnetic Field

Objects such as a magnet or a current-carrying wire can influence materials holding magnetic properties without contacting them physically. This property is owed to their capability to produce magnetic fields, which are represented by magnetic flux lines, which in their turn show the radial spread of a potential of effect out of a magnetic source. At any point, the direction of the magnetic field is the same as the direction of the flux lines, and the magnetic field also possesses a strength that is proportional to the space between the flux lines. For example, in a bar magnet, the flux lines start at one end of the bar, then curve around the other end; the flux lines can be thought of as being closed loops, part of it loop inside, and part of it outside the magnet. The magnetic field is strongest at the ends of the magnet, where the flux lines are closest together. On the other hand, toward the side of the magnet, where the flux lines are farther apart, the magnetic field is weaker. Depending on their shapes and magnetic strengths, different kinds of magnets produce different patterns of flux lines. The pattern of flux lines created by magnets or any other object that creates a magnetic field can be mapped by using a compass or small iron filings. Affected through the interaction imposed through an area of force, magnets align themselves along these lines. So, even a compass, which itself is a small magnet that is free to rotate, will tend to orient itself in the direction of the magnetic flux lines. The direction of the compass needle at each where the compass is placed around the source of the magnetic field, can give the pattern of flux lines. Alternatively, when iron filings are placed around an object that creates a magnetic field, the filings will line up along the flux lines, revealing the flux line pattern.

Magnetic fields influence magnetic materials, and also influence charged particles that move through the magnetic field. Generally, when a charged particle moves through a magnetic field, it feels a force that is at right angles both to the velocity of the charged particle and the magnetic field. Since the force is always perpendicular to the velocity of the charged particle, a charged particle in a magnetic field moves in a curved path. Magnetic fields are used to change the paths of charged particles in devices such as particle accelerators and mass spectrometers.

Electric field on the other hand, which is a corollary of the magnetic field, is defined as the electric force per unit charge. The direction of the field is taken to be the direction of the force it

would exert on a positive test charge. The electric field is radially outward from a positive charge and radially in toward a negative point charge.

The electric field of a point charge can be obtained from Coulomb's law:

$$E = \frac{F}{q} = \frac{kQ_{\text{source}} q}{qr^2} = \frac{kQ_{\text{source}}}{r^2}$$

Equation 0: Finding the Electric Charge from Coulomb's Law

The electric field from any number of point charges can be obtained from a vector sum of the individual fields. A positive number is taken to be an outward field; the field of a negative charge is toward it.

Analogy

From the first half of the 19th century, a challenge to apply the theory of gravity to human interaction emerged. At that time, Carey (1858-59) theorized “Gravitation is here, as everywhere, in the direct ratio of the mass and the inverse of the distance”. Work by Ravenstein (1885-1889) and later by Young (1924) confirmed the belief that gravitational function does apply to the migration of people from one area to another.

Reilly Law had long stated that the potential of a market area was proportional to its market size and inversely proportional to the distance in between. Q. Steward on the other hand, had calculated potentials for the population based on these assumptions, that is, that the potentials of places could be calculated based on the addition of individual attractive forces the places applied on different points on the map. He had found out, for USA, that the highest potential was concentrated around New-York and gradually spread out in expanding circles over the map further away, indicating to a dilution and contraction with respect to relative positioning over the urban areas.

It may be thought much as bodies and electric forces attract each other, people and their communities have an attire just as well. This new form of accumulation may be regarded as a form of synergy that the collectivity produces.

It is the very same formula explained before that has been proven to be effective between particle attractors and over huge masses (like the attraction between the planets or the attraction that the earth applies on us-it is due to a common reason why one weighs less on the moon than on earth). Therefore, the same physical phenomenon may be effective through other disciplines.

When it comes to commercial significance, one may think that the city’s potential would be best used at its immediate proximity. However, there should be a pattern describing how as one gets away from this very centre the effect would drop.

A variety of subjects such as migration routes, telephone traffic, passenger movements, commodity flow, etc. have been analyzed using this particular model (Johnston).

Further examples of the use of the gravity model are available, besides in the works of Steward (1947-48-50) who presented three primary concepts based on Newtonian physics, demographic force, demographic energy and demographic potential. Zipf (1946-49) examined for pairs of cities interaction phenomena such as bus passenger trips, airline passenger trips, telephone calls etc and the factor, finding a straight-line relationship between this factor and those phenomena where the entire factor is raised to some power. Isaard and Whitney (1949), Cavanaugh (1950) and Dod (1950) dealt with demand and location according to product. Artle (1959) carried out a study on income groups and the interaction among them in the city of Stockholm.

Meanwhile, the model was subject to many different interpretations and novel visions. Klein Institute has emphasised the importance of taking in account the size as well as the population whereas. Huff's Model proposed that it would be more logical to assign probabilities to movement rather than trying to gauge on the magnitudes of flow.

Converse (1949) meanwhile has applied the maps including the breaking point formula, which would have a network of isodopanes to show the limits of market areas of similar potentials.

Applebaum(1961),Huff(1963),Jones and Muck(1984), Fotheringham and O'Kelly (1989), Rust and Donthu (1995) etc. are among many who have also come up with applications of the very same concept.

The gravity model has been used widely as a model for estimating international trade flows and as a baseline model for estimating the impact of a variety of policy issues, such as regional trading groups, political blocs, patent rights, and various trade distortions.

From a microeconomic perspective, gravity models deal with the question of their theoretical foundations for optimizing the decisions of economic agents. The question is complex, because of the fact that there are connections that have yet to be analyzed in detail. These include the generic and formal minimal action principle associated with Hamilton's formulation of movement equations. Anderson (1979) and Bergstrand (1985) derived gravity models from models of monopolistic competition. From a perspective of International trade, Deardorff (1998) demonstrated that the gravity model can be derived within Ricardian and Heckscher- Ohlin frameworks.

Among other prominent authors in the theoretical foundations of the gravity models one may count Feenstra et al. (1998) and Egger (2000). Leaving aside these theoretical questions, the gravity formulations are basically empirical models, and their intrinsic value lies fundamentally in their ability, either to predict the interactions among the system's components, or to represent the relationships and structures of the said components. The explanations that follow, attempt to do the latter and focus on the treatment of spatial information through the construction of potential maps, based logically, on the calculation of potentials of population.

Two further important characteristics of this type of model are that they have a clearly defined structural perspective and are macroscopic in outlook.

As far as structural perspective is concerned, potential maps constitute a common technique in the social sciences, and this technique assumes that the relationships between the components of a system are influenced by the arrangement of the permanent elements.

The fact that the models are macroscopic in outlook really means that the gravity models are capable of providing us with an aggregate representation consisting of aggregates of contours of equi-potentials of population and differing grades or strengths of the potential field, so that they produce a macroscopic representation of populations within a territorial structure.

The formal expression of the gravity models is of the type denoted as (1) in the set below:

$$F_{ij} = K \frac{A_i^{\alpha_1} \cdot A_j^{\alpha_2}}{D_{ij}^{\beta}} \quad (1)$$

$$F_{ij} = K \frac{A_i^{\alpha} \cdot A_j^{\alpha}}{D_{ij}^{\beta}} \quad (2)$$

$$F_{ij} = K \frac{A_i \cdot A_j}{D_{ij}^2} \quad (3)$$

$$V_j = K \frac{A_j}{D_{ij}^2} \quad (4)$$

$$V = K \frac{A_1}{D_{i,1}^2} + K \frac{A_2}{D_{i,2}^2} + \dots + K \frac{A_n}{D_{i,n}^2} = K \sum_{j=1}^n \frac{A_j}{D_{i,j}^2} \quad (5)$$

Here F_{ij} represents the frequency or the intensity of the force of the interaction between the places i and j , where as D represents the distance and A represents the magnitude of the quantity in question for each of the places.

It is worthwhile to note that this expression, in the Reilly equations had 1 for B , the relative weight or the coefficient of friction for transportation and for both alphas.

Different exponential weights for each of the quantities actually apply when the two quantities are distinct in nature (one reflecting the GNP, one reflecting the population for instance. Since we do not have any such differentiation we may take the weights as equal as in equation (2) and give the overall weight to the distance by rendering them 1.

In the past where communication between the centres was especially difficult over hard terrains, this type of an analogy would be rendered null since it was harder to calculate which places were easier to be accessed and which were on a less accessible land.

However, in the globalised world of today, it is almost as easy to access places at similar distances. Therefore it is more logical to think of methods that would offer a common cap on the distance.

At this point, the application of the very equation emerging out of Coulomb's Law to describe the multipliers around a market area, which would imply offering a friction of transportation of 2, as in equation 3. This in turn would imply an electric field imposed from a point particle at j over another point, say i over the map az given in equation 4, which gives way to the famous demand cones that decay around a demand centre forming the shape of a cone. The addition of these forces in return brings us to the equation 5.

Another significance that emerges duly is the analogy that extends over to electric force. As explained before, when a point particle is placed on an area that already possesses a potential, a force emerges.

This force may be interpreted in different ways. It may be seen as the trade link that is available or potentially there along two different towns or as the attire a city may be imposing on the other.

Either way, through many applications, for instance, the effect of this relation on migration has been found to have a clear bias. My own regression of net migration in Turkey (which attained an 89% R²), through backward substitution for example, has left this very force as a possible determinant for migration.

As the theory of relativity suggests, we are compelled to review things in their very particular standings. Generalisations on “objective” points of view are often misleading. Therefore, thinking of the electric attraction as the super-imposition of population potentials over a field of potential attractors may be more appropriate than merely concentrating on one at a time results obtained in cities, which are more difficult to be interpreted.

Turkey

Turkey has been a place where change in social and demographic structure juxtaposed with tremendously changing landscape and economy. Boratav (1989), suggests that the country has experienced a multilayered transition from an agrarian into a more capitalist society without really experiencing the course followed up by industrialised nations. This in its turn implies that the country has been passing through a development course that involves an even more chaotic and unpredictable change.

However, once the development patterns in Turkey are studied, it may be found out that development actually followed a course of spread and intensification at the same time. On the one hand the massive concentration around Istanbul carried on adding on to its potential whereas industry and other sectors did spread to neighbouring villages of the city, which were once towns of not even minor importance.

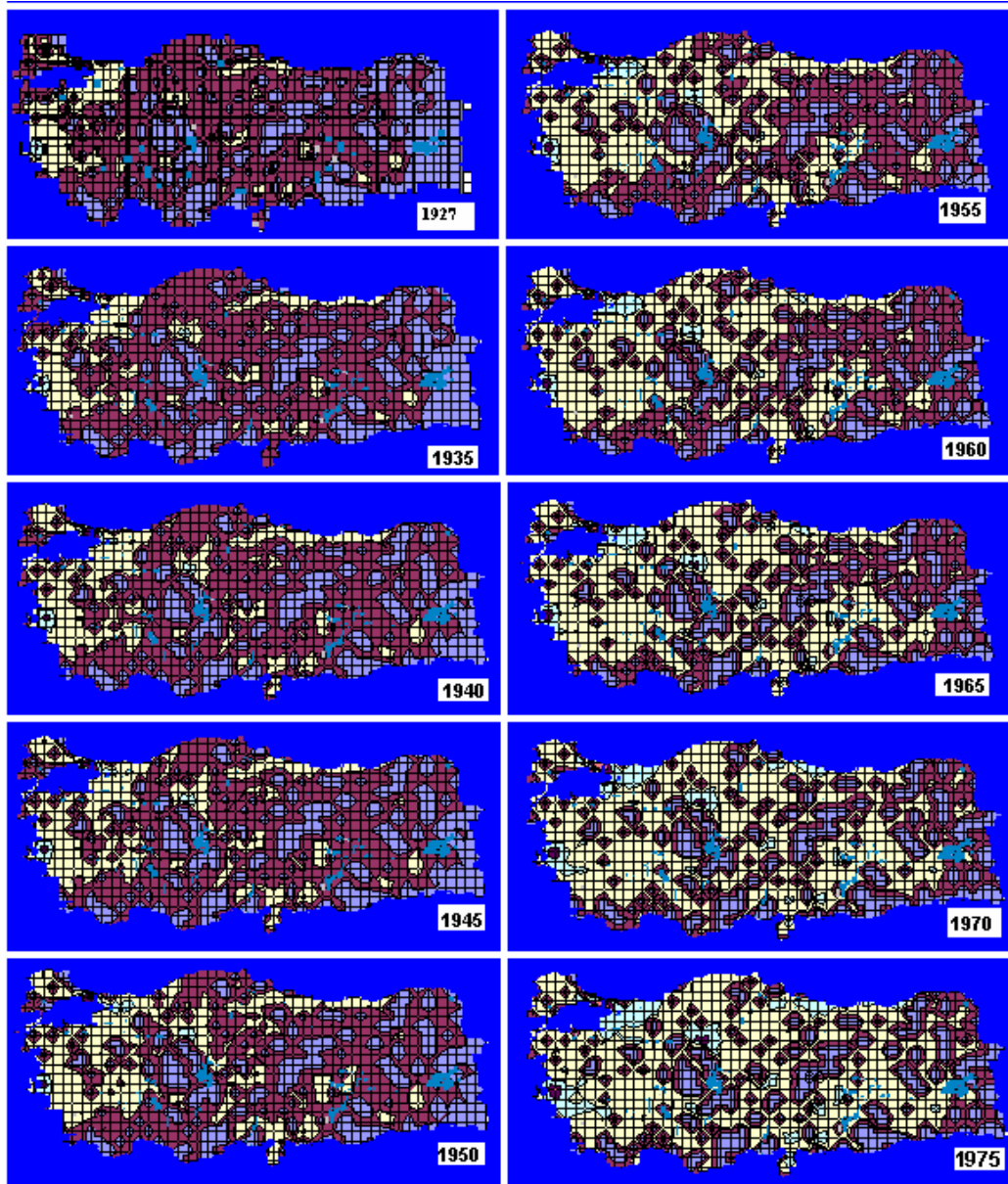


Figure 1: The Change in the Gravitational Field in Turkey from 1927 through 1975 at urban-level

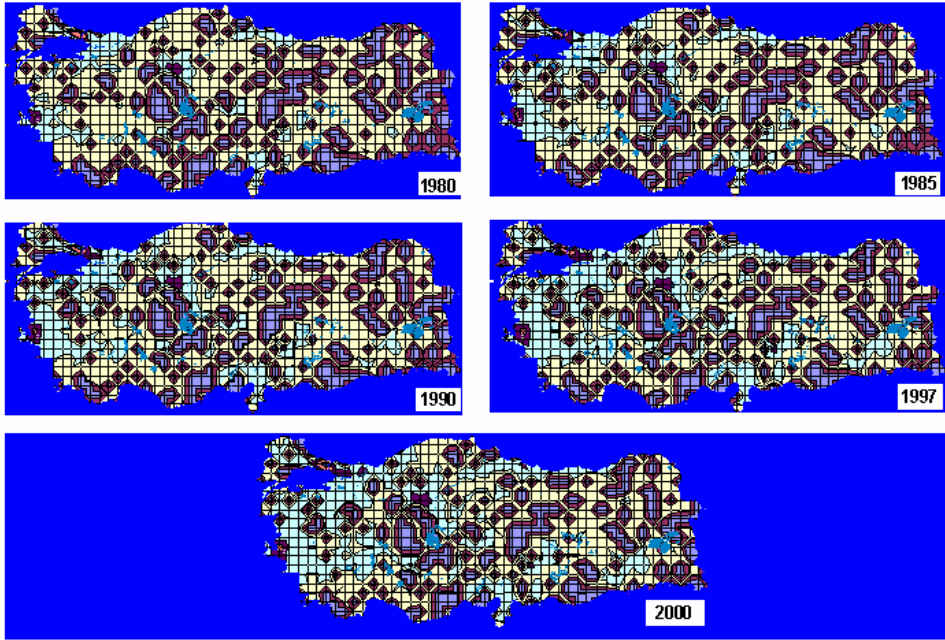


Figure 2: The Change in the Gravitational Field in Turkey from 1980 through 2000 at urban-level

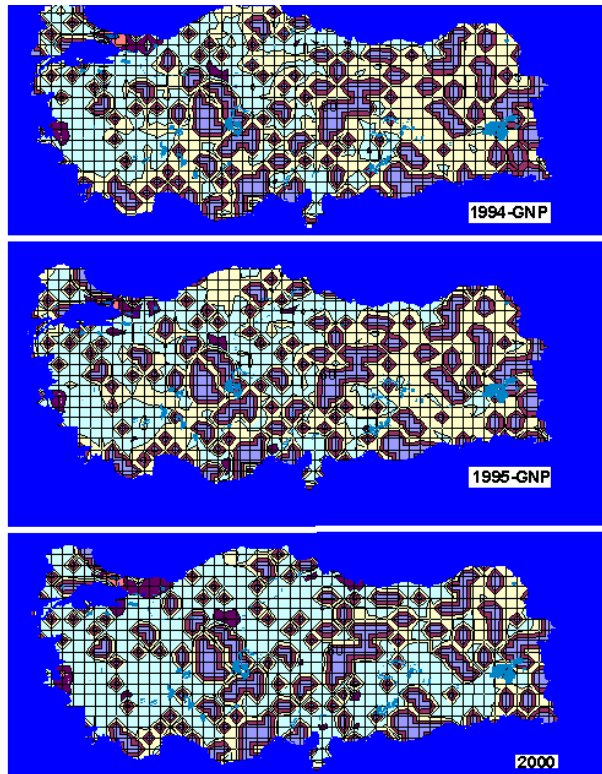


Figure 3: The Gravitational Fields in Turkey calculated for the GNP (1994 and 1995) and for the overall census of population in 2000 at localities-level

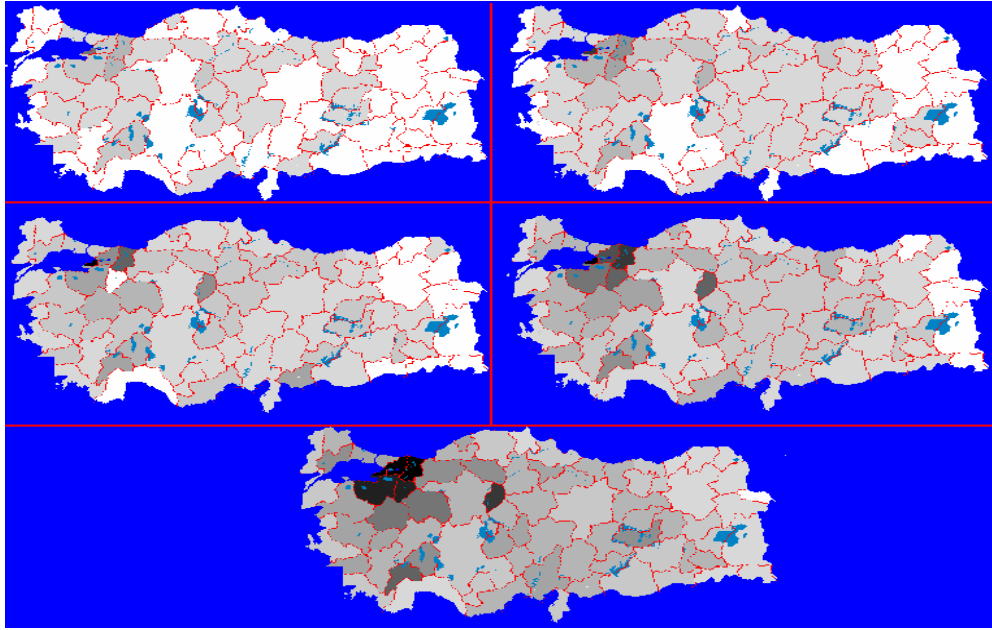


Figure 4: The Gravitational Fields in Turkey calculated for the population at city-level

The basic axis of development is quite obvious. From the very beginning of the republican era, a development axis around Istanbul, extending around the Southern Coast of Marmara and following down through the Aegean Coast is visible.

After 10 years of Republican life, it can be seen that by 1935, the development programmes followed up by the new government has accentuated a development region around Ankara. The relative peace around the coast of the Black Sea has also lead to an extension of the area of development right to the very borders of the region.

By 1950's, it can be seen that high levels of development around each of the cores has lead into a merging of all the regions. The agglomeration that extends from Edirne right through to Ankara and down to Iskenderun and from Ankara back up to Rize gives the signal to an emerging potential that will give rise to the gigapolis formed from Istanbul to Ankara.

However, the major leap forward actually coincided with the trends in Europe, that is, through 1950's. At this time, an area of potential has spread around over the North of Adana, contouring Southern Anatolia. It should not be surprising, to this end that Southern Anatolian development project, GAP, should have had its first precursors

emerging at this time. This simply indeed is a reflection of the trends that created a potential around the area.

It should nevertheless be seen that the highest levels of development should be observed along the Axis from Ankara to Istanbul, which indeed still is the main axis around which Turkish cores of politics, culture, trade and industry are aligned.

One thing to note here is that the reason for the massive accumulation of potential around this very region cannot be uniquely explained by the potential generated by Istanbul only. If this were to be the case, then, the same levels would have to be observed around the Thracian sub-region also, which is not the case. Therefore the very distribution of diversified industries and sectors around Bursa, Istanbul and Ankara should be seen as the main reason lying behind this influx. It is again this influence that has made the area the very industrial core of Turkey at large, which although devastated by two major earthquakes, one in mid-60's and one at the end of the 20th century, retains to be so. This mainly is due to the massive accumulation around this area that necessitates the region to develop.

From late 1970's on the other hand, another region of similar, yet lessened potential revolves around Izmir-Aydin axis, which is an important textiles centre, that decreased in importance after the exchange of populations.

At this second stage of development when, from 1980's onwards, development similar to that observed at the beginning of the republican area was observed through similar places, this time with the inclusion of the core around Iskenderun-Adana sticking out as prominently. However, it should be well remembered that this time the growth happened up a scale of logarithm. A level of development that was only observed in the West, at these late years came to be present even to the very unlikely neighbourhoods of the East.

Nevertheless, all through these cycles of development, the major lines that divide the East and the West of the Mediterranean Region; the belt that continues all through up to the Eastern Black Sea Region and has a turn West to divide the Central Anatolian Region from the Aegean Region remain as "empty". These places are where mountains prevail in any case and this also shows that development patterns in Turkey indeed stem from what is inside the region. Development does not seem to be extending over the regions in the same sense.

When the data for GNP's were evaluated, the striking similarity, despite a leap of 10 years in between is striking. The development in the West seems to be even more emphasised whereas the development in the East follows the growth in population potentials by a certain time interval.

However, although these results show themselves, through the regressions that carried out (regressing the growth rate on to the value of the magnetic field), we could not reach anywhere above 17% R² rates. This nevertheless should not be misleading since between the potential at a place and the result obtained, it is logical that there should be a difference.

On the other hand, the very same result may be interpreted as a loss to the society since the potentials do not seem to be very efficiently used.

When the regression was cast one period after the values observed, on the other hand, the significance somewhat increases. However, the power still falls low.

That the population at a place and the potential should not overlap may be indicating at two things, one being that the potential at the place is not used very efficiently and the other being that the potential is not a concept shadowed by the imminent surrounding and not necessarily the very town itself. This also is visible in the fact that the potential accumulation around Adapazari is higher than around Kocaeli, which is closer to Istanbul indeed.

In order to better visualise the same effect, the accumulations are also given at city-levels. It can be seen that the concentration areas get more remarkable around Istanbul and a promising area around Adana also sticks out.

One may therefore claim that the next possible leap will be around these areas for a while. Especially when GAP will start operating functionally, the potential of these places will increase drastically.

Conclusions:

It has long been claimed that Turkey lacks the ability to make optimal use of its ample potentials.

This very fact is very much revealed in our study in that there at times is a slight divergence among the potentials around the towns and the actual growth rates, although a vague relation can be traced.

The allocation of the funds and the emergence of new sectors seem to occur at places that traditionally held the economic and cultural power or simply dispersed in an unorganised manner, randomly around the spectrum. However, as studies suggest, the potential at a place does give clues on the purchasing power parity obtained at places. Faíña and Rodriguez have found out a 59% correlation between these two phenomena along the European Union.

Therefore the limits and the potentials to growth should be better evaluated, which would mean a further emphasis outside the core areas, extending along their connection gateways. This would as well help the emergence of spread effects, which would find their patterns to expand over the horizon in a profitable manner. In either case, as can be inferred from the maps, we may see that a place ultimately reaches to a level of higher development if it does happen to attain a level of potential. However, it often takes a matter of chance or time to evaluate the ultimate gains out of an investment. Therefore the loss in particular inevitably may be the loss of profit all through the time that the value is not evaluated.

A part of the study that was missing may be the interactions among the places in Turkey and the neighbouring towns. Faíña and Rodriguez's study on the enlargement of the EU for example showed how much the newcomers to the EU could indeed bolster the economic potentials within. However, this is brought by at a level where frontiers to trade are totally upheld, in which case markets truly conjoin. In the case of Turkey, vis a vis the relations with the neighbours, it may be claimed that assigning probabilities and using them either as multipliers to smooth out the difficulty of trade or evaluation of perspectives through a scenario-analysis fashion may be useful

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