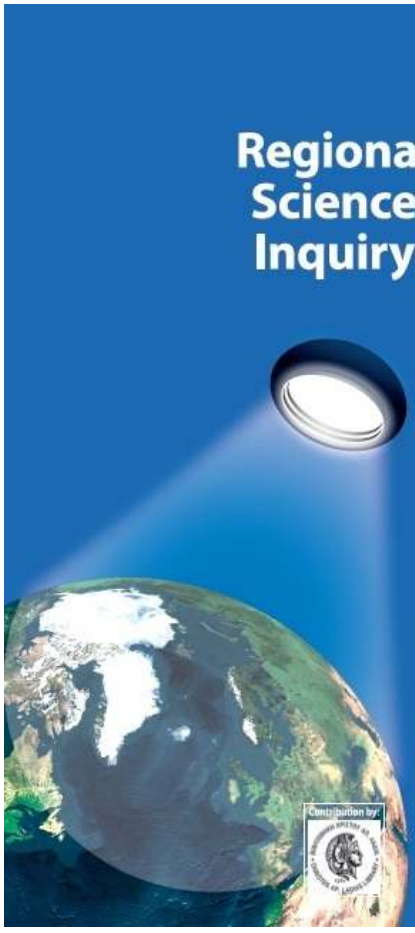


Regional Science Inquiry

December 2012 Volume IV Number 3

# Regional Science Inquiry

THE JOURNAL OF THE
Hellenic Association of Regional Scientists

December 2012
Volume IV
Number 3

*Special Issue*

English Edition
ISSN: 1791-5961 Print
ISSN: 1791-7735 Online

# H.A.R.S. - RSI J – KIIE - R ICR – ZRW

# Editorial Board 2011 – 2012



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**Electronic and hard copy editions are offered free of charge (ISSN: 1791-5961) (ISSN ONLINE: 1791-7735)**
**The RSI Journal is included in the Reference Lists of: EconLit (3/2011), RSA I, EconPapers**

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# Contents

## Special Issue of the RSI Journal, Volume IV, Issue 3 – Editorial

In the present Special Issue are presented twelve papers, all written by academics and policy-makers from all over the world. It is the intention of the editorial board of the Regional Science Inquiry Journal to present in this Special Issue a wide range of topics, such as economics, environmental, politics, theoretical aspects of regional development, empirical case studies. In the first part are presented five papers, which deal with different aspects of the central theme of ''The Impacts of ICTs on Spatial Structures''.

More specifically:

*Voula Psaraki and Ioanna Pagoni*, in the first paper, focus on the role of Intelligent Transport Systems (ITS) in addressing road capacity issues, and delivering environmental benefits. For this purpose, three ITS technologies are selected: Driver Assistance Systems (DAS); Automated Highway System (AHS) for passenger traffic; and Commercial Vehicle Operations (CVO) for freight traffic, based on the profile of their characteristics and the projected implementation pathways. These are further evaluated as to their potential for improving the road capacity of the TEN-T European network; achieving fuel savings; and reducing $CO_2$ emissions.

In the second paper, *Kostas Physentzides* elaborates on the major transformation processes of a city into a cybercity and the process of embedding the virtual into the real. The paper aims to shed light on the integration of human capabilities (intelligence, imagination, creativity) by use of ICTs applications that drive processes which transform the city of geography and place into a hybrid: the cybercity. The emerging cybercity expands beyond its traditional geographical boundaries of place, embracing a new digital virtual space, which is placeless and timeless. At the same time, the embedding of human intelligence in the urban material structures creates intelligent and smart environments that transform society.

*Vassileios Vescoukis, Anastasia Stratigea and Maria Giaoutzi* in the third paper elaborate on the prospective developments of teleworking, as these relate to the dynamics of ICTs developments. The paper presents various types of teleworking applications, linked to the evolving potential of technological developments; then discusses the evolving patterns of teleworking, followed by emerging trends and applications appearing at a macro and micro level with their prospective impacts; and finally explores the implications of teleworking on the restructuring of the social patterns.

*Kostas Tolidis and Efi Dimopoulou* in the fourth paper discuss the issue of land use planning and land policy making for mountain regions, which are regions with specific characteristics (natural, cultural, etc.), but also development constraints. Spatial decision making in such regions is characterized by complexity (semi-structured spatial decision problems) and multiplicity of problems. These indicate the need for qualitative information in support of the decision-making process, in order to improve effectiveness in decision making. Toward this end, they first present the state-of-the-art of MC-SDSSs and their significance as a planning tools for mountainous areas; second outline the multiple benefits from the use of Artificial Intelligence (AI) tools in the context of MC-SDSS for Multisite Land Use Allocation (MLUA) procedures applied in mountainous areas; and finally propose a MLUAL methodological framework as the core of a future MC-SDSS.

In the fifth paper, *Elpianna Emmanouilidi,* presents an environmental application, investigating land use changes of forests and semi-natural areas in the Greek region of Western Attica. Its objective is to estimate the spatial equilibrium distribution of individual deforestation actions and determine the degree of coordination in individual behaviour. For this purpose, the paper starts by creating a virtual economic network of 156 agents, by laying an ad hoc square grid over the region. Next, the dominant forest land use changes have been determined for each land parcel, using CORINE land cover maps for the years 1990 and 2000. The economic model used is a discrete choice model, with endogenous spatial interactions. Even though spatial interactions produce multiple equilibria, the present research proposes a two-stage fixed point estimator, yielding a unique solution. Empirical findings suggest that equilibrium deforestation actions are strategic substitutes for the environment and complements for agriculture, and are characterized by a relative lack of coordination in individual behaviour.

Following, the paper by *Ioannis Mazis and Michalis Sarlis* analyze the geopolitical impact that the Syrian crisis has on Lebanon. This impact is manifested in two forms: a subsystemic one (within the Syria-Lebanon subsystem) and a systemic

one (exerted from the system of the wider Middle East). The first refers to the direct repercussions that the increasing instability of the Syrian part has on the Lebanese part of the subsystem. The second form of impact refers to the indirect yet critical repercussions that the instability at the centre of the Middle Eastern system has on Lebanon.

In the seventh paper, *Evangelo Asprogeraka* and entitled "In search of the policy applied and spatial correlations of electronic Government applications in Greece". The author deals with the policy concerning the development of electronic governance (eG) applications and how their use is affected by and determines spatial correlations. The adopted methodology includes a bibliographical approach and a case study analysis based on the use of taxation electronic applications, particularly popular as eG applications, in Greece.

The next one paper is by *Shamsunnahar Khanam and Yuzuru Miyata,* entitled "New Industrial Structure Coping with the Economic Impacts of Shifting Production to Battery-based Electric Vehicles in Toyohashi city in Japan -A CGE Modeling Approach-". They support that the broad-scale adoption of the Battery-based Electric Vehicles (BEVs) could bring significant changes for our society in terms of moving the economics away from petroleum and lessoning the environmental footprint of transportation. In essence, this paper provides a computable general equilibrium (CGE) model to investigate the economic repercussion of BEVs production in the automobile industries, afterward suggests a new industrial formation to cope with the change of production system to BEVs in Toyohashi city in Japan

The ninth paper by *Nahid Hossain and Yuzuru Miyata*, entitled "Environmental Sustainability, Energy Use and Economic Growth: an Analysis of Toyohashi City Energy –Economy Interaction". This paper attempts to study the growth of Toyohashi city over time and resultant increase in consumption of electricity and gas. Another objective of the paper is to find features of effect of technological yield in use of energy. The results of the study show that manufacturing and trading sector of the economy are causing expansionary pressure on use of combustion energy. The study also finds that contribution of technology to reduce use of energy in production side of the economy yet a dormant factor. Hence, introduction of technology to ensure improved and efficient use of energy has been recommended by the findings of the paper.

The tenth paper by Ilias P. Vlachos and George P. Malindretos, entitled "Farm SMEs sustainability assessment based on Bellagio Principles. The case of Messinian Region, Greece". The purpose of this paper is the sufficient support of the sustainability of farm products embedded in a region (such as Products of Designated Origin / PDOs) to overcome significant obstacles to access domestic and remote markets. Main research question is how to overcome such inherent difficulties and transform them into challenges and opportunities to the new market environment

The final paper by *Charalampo Botsari and Vicky Vambaka,* entitled "Determinants of entrepreneurial behaviour: Are they amenable to change through a learning process?" is actually part of a new breed of papers that examines the role of the entrepreneurship within the global marketplace and as contributing to prosperity and economic growth at a national level. More specific, the authors try to provide a review of extant literature related to models of the determinants of entrepreneurial intention and behaviour, and to examine which of these determinants have been found to be affected by entrepreneurship education. A conceptual model of entrepreneurial intention and behaviour is also proposed.

Maria Giaoutzi
Anastasia Stratigea
Vasiliki Vamvaka
Christos Genitsaropoulos
RSI Journal

# Papers

# CAPACITY-ENHANCING AND LOW-GHG EMISSIONS INTELLIGENT TRANSPORT SYSTEMS (ITS) TECHNOLOGIES

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**Abstract**

*The focus of the present paper is on the role of Intelligent Transport Systems (ITS) in addressing road capacity issues, and delivering environmental benefits. For this purpose, three ITS technologies are selected: Driver Assistance Systems (DAS); Automated Highway System (AHS) for passenger traffic; and Commercial Vehicle Operations (CVO) for freight traffic, based on the profile of their characteristics and the projected implementation pathways. These are further evaluated as to their potential for improving the road capacity of the TEN-T European network; achieving fuel savings; and reducing $CO_2$ emissions.*

***Keywords***: *Intelligent Transport Systems, Driver Assistance Systems, Automated Highway System, Commercial Vehicle Operations, capacity improvement, $CO_2$ emissions reduction.*

***JEL classification*: R10, R11**

## 1. Introduction

Intelligent Transport Systems (ITS) constitute a primary Information and Communication Technology (ICT) that can increase safety, improve operational performance, particularly by reducing congestion, deliver environmental benefits and expand economic and employment growth (Commission of European Communities, European Commission). ITS applications can be grouped into the following categories: Driver Assistance Systems (DAS), Advanced Traveller Information Systems (ATIS), Advanced Transport Management Systems (ATMS), Cooperative Vehicle-Infrastructure Systems (CVIS), which enable the operation of the Automated Highway System (AHS), and Commercial Vehicle Operations (CVO). Within the wide spectrum of ITS systems, three technologies are selected, which are anticipated to emerge in the next decades in Europe and deliver infrastructure capacity and environmental benefits. More specifically are selected DAS and AHS for passenger traffic and CVO for freight traffic. The expected impact of DAS and AHS has been analyzed in a number of studies and reports. The impact of DAS applications on road capacity, traffic conditions and emission reduction is examined in Carslaw et al., Khayyam et al., Minderhoud, Zwaneveld and van Arem, while the implications for safety are studied in Wilmink et al., Baum et al., Abele et al. Capacity calculations under AHS implementations are provided in Carbaugh et al.], Godbole and Lygeros, Hall and Chin, Kanaris et al., and Michael et al. . Fuel efficiency of intelligent vehicles with cooperative communication potential within a vehicle fleet is studied in Manzie et al., Partners of Advanced Transit and Highways. The capabilities of CVO to optimize freight operations and reduce fuel consumption and truck emissions are presented in Crainic et al., Hall and Intihar, The Climate Group. Effects of general ITS on fuel consumption and $CO_2$ emissions are discussed in

The Climate Group, Klunder et al., Reinhardt et al., Ezell, while social acceptability issues are addressed in van Wees and Brookhuis, Petica et al., Haynes and Li.

The present paper contributes to the above literature in two ways. First it conducts an economic analysis of the three ITS technologies, based on the most probable implementation scenario for the time period 2012-2030. The costs associated with these technologies are the primary factor in determining social acceptability. Second, an assessment of capacity improvements, fuel efficiency and reduction of $CO_2$ emission is carried out.

The rest of the paper is organized as follows. Section 2 outlines the main characteristics of DAS, AHS and CVO technologies and their implementation pathways. Cost estimates including retail prices and yearly costs are derived in Section 3. Capacity improvements and reduction of $CO_2$ emission over the TEN-T road network are considered in Section 4. The main conclusions are summarized in Section 5.

## 2. DAS AHS and CVO Characteristics and Implementation Trends

In this section, the main characteristics of the three ITS technologies are presented and their respective implementation pathways in the time horizon 2012-2030 are delineated.

*Driver Assistance Systems (DAS)*

Driver Assistance Systems comprise a range of ICT in-vehicle systems, which support drivers in maintaining a safe speed and distance, driving within a lane and avoid overtaking in critical situations. They inform and warn the driver, provide feedback on driver actions, increase comfort and reduce the workload by actively stabilizing or maneuvering the car.

**Table 1**: DAS applications and status of implementation

| DAS application | Description | EU Market Introduction | Diffusion |
|---|---|---|---|
| Anti Blocking System (ABS) | Prevents the wheels of the vehicle from locking up while braking | 1978 | All new European vehicles |
| Electronic Stability Control (ESC) | Stabilizes the vehicle and prevents skidding | 1999 | All OEMs[a], but not in all lines. By 2012-2014 standard equipment |
| Emergency Call (eCall) | Automatically calls emergency services and transmits location data from the scene of an accident | 2003 (for premium cars) | Partially on market: BMW, Lexus. Optional, but may become mandatory |
| Adaptive Cruise Control (ACC) | Maintains a preset distance to the vehicle ahead and adjusts driving speed automatically | 2005 | Optional as comfort function Already available in the market: BMW, Audi, Lexus, Mercedes-Benz |
| Lane Departure Warning (LDW) | Warns the driver when the vehicle begins to move out of its lane (unless a turn signal is on in that direction) on highways | 2005 | Optional equipment sold as safety function. On market: on a number of vehicle models from Citroen to Mercedes-Benz. |
| Lane Change Assistant (LCA) | Continuously monitors the rear blind spots on both sides of the vehicle | 2005 | Partially on market: Audi, Volvo- warning and only small steering force Optional, as comfort function |
| Intelligent Speed Adaptation (ISA) | Constantly monitors vehicle speed and the local speed limit on a road and implements an action when the vehicle is detected to be exceeding the speed limit | 2006[b] | Several systems for speed limit advice are available May become mandatory already installed in BMW |
| Collision Avoidance System (CAS) | A sensor, installed at the front end of a vehicle, scans the road ahead for vehicles or obstacles. When an obstacle is detected, the system decides whether collision avoidance action is needed and a manoeuvre is undertaken | After 2015 | Optional as safety function with potential to become mandatory. |

Table notes: [a] OEM: Original Equipment Manufacturer
[b] As warning function-based on digital maps. After 2015: as an adaptive function.

Table 1 describes each DAS application examined in this paper, along with its market introduction and current status in Europe (Commission of European Communities, Wilmink et al., Abele et al., Department for Transport, Mercedes Benz, BMW, European Commission). Most DAS are currently offered as a 'comfort function' and are optional on luxury passenger cars, while some have the potential to become mandatory standard equipment in European cars in the coming decade. The implementation of DAS results in a first-generation 'intelligent' vehicle, which can operate both in urban and highway environments and provides a driver aid through look-up displays of recommended speeds or routes. The DAS technology is mature and already exists in the European car fleet in the form of driver advisory systems providing guidance, warnings and alerts to drivers (passive form of DAS). At a later stage, active DAS systems, which intervene and automatically control the vehicle, are expected to become available on passenger cars.

*Automated Highway System (AHS)*

AHS combine the use of in-vehicle devices with wireless communications between vehicles and infrastructure. In this way, AHS represents a complete driver replacement system, where driving is computer-controlled. Vehicles can organize themselves into platoons and be linked together in communication networks, which allow the continuous exchange of information about speed, acceleration, braking and obstacles.

To provide a safe and driverless driving, platoon operation is enabled by the use of three different control systems. A longitudinal control system maintains speed and spacing accuracy between the vehicles through the use of radar and radio communication between cars. This system enables short spacing between the cars and thus increases highway capacity, while the maintenance of a constant speed of the platoon leads to a smooth ride. A lateral control system (or steering control system) uses sensors, placed on the infrastructure and the vehicles and aims to keep the vehicle within the dedicated lane. Finally, a fault management system detects and handles failures in the sensors on the vehicles. As a result, in case of a detected failure in a vehicle, the fault management system is activated and puts under control the other cars of the platoon to avoid a crash.

In general, ITS implementation on passenger cars is currently based on in-vehicle technology. It is expected that future ITS applications will be based on a combination of in-vehicle and infrastructure technology, which may slowly evolve to an initial form of AHS. For this purpose, infrastructure providers need to cooperate with vehicle manufacturers and ITS developers to achieve a wider implementation of AHS. However, the potential form of platoons operating in an AHS is not expected to materialize before 2030, as several challenges associated with interoperability, standardization and social acceptability need to be resolved for a wide implementation. The lack of interoperability of ITS, especially for infrastructure-based applications, developed at local or regional levels, prevents the use of ITS across borders or national domains. EU intervention is therefore required to address interoperability and standardization issues. If no new policy is adopted, the above challenges may hamper the wider uptake of ITS.

*Commercial Vehicle Operations (CVO)*

CVO systems incorporate the use of a range of equipment, including roadside equipment, databases, and in-vehicle transponders or other tags. In this paper, Electronic Credentialing, Electronic Screening and Clearance and Fleet Management Systems are considered. In general, CVO applications have already been installed in several European regions, showing a wide variation of implementation. It is expected that some initial penetration of CVO in freight transport sector may be achieved within the next 5 years to meet European demand, while full potential is expected only after 2020. Current initiatives in Europe include e-freight which encompasses the use of ITS in order to minimize paperwork and unproductive processes, lower costs and enhance freight operations (Commission of the European Communities]). The main barriers that could slow CVO deployment include the lack of interoperability, the shortage of technically trained employees within the industry and the lack of a complete digital road map for all major European cities and the Trans-European road network (Hall and Intihar).

Based on the above considerations, the potential evolution of DAS, AHS and CVO will most likely take the form of Figure 1.

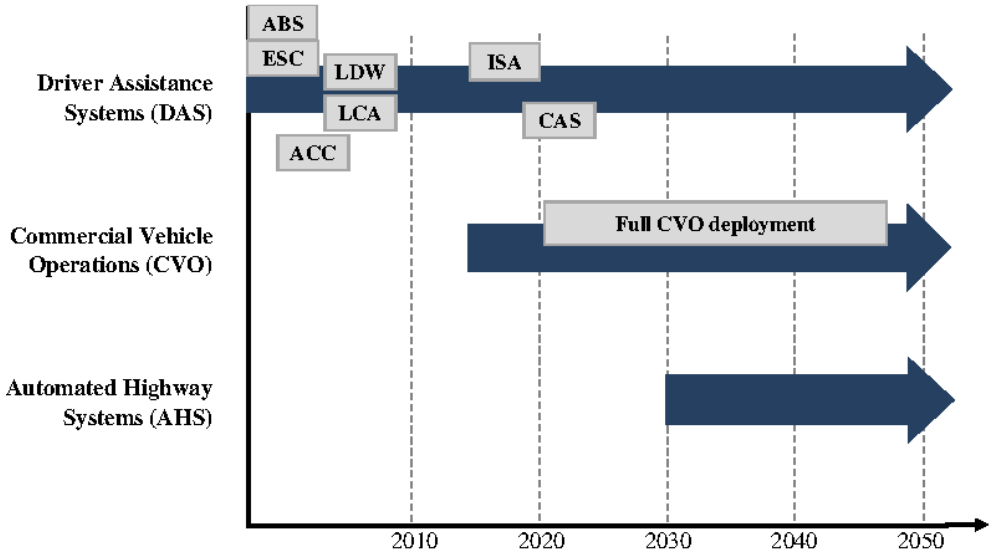


**Figure 1**: Evolution of DAS, AHS and CVO applications over years

## 3. Cost Estimates and User Acceptability

The initial acquisition cost of the three ITS technologies and their yearly costs constitute an important factor in the purchasing decision of consumers. In this section, we assess the retail price of intelligent vehicles along with their yearly costs and compare them with existing vehicles.

**Table 2**: Reference system characteristics

| Characteristics | Reference Passenger Car | Reference Heavy Duty Truck |
|---|---|---|
| Payload | - | 25 tn |
| Fuel type | Petrol | Diesel |
| Fuel Consumption | 6.2 lt/100km | 12.8 lt/1000 tn-km $_{(100\% \text{ utilization})}$ |
| $CO_2$ Emissions | 145gr/km | 40.4 gr $CO_2$/tn-km |
| Retail Price | 16,500€ | 67,000 € |
| Capital Costs | 660€/year | 2,680 €/year |
| Depreciation | 1,650€/year | 6,700 €/year |
| Operating costs (excluding fuel) | 1,260€/year | 7,005 €/year |
| - Maintenance | 0.049€/km<br>735€/year | 0.039 €/km<br>3,900 €/year |
| - Tires | - | 0.013 €/km<br>1,300 €/year |
| - Parking and tolls | 0.013€/km | 0.008 €/km<br>800 €/year |
| - Insurance | 330€/year | 1,005 €/year |
| Yearly Costs (excluding fuel costs) | 3,570€/year | 16,395 €/year |
| *Average annual distance traveled* | 15,000 km/year | 100,000 km/year |

For comparison purposes, we take the average new European passenger car and the average new European heavy duty truck, operating within the EU-27 road network as a reference baseline. The main characteristics of the reference vehicles are summarized in Table 2 above.

The EU-27 road network is represented by the Trans European (TEN-T) network. The distribution of highway lanes over the network is important for the assessment of AHS platoon operations. It is depicted in Figure 2. Highways with three lanes per direction constitute the majority with a share of 51%. Highways with 3-4 lanes per direction follow, with a share of 15%.

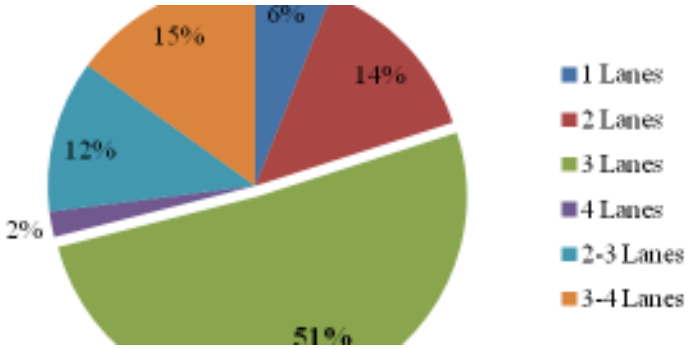


**Figure 2**: Lane distribution over the TEN-T network

The retail price of the reference vehicle is given by the manufacture recommended price, excluding Value Added Tax. Yearly costs are given as the sum of capital costs, depreciation and operating costs (including maintenance, tires, parking and tolls and insurance and excluding fuel costs) and can be expressed by the following equation:

$$\text{Yearly costs} = CC + D + O = r \cdot I + I/n + O \quad (1)$$

where CC is Capital Costs [€/year], D is Depreciation [€/year], O denotes Operating Costs [€/year], r is discount rate (equal to 4%), I is the initial investment-retail price of the vehicle [€] and n is the vehicle lifetime (equal to 10 years). Insurance costs are assumed to be 2% of the retail price of a passenger car and 1.5% of the retail price of a truck (Psaraki and Pagoni and).

In-vehicle ITS devices are add-ons to the purchase price of a vehicle. The retail price of the intelligent vehicle consists of the retail price of the reference vehicle and the extra unit costs to obtain and integrate the appropriate ITS applications. Cost data for ITS applications were derived from several sources (Wilmink et al. , Baum et al., Research and Innovative Technology Administration) and, then, special effort was made to specify which elements are used by the proposed technologies. The ITS elements that are assumed to be used for DAS, AHS and CVO operations are given in Table 3, along with their unit costs and maintenance costs. Unit costs represent the costs for obtaining ITS components plus the costs for integrating them on the vehicle. An effort has been made to assess components that have already been installed on the vehicles for other purposes (such as DAS) and can be re-used for AHS as well, and components needed only for AHS. The cost estimates for DAS equipment are rough, as DAS systems are typically bundled, while other technologies are rarely installed as a standalone option.

Yearly costs of ITS-equipped vehicles are calculated the same way as for the reference system (based on equation 1). Analysis of individual annualized costs, such as capital, depreciation or operating costs is given in Table 4. Capital and depreciation costs will increase after ITS deployment, as they are directly related to the retail price of intelligent vehicles. Operating costs are also expected to increase. For example, maintenance costs for intelligent vehicles are higher due to the maintenance of the extra ITS elements (see Table 3). For AHS-equipped cars, maintenance costs are expected to increase by

25 €/year. For CVO-equipped trucks, extra costs of about 400 €/year are expected due to the maintenance and repair of the CVO elements. However, it is assumed that other maintenance costs of trucks are about to decrease by 10% in comparison with the reference system, due to their better performance, resulting from fleet management systems. Costs for tires, parking and tolls are assumed to be constant for trucks after CVO installation. Costs for tolls, in the case of AHS, are assumed to be about 10% higher to account for the additional AHS infrastructure investments and maintenance. Insurance costs, which are given as a constant percentage of the retail price of the vehicle (2% for passenger cars and 1.5% for trucks), are expected to increase. Annual insurance costs of AHS compatible vehicles will reduce, because the accident rates will decline as a result of AHS operations, provided liability issues are properly addressed by legislation.

**Table 3**: Unit costs and maintenance costs for DAS AHS and CVO in-vehicle elements

| | Unit costs [€/vehicle] | | | Maintenance Costs [€/vehicle/year] |
|---|---|---|---|---|
| | Average | Minimum | Maximum | |
| ***DAS ELEMENT*** | | | | - |
| Electronic Stability Control (ESC) | 150 | | | - |
| eCall | 60 | | | - |
| Adaptive Cruise Control (ACC) | 120 | 80 | 160 | - |
| Lane Departure Warning (LDW) | 300 | | | - |
| Lane Change Assistant (LCA) | 225 | 150 | 300 | - |
| Intelligent Speed Adaptation (ISA) | 230 | | | - |
| | | | | |
| ***AHS ELEMENT*** | | | | |
| Communication Equipment | 190 | 130 | 260 | 5 |
| GIS Software | 120 | 100 | 140 | 0 |
| Sensors for Lateral Control | 350 | 290 | 410 | 10 |
| Sensors for Longitudinal Control | 190 | 140 | 240 | 5 |
| Advanced Steering Control | 200 | 180 | 220 | 5 |
| **TOTAL COSTS FOR AHS** | **1,050** | **840** | **1,270** | **25** |
| | | | | |
| ***CVO ELEMENT*** | | | | |
| Electronic Tag | 410 | 300 | 510 | 8 |
| Communication Equipment | 1,090 | 740 | 1,450 | 6 |
| Central Processor and Storage | 190 | 140 | 230 | 4 |
| Differential Global Positioning System (DGPS) | 680 | 300 | 1,070 | 215 |
| Cargo Monitoring Sensors and Gauges | 120 | 80 | 160 | 12 |
| Electronic Cargo Seal Disposable | 10 | 5 | 15 | 0 |
| Autonomous Tracking Unit | 330 | 200 | 465 | 164 |
| ***TOTAL COSTS FOR CVO*** | **2,800** | **1,800** | **3,900** | **400** |

The resulting cost estimates are presented in Table 4 and Figure 3. Table 4 indicates a moderate increase of the vehicle's retail price (about 6.4% for passenger cars and 4.2% for trucks) after ITS implementation. Operating costs are also increased. However, these additional costs are not much higher than those of a conventional vehicle. Yearly costs (excluding fuel costs) are increased by 6% for AHS cars and 2.7% for CVO-equipped trucks in comparison with conventional vehicles.

Since fuel costs represent high percentages of yearly costs, especially for reference trucks (see Figure 3), the fuel economies offered by the technologies should be taken into account. Fuel consumption data for the reference (see Table 2) and ITS-equipped vehicles (see Table 5) are considered. Annual mileage for conventional and intelligent vehicles is assumed to be the same (given in Table 2). About 35% of the trips of AHS cars are inter-urban and are carried out on highways. An additional 15% corresponds to trips within urban areas over three-lane freeways, which can accommodate AHS-equipped cars. Based on these rough estimates, which vary between countries, we assume that 50% of the annual mileage is potentially

done on roads over which AHS will be implemented. Finally, fuel prices in EU-27 during base year were assumed to be: 1.33 €/lt for petrol and 1.25 €/lt for diesel. Table 4 gives a comparison of the yearly costs with and without fuel costs, for reference and ITS-equipped vehicles. The implementation of CVO in trucks results in a reduction of yearly costs (including fuel costs) of 10.6%. The yearly costs (including fuel costs) of AHS cars are only 1.9% higher than the reference cars. We conclude that ITS technologies offer significant savings in fuel consumption in comparison to the average new European car. These savings are estimated to 10% for AHS cars and 16% for CVO trucks.

Besides cost, other factors that influence consumers' decisions to purchase ITS systems include driver safety and comfort, privacy, and liability issues. Each of these factors and behavioural impact are discussed next.

**Table 4**: Cost estimates for AHS and CVO

| | **PASSENGER CARS** | | | **HEAVY DUTY TRUCKS** | | |
|---|---|---|---|---|---|---|
| | **Reference** | **AHS** | **$\Delta_{(ref-AHS)}$** | **Reference** | **CVO** | **$\Delta_{(ref-CVO)}$** |
| **Retail Price** | **16,500** | **17,550** | **+6.4%** | **67,000** | **69,800** | **+4.2%** |
| Capital costs (€/year) | 660 | 700 | +6.1% | 2,680 | 2,790 | +4.1% |
| Depreciation(€/year) | 1,650 | 1,755 | +6.4% | 6,700 | 6,980 | +4.2% |
| Operating Costs(€/year) | 1,260 | 1,330 | +5.6% | 7,005 | 7,055 | +0.7% |
| *- Maintenance(€/year)* | 735 | 760 | +3.4% | 3,900 | 3,910 | +0.3% |
| *- Tires(€/year)* | - | - | - | 1,300 | 1,300 | 0% |
| *- Parking & Tolls(€/year)* | 195 | 220 | ~+10% | 800 | 800 | 0% |
| *- Insurance(€/year)* | 330 | 350 | +6.1% | 1,005 | 1,045 | +4% |
| **Yearly Costs (€/year) (excluding fuel costs)** | **3,570** | **3,785** | **+6%** | **16,395** | **16,830** | **+2.7%** |
| Fuel Costs (€/year) | 1,240 | 1,115 | -10% | 40,000 | 33,600 | -16% |
| **Yearly Costs (€/year) (including fuel costs)** | **4,810** | **4,900** | **+1.9%** | **56,395** | **50,430** | **-10.6%** |

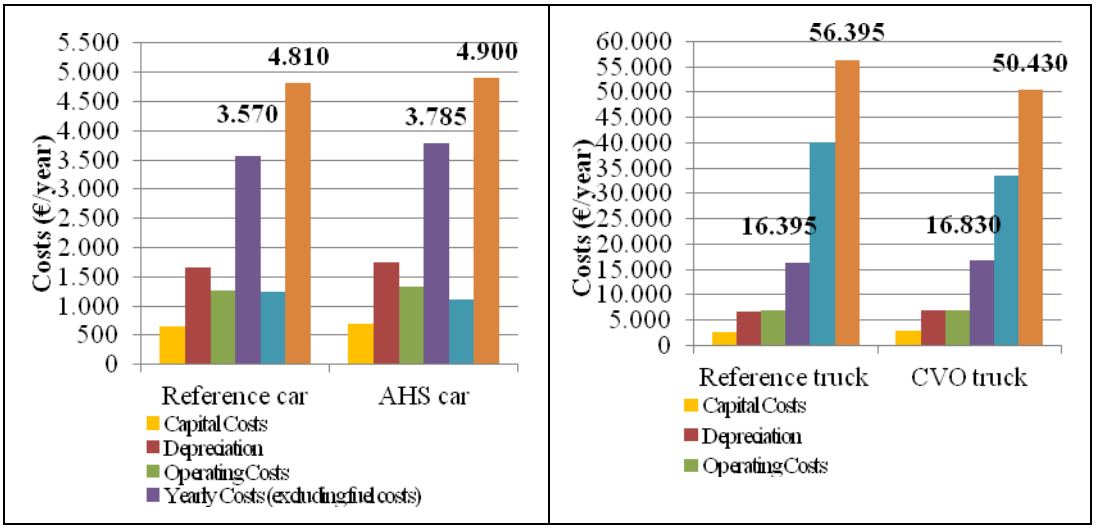


**Figure 3**: Annualized vehicle costs prior and after ITS (AHS or CVO) implementation

*Passenger/Driver safety and comfort*: DAS, AHS and CVO technologies are anticipated to play a significant role in improving road safety. DAS applications such as CAS, ACC, ABS and LDW alert the driver to take action if hazardous conditions are detected or, if no action is taken, they intervene and take over control. ISA and ACC adapt vehicle's acceleration and deceleration and reduce the probability of collisions, often caused by unstable traffic flow, leading drivers to apply high decelerations (Halle). The AHS control systems - longitudinal, lateral and fault management systems - can implement automatic recovery maneuvers to ensure the platoons' safety in the presence of failure, affecting the vehicles and their environment. Furthermore, in case of a failure affecting a vehicle in the platoon, the system is designed to take actions and allow the vehicle to leave its platoon without any hazard (Hamouda et al. ). CVO deployment is also expected to enhance freight transport safety. On the negative side, the use of on-board ITS devices may overload the processing capabilities of drivers and distract them from their primary driving task and create dangerous situations (Hancock and Parasuraman, Golias et al.). Researchers at Ford (Faber) (cited in Haynes and Li) have noted that the average driver does not want to be bothered more than three times in adjusting in-vehicle equipment. In other circumstances, drivers using ITS may have false expectations from their assisting function and adapt unexpected driver behaviour (less alertness and over-expectations), which could eliminate positive safety impacts (van Wees and Brookhuis). At an initial phase of AHS implementation, drivers may feel uncomfortable in a driverless car. The loss of control and the small headways achieved in an AHS may lead to inconvenient driving (Petica et al., de Vos and Hoekstra). There should be an adaptive period after initial implementation, so that drivers get used to the new technologies.

*Privacy*: A number of ITS applications such as eCall, ISA, AHS and CVO implicitly require collection and exchange of traffic data that could raise privacy concerns. These need to be addressed by European regulation.

*Liability*: Liability aspects are mainly attributable to ITS applications (for example ACC, AHS, CAS) that take over control from the driver in critical situations. If the boundaries of responsibilities among vehicle manufacturer, driver, ITS developer or roadway authority are not clearly defined in case of an accident, potential customers may not be willing to pay for the ITS application or service, or vehicle manufacturers may not be willing to sell vehicles with unsolved liability aspects.

Under the assumption that privacy and liability issues are successfully addressed by regulation at the European level, the above analysis and the finding of the experts' survey (Psaraki and Pagoni,) demonstrate that the three ITS technologies hold good promise in terms of user acceptability and should lead to substantial market penetration of ITS applications and services in the next two decades.

## 4. Improvements in Capacity and $CO_2$ Emissions

In this section gains offered by DAS, AHS and CVO in terms of capacity, fuel efficiency and emissions reduction are estimated. Under ideal traffic and geometric conditions, highway capacities can be as high as 2,400 vehicles per hour per lane (veh/h/l). In practice, a 75-80% of the theoretical value should be taken as a realistic figure (Featherstone and Lowson [**Error! Reference source not found.**]), resulting in lower capacities of about 1,800 veh/h/l.

To determine the gains in capacity and emissions, three evolution trends need to be determined: (i) growth of traffic demand, (ii) growth of transport related $CO_2$ emissions, (iii) fuel prices increase.

From 1995 to 2008, passenger kilometers operated by passenger cars went up by 21.4% (approximately 1.5% per year). This was accompanied by a high growth of motorization in Europe, which grew from 380 to 470 cars per 1,000 inhabitants between 1995 and 2008, an annual average of 2 %. The increase of the number of tonne-kilometres transported by road reached 39%. Apart from the bottlenecks in several European corridors, the intense growth of road traffic led to an increase of transportation related $CO_2$ emissions. Based on EU statistics, the amount of $CO_2$ emissions due to road transportation went up by 18% from 1995 to 2007. Finally, fuel price increase is a critical factor for road users, as it adds up to vehicles' operating costs. Despite the variability in automotive diesel oil prices, between 2001 and 2008 prices went up to 48% (European Union [**Error! Reference source not found.**]). Figure 4 presents the evolution of these indicators in EU-27 since 1995.

The European road network expanded to support the trends illustrated in Figure 4. However, it was also recognized that any increase in road capacity, achieved by constructing new highways, provides only temporary relief from traffic congestion, while imposing a high financial and environmental cost. ITS technologies emerged as an alternative for addressing road capacity issues, while at the same time delivering environmental benefits.

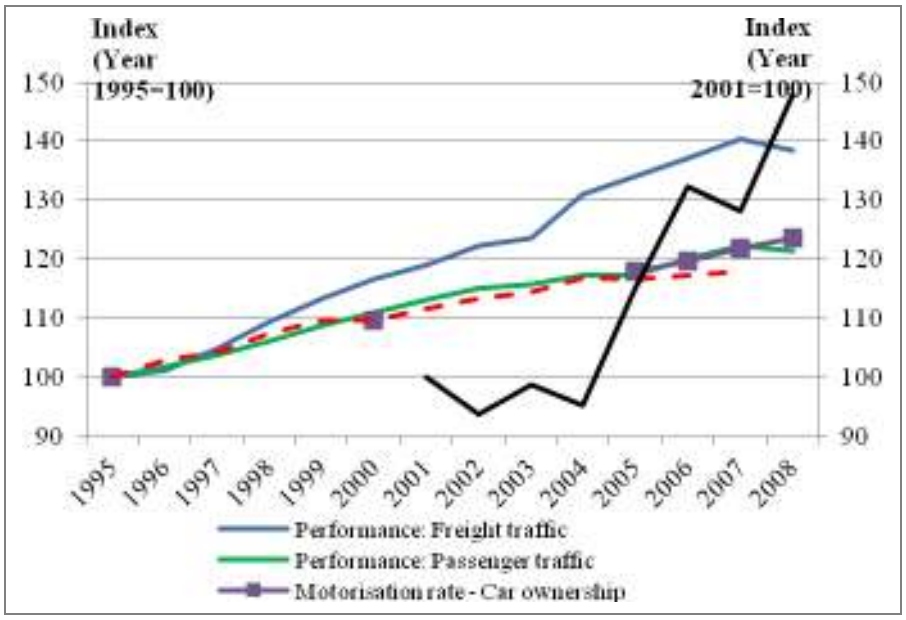


**Figure 4**: Indicators for EU-27 road transportation

Capacity enhancement is achieved mainly through speed and headway adjustment. DAS applications that affect longitudinal control of the vehicles (such as ACC and ISA), have direct effect on road capacity through the decrease of headways and the reduction of accelerations and decelerations. Thus, traffic flow is smoother in comparison with manual traffic. VanderWerf et al. indicate that if 100% of vehicles in a road network are equipped with cooperative ACC, the road may carry twice as many vehicles. ISA keeps the traffic flow more homogenized and thus can increase total throughput by 5% (Vanderschuren). Capacity improvements of about 7-8%, in comparison with manual driving conditions due to the

decrease of headway are reported by Zwaneveld and Van Arem, depending greatly on the penetration rate and the headway setting. If we consider that manual driving results in capacities of 1,800-2,400 veh/h/l, driving with DAS would achieve maximum capacities of 1,900-2,600 veh/h/l. Nevertheless, Minderhoud indicates that DAS applications, such as ACC, offer an increase of road capacity only under strict conditions on market penetration and use. Other DAS applications, such as eCall, contribute to capacity enhancement through safety improvements. Usually, road accidents impede the flow of traffic until rescue services have provided first aid to the accident victims and the police have documented the incident. DAS limit accident severity or improve the efficiency of the rescue chain. Thus the accident site is cleared more quickly and congestion is relieved.

Capacity improvement is much higher with AHS applications. Distances between fully automated vehicles are significantly reduced until they reach the minimal safe distance. This results in more vehicles in a given lane. For example, a study of PATH research program (Partners of Advanced Transit and Highways) describes an eight-car platoon with fixed separation distance of 6.5 meters at all speeds up to full highway speed. Other studies (Michael et al., Tsao et al.) report even shorter intra-platoon spacing, significantly depending on the relative velocity. Higher speeds require larger headway and thus lead to small capacity increase. In addition, AHS stabilizes traffic flow and provides the vehicles with conditions of constant cruise speed. Thus, traffic equilibrium can be reached avoiding stop-and-go operations and inefficiencies caused by inattentiveness, merging, weaving, and lane changing (Halle). Studies that have simulated automated highway capacity have resulted in capacities up to 8,000 veh/h/l. This high capacity corresponds to 16-vehicles platoon, with a vehicle length of 5m and intra-platoon spacings of 0.1 seconds (Featherstone). We suggest that this theoretical value is reduced by 20-25% to account for the entry and exit of vehicles to and from the dedicated AHS lane. Then we obtain capacity values of 6,400 veh/h/l.

The level of capacity improvement strongly depends on the platoon size, the intra-platoon (between vehicles) and inter-platoon separations, the vehicle mix, the length of the trip operated in the platoons and the frequency with which vehicles enter and exit platoons. Platoon size may vary from 5 to 20 vehicles per platoon. The size of the platoon is constrained by the need to achieve communication between the platoon leader and all its followers in the platoon (Tsao et al.). With regard to vehicle mix, introducing even small percentages of trucks or buses to the flow of passenger cars can significantly reduce the achievable capacity because of the poorer performance of heavier vehicles. For example, mixing of different classes of vehicles reduces capacity by about 11% in the case of mixing 2.5% buses and 2.5% trucks with passenger vehicles, and by about 23% for 5% buses and 5% trucks (Kanaris et al.). Finally, the length of the trip operated in AHS is significant for determining capacity improvement, with short trip lengths and frequent entries and exits limiting capacity gains. Our calculations consider that AHS is implemented in 50%-60% of the high priority corridors of European highways, where drivers intend to travel long distance trips and one lane is dedicated for AHS operations.

Fuel efficiency is improved by the potential of DAS applications to reduce vehicles' accelerations and decelerations and smooth traffic flow. The positive effects of ISA on the environment are due to the reduction and homogenization of driving speeds. Likewise, ACC maintain constant speed and make 'speed-ups' and abrupt braking unnecessary. For other DAS such as eCall, LDW, LCA, reduction of $CO_2$ emissions comes as a side effect of safety improvements and congestion reduction. Accidents are reduced and queue formation is avoided, reducing the amount of congestion and emissions generated (Klunder et al., The Department of Transport). ISA deployment can achieve a 2-5% reduction of $CO_2$ emissions (Carsten and Fowkes, Goodwin et al., Regan et al.). For ACC, 0.5-10% $CO_2$ emissions reduction is reported (Klunder et al., Mercedes Benz, Halle, Liang and Peng). Other DAS applications such as ABS, show no clear potential on fuel consumption and $CO_2$ emissions. For this reason, the lower bound on fuel consumption and reduction of $CO_2$ emission by DAS is set to zero in Table 5.

Apart from the ability of the longitudinal control of the AHS to reduce the severity of accelerations and decelerations and create smoother traffic flow, fuel burnt reduction may come as a result of the unique platoon configuration. Short spacing between platoon vehicles, produce a significant reduction in aerodynamic drag for all of the vehicles, both leader and followers. An estimate of 15-25% reduction in fuel consumption and $CO_2$ emissions is possible with the implementation of

AHS (Partners for Advanced Transit and Highways, Browand and Michaelian). The reduction of delays and elimination of stops achieved by CVO may contribute to an average 16% reduction in fuel burnt and transport emissions (The Climate Group, Reinhardt et al.).

Table 5 summarizes the capacity and environmental benefits provided by the DAS, AHS and CVO deployment. The minimum and maximum values support different modeling assumptions. The overall gains strongly depend on the penetration levels of these technologies.

**Table 5**: Capacity and environmental benefits of ITS

| | Capacity (veh/h/l) | | | Fuel consumption & $CO_2$ Emissions Reduction [(a)] | | |
|---|---|---|---|---|---|---|
| | Average | Minimum | Maximum | Average | Minimum | Maximum |
| **DAS** | 2,000 | 1,900 | 2,600 | 5% | 0% | 10% |
| **AHS** | 4,300 | 4,300 | 6,400 | 20% | 15% | 25% |
| **CVO** | | No direct effects | | 16% | 6% | 26% |

*[(a)] These percentages apply to both fuel consumption and $CO_2$ emissions reduction. There is a direct and proportional relationship between fuel consumption and $CO_2$ emissions. An improvement in terms of fuel efficiency would be immediately translated into a reduction of $CO_2$ emissions and vice versa (when related to road traffic and fossil fuel) (Reinhardt).*

## 5. Conclusions

In this paper DAS, AHS and CVO have been considered. Retail prices and yearly costs were estimated and factors influencing user acceptability were discussed. Capacity gains over the TEN-T road network, fuel savings and reduction in $CO_2$ emissions were presented. Cost estimates indicate a 6.4% increase of the vehicle's retail price for passenger cars and 4.2% for trucks. Yearly costs of intelligent vehicles excluding fuel costs rise by 6% in the case of AHS cars and 2.7% in the case of CVO-equipped trucks. The inclusion of fuel costs reduces yearly costs by 10.6% in comparison to conventional trucks. In the long term, AHS is the most promising technology, offering an average of 20% reduction in $CO_2$ emissions. Highway capacity on AHS lanes is estimated to be 6,400 veh/h/l, when the reference capacity is 1,800 veh/h/l.

The advantages offered by ITS require wide adoption rates. High penetration mandates resolution of interoperability, privacy and liability issues with appropriate legislative initiatives at the European level.

**Acknowledgements**

This study was carried out as part of TOSCA (Technology Opportunities and Strategies towards Climate friendly trAnsport) research project, which was funded by the European Commission, 7th Framework Programme (www.toscaproject.org).

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# CYBERSPACE AND THE TRANSFORMATION OF CITIES TO CYBERCITIES: A TRIALECTIC APPROACH

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**Abstract**
*The present paper elaborates on the major transformation processes of a city into a cybercity and the process of embedding the virtual into the real. The paper aims to shed light on the integration of human capabilities (intelligence, imagination, creativity) by use of ICTs applications that drive processes, which transform the city of geography and place into a hybrid: the cybercity. The emerging cybercity expands beyond its traditional geographical boundaries of place, embracing a new digital virtual space, which is placeless and timeless. At the same time, the embedding of human intelligence in the urban material structures creates intelligent and smart environments that transform society.*

***Keywords***: *Cyberspace, cybercity, digital virtuality, transformation, trialectic, virtual*
***JEL classification*: R10, R11.**

## 1. The Nature of Cyberspace

Modern cities, like human society as a whole, are ceaselessly transformed. Human beings and ICTs emerge as the two main factors involved in this type of transformation that is most visible in the modern urban environment. Establishing a scientific explanation as to the nature of the transformation of cities into cybercities, due to the embedding of cyberspace in society, is a very difficult task, mainly because some of the major processes of transformation are extremely complex and transparent.

The use of proper analytic tools (e.g. Trialectics) can reveal part of these hidden transformative processes that underpin all (epi)phenomena related to cyberspace, thus aiding to a better understanding of the true nature of a cybercity.

Even though generally the terms ICTs and cyberspace are used interchangeably, there exists a small, but significant, difference between the two. The ICTs constitute only a part of the totality that is called cyberspace. Cyberspace incorporates not only digital, electronic, and photonic technologies, but also human beings and their attributes (thoughts, knowledge, dreams, intentions, feelings, etc.). As a whole, cyberspace is larger than the sum of its parts, because it includes an infinite number of possible connections and relationships on various levels of existence (e.g. economic, political, scientific, and cultural). Yet the question remains: what is cyberspace?

People like Richard Coyne [4], see cyberspace as a matrix of infinite dimensions, created when the real and the virtual come together. All actions using ICTs are embedded within cyberspace, including all virtual/potential reality.

Similarly, Downing et al. [8] describe cyberspace as being that part of human society, which exists in the networked information systems rather than a specific geographical place.

A different interpretation is given by Sterling [27], who regards cyberspace's informational component as a type of space that exists somewhere out there, but not within the digital electronic/photonic machines or, even, between them (i.e. in the wires).

Closer to Sterling's view are the ideas of Cobb [3], Rushkoff [23], and Leary [17], who describe cyberspace as something enabling people to live in the virtual worlds of thoughts, ideas, and information as non-material entities, while leaving their bodies behind within a specific geographic location.

A common element to all the various definitions given above is that cyberspace is seen as something like an informational web or matrix embedded in social reality. Even though cyberspace becomes accessible mainly through

electronic/photonic devices, due to recent inventions, today people have the possibility to wirelessly connect to it through biophotonic and bioelectronic devices (e.g. biochips and biosensors) embedded within their bodies. The amazing advancements occurring in areas such as nanotechnology and molecular bioengineering could soon seamlessly integrate people to the global informational web. Having said that, is it really possible to accurately define cyberspace's basic structure?

The majority of the models, such as those proposed by Shields [24] and Groothuis [12], employ, directly or indirectly, outworn binary approaches. As a result, they describe cyberspace as made of two major components: (a) material/physical (e.g. cables, computers and satellites), and (b) non-material or informational (e.g. data). This binary way of thinking is witnessed in the way people refer to cyberspace by using phrases such as 'the world outside the wires' and 'physical city' (the material component), and terms such as 'the world within the wires', 'information city', 'e-city' and many others referring to the non-material informational component.

Even though other scientists suggest different (non-binary) models (Benedikt [1]; Dodge and Kitchin [6] and [7]; Graham and Marvin [11]; Kitchin [15]; Mitchell [20]), nevertheless, they disagree with the notion that a simple model or a single theory (e.g. feminism, Marxism, technological determinism, and postmodernism) will be able, by itself, to fully explain the complex phenomenon known as cyberspace. They regard the multifaceted embeddings within the material and the non-material structures to be creating a third category embracing the two other structures.

Therefore, cyberspace's synthetic and multifaceted embeddings can be regarded as a coming together or a coexistence between material (tangible) and non-material (intangible) structures that form a third category within cyberspace (Castells [2]; Crang et al. [5]; Dodge and Kitchin [6]; Graham and Marvin [11]; Heim [13]; Mitchell [20]).

The various rigorous scientific attempts made to untangle cyberspace's threads of meaning using binary models have failed, because they do not address the essential difference that exists between cyberspace's major components. The binary models impose a restriction to the depth of analysis due to the granularity of the binary analytic tool, which is too coarse. It reduces the complexity and ambiguity inherent in social life to a true/false, and on/off conflicting and opposing state (Lefebvre 1991: 38) [18].

Instead, and in order to achieve clearer results from the analysis, we employ a different approach based on Henri Lefebvre's trialectics (Lefebvre [18]). Lefebvre believes that the dialectic relationships still operate, albeit transformed, within his trialectic approach. In addition to the two categories present in a binary model, in trialectics the third category acts as a hybrid and a meeting place of the other two. It expands the domain of meaning, and enables the transcendence and coexistence of opposing and contradictory mind sets, thus giving rise to multiple ways of interpreting nature.

An example of the above can be clearly seen in the three aspects of space introduced by Lefebvre in his trialectics of spatialization (Figure 1), namely:

(a) Physical space, spatial practice (perceived);

(b) Mental space, representations of space (conceived); and

(c) Social space, representational space (lived).

Lefebvre insists that these three types of space are very different to each other. Even though they coexist and they are interdependent, only the third type of space, Social Space, is lived. In the process of spatialization described by Lefebvre, a complete analysis can only be done if, an only if, all three types of space are examined together.

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Similarly, by adapting Lefebvre's trialectic approach, and by applying it to the analysis of cyberspace's nature (Figure 2), we get the three fundamental components of cyberspace described as:

(a) Material or geographical (perceived)

(b) Non-material, virtual, mental or potential (conceived)

(c) Hybrid, cyber or embedded (lived)

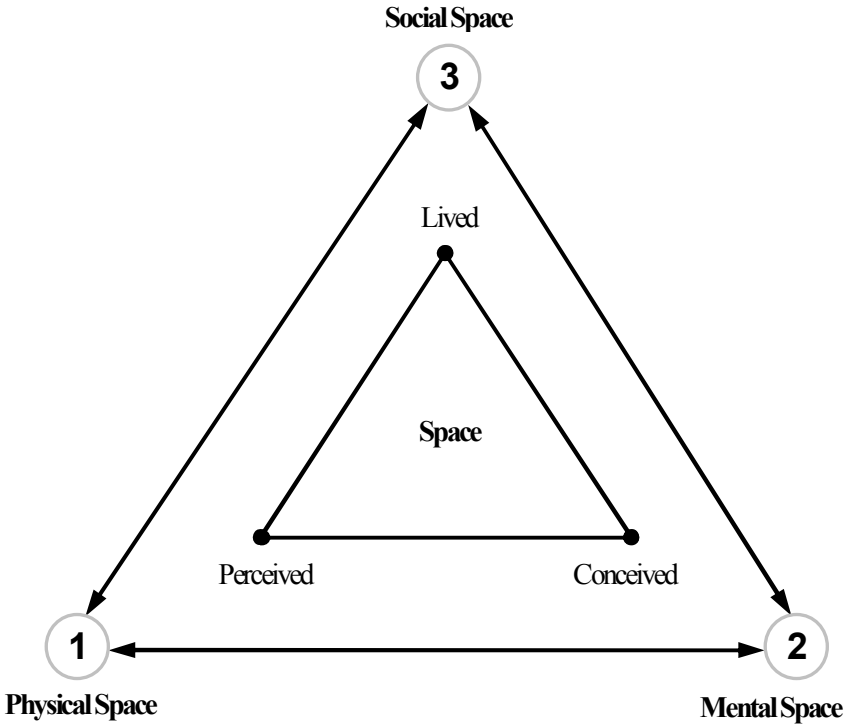


**Figure 1** – The three main structures of Space
(based on Henri Lefebvre's Trialectic)

If the above analysis is correct, then there is a very important meaning derived from the results: the third component is a hybrid, it is the result of the embedding of the virtual to the material, and it is the only one that is lived. This means that the other two components (geographical and virtual) could only be fully revealed through the existence of the third (cyber), and not in isolation. In other words, the true nature of cyberspace is (will be) revealed not simply through perception or conception, but when it is experienced in everyday life as a whole. Lefebvre, with regards to space, arrives precisely at the same result when examining the process of spatialization: the Physical and Mental types of space are experienced through the existence of Social Space, and never in isolation (Lefebvre [18]).

The above provide a very good theoretical foundation to expand our knowledge about cyberspace's nature and structure, arriving closer to its understanding. After all, as Stenger explains, it is not possible to fully define cyberspace because it is like the country of Oz 'it is, we get there, but it has no location' (Stenger 1991/1994: 53) [26].

Therefore, cyberspace can be considered as many things: another parallel Universe (Cyber-Universe) with different space-time characteristics (Benedikt [1]), an electronic networked space navigable through the use of cybernetic devices (Gibson [10]), and a Galactic Network within which, as Licklider believes, people will fully interact symbiotically exchanging information (Kleinrock [16]).

Even though cyberspace is anchored in geography, it cannot be completely mapped not due to the lack of knowledge or technological means, but because a part of cyberspace is non-material (i.e. information) and, therefore, it has no geographical structures (Dodge and Kitchin 2001: 259) [7].

**2. What is a Cybercity?**

In addition to the many different views of a city, depending on the way people experience specific parts of a city at a certain point in time, and by applying the same trialectic approach to the modern urban environment, the city unfolds its fundamental triple nature as:

(1) Material or Geographical City
(2) Non-Material or Virtual City
(3) Cyber City or Cybercity

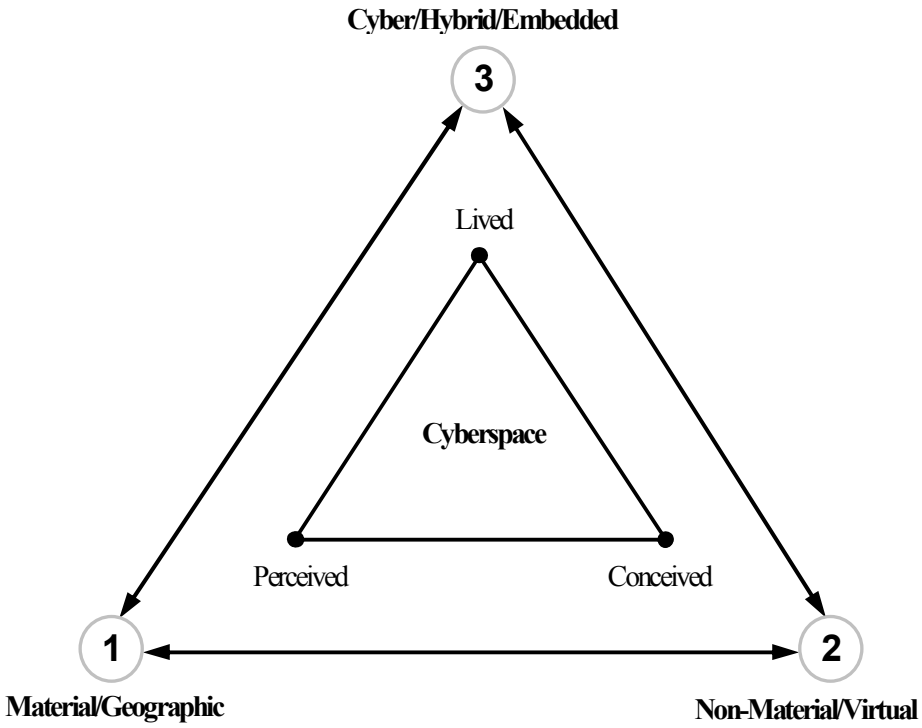


**Figure 2** – The Three Fundamental Structures of Cyberspace
(based on Lefebvre's Trialectics)

As is the case in Cyberspace, these three aspects are interdependent and interrelated (Figure 3).

(1) *The Geographical City* (sometimes incorrectly referred to as the Physical City) is the city that is bound by geography and it is the city of places and history. It is the city revealed by the human physical senses. Every phenomenon within the geographical city can be described through Einstein's space-time continuum model (three spatial dimensions and one temporal).

(2) *The Virtual City* is the city that is made of information and it does not represent a Geographical City (as a whole or in part). The spatial element within the Virtual City is not geographical, but it is programmed to simulate the three known spatial dimensions. This is not a *city of places*, because the term *place* implies a geographical location. Similarly, the temporal dimension is programmed to represent the temporal element within space-time continuum, as it is experienced in everyday life. *Alpha World* is an example of a Virtual City. In this category belong virtual digital imaginary environments, created for video and computer games, and movies such as the *Matrix*, and the planet *Pandora* in the film *Avatar*.

(3) *The Cyber City* is the city created through the embedding of the Virtual into the Geographical. It is a meeting place between the material structures and the non-material digital informational flows. This hybrid state enables it to accommodate complexity, ambiguity, and contradiction. It is that environment in which people experience their everyday life and it is permeated by cyberspace's *digital ether*.

It is significant to note that the cybercity is a hybrid entity, created through the embedding of the virtual in the geographical city of places. It is through the cyberspace's virtual component (i.e. digital virtual) that human spiritual properties (e.g. thoughts, desires, dreams, and intentions) are digitally codified and then embedded in the modern city.

Due to the virtual component's qualities, cybercities share three major characteristics. First, they are global. They spread beyond their geographic boundaries. Second, they are fluid. They are more like spaces of information flows rather than spaces of places (Castells [2]). Third, they cannot be completely defined by location. Part of a cybercity cannot be described in geographical terms, it exists somewhere that can be described as a non-geographic space, without places.

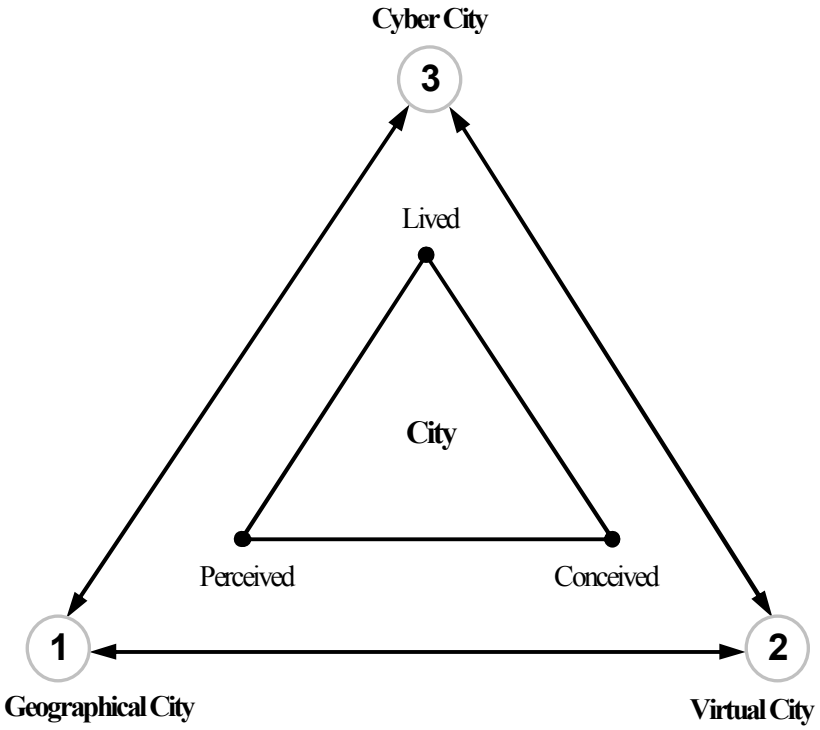


**Figure 3** – The Cyber City
(based on Lefebvre's Trialectic)

The creation of cybercities has not put a stop to the increase of urbanization. On the contrary, in some instances, it exacerbates the existing phenomenon of urbanization. Cities have not vanished as it was previously believed by people like McLuhan [19], Toffler [28], Virilio [29], and Negroponte [21]. Instead, it is estimated that by 2030, 80% of the World's population could be living in urban environments (<http://www.citymayors.com/>).

Therefore, it is important to understand the significant role of cybercities in the emergence of the information age. Conceptions and perceptions become the main threads used to weave the complex tapestry of social life, experienced within modern cities. The existence of cybercities signifies the incessant processes of transformation and creation of new forms, environments, and meaning.

**3. The Main Transformation Processes**

In the last decades, human society is undergoing a tremendous transformation that is becoming apparent not only from the changes occurring to the material/tangible human-made structures (e.g. buildings) but also, more importantly, from the ways people relate to their environment (i.e. through digital technology), and from their different way of thinking (e.g. socio-technological).

In this process of transformation the cybercity, both ontologically and epistemologically, becomes central because it is the result of the digital virtual embedded in the material/geographical city. There are two main transformative agents contributing towards a cybercity's globalization: human beings and cyberspace. This type of transformation embraces all social functions and structures: material, non-material, and people. Through these processes, human society transforms its habitat and, at the same time, it is transformed by it.

The rate of penetration and usage of ICTs-related social infrastructures and services in the city is fast increasing. Digital technologies and information are part and parcel of public and private services, such as electricity and telecommunication systems. Whereas the outside structures of a city that comprise its shell, such as buildings, do not change so quickly. This relative slow rate of change in the transformation of the shell of a city could give the false impression that the new paradigm of informationalism (Castells [2]) is not yet upon us. And, as a result, it could be inferred, incorrectly, that the cities of the 21$^{st}$ century are similar, or not significantly different, to those of the early 20$^{th}$ century.

The constant flow of digital information through the global communication network enables people from all over the globe to come together. The ICTs, instead of discouraging people from meeting face to face, in most instances, are assisting in the creation of the globalization of urbanization which, in turn, it changes the way people think and live, and experience themselves and their environment. Of course, ICTs are only one factor affecting the globalization of urbanization, people move to cities due to economic, cultural, and other reasons.

Therefore, the above do not simply refer to the transformation of material (e.g. tangible) structures, and the changes occurring to the forms and functions of urban environments. Most important, these changes signify a global cultural/spiritual transformation, creating a new human civilization based on digital information.

Cybercities are the places where the dawn of new techno-sciento-spiritual age is ushered, where intelligence, dreams, and desires could be materialized through the use of ICTs. For example, the embedding of human knowledge and intelligence as artificial intelligence does not only render cybercities intelligent but, through the expansion of human awareness, it brings closer the realization of new types of consciousness through the coexistence of biology and technology (e.g. cyborging).

It could be said that the major contribution of humanity and cyberspace to this expansion in awareness and this shift in consciousness could be organized in three main categories.

First the ICTs and cyberspace become, at the same time, symbolic and technological. As such, they enable people to produce new meaning and employ new tools, such as mobile technology and computers.

Second, the digital information constitutes an ever increasing component of the intangible digital matrix that underlies all communications within the global social web. Cyberspace's digital ether underpins the fabric of human society.

Third, the embedding of human psychological and spiritual attributes (dreams, wishes, desires, knowledge, intentions, intuitions, etc.) in the material socio-spatial and the non-material (e.g. ideological) structures, transform both human beings and society as a whole. Similarly, the digital virtual becomes part of the virtual/potential (εν δυνάμει)[1] world and by doing so it closely interacts with the human psyche.

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[1] Following in the footsteps of ancient Greek philosophers, like Aristotle, *εν δυνάμει* means that something exists as a *possibility* (*potency*), before it is materialized or actualized as a phenomenon by acquiring form within the phenomenal world.

Therefore, it is the transformation of space-time that lies at the core of the impact that the virtual/potential cyber-technologies have on humanity: social transformation occurring through spatio-temporal transformations (Kitchin 1998:15 [15]).

Edward Soja arrives at a similar understanding when he proposes that space-time, as a way of thinking and praxis, exists within the core of the modern society and that it becomes visible through the sensitivity and the actions displayed during the reconstruction of that society with respect to spatiality and spatialization (Soja 1989:173 [25]).

Based on the aforementioned, and using Lefebvre's trialectic approach, it is now possible to put forward a hypothesis regarding the major types of transformations occurring due to the emergence of cyberspace and ICTs, not only as tools but also as ways of changing ourselves and changing the material basis of today's society.

The three transformation processes due to cyberspace's embedding in society, as shown in Figure 4, are based on the cyberspace's three main components: Material, Non-Material, and Hybrid and they can be described as follows: (1) Materialization, (2) Spiritualization[2], and (3) Expansion of Consciousness/Awareness.

(1) *Materialization*. The shape giving potential existing within the non-material/invisible world (desires, thoughts, etc.) as it finds expression first through the digital virtual and then through material things.

(2) *Spiritualization*. The spiritual human qualities transform matter through the embedding of the digital virtual. An example of its effects is the transformation of material structures into what is usually referred to as *smart* or *intelligent*.

(3) *Expansion of Consciousness/Awareness*. Human consciousness emerges, expands, and is transformed within the social becoming as a result of the other two processes: Materialization and Spiritualization.

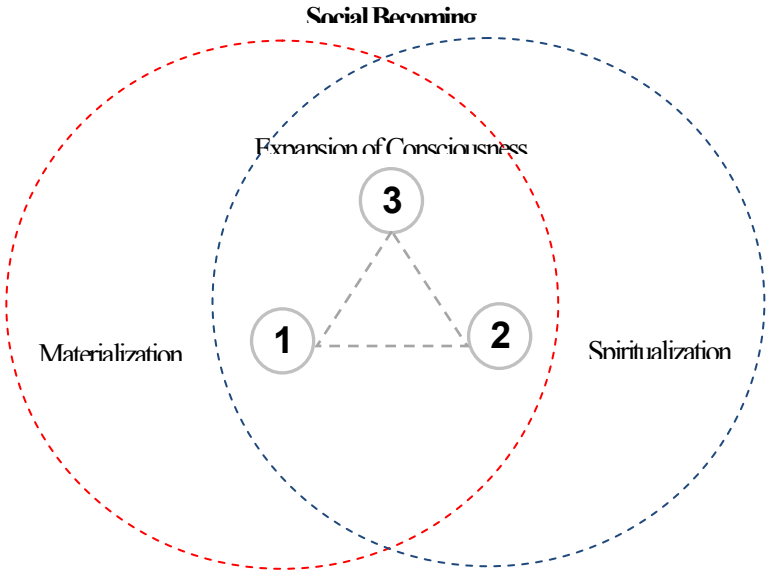


**Figure 4**: The three types of transformation

These three processes could be regarded as the three main phases in the major information flow affecting the whole of society on all social-spatial-temporal scales.

The term Spiritualization, as it is used here, relates to the ideas of people like Emmons [9], Noble [22], Zohar and Marshall [32], Vaughan [30], and King [14]. For example, Zohar and Marshall [32] define the term 'Spiritual Intelligence'

[2] The term *Spiritualization* refers to a type of enrichment and enhancement given to the form aspect of material reality through the use of human spiritual/cultural qualities. It is not simply a process of intellectualization or mentalization, but something much more.

(SI) as 'the intelligence through which we gain access to our deepest meanings, intentions, and highest motives'. Similarly King [14] believes that SI is 'a set of adaptive mental capacities based on non-material and transcendent aspects of reality'.

The idea of the existence of a non-material metaphysical reality is not a modern age construct, it originated thousands of years ago. For example, the ancient Greek philosopher Plato introduces such notions through his famous theory of Formless Forms, the world of ideas, which is also depicted through the Allegory of the Cave. Similarly, Aristotle in his book Metaphysics explains that matter, as the first substance (πρώτη ύλη), cannot be revealed by using the human physical senses because it is formless, a potential (εν δυνάμει) that underlies all physical reality.

Therefore, the idea of the virtual as potential (εν δυνάμει), which is central to the process of transformation as described above, is also not a new one. For example, for thousands of years, the virtual has been expressed through ceremonies, structures, and imaginary environments and, generally, it has been conceived as something linked to other spaces, dimensions, and domains. Shields [24], in his book 'The Virtual', gives a good enough explanation as to the meaning of the virtual when he explains that the dictionaries define this term

> *'as that which is so in essence but not actually so' […] More philosophically, the virtual captures the nature of activities and objects, which exist but are not tangible, not 'concrete'*. The virtual is real but not concrete (Shields 2003: 2) [24]

The aforementioned support the hypothesis presented in this paper that the relationship between the virtual and the real cannot be adequately defined by opposition/contradiction (because the virtual is also part of the real), nor by mirroring and representation (because elements that exist in one do not exist in the other). Instead, the relationship between the virtual and the real will be better understood if it is approached through the idea of their coexistence within a Greater Reality - part of which is still unknown.

Therefore, the digital virtual, the informational component of the virtual that is part of cyberspace, carries a tremendous significance, because it is at the core of the transformation of the whole human society, not only of the urban environment.

**4. The Significance of the Transformation Processes due to Cyberspace's Embedding**

The human mind creates concepts through which things are represented, embracing a person's inner and outer reality. Words, as names or terms, are also representations of concepts. In order to transmit knowledge there is the need for both the transmitter and the receiver to know the syntax rules and their meaning. Therefore, information and consciousness play a central role in the process of creating meaning for ourselves.

> *Where a man's word goes, and where his power of perception goes, to that point his control and in a sense his physical existence is extended. To see and to give commands to the whole world is almost the same as being everywhere (Wiener 1950/1954: 97-98) [31]*

Wiener's ideas are very important, and still extremely relevant today, because they assist to understand the significance of society's transformation in relation to cyberspace' embedding in it. The significance to today's society can be seen in the following paragraphs incorporating Wiener's main ideas.

Human beings, as creators/transmitters/receivers of information, expand their horizon of collective awareness through the use of technology. By doing so, their senses extend as if the physical senses themselves have been extended to cover the whole spatio-temporal domain of information. A human's physical organ's sensitivity scale of hearing and vision remain constant, however digital sensors provide information of electromagnetic waves beyond the physical audible and visual range. For example, data from infrared or X-ray scanning can be displayed using different colors within the visual range of the human eye.

Human nature is created through information, therefore without information a person cannot grow or survive (physically, psychologically, and spiritually). This is so because there is a paramount need to be able to process information.

Consequently, according to Wiener, communicating and controlling information is part and parcel of a person's inner life and, in addition, it enables a person to be a social being (Wiener 1950/1954: 18) [31].

The main hypothesis behind the trialectic relationship humanity-information-nature is also found in Wiener's central idea that the existence and survival of a human being is closely interrelated with the ability to process information. Therefore, humanity's survival depends on that ability.

Through the use of ICTs and cyberspace, human beings can expand their conscious awareness, knowledge, and imagination beyond the physical limitation imposed by geographical boundaries. Sensors, micro- and nano-devices bring information directly to the physical senses, thus enabling people to extend their awareness as far away as information can travel. The limit is their imagination.

At the same time, through the use of new technologies such as nanotechnology, and molecular biology, human beings will be able to (re)build atom-by-atom and molecule-by-molecule any physical structure. By doing so, people will be able to embed within those structures their knowledge and dreams, first by codifying knowledge and then by manipulating their material reality. Through the embedding of the codified human intelligence in the urban material structures, people create intelligent and smart environments that transform society. Thus, digital information is becoming a major currency in everyday life, giving rise to a new post-modern information society, post-humanity.

Examples of the value of digital information and its importance in the daily activities of people, organizations, and countries are visible in the: markets, internet, media, education, and the plethora of data bases necessary to keep the service industry running. In the modern urban environment, it is almost impossible for citizens to go about their daily lives without having access to the digital information made available.

In a research made by GlobeScan for the BBC, the sample was from 26 countries, it seems that 87% of Internet users and 70% of non-Internet users believe that access to the Internet must be a 'basic human right' (http://news.bbc.co.uk/2/hi/8548190.stm). The United Nations organization supports and promotes the freedom of access to the Internet. It is a type of human right that has already become law in countries like Sweden and Finland.

Similarly, Hamadoun Toure, General Secretary of the ITU (International Telecommunications Union), supports the right of every citizen to the Internet access, because it is the most democratic and most information-rich source/repository of human knowledge available today. He, therefore, insists that it is as essential for people to have access to the Internet as it is for all other basic infrastructures, e.g. electricity and water (http://news.bbc.co.uk/2/ hi/8548190.stm).

Toure's argument, coming back to Wiener's idea of a person's need to process information, drives home the idea that the knowledge available in cyberspace should be treated as a source openly available to humanity and not as a commodity. The free exchange of ideas and the free sharing of knowledge through electronic mediated discourse enhance the establishing of true representative democracy.

Unfortunately, by using the same technological means (e.g. ICTs), humanity could be enslaved by a group of people, powerful elite controlling the main techno-politico-economic structures and sources (Castells [2]). Similarly, people and countries are using cyberspace as a new domain to fight out their wars (e.g. military, economic, and ideological). Cyber attacks, cyber warfare, and cyber espionage against individuals, groups, organizations, and governments are on the increase costing billions of €/$ and many human lives (http://foreignaffairs.house.gov/112/Fis041511.pdf).

ICTs and cyberspace have not only given birth to the age of digital data and information flows, but they have also kick started a new revolution in consciousness. The changes and transformations, locally and globally, due to the embedding of cyberspace affect people's way of thinking and living. It is the birth of the post-human and the dawn of a new civilization where people, both individually and collectively, are urged to assume new roles and identities within information- and knowledge-rich environments.

## 5. Conclusion

By using Lefebvre's trialectic approach, instead of a simple binary model, the cybercity emerges as a hybrid complex environment, created through the embedding of the virtual city to the geographical city.

Similarly, by applying Lefebvre's trialectics, we gain greater knowledge of the transformation processes of society due to the embedding of the digital virtual to the material. The processes of materialization and spiritualization create a third process: expansion in consciousness/awareness through the use of ICTs.

The embedding of cyberspace in society opens up tremendous opportunities to humanity. The expansion of awareness and consciousness through the globalization of information gathering and processing enables people to extend themselves to a variety of spatio-temporal scales, expanding their information-horizon beyond the range of their physical senses.

The transformation of cities to cybercities through the embedding of cyberspace, so far, appears to be assisting the globalization of urbanization. Cybercities emerge as the modern urban intelligent environments within which human beings increasingly produce and control more digital information than ever before. By doing so, people transform themselves, society, and their material reality.

Through the use of ICTs, humanity finds new ways of creativity as well as new ways of destruction. While the use of cyberspace could liberate the human spirit in building a better society by providing free access to human knowledge, at the same time, the same technological means could be used to enslave humanity. Due to our civilization's dependency on cyberspace, a small group of people could gain total control of the main information flows and ICTs and, by doing so, affect major changes in society.

Humanity's main challenge today, through the transformations produced by the embedding of cyberspace, is to face the new crises/opportunities by assuming a spiritually mature stand in order to create a new civilization for the benefit of all.

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# TELEWORKING: FROM A TECHNOLOGY POTENTIAL TO A SOCIAL EVOLUTION

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**Abstract**
*The present paper elaborates on the prospective developments of teleworking, as these relate to the dynamics of ICTs developments. The paper presents various types of teleworking applications, linked to the evolving potential of technological developments; then discusses the evolving patterns of teleworking, followed by emerging trends and applications appearing at a macro and micro level with their prospective impacts; and finally it explores the implications of teleworking on the restructuring of the social patterns.*

***Keywords:*** *ICTs, working patterns, teleworking, business organization, societal changes*
***JEL classification*: R10, R11., R30, R40.**

## 1. Introduction

The emergence of Information Society through the fast deployment of communication infrastructures and services as well as their applications in many domains of the everyday life, implies a structural transformation of society, leading to the strengthening of the competitive advantages of businesses, greater flexibility, among others, in employment and jobs, as well as new sustainable economic growth (EC [4]).

The evolution of interactive digital networks has greatly affected the above transition, where the revolutionary network technologies have influenced the network business characteristics. New location and time-independent working structures are now offering the potential for decentralization of work through various teleworking schemes. As telecommunications and IT technologies evolve, network structures become realistic options for the vast majority of companies, as opposed to the early days where 'network business' was an option for just a few large organizations. As a result, firms' organizational structures and markets rapidly evolve, driven by the lower transaction costs, the removal of boundaries, the shifts in power relationships, the globalization, the competition and the new organizational models, enabled by network technologies, with certain impacts on spatial patterns and the world society.

Decision-makers, firms and individuals are facing new challenges, induced by the increasing flexibility in time and place, as well as the impacts implied by the changing working cultures upon economy, society and private life-style, characterizing the Information Economy.

Teleworking, in this context, appears as an option, opening new possibilities for work and business development. Various definitions of teleworking can be met in the literature. Olson [15], in his broad definition embracing a range of various

opinions, claims that 'teleworking describes organizational work, performed outside the normal organizational limits of space and time, supported by computer and communication technologies'. Another more general definition describes teleworking as 'work enabled by network technologies, which actually incorporates a shift in performance focus from physical presence to results, empowerment and location - time independence' (EC [4], Nilles [14], EC [5]).

Several empirical surveys though indicate that, despite the technology potential available, teleworking has not gained yet as much ground in practice as someone could expect. This is due to the fact that teleworking is not simply another network application, but involves decisions at various levels, which have both direct and indirect impacts on the economy and the society at large. Absolute numbers do indeed support the above argument, but at the same time indicate a certain shift towards the potential applications offered by teleworking to private companies and public organizations (Nilles [14], EC [5]).

Apart from the structural constraints implied by the nature of these applications, several other issues have to be taken into consideration for the revision of the 'work' concept and the restructuring of the work relations as such. These issues concern technical connectivity and security requirements, working patterns, work relations and social aspects of work itself.

Despite the technological and work-specific constraints involved in such a context, several types of teleworking applications appear already in practice and have been the field of study for several years. These may range from 'self-employment' applications, referring to individual working schemes, to 'telecottages', referring to collective working schemes, adopted by businesses in order to increase effectiveness through geographical distribution and better manage business costs. Both of them introduce geographical dispersion of activities and operation of both companies and employees. As can also be seen in previous research findings, teleworking applications appear to be closely related to the restructuring of socio-economic patterns. Moreover, they involve a broad range of positive impacts upon employee and employer as well, influencing life styles, leisure time, flexibility, household location, work satisfaction etc. (EC [5]).

The focus of the present paper is on the prospective developments in teleworking, as these relate to the dynamics of technological developments. In the first section, the various types of teleworking applications are somehow linked to the evolving potential of technological developments. In the second part, the evolving patterns of teleworking are presented; while the final part, on prospective impacts, elaborates on emerging trends and applications at a macro and micro level. This is followed by a discussion on the positive and negative impacts of teleworking on the restructuring of the social pattern.

## 2. Technological Evolution Supporting Teleworking

In this section a brief discussion on the evolution of enabling Information Technologies and network technologies supporting teleworking is presented, before going further into the impacts of teleworking upon the organization of work and the society at large. The rapid evolution of technology offers potentially a range of possibilities for the restructuring of the work concept, which cannot be adopted at equal pace by the society and business environments as such. Three generations of technologies relating to teleworking can be distinguished: the early days, the first days of corporate networks and the current technologies, including wireless access. Although these three generations have certain degree of overlapping, the term 'generation' is used not in the strict temporal sense, but in the broader sense of 'category'.

### 2.1 The early days

In the early days of teleworking, the technologies involved were proprietary technologies for connecting dump terminal stations (workstations with no processing power of their own) to centralized computing facilities. By that time, a computer-related workplace required the connectivity of terminal stations to some mainframe or mini-computer, using the terminology of the time. This was achieved through special equipment called a 'terminal server'. The remote access to a terminal server, which could be achieved by using a modem connected to a public or private line, was enabling access to a main computer from a distant location. In the simplest case of an individual teleworker, a one-to-one connection allowed a single workstation

to access the main computer by using a dummy terminal or a personal computer with some terminal emulation software, as shown on the left hand side of Figure 1.

In a more complex setting, a multiplexer could be used to share the communication line and allow access of multiple terminals to the central facility, enabling the creation of satellite offices or telecottages / televillages, shared by more than one type of teleworkers, as shown on the right side of Figure 1. In this case, the telecom line had to be of higher bandwidth, and thus, more expensive. In both cases, the communication protocols, the billing and the implementation of communications security were mostly proprietary, depending on the specific implementation of the host computer, the remote access equipment or both. Even today, this deployment is by no means 'ancient useless history', since there are domains where it is still used, such as ticket reservations or other applications.

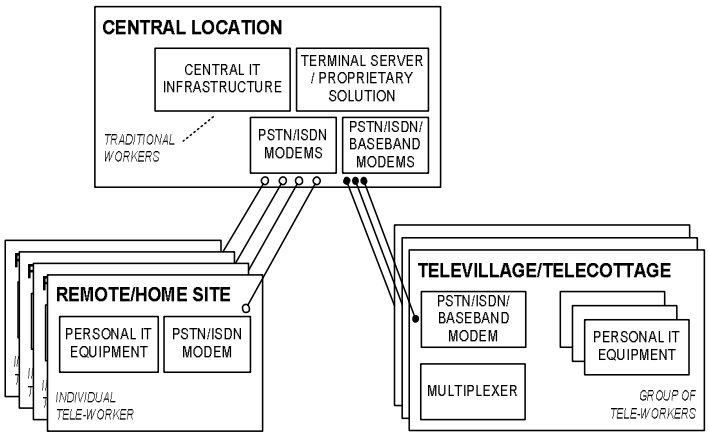


**Figure 1**: The early days of teleworking technology

### 2.2 The first corporate networks

In the 80's, as the small corporate local area networks (LANs) become popular, more companies could use alternative methods allowing employees to work partially or more infrequently completely remote. A LAN enabled the connectivity of the newly introduced 'personal computers' and the sharing of resources, mainly hard disks and printers. The mainframe was not required, since the computing power was distributed to small 'cells' and was there only as legacy equipment. Remote connectivity to the company's computer actually meant remote access to the company's LAN and ability to work as if one was physically present at the company's offices. A quite popular way for achieving this was the remote control of workstations, connected to the company's LAN. Using one modem for each remotely controlled workstation and one modem and some remote control software on the other side, it was possible to work on the company's LAN without physical presence to the company's premises, as can be seen in Figure 2. The actual data that was transferred over the telecom line was the keystrokes of the remote station, which were reproduced at the controlled station by the remote control software, while the same would happen for the video terminal output, which was sent over the telecom line to the remote station. The telecom lines required were ordinary ISDN/PSTN lines, having their ends both at the company's offices and the teleworker's location. Solutions for remote control through the Internet were also present, although they became quickly rather obsolete due to the native/naive networking ability of the operating systems of the 90's.

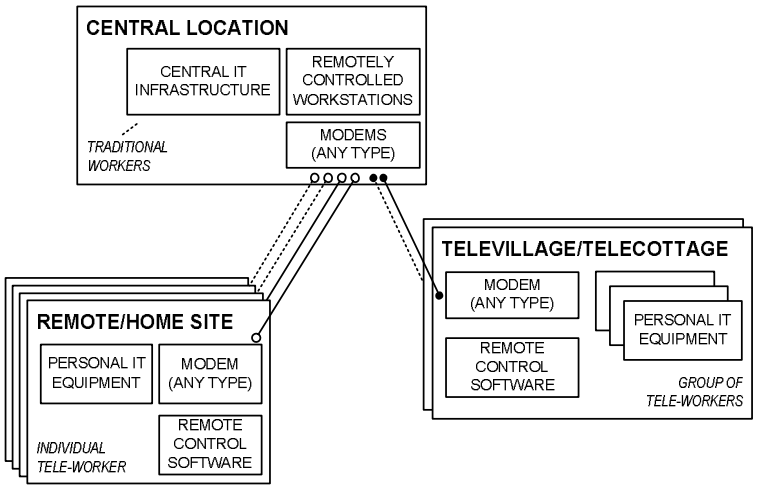


**Figure 2**: The first corporate networks

Provided that, at the time, the computer applications were text-based (no graphical interfaces), this worked quite satisfactorily, with few shortcomings and a major advantage. The most important shortcoming of the idea was the fact that the controlled workstations (those on the company's LAN) where dedicated and could be used either locally or remotely, but not both at the same time. Some operating system utilities could overcome this, but not without creating other technical concerns. The major advantage was that the remote control was no more based on proprietary technologies, which, from the technical perspective, allowed several versions of the concept to be introduced as remote control solutions, as well as enabling technologies from the teleworking point of view.

### 2.3 Current technologies

As main characteristic of the current networking technologies could be described the 'transparent IP connectivity'. By transparent is meant that the network physical connection is no more of concern: ISDN, cable, xDSL and public data packet switching networks are all choices that offer remote wired connectivity with very high bandwidth. GSM, GPRS, 3G, IEEE 802.11b, satellite, microwave, and more, are wireless connectivity technologies that are no longer science fiction either in terms of potential or in terms of cost, while the locational aspect is not an issue anymore. By IP is meant that everything is now based on the Internet Protocol (IP) the next version of which (IPv6) is expected to provide secure connectivity and identification to any possible device that could use it, regardless of its nature (computers, PDAs, phones, as well as cars and . . .refrigerators). Finally, the current trend for connectivity is that it is no more made upon request (as is the case of any dial-up connection), but is always active.

IP networking capabilities are now part of all popular computer operating systems and are the only required element that makes remote connections possible, as shown in Figure 3. It is now clear that IP networks are location-independent utilities, as power and phone telephony networks were in the early 1900's. Through IP networks many services can be offered, ranging from the traditional voice telephony to computer/PDA connectivity, to multi-party videoconference, to 'view on demand' TV broadcasts.

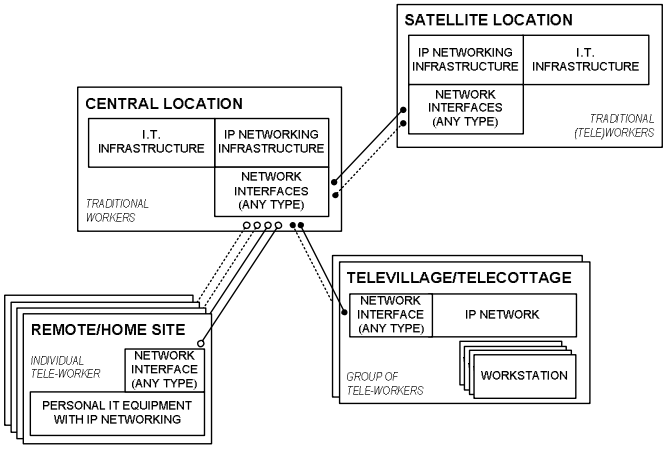


**Figure 3**: Current teleworking deployments

Table 1 below provides a summary of the three generations of teleworking technologies along with the characteristics of their potential users. The left column contains generic teleworking deployments for each generation of supporting technologies. A shift from custom-made teleworking sites to more flexible structures can be noted, which has come possible through the evolution of ICTs. The columns of the table contain the following attributes for each of such deployments the:

- equipment used at the central location and at the teleworkers' location;
- telecommunication lines that are required;
- kind of technology with regard to its proprietary, third-party, or open nature;
- implementation of security;
- availability of standards;
- communication/information services available; and
- rough estimate of the cost involved.

As can be seen in Table 1, in the early days of teleworking (Generation 1), the requirements for both the central and remote sites' infrastructure were rather high. A dump terminal or a terminal server had to be connected to the company's mainframe, using dedicated lines and proprietary communication protocols and solutions, implemented and offered usually by the vendor of the central infrastructure. In this case, remote sites that supported more than one teleworkers, such as televillages, was rather difficult to be connected to central locations of many different companies, due to technical constraints and incompatibilities.

**Table 1**: Summary of teleworking technologies

| | *Equipment (central)* | *Equipment (teleworker)* | *Telecom lines* | *Techno-logy* | *Security* | *Open stds* | *Services* | *Cost* |
|---|---|---|---|---|---|---|---|---|
| GENERATION 1. EARLY TELEWORKING TECHNOLOGIES | | | | | | | | |
| Individual teleworker sites | Mainframe/mini computer | Dump terminal or software emulator | Private or dedicated, low speed | Proprie-tary | Proprietary solution | No | Text-based terminals | Mid to high |
| Telecottages/ televillages | Mainframe/mini computer | Multiplexer, terminal server, dump terminals | Private or dedicated, mid-to-high speed | Proprie-tary | Proprietary solution | No | Text-based terminals | High |
| GENERATION 2. CORPORATE LANS | | | | | | | | |
| Individual teleworker sites | LAN, mainframe | PC, remote control software | Dedicated or internet, low speed | Third party | Pre-standard | Partly | Remote control of text/graphics workstation, chat, voice | Low |
| Telecottages/ televillages | LAN, mainframe | PC LAN, remote control software | Dedicated or internet, mid-to-high speed | Third party | Pre-standard | Partly | Remote control of text/graphics workstation, chat, voice | Mid to low |

| GENERATION 3. CURRENT TECHNOLOGIES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Individual teleworker sites / SoHos | Any IP network | Any IP client | Internet, any speed, wired or wireless | IP-based | Standard | Yes | Integrated chat, voice, video, distr. applications | Low to mid |
| Mobile sites / Satellite offices / telecottages / televillages | Any IP network | Any IP network | Internet, any speed, wired or wireless | IP-based | Standard | Yes | Integrated chat, voice, video, distr. applications | Mid to high |

The evolution of *corporate LANs* improved this situation by lowering the barrier of cost through the technical requirements of new equipment that was performing better and was more widely available. The 'remote control solutions' allowed the connectivity of single or multiple work places to the main company LAN and enabled more flexible and affordable teleworking deployments. No proprietary technology was required, since the remote connectivity solutions were provided by third-party vendors, required cheaper communication lines and allowed flexible connectivity of the (single or multiple) teleworker's site to more than one employers, which was a turning point for the evolution of the labour relation, as will be discussed later in this paper. Telecottages and group-based remote-working sites could then be offered both to teleworkers and employers as a service of the community or private companies.

However it was the domination of IP connectivity (based on the open 'Internet Protocol') that practically eliminated any technical barrier to flexible teleworking. As can be seen in Table 1, any IP device can be connected to any IP central network, through any telecommunication line, wired or wireless. This connectivity is based on open standards, and uses equipment and solutions offered by multiple vendors at very competitive prices. The services offered are not only considerably broader than in the past, but also the costs are remarkably lower, provided that *many-to-many connectivity is now readily available*, embedded as a service of modern operating systems and devices.

Although security still remains of heavy concern, it can now be claimed that the connectivity-related enabling technologies for teleworking are already here and what remains to be discussed is less technical and more oriented to the social aspects of teleworking.

## 3. Teleworking Applications on the Move

In this part, teleworking schemes adopted through time are presented, as these relate to the opportunities offered by the technological developments presented above.

At the early stages, home was the most popular work location. Work results could be transferred to the company either by traditional media such as mail, courier etc. - a broader point of view of teleworking, characterized by low level of ICTs use - or by establishing a communication link between the employee and the employer / contractor - a more focused point of view, characterized by high level of ICTs use. Teleworking, at that time, was applied more in the context of clerical, routine work.

Home-based teleworking could be applied both on a full and a part time basis, having always home as a base location. Changing needs of both teleworker and the company have given rise to alternating work (or multi-locational), having the same characteristics as home-based work, where the workplace of teleworkers could be shifted between an office-based and a home-based option (Nilles [14]).

A specific application of home-based teleworking is the Small Offices-Home Offices (SoHos) development, which took place in several European countries (EC [5]). The above type was based on traditional forms of already existing firms with one or more persons. The introduction of ICTs in these firms offered the possibility to telework, communicating with customers and business partners. Owners of such firms could either stand-alone or be partners / associates of one or more than one companies.

In the mid 1990's, a growing interest appeared in teleworking applications among various economic groups or agents, realizing that teleworking had a serious impact on the productivity and creativity of firms, as well as their organizational

options for distant co-operation. This was followed by a take-off in teleworking applications (1997-98), where both economic agents and employees, each for their own reasons, took advantage of the potential offered by teleworking (EC [5]).

This take-off had been largely advocated by the developments in mobile computer systems and telecommunications, which led to portable systems, computers and telecommunications advances, enabling teleworkers to practically work anywhere. Mobile or flexible teleworking becomes an option, in which place of work may vary from work at home or main work place to work at any place, depending on work demands. This evolution has given ground to managerial, professional and innovative teleworking applications, both at a work and business level.

The adoption of ICTs led to the emergence of new types of self-employment working structures. Free agents are such an example, appearing recently in many countries (USA but also Europe). Based on the traditional free-lance form and taking full advantage of ICTs, they extend geographical scope of their business and number of markets they mobilize through intensive use of network capabilities. They can be completely flexible and have total control over how, where and when they work, picking-up work opportunities from a great number of potential clients (EC [5]). This type of business is becoming of growing presence worldwide.

The strong influence of ICTs on the organizational structure of firms has laid emphasis on the potential of carrying specific tasks by independent contractors. This has supported the emergence of freelancers, namely contractors who are electronically connected – e-lancers – running networks with temporal goals. Main characteristics of these networks are their horizontal structure and temporal character.

Teleworking centers can be considered as a collective approach to teleworking, as opposed to individual patterns of work. Their scope is reflecting the efforts of business strategies to cope with new challenges, to retain and attract qualified labour in a region, to exploit new markets for their products, to offer technical support as well as access to administrative services and sophisticated technology, to cope with social and business isolation of workers etc. Public initiatives are mainly oriented towards developing teleworking centers in support of employment in less advantageous regions or managing environmental problems in urban centers e.g. traffic pollution.

The various types of collective teleworking schemes - telecenters, are the outcome of either private initiatives e.g. parent firms, groups of firms or public initiatives, taking the form of:

- *Satellite offices* created by a parent firm at a certain location;
- *Offshore offices* created by a parent firm in order to take advantage of lower labour costs at a certain location;
- *Neighbourhood offices* created and supported by several organizations/firms;
- *Televillages* operating in rural areas, which gave teleworkers, living in a specific area, the opportunity to telework;
- *Resort Offices*, introducing an integrated approach of work and relaxation;
- *Business Centers*, serving business travelers to get access to computing and telematic services, while they are on the move.
- *Telecottages*, known also as Telehouses or Community Teleservice Centers or Telecenters, which are fully equipped locations, based on public initiatives, in support of individuals and SMEs.

The above described evolution of teleworking schemes reveals that teleworking at the early stages was considered as a possibility to remove time and space barriers and give employees the possibility to better combine private life with work, having home as a work basis. Early teleworking activities were placing emphasis on personal aspects of life-styles, family life and home settings.

At a later stage though, teleworking becomes much more than that. Its value lies on the flexibility in space (mobile schemes) and the range of employment options and schemes (work independence e.g. freelancers) it provides, both for employers and employees, which keeps growing in parallel with the evolution of technology and its specific applications (Figure 4).

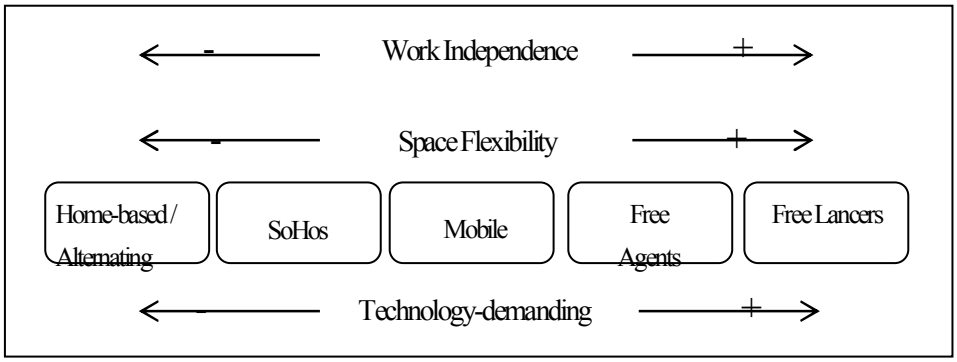


**Figure 4**: Teleworking in perspective

These developments have largely affected work relations through a growing shift towards more independent working schemes, wherein employees can work and cooperate with anyone, anytime, anywhere in the world. Of course, this strongly depends on the type of work and its commitment to technological applications, but it can also apply to certain types of clerical work e.g. translation work. These developments enable also greater freedom in terms of business organization, by providing opportunities for new schemes, which are more task-oriented and of wider geographic scope. These represent new options for business organization, in reality, where the type of organization is considered as 'one of the tools to carry out a task' (EC [5]).

## 4. The Context of Teleworking

The introduction of teleworking applications at the various levels of the economic and social life has already formulated certain trends as to the advantages and disadvantages at the individual, business as well as societal domain (Stratigea and Giaoutzi [20]).

More specifically, in Table 2 below are presented the advantages and disadvantages of teleworking at the individual level in respect to the work domain.

**Table 2**: Advantages and disadvantages of teleworking at the individual level

| Individual level - Work domain | |
|---|---|
| *Advantages* | *Disadvantages* |
| - Greater *work flexibility* in terms of *time*, leading to a better combination of work with other activities of the everyday life.<br>- Greater *flexibility* in terms of *space*, resulting to a greater freedom in respect to the *residential choice*.<br>- Greater work *satisfaction*.<br>- Savings in *travel time* and *travel costs* for commuting, which is quite important especially for those living in large urban centers.<br>- Improvement in the *quality of life* following the above aspects.<br>- Better *balance* between company tasks and personal needs, which leads to a better time management.<br>- Increase in *work productivity* and *quality* as various empirical studies show (Korte and Wynne [10], Korte [11]).<br>- An increase in the prospects of *disabled* or *specific groups of people* to have equal access to the labour market. | - Need for *employees' adaptability* to a continuously changing work environment, which is skill-demanding and, even more, involves a rapidly changing skill mix, continuous need for education and evolution of work portfolios. This may exclude many workers, especially those employed in traditional jobs (EC [5], EC [6]).<br>- *Social isolation*, which could be more pronounced in future generations of teleworkers, who have as an option for teleworking from the very start of their professional lives.<br>- *Career perspectives* in purely orthodox career terms (Bibby [1]). Many researchers argue the career prospects of teleworkers, mainly due to their isolation from the work environment, their ambiguous work status and their limited training opportunities to new work skills. This seems to be the case, at least for certain categories of working staff.<br>- Employees lose sight of developments within the company (Bibby [2]). |

**Table 3**: Advantages of teleworking at the business domain

| Business Level – Advantages | |
|---|---|
| *Work Level* | *Organization Level* |
| - Significant *cost savings*, related to labour, central facilities, overhead costs, parking etc. (EC [5]).<br>- More *effective use of labour resources* through better retention of staff and recruitment from a wider pool of staff (Nilles [14]).<br>- *Restructuring of jobs* within a business, which gives rise to a "re-engineering" in a more radical and effective way.<br>- Increase of firms' *competitive advantages*.<br>- Improvement of the *quality and performance of work* (EC [5]).<br>- Better management of different types of work, tasks and skills level, maximizing thus workforce *efficiency*.<br>- Teleworking is viewed as a mean to achieve a more flexible allocation of skilled people, currently possible only within a centralized office environment.<br>- Retention and recruitment of *scarce skills*, which they would not be able to acquire otherwise (EC [4]).<br>- Recruitment of *qualified staff* or individuals, which provide services at a lower cost for the company, resulting in a skill upgrading of employees.<br>- Improvement of the company's possibility to cope with *work peak periods* in terms of both employees and office space.<br>- Enhancement of *motivation* and *creativity* of teleworkers as well as their *productivity* (EC [5]).<br>- *Flexible office space arrangements*, where firms are getting more value from existing office space since they are able to rearrange office space for staff needs and avoid expensive office expansions or relocations (EC [5]). | - A plurality of *organizational forms* is at firm's disposal, each corresponding to a different organizational status ranging from old traditional hierarchical schemes to virtual corporations (Schwarzer and Kremar [18], Skyrme [19], Sandhoff [17]).<br>- Developments in the field of firm's organization have influenced both the *internal structure* and the *cooperation schemes* adopted, in order to cope with increasing competition.<br>- *Spatial dispersion* of firm's activities in their efforts to take advantage of resources or networked cooperation schemes respectively as well as in marketing and delivering their products.<br>- *Trans-border links* and cooperation possibilities are enhanced (EC [4], EC [6]).<br>- *Networking*, enabling various forms of alliances and new division of labour in developing a product and providing specific services, are emerging (Powell [16], Holm et al. [9]).<br>- *Virtual organization* of firms is increasing their ability to leverage their knowledge and resources without extending their fixed overhead. This has as a result the amplification of their skills and competencies, skills, resources, knowledge management and infrastructure (Dembski [3]).<br>- New types of *interaction* with *clients* and *customers*, providing the potential for (EC [5]):<br>✓ Round the clock interaction with clients and customers.<br>✓ Continuously increasing market for networked information services.<br>✓ Globalization of trade and markets.<br>✓ Development of electronic commerce. |

At the business domain, advantages are gained at the work level, through teleworking schemes, but also at the business level, through new organizational structures. Advantages at both levels are shown in Table 3. Disadvantages at this level, on the other hand, are mainly associated with the: security and safety aspects of ICT and their application to different regulatory frameworks; pace of technological reform of different nations; competition rules etc. (EC [6]).

The increasing commitment to new technologies has influenced every aspect of the everyday life, either at work or home/leisure time. This is the outcome of the rapid diffusion of home and office technological platforms, providing access to information and interactive services with new multimedia features, including video and data at any time and place, overcoming thus time and space barriers (EC [4]). The advantages and disadvantages of new patterns of work and business organization structures at the *societal level* are shown in the Table 4 below.

**Table 4**: Advantages and disadvantages of flexible working patterns at the societal level

| Societal level | |
|---|---|
| *Advantages* | *Disadvantages* |
| - Reduced *traffic congestion*, especially in urban centers due to e.g. support of car sharing in case of telecentres; impacts on traffic patterns emerging from the decentralized working patterns (Teleport Sachsen-Anhalt [21]).<br>- *Environmental quality* due to the reduction of unnecessary commuting (Teleport Sachsen-Anhalt [21], Korte and Wynne [10]).<br>- *Energy savings* and maintenance costs for cars by reducing commuting trips (Korte and Wynne [10]).<br>- Impacts on *employment*, substantial new job creation coupled with a very strong job growth in the service sector (Korte and Wynne [10]; EC [5]).<br>- Impacts on *cross-border cooperation* among companies and institutions, contributing to social and economic cohesion (transborder teleworking and cooperation) (EC [4], EC [5]).<br>- *New ways of delivering social services* such as health services, education, public services etc.<br>- The emergence of the *24-hour society*, where availability of services runs around the clock (EC [5]).<br>- *Social inclusion* in terms of new working possibilities for disabled people or disadvantaged regions e.g. remote regions (EC [6]). | - *Social isolation* of employees (EC [5]).<br>- *Uncertainty* of both individuals and businesses by sweeping away from old secure certainties.<br>- *Restructuring of jobs* leading to the loss of certain types of jobs. Routine work is mainly affected, while managerial and professional work as well as work committed to innovation is relatively increased (EC [6]).<br>- Decline of *employment* in traditional business sectors unable to join the ICT developments (EC [6]).<br>- Difficulty to *adapt* to a continuously changing situation and demand, involving risks of exclusion.<br>- *Time* and *resource consuming* processes inherent for those who are able to adapt to the new working patterns.<br>- Lack of *social security systems rules* for teleworkers (EC [5]).<br>- Lack of *legislative and regulation framework* coping with the teleworking issues e.g. definition of work, relationship between employee and employer, place of work, working hours, health and safety aspects etc. (Bibby [2]).<br>- Difficulties in the process of integrating home and work activities in case of home teleworking.<br>- Lack of *boundaries* between work and private time (Hodson [7]). |

## 5. Prospective Impacts of Teleworking

Teleworking has formed the basis for a whole range of developments and innovations in work and business strategy and organization. It exhibits a wide range of types and characteristics and applies to a large number of sectors and levels, all of them having at their core the use of teleworking. Electronic commerce, knowledge management, globalization of trade and markets, virtual organizations and teams, intellectual capital development, skills and competence development, organizational teaming, smart organizations, digital or network economy, de-materialized or intangible production etc. can be thought as further evolutions in the field, largely based on teleworking (EC [5]). The above developments stress the importance of *information exchange* at a global level and advocate the necessity for further enhancing the potential of teleworking in a globalized world.

The broad range of teleworking applications has considerably marked its penetration not only into work and business organization processes, but also into many social processes, where the number of teleworkers worldwide is continuously growing. At a European level, it is expected that further technological advances and speed of work and business innovation will support dramatical changes in the field, which will affect 'almost everybody in Europe at some stage of his working live' (EC [4]). The same picture is given by Nilles [14], in his work on the future of teleworking in the various world regions.

Prospective future impacts of teleworking appear to be based not on the technology itself, but on applications, methods and services as well its adoption rates, which will provide the ground for further opportunities in work, business and social processes. It is now rather clear that technology will no further be the 'filtering point' in any innovative teleworking concept. Progress in the field shows, that the technological advances enable the implementation of a broad range of teleworking applications. Some major trends of work and business innovations as well as social processes enabled by teleworking are presented in the following.

First, it is discussed the emergence of a *new working culture* that places workers at the center of work. This has mainly been the outcome of the mobile teleworking potential and the Internet explosion. In this new working culture, work is attached to persons and not to places, and as a trend it appears that 'the fundamental unit of the future network economy will be the

individual rather than the corporation' (EC [5]). The traditional form of organization based on a space of places, specific working conditions, hierarchical organizational structures etc. is gradually replaced by groups of people sharing common goals that are determined by the changing needs of the market. In this context, the corporate culture is gradually replaced by a new, small-teams oriented, working culture. This is the case especially among those working in fields highly committed to specific ICT applications, who are able to take advantage of space and time independence, provided by teleworking innovations.

The above developments enable also the joining of fluid and temporary networks in their activities (Dembski [3]). In that sense, working relationships are becoming vaguer and of a dynamic nature, determined on the basis of changing tasks and challenges worldwide and based on trust and confidence among collaborators. Electronically connected freelancers (e-lancers), namely independent contractors cooperating on specific purposes, are a distinct example of the new working culture.

The social change marked by the increasing familiarization of people with technological innovations is touching many aspects of social processes, which were previously characterized by their mass nature and commuting. Examples are shopping (e-commerce), education (tele-education), scientific conferences (teleconferences), medical services (tele-medicine), leisure, information searching and acquaintance, etc. Many of them are now shifting towards less and less mass procedures, as well as less and less commute-demanding. Commuting has been gradually shifted to communicating, remodeling thus many fields of social life apart work (EC [5]).

Teleworking is having a great impact on *work definition and rules*. Indeed, traditional forms of work were very clearly defined in terms of labour relations, working hours, work location, health and social insurance systems, vacations, time budgeting, rewards, tax systems, labour chambers organization, etc. in every country's labour legislation framework. The revision of the work concept, introduced by teleworking, has changed to a large extent not only the rules but in many cases the substance of these terms, implying the re-definition of their characteristics as well as their adjustment to the new working schemes. For example, vacations, in the traditional sense, may have no meaning for a teleworker, since he/she can combine work and entertainment in resort centers, following thus an integrated scheme of work and relaxation. By realizing the rapid diffusion of teleworking schemes in the society, the European Labour Unions have already taken action along reviewing their policies (Bibby [2], EC [5]).

Another major trend is associated with the widening of the *geographical scale*, in which businesses are searching for potential skilled employees and vice versa, i.e. employees searching for employment opportunities at a distance. This, of course, implies certain transaction costs, as widely dispersed skilled employees need to offer their services at a distance. The progress of telecommunications technology and more specifically ground and satellite wireless communications as well as the increasing competition among telecommunication providers disentangle even more the role of distance between employees and employers as a cost element. As various empirical studies show, communication costs, which are already exhibiting declining trends, will in the future consist a small part of the total cost of teleworking transactions (Nilles [14]). This will encourage businesses to search for their potential employees in a global rather than a local labour pool. The new option encompasses the increase of competition among specific labour skills, which, in open market terms, would require a continuous upgrading of labour skills in order to survive.

A major impact is expected on *business organization*, applied both at the intra and the inter-organization level. Location independence, introduced by the technological advances and teleworking, is potentially affecting business organization along two major axes, associated with: the enhancement of the firm's capability to enable activities to be undertaken at a distance; the strengthening of the capability to enable new activities, which were previously refrained due to either the costs or the efforts involved (Holm et al. [9]).

ICTs, by enabling activities at a distance, enhance the flexibility of businesses to relocate their activities on the basis of decreasing operating costs and increasing profitability. This consequently leads into a remarkable restructuring of the geography of employment. At a first glance, it seems that relocation addresses to white-collar 'information' work. Many

research efforts, though, show that relocation is also associated with work in general, especially information processing work, since digitization of data and sophisticated international communication links have increased enormously the possibilities for 'offshore' information processing (Bibby [2]). An example is the service provision through the development of call centers, operating across national borders, which are activated in tele-sales, tele-service enquiries, etc.

Another major trend appearing during the last decade is the *downsizing* of businesses and the rise of small and very small businesses. This trend, as Nilles [14] claims, is based on the need of large firms to reduce operating costs and increase profitability, which results into a reduction of the number of levels in organizational hierarchies and provides them with a much broader range of options in terms of outsourcing certain tasks. Subcontractors, in such a context, undertake the task to accomplish specific parts of their production, while the focus of their efforts shifts on their own core business areas. As a result, businesses are downsized, while at the same time, they are outsourcing parts of their production either locally or at a distance, depending on where the job or skill needed for the specific work can be found at a reasonable cost.

The growing trend towards downsizing of businesses has left skilled labour force with no job (Nilles [14]). The rapid growth of information technology and the location flexibility it entails, together with the growing demand for specialists to deal with the rapid changes in the nature and composition of markets, have given rise to a growing number of teleworkers, who are running small or very small (one person's) businesses, searching for work opportunities around the world. In such a context, new types of self-employment working structures are emerging during the last years in many places in the world, taking full advantage of network capabilities (EC [5], Nilles, [14]).

ICTs, in their function to diffuse information, are 'enabling technologies', supporting business cooperation. The diminishing importance of physical location has led to a certain organizational flexibility in spatial terms. Based on network technologies and teleworking potential, *new business models* have been developed, which offer the opportunity for businesses to adjust their policies in order to: increase productivity and competitiveness; develop opportunities for creativity and new forms of expression; adjust to the rapidly evolving markets; remove boundaries between them and suppliers or customers; enable the undertaking of new activities, which were previously not accessible due to either costs or effort involved (Skyrme [19]). Actually, business organization has been handled as the 'tool', via which specific tasks or opportunities can be successfully dealt with.

In order to meet the requirements of the new era, new forms of businesses' organization are rising, being the outcome of the potential offered by technological evolutions. Virtual organization (Lockett and Holland [12]), strategic web (Lorenzoni and Baden-Fuller [13]) network organization (Powell [16]), strategic/co-operative alliances (Holm et al. [9]) are such examples.

Old traditional organizational schemes, like strategic alliances, value-adding partnerships etc., have been gradually abandoned. These are replaced by networks of firms, located anywhere and communicating through the network for the whole range of their activities (production, selling, marketing, contacting with customers and co-operators etc.) (Dembski [3]). New forms of cooperation are defined by their product-market strategy, network structure, information systems and business communication patterns (Schwarzer and Kremar [18], Holland [7]). These are also characterized by their temporary nature, serving the purpose of a specific task or opportunity.

In conclusion, teleworking goes far beyond being an application of network technology. It introduces profound transformations in the society, driven by technological evolution, which are clearly 'affecting individuals at work and at home, in production and consumption, in commercial and social interactions' (EU, 2001). It consists of a key variable in the Information Society, 'breaking down barriers between people, places, roles and activities' (EC [5]).

As a counter argument appears the need to focus on the *threats* introduced by teleworking. Two major streams of negative impacts can be identified. The first is related to the impacts from the adjustment of labour force to the new working conditions and their social implications. Old traditional working schemes, characterized by discrete units of time and space of work, are dramatically altered. Security, exhaled from those structures, is swiped away, and is replaced by work uncertainty

and a continuous effort to correspond to a rapidly changing and very demanding working environment (Bibby [2], EC [5], EU [6]). The second stream is associated with the gradually *disappearing of boundaries* between work and private life, individual and community structures both in time and space, particularly in relation to work. Many authors have argued that the blurring of boundaries under the new conditions may lead to psychological and identity problems (Hodson [7]), experienced under the new circumstances.

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# ADDRESSING COMPLEX SPATIAL DECISION PROBLEMS IN MOUNTAINOUS AREAS: THE INTELLIGENT SPATIAL DECISION SUPPORT SYSTEMS (SDSS) APPROACH

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**Abstract**

*This paper discusses the issue of land use planning and land policy making for mountain regions, considered as regions with specific characteristics (natural, cultural, etc.), but also development constraints. Spatial decision making in such regions is characterized by complexity (semi-structured spatial decision problems) and multiplicity of problems. These indicate the need for qualitative information in support of the decision-making process, in order to improve effectiveness in decision making. Toward this end, it is first presented the state-of-the-art of MC-SDSSs and their significance as a planning tools for mountainous areas; second are outlined the multiple benefits from the use of Artificial Intelligence (AI) tools in the context of MC-SDSS for Multisite Land Use Allocation (MLUA) procedures applied in mountainous areas; and finally, a MLUAL methodological framework as the core of a future MC-SDSS is proposed.*

***Keywords***: *MC-SDSS, mountainous areas, spatial planning, decision making, artificial intelligence*
***JEL classification***: **R10, R11**

## 1. Introduction: Mountainous Areas

According to Diaz et al. [6], mountains are amongst the most fragile environments in the world. The world's mountain areas cover 24% of the Earth's land surface [14] and are home to 12% of the global population (Huddleston et al. [13]). A further 14% of the global population is estimated to live in the vicinity of their surrounding areas (Meybeck et al. [26]).

A far greater proportion of the global population relies on the goods and services provided by these areas, particularly water, which can be vital for agriculture, communities and for industries that are even located hundreds or thousands of kilometers away from the mountains. As urbanization continues to increase in the world, the mountains are also key centers for recreation and tourism; their attraction is often heightened by their remarkably high levels of biodiversity (Messerli and Ives [25]). Furthermore, they are also of major importance in shaping regional climates of the surrounding areas. Currently, these environments are affected by different pressures from economic and population growth. Quantitative data about global mountainous areas (km2) are presented in Fig. 1, according to the classification of the World Mountain Map of UNEP-WCMC (United Nations Environmental Program-World Conservation Monitoring Centre).

The focus of the present paper is on the development of a methodological framework for addressing complex spatial decision problems in mountainous areas. In this respect, in Section 2 is discussed the context of spatial planning in mountainous areas in Greece. In Section 3 is presented the state-of-the-art of MC-SDSSs and their significance as planning tools for mountainous areas. Section 4 focuses on the MC-SDSS for Spatial Planning in Mountainous Areas, where are outlined the multiple benefits from the use of Artificial Intelligence (AI) tools in the context of MC-SDSS for Multisite Land Use Allocation (MLUA) procedures, applied in mountainous areas. In Section 5 is proposed a MLUAL methodological

framework, using AI techniques, as the core of a future MC-SDSS for coping with complex spatial decision problems in mountainous areas. Finally, in Section 6 some conclusions are drawn.

### 1.1. Europe's mountainous areas

In the ESDP [8] mountain areas are characterized as unprotected and environmentally sensitive areas. Europe's mountains are of vital importance to the continent's population in many ways, and have been described as 'the undervalued ecological backbone of Europe" (EEA [9]). The mountains of Europe, just as elsewhere, are connected to the biological and cultural diversity of their geographical environment. They are the home of many of Europe's ethnic minorities, with specific cultures, languages or dialects and traditions. However, this remarkable cultural diversity is gradually being weakened in many areas, by external influences and the diminishing local populations, especially among the younger generations. This affects not only mountain people's sense of identity, but also the ways in which they use the landscape, the crops they grow, and the food they produce (Nordic Center for Spatial Development [27]). According to UNEP-WCMC analysis approach, Europe's mountainous areas cover a total land of approximately 2.2 million km$^2$ (Fig. 2).

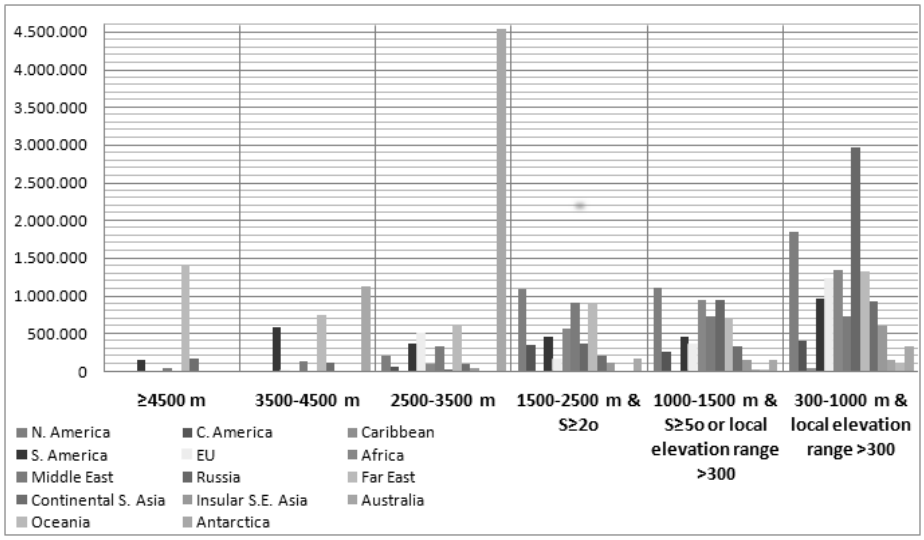


**Figure 1:** Global mountainous areas statistics by region[3]

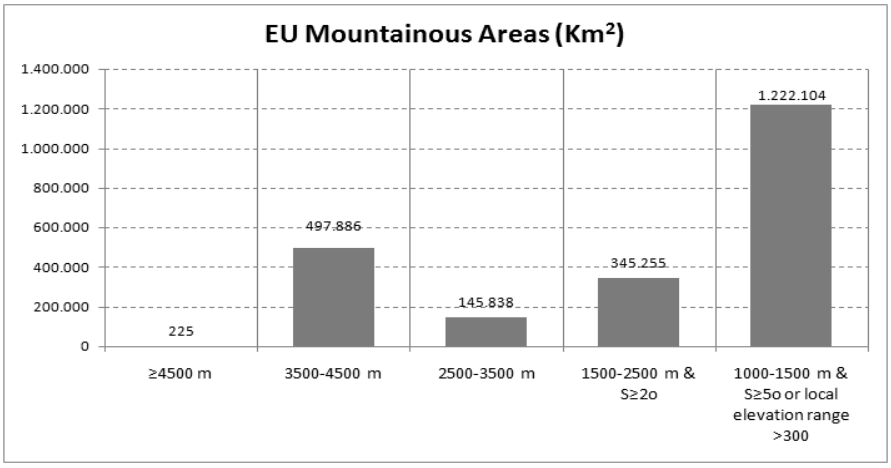


**Figure 2**: Europe's mountainous areas (km$^2$)

[3] *Adopted from: http://quin.unep-wcmc.org/habitats/mountains/statistics.htm*

The 'ideal world' of mountain areas is now threatened by socio-economic shifts, increasing negative impacts of tourism and traffic and other changes in land use. In the Accession Countries, more mountain areas are expected to become endangered through rapid economic development (EEA [9]).

Greece is one of the most mountainous countries in EU. According to the Hellenic Statistical Authority (2001), approximately 70.5 % of total country area is mountainous (42.0%), and semi-mountainous areas (28.5 %). Recent results from the Nordic Center of Spatial Development [27] indicate a greater percentage of approximately 78.0% of the total country area (Tolidis et al. [35]). The following are some basic issues concerning the Greek mountain profile:

- An intense abandonment in the past due to urbanization (Figure 3). Nowadays, the situation is reversed due to the fact that citizens who expect a better quality of life and more profitable occupation opportunities are returning to rural areas.
- Multidimensional interdependence and interaction of natural and socio-economic reality that lead to attractive areas which appeal to tourists.
- Conflicts over land use, due to lack of specific strategic land use allocation and local spatial plans (See Section 2).

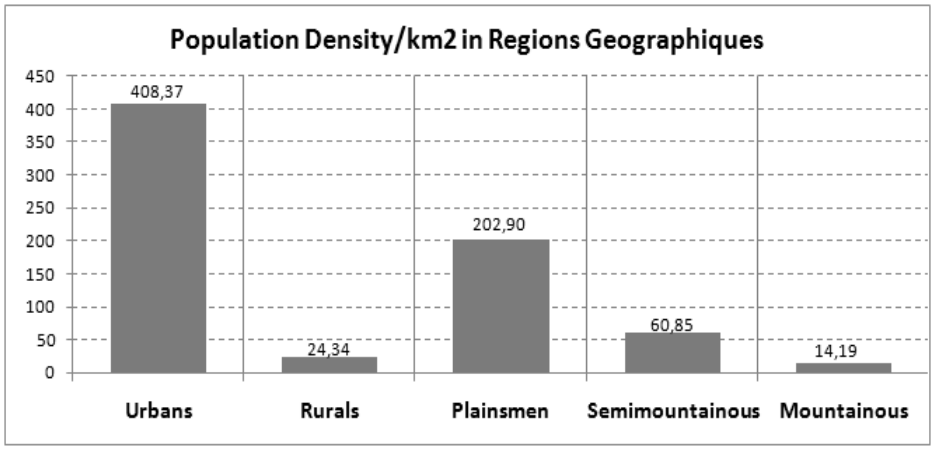


**Figure 3:** Population density/Km$^2$ in different types of Greek regions

## 2. Spatial Planning in Mountainous Areas: Greece

Mountains have been directly addressed in few policy documents. In general, every policy action should consider the network of direct and indirect interactions which is affected by the relevant policy. For mountain areas, it is crucial to adopt a comprehensive, spatially-integrated policy which is able to reflect and support multi-functionality, which has been the sustainable concept regarding mountains for many generations. Spatial and urban planning in Greece is a fundamental tool for decision making to define strategy for land development and to secure economic growth, social stability, environmental protection and quality of life (Potsiou and Muller [29]).

At the national level, the responsible authority for spatial planning in Greece is the Ministry of Environment, Energy and Climate Change, who provides the spatial planning legislation and the strategic framework, comprising of a variety of laws, plans and regulations. The establishment of the law 2742/99 for national and regional spatial planning provided two main planning instruments (Serraos et al. [31]:1) The "General Framework for Spatial Planning and Sustainable Development" (GFSPSD) and 2) The "Special Frameworks for Spatial Planning and Sustainable Development" (SFSPSD). The GFSPSD consists of a national territorial plan and SFSPSD of sectoral territorial plans. Furthermore, the "Regional Frameworks for Spatial Planning and Sustainable Development" (RFSPSD), which constitute practically Regional Territorial Plans, play a central role among the spatial planning instruments at the Regional level, according to the Law 2742/99. The Greek Spatial Planning System can be schematically presented in the following flowchart, organized by planning levels (Figure 4).

The goals which are directly connected to space and consist of the content of Greek spatial development are[4] (Tolidis et al. [35]) the development of a balanced and polycentric urban system and a new urban– rural relationship, b) securing equal access to infrastructure and knowledge, c) sustainable development, wise management and protection of nature and cultural heritage. According to the "National Framework for Strategic Development-ESPA" (implementation period: 2007-2013), the strategic development of mountainous areas mainly aims at restructuring production and habitation. Although the GFSPSD recognizes the importance and the need for further specialization of the strategic choices and priorities of planning in mountainous areas, there is a lack of specific legislative guidelines and planning framework for mountains. Furthermore, Greek Spatial Planning at a local scale (municipalities) is implemented by the "General Urban Plans-GUP" and "Open City Spatial and Housing Organization Plans-OCSHOP", which are basically the "tools" for local spatial plan implementations. However, only 4% of the total municipalities' local spatial plans have been established (Tolidis et al. [35])[5].

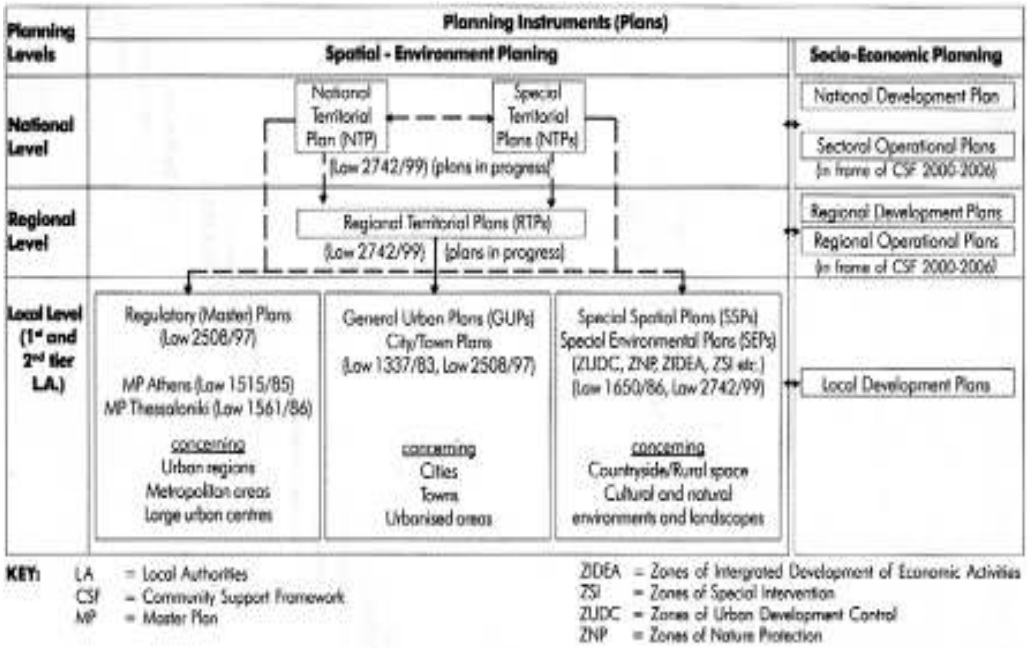


**Figure 4:** The general Greek Spatial-Environment Planning System (Beriatos [2])

## 3. Spatial Decision Support Systems-SDSS

### 3.1. Spatial decision-making process

A decision can be defined as a choice that is made between two or more alternatives. Any decision-making problem falls upon a continuum that ranges from completely structured to unstructured decisions (Malczewski [19]). The structured decisions can be programmed and solved by a computer. The structured problems are repetitive and routine, and the computer can solve the structured problem without requiring any intervention from a decision maker. The unstructured decisions must be solved by decision makers without assistance from a computer. In this case the decision makers use their experience.

According to Malczewski [19], they employ heuristic and common knowledge that involve the narrowing down of the field of search, for a solution, by reasoning on past experience of similar problems. Most real-life decision problems can be found somewhere among the above extreme cases of completely structured and unstructured decisions. These decisions are called semi-structured and can be solved by decision makers with computer support. Furthermore, for most decision

[4] *Not in compliance with policy guidelines for the spatial development of EU.*

[5] *According to statistics from 2010.*

situations, the spatial decision problems are ill-structured because of the variety of interest groups and uncertainties associated with assessment and evaluation of the distribution of the quality and quantity of impacts at alternative locations (Malczewski [19]). These semi-structured problems are often multidimensional, with goals and objectives that are not completely defined, and have a large number of alternative solutions (Gao et al. [12]).

Also, the types of spatial decisions can be organized into four main categories (Kemp [15]): (a) site selection, (b) location allocation, (c) land use selection, and (d) land use allocation. The great complexity involved in spatial decision making suggests the use of automated or computer-based techniques. However, there is usually not a single solution that meets all objectives for all stakeholders (Xiao [37]).

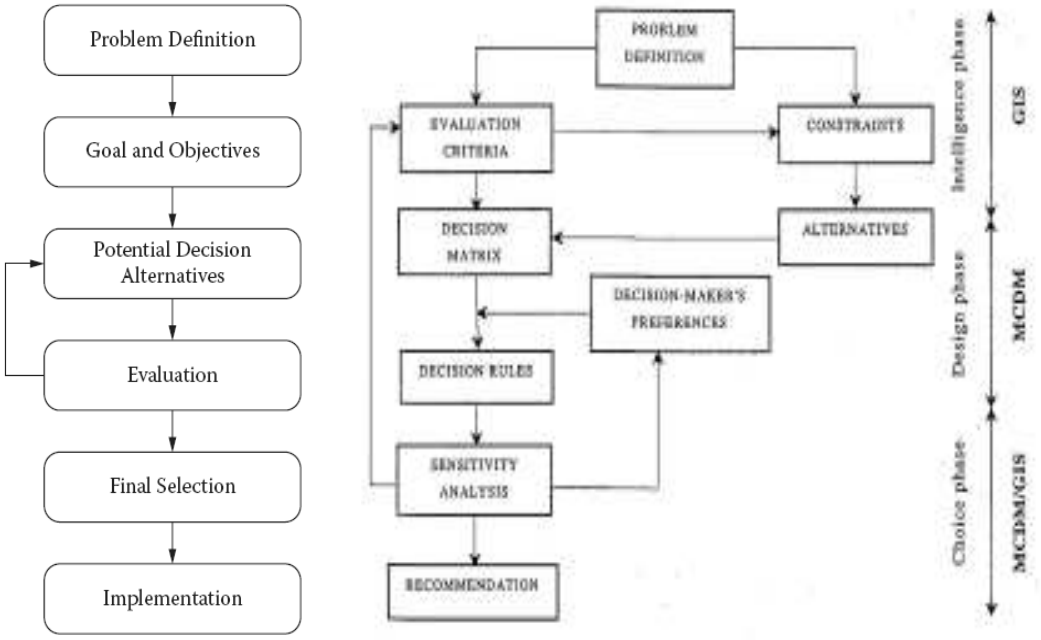


**Figure 5:** General Spatial Decision Making Process (left) and Spatial Multi-criteria Decision Analysis (right)

Considering the above comments, it is more obvious that the spatial decision-making process is basically a Multi-Criteria Decision Making Process (MCDMP). In particular, spatial multi-criteria decision problems, typically involve a set of geographically-defined alternatives (events) from which a choice of one or more alternatives is made, with respect to a given set of evaluation criteria (Malczewski [19]). Spatial multi-criteria analysis requires information on criterion values and the geographical locations of alternatives in addition to the decision makers' preferences with respect to a set of evaluation criteria. In Figure 5, the general spatial-decision making process as proposed by Sugumaran and DeGroote [33] and the spatial multi-criteria decision analysis as proposed by Malczewski [19] are shown.

It should be noted that:

- Spatial decision problems are indeed complex and ill-structured (semi-structured), because of the variety of interested groups and uncertainties associated with the assessment and evaluation of the distribution of the quality and quantity of impacts at alternative locations.
- Greek Spatial Planning at a local scale (municipalities) implemented by the 'General Urban Plans-GUP' and 'Open City Spatial and Housing Organization Plans-OCSHOP', but there is a lack of specific legislation guidelines and planning framework for mountains.

- The *mountainous areas are "warehouses"* of cultural and natural resources, with specific socioeconomic features, multidimensional human geography and are characterized also by multidimensional interdependence and interaction of natural, cultural and socio-economic reality and
- Both spatial and temporal analyses have to become more complex[6] by the decision makers in order to improve spatial decisions.

There is added value in the implementation of Spatial Multi-criteria Decision Analysis (S-MCDA) techniques for Spatial Planning in Mountainous areas at local scale (municipalities) supported by "smart" geographical databases aiming to capture the decision maker's expectations.

### 3.2. SDSS: overview, characteristics and trends

The systemic approach is crucial and it's the main feature of an optimum methodological approach for supporting decisions related to solving semi-structured spatial problems in planning processes. It has proved to be the most suitable demarche to analyze the system and to formalize the relations and interactions between the system components. The systemic approach consists of developing the models closer to reality, and therefore is able to apprehend the complexity of the system by formalizing the interactions between its components (Bouloiz et al. [3]). The use of Spatial Decision Support Systems (SDSS) has grown dramatically over the last few decades, but there is still no universally accepted definition. An SDSS must be built to be flexible to accommodate various stakeholder preferences and restrictions and allow for effective user interaction in an iterative problem-solving environment (Sugumaran and de Groote [33]). According to Malczewski [19] an SDSS aims to improve the effectiveness of decision making by incorporating decision-maker judgments and computer-based programs within the decision making-process. The purpose of such a system is to support a decision maker in making "better" decisions. Furthermore, the structure of SDSSs can be described by identifying the major components or subsystems of the system. An SDSS typically contains three genetic components (Malczewski [19]): a) A Database Management System (DBMS) and geographical database; b) A Model-Based Management System (MBMS) and model base; and c) A Dialogue Generation and Management System (DGMS).

#### *3.2.1. Multi-Criteria spatial decision support systems (MC-SDSSs)*

The multi-criteria problem is at the core of decision support. MC-SDSS can be viewed as a spatial Decision Support System (DSS). The essential difference between these two concepts is that MC-SDSSs emphasize the multi-criteria character of spatial decision making. In general, the main feature of an MC-SDSS is the integration of GIS capabilities and Multi-criteria Decision Making (MCDM) techniques (Malczewski [19]). MC-SDSSs offer a flexible, problem solving environment where the decision problem can be explored, understood and redefined; Tradeoffs between multiple and conflicting objectives are investigated and priority actions are set (Ascough et al. [1]). The basic structure of an MC-SDSS is composed of three main elements as shown in the following diagram (Figure 6).

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[6] Complexity is the combination of a whole whose elements are combined in a way which is not immediately clear in the analysis (LeMoigne [16]).

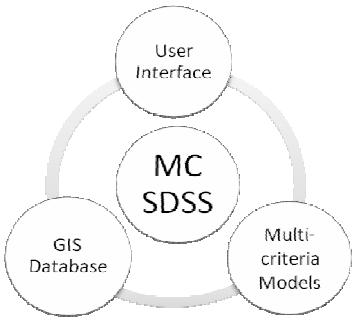


**Figure 6:** Basic structure of Multi-Criteria Spatial Decision Support Systems (MC-SDSS)

In a review of literature on SDSS publication per year, Sugumaran and DeGroote [33] showed that approximately 72% of SDSS publications came after 2000. These are similar to the results in a review of literature on GIS-based Multi-criteria Decision Analysis, by Malczewski [21], who found that 70% of reviewed articles were published after 1999 (see Fig. 7).

## 4. MC-SDSS for Spatial Planning in Mountainous Areas

In order to move on to the next framework analysis on the use of MC-SDSSs for spatial planning in mountainous areas, the following assumptions need to be considered:

- Mountains must be considered as a *separate geographic unity* in the strategic spatial plans and spatial decision problems, especially for mountainous areas, *which are very complex and ill-structured (semi-structured).*
- Spatial planning of mountainous areas is crucial for preserving the natural, cultural and human environment and consists of one of *the major processes of an integrated spatial policy*.

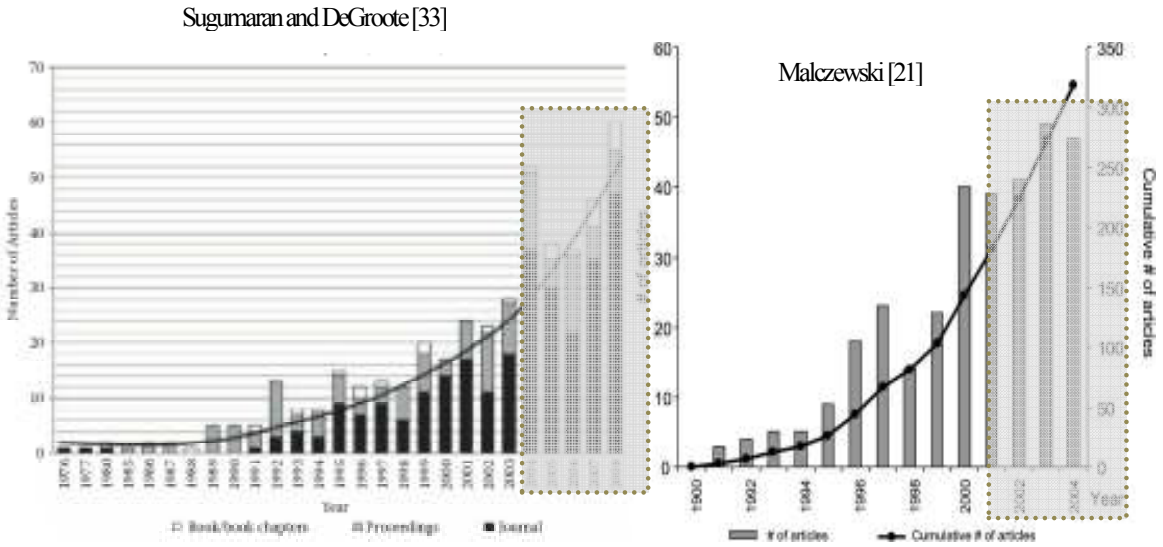


**Figure 7:** SDSS Publication/Year (1978-2008) (left) and Total Number of GIS and MCDM articles/year (1990-2004) (right)

- The spatial planning process and policies for mountain areas must be based on a thorough understanding of the *spatiotemporal changes* of social, economic, cultural and environmental reality, as well as the inherent problems due to their particular characteristics and development constraints.

- Due to the fact that the features in mountain areas vary spatially (development degree, human geography, socio-economic reality, relations of dependency and interaction with other areas-regions), *the local scale of spatial planning* (municipalities) seems to be the most appropriate.
- Apparently, *the main trend of actual European landscape changes* relates to the polarization between a more intensive use of land in most favourable areas and a more extensive use, or even land abandonment, in remote rural areas having less favourable economic and environmental conditions such as mountain areas.
- MC-SDSS can be used to *bridge the gap between policy makers and complex computerized models* aiming to improve the effectiveness of decision making of mountainous areas spatial problems.
- Multisite Land Use Allocation (MLUA) is crucial for the integrated development of mountainous areas (problem of allocating more than one land use type in a given area). According to Stewart et al. [32] this is a complex process, as in land use, planning decisions must be made not only on what to do (selection of activities) but also on where to do it, adding a whole extra class of decision variables to the problem.
- In Greece there is additional value in using MC-SDSS, due to the fact that *there is a lack of land use allocation in mountainous areas*, resulting in conflicts which in future will become more intensive. (See Section 2.2).
- An integrated MC-SDSS for MLUA in mountain areas should incorporate features related to the spatiotemporal analysis of external entities outside geographic boundaries of the study area. Hereby, external entities include the natural, cultural and anthropogenic environment, as well as the regional planning guidelines affected by or affecting the MLUA process.

### 4.1. Rationale behind the development of MC-SDSS for MLUA in mountainous areas

An integrated MC-SDSS for MLUA in mountainous areas must be characterized by the ability for both spatial and temporal analysis in order to better represent the reality by a modeling approach. Moreover, according to Ascough [1], multi-criteria spatial decision support tools must be capable of dealing with uncertainty. Also, a key feature of such a prototype system is the ability to predict the spatial pattern of a mountainous area for a given MLUA plan both in local and regional scale aiming to answer the following questions:

- What if the proposed LUAL plan is implemented (spatiotemporal evolution)?
- What are the spatial implications of the local plan at regional level?
- What is the risk of the final decision making at environmental, cultural, human geography and socio-economic level in and outside the boundaries of the study areas?

Developing a MC-SDSS for MLUA is a complex process in which, during the design phase, the following questions must be answered in order to proceed to the development and implementation phase:

- Who will use the system (single-user, group of users etc.)?
- Would it be a desktop or Web-based SDSS?
- Which is the spatial scale of planning?
- What spatiotemporal methods will be provided for the user/users?
- What kind of data (quantity and quality) should be used?
- Which are the geographical database characteristics?
- What strategy must be chosen for coupling GIS and spatial modeling systems (loose or tight)?
- Modeling techniques?
- Functionalities by the user interface?
- Sensitivity analysis techniques?

Although the above questions are the basis of the development of a prototype MC-SDSS for MLUA in mountainous regions, the core of such a system, refers to the computational techniques that can help in modeling and describing complex systems for inference and decision making. Regarding the assumptions and the rationale behind the development of a MC-

SDSS for MLUA in mountainous areas, we strongly believe that Artificial Intelligence Techniques (AI-computational techniques) when incorporated in a MC-SDSS, provide various benefits for both spatiotemporal analysis and spatial planning in the context of an Intelligent MC-SDSS (Fig. 8). In particular, for MLUA in mountainous areas, these techniques offer new opportunities for more complex analysis, with an improved representation of the reality and predictions.

According to Malczewski [20], AI seeks to develop systems that attempt to mimic human intelligence without claiming an understanding of the underlying processes. The common denominator of AI methods is that, unlike conventional approaches, they are tolerant of imprecision, ambiguity, uncertainty, and partial truth. During the last decade prominent research areas in developing hybrid systems include the integration of GIS and AI approaches such as Fuzzy Logic (FL), Genetic Algorithms (GAs), Artificial Neural Networks (ANNs), Cellular Automata (CA) and Agent-Based Modeling (ABM). The current surveys on coupling SDSS and AI have been focused on the evaluation of the accuracy of these techniques, especially when used to solve complex spatial planning and land use allocation problems.

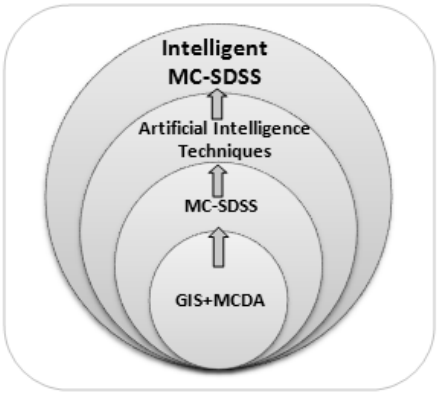


**Figure 8:** Framework of an Intelligent MC-SDSS for MLUA in mountainous areas

### 4.2. AI Techniques in Spatial Planning

#### *4.2.1. Fuzzy Logic*

The conventional methods based on Boolean algebra are unable to provide the precise numerical information required in complex land-use suitability analysis [20]. The inclusion of crisp boundaries in spatial and non spatial data produces similar definitive or crisp results in any modeling or SDSS activity (Sugumaran and DeGroote [33]). The fuzzy set theory allows objects or locations to belong partially to multiple sets instead of being completely discrete (Malczewski [19]). The Fuzzy set theory can also be used for linguistic statements that are used to provide an ordering of criteria such as low, moderate, and high.

#### *4.2.2. Genetic Algorithms (GAs)*

Genetic algorithms are search methods that mimic biological evolution in that they involve a competitive selection that eliminates poor solutions (Malczewski [20]). These types of algorithms have been used commonly in land use planning and suitability analyses (Malczewski [20]). Brooks [4] demonstrated that generic algorithm can improve the conventional land-use suitability approaches by its capability to identify a specific site for locating activities. Matthews et al. [24] suggested that a GA can be a key component of the land-use planning and management support system. Parolo et al. [28] propose a new model for optimizing the allocation of tourist infrastructures (refuges and camping sites), and apply it to a protected area in the European Alps. To reach this goal, a complex model based on genetic algorithms was required (instead of a common multi-criteria analysis), to obtain a complex interplay in the form of a dynamical simulation, where candidate solutions are interactively evaluated. Stewart et al. [31] provide a mathematical formulation for the land use planning problem, and motivate and develop

a goal programming/reference point methodology for incorporating multiple objectives into its solution. This formulation gives rise to a nonlinear combinatorial optimization problem, for which a GA was developed.

*4.2.3. Artificial Neural Networks (ANNs)*

Malczewski [20] points out that it is convenient to think of neural networks in terms of the following three steps: input (e.g. data for land use analysis), model (e.g. model of land use), and output (e.g. the best pattern of land use). In a neural network procedure, each input is presented into the network during a training phase, where the network is told the correct output for each given set of inputs. The network is presented by many of these input and output sets, and it begins identifying the relationships between the data. Like a brain, the memory or 'knowledge' of the resulting network is stored in the overall pattern of connections that determine the network's structure. Neural networks approximate solutions to complex land-use suitability problems, rather than provide deterministic solutions (Fischer [11]). A neural network can be seen as an adaptive system that progressively organizes itself, in order to arrive at an approximate solution. It has the capability of progressively improving its performance on a given task, by somehow 'learning' how to do the task better. Thus, the approach does not require the analyst to specify accurately and unambiguously the steps towards solutions. According to Malczewski [20], the problem with neural networks is that it is not clear what constitutes the optimal structure of the network. He characterizes the nature of the ANN methods as a 'black box' which is a limitation as far as real-world applications are concerned.

*4.2.4. Cellular Automata (CA)*

A CA is a discrete dynamic system composed of a set of cells in a one-or multidimensional lattice. The state of each cell in the regular spatial lattice depends on its previous state and the state of the cells in its neighbourhood (Malczewski [20]). The CA data structure is very analogous to the GIS raster data model (Sugumaran and DeGroote [33]). Cellular automata methods are inherently spatial and are among the simplest representations of dynamic systems, and because of this, it can be very useful for modeling land use dynamics [36]. Sugumaran and DeGroote [33] point out that weakness of CA techniques is that they are based on neighbourhood relationships and generally does not account for global effects that also affect spatial phenomena. Mathey et al. [23] developed a decentralized spatial decision support tool for forest management planning, based on cellular automata (CA) modeling. An innovation of this model is that beyond spatially allocating/simulating management activities, the CA rules and state space are modified to allow cells to co-evolve until a plan for all periods of the planning horizon has been achieved.

*4.2.5. Agent-Based Modeling (ABM)*

The main concept of ABM is that it captures the observed behaviour of organized complex systems by using fine-grained entities (the agents) that represent the main drivers of changes in the state of the system. All agents are structurally coupled to an environment and to each other by a set of rules. In principle, each agent "behaves" autonomously. The reactive or proactive behaviour of individual agents is determined by rules and based on reasoning about observations of agents of its environment. The cumulative effect of the individual behaviour of agents is a global change in the state of the environment (Ligtenberg et al. [18]). The rationale of this approach is that it is easier to model the behaviour of individuals than it is to model a system as a whole. However, by modeling the behaviour of individual agents, system-level lessons can be discovered (Sugumaran and DeGroote [33]). Ligtenberg et al. [18] designed a method to generate insights that can improve the understanding of the behaviour of socio-spatial systems in a planning context. The method was tested by carrying out an experimental role play to validate individual agent tasks, focusing on the ability of agents to generate beliefs and preferences about their environment. In addition, an earlier study of Ligtenberg et al. [17] describes a spatial planning model combining a multi-agent simulation (MAS) approach with cellular automata (CA). The model includes individual actor behaviour according to bottom-up modeling concept.

## 5. Process Concept of MLUA in Mountainous Areas

Taking into consideration all the above, in this section we intend to propose a schematic methodology approach for MLUA in mountainous areas, using AI techniques in the terms of a MC-Spatial Decision Support System. Although there is no case study application, it's an analytic methodology flowchart providing the main steps and its expected results as the core of a future MC-SDSS.

As already mentioned, Land Use Allocation (LUA) process is a very complex procedure, especially in mountainous areas, due to inherent environmental, socio-economic and anthropogeography characteristics and interactions which, in the terms of modeling, lead to very sensitive systems. It is obvious that changing an existing spatial pattern, by introducing new or changing existing land uses, could lead to "new" local development realities. Furthermore, the MLUA process increases the decision difficulty because decision-maker/s in the early stages must provide robust answers for two main questions regarding the types of land uses: "Where?" and "What?" to plan and in the final stages of the question "What if?" Regarding these challenges, mountain land must be evaluated in the terms of 'land use capability' and 'land use suitability' for a set of alternative land uses.

The term 'Land Use Capability-LUC', introduced in 1960 by the Soil Conservation Service in USA and has been widely used, especially in the American Continent [5] "Capability" is viewed by some as the inherent capacity of land to perform at a given level for a general use, and "suitability" as a statement of the adaptability of a given area for a specific kind of land use; others see capability as a classification of land primarily in relation to degradation hazards, whilst some regard the terms 'suitability' and 'capability' as interchangeable (FAO [10]). In literature, few studies consider this separation in land evaluation procedures and, in most cases, the 'Land Use Capability' is used as a spatial indicator to evaluate agricultural land uses. A recent example is the study of Tenerelli and Carver [34] who set-up a GIS based multi-criteria approach to assess a range of possibilities for perennial energy crops conversion by applying a land capability model and describing the suitability of the land for energy crop growth. The model is based on a multicriteria evaluation (MCE), which assesses the suitable area and the capability level for energy crops by considering pedo-climatic and topographic diagnostic criteria.

In this study, the general methodology is composed of three different phases. LUC evaluation and classification is used not only for evaluating agricultural land uses but also for any proposed land use type. In the overall MLUA procedure LUC is an intermediate phase. In preliminary stage, advanced spatiotemporal analyses must take place, in order to support the decision maker to define specific regions, where interventions are needed. Further spatial choices (e.g. regional, national etc), existing plans and legislation are also considered in this stage, to recognize spatial constraints, limitations and general spatial development directives (see Section 2) for the study area. Table 1 presents further details about this preliminary phase (Phase A).

Through this stage, the decision-maker is able to:

- Identify the spatial problems related to the existing land use patterns (e.g. land use conflicts).
- Formulate alternative land use scenarios and to define its main objectives and sub-objectives. Each of these scenarios consists of a set of main and sub land use types (Fig. 9).

**Table 1:** Description of the preliminary phase

| Phase A: Preliminary Spatiotemporal Analyses and Simulation | | | | |
|---|---|---|---|---|
| **Sub-stages** | **Description/Details** | **Tools and AI Techniques** | **Expected Results** | **Expected Outputs** |
| **A1** | Evaluation of existing Land Use Pattern | Remote Sensing. Spatial Statistics, GIS, Fuzzy Logic | Land use index | Land use map |
| **A2** | Existing spatial plans, legislations and directives | GIS and literature | Spatial constraints and limitations, spatial development directives | Constraints/Limitation Maps. Spatial Development Directions Maps (classified) |
| **A3** | Spatiotemporal analyses of existing land use pattern (past to present) (at least 30 years ago). | GIS, Remote sensing, spatial statistics, Cellular Automata (CA). Agent-based Modelling (AMB). Case-Based Reasoning (CBR) | Spatial Dynamics Simulation. Land use types evaluation in the overall development profile of the study area. | Temporal Maps of Land Uses. |
| **A4** | Future forecast of the existing land use pattern. | GIS, Artificial Neural Networks (ANN). Case-Based Reasoning (CBR) | Problem definition and identification of regions which need to be examined in the terms of Land Use planning. | Map of specific regions for Land Use Allocation |

Artificial Intelligent (AI) techniques are necessary almost in every sub-stage. Furthermore, this stage is crucial in the overall MLUA process, where the expected outputs from sub-stage A4 are the inputs for the next stage of LUC evaluation.

Moving on the next phase (Phase B: Land Use Capability Evaluation) a first set of allocation criteria, which consists of constraints (exclusionary criteria) and capability factors (non-exclusionary criteria) need to be determined, regarding only the Main Land Use types (MUij) of alternative scenarios proposed in the first phase. A classified map will be produced for its main land use type, in compliance with the evaluation criteria where the land capability classes reflect degrees of capability. A sample of classes presented in Table 2. This stage requires good knowledge and expertise relevant to the requirements of every land use type and especially to the factors which impact the allocation procedure. Otherwise, a sub-database including qualitative and quantitative information about various land use types should be integrated into the main SDSS database.

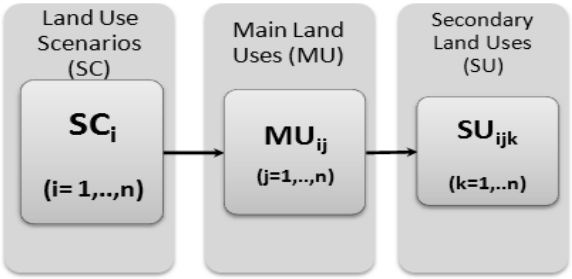


**Figure 9:** Scenarios and land use types' structure

The expected outputs from this phase are land use capability classification maps of each MU (MUij) according to the scenarios proposed by first phase. The methodology approach comprised the following steps (Dimopoulou et al. [7]):

**Table 2:** Sample of capability classes

| Classes | Description |
|---|---|
| 1 | Land having no significant limitations to sustained application of a given use, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level. |
| 2 | Land having limitations which in aggregate are moderately severe for sustained application of a given use; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class 1 land |
| 3 | Land having limitations which in aggregate are severe for sustained application of a given use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will be only marginally justified |

- Using buffer zoning excluded areas are indicated, i.e. sub-regions where a specific land use type cannot be located according to the constraints applied. Overlay of buffer maps of various thematic layers to identify and represent areas of constraints. Constraining criteria remain as Boolean images, dividing the study area in two land categories, i.e., capable (capability index 1) and uncapable (capability index 0). The mathematical formula using exclusionary criteria only, is:

$$CI = \prod_{j=1}^{K} bj$$

where: CI = overall capability index value (0 or 1); $b_j$ = capability index value for each constraining criterion (0 or 1); K = number of constraining criteria.

- Creation of classified maps for each factor (non exclusionary criteria) using appropriate grid cell size.
- Weights assignation to each factor according to their relative impact on every MU allocation. For an objective weight assignment process, a pair wise comparison can be applied in the context of the Analytical Hierarchy Process (AHP) decision-making process (Saaty [30]) or the Order Weighted Averaging (OWA) approach (Malczewski [22]).
- The final capability maps for every MU, evaluation are formed by overlaying the maps produced from step 1 and 3. The mathematical form for the assignment of the overall capability index, applying both exclusionary (constraints) and non-exclusionary (factors) criteria, is:

$$CI = \sum_{i=1}^{N} w_i x_i \times \prod_{j=1}^{K} bj$$

where: CI = overall capability index value; $w_i$ = weight of factor i; $x_i$ = criterion score of factor i; $b_j$ = criterion score of constraint j; N = number of factors; K = number of constraining criteria.

Finally, in the third phase (Phase C: Land Use Suitability Evaluation) a second set of allocation criteria are applied, regarding the Sub Land Use types (SUijk) of every MU type (MUij). These criteria are divided into constraints and factors and are based on more specific local scale conditions of the study area. A classified map will be produced for its SUijk, in compliance with the allocation criteria, where the land suitability classes reflect degrees of suitability. The expected outputs from this phase are land use suitability classification maps of each SU (SUij). The methodology approach comprises the same steps with the land use capability evaluation procedure. The mathematical form for the assignment of the overall suitability index, applying both exclusionary (constraints) and non-exclusionary (factors) criteria, is:

$$SI = \sum_{i=1}^{N} w_i x_i \times \prod_{j=1}^{K} bj$$

where: SI = overall suitability index value; $w_i$ = weight of factor i; $x_i$ = criterion score of factor i; $b_j$ = criterion score of constraint j; N = number of factors; K = number of constraining criteria.

Final Land Use Map can be resulted from and aggregation procedure using both the Land Use Capability and Suitability Maps. The mathematical form is:

$$FI = \sum_{ij=1}^{N} CI_{ij} \times \sum_{ijk=1}^{K} SI_{ijk}$$

where: FI = overall allocation index value; N = number of Main Land Uses (MU); K = number of Sub Land Use types (LU), $CI_{ij}$ = Capability Index of $MU_{ij}$, $SI_{ijk}$ = Suitability Index of $SU_{ijk}$.

The final land use map can be used as an input in the Sub-stage A4 (see Table 5.1) in order to predict spatiotemporal evolution of the proposed land use plan. The overall MLUAL methodology is presented in the following flowchart (Fig. 10) according to the phases described above. Among others, sensitivity analyses it has been integrated in the overall methodology approach.

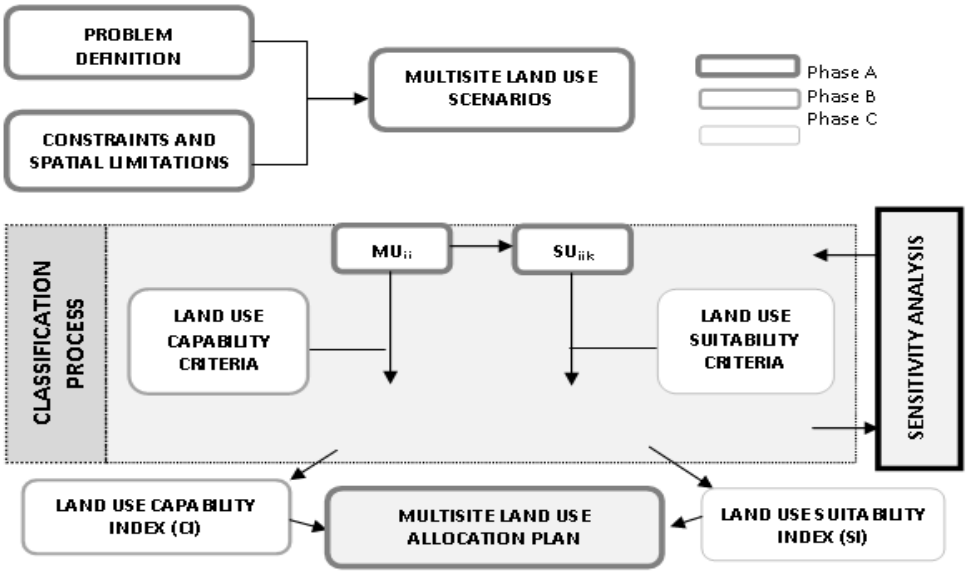


**Figure 10:** Overall MLUAL methodology flowchart

## 6. Executive Summary and Conclusions

There is no doubt that spatial problems vary depending on the features of the wider environment in which they are located (natural, cultural, socioeconomic, and anthropogenic). In particular, spatial decision problems, especially for mountainous areas, are very complex and ill-structured (semi-structured) and it is crucial to adopt a comprehensive, spatially integrated policy which is able to reflect and support the multi-functionality which has been the sustainable concept in mountains for many generations. Spatial planning of mountainous areas is also crucial for preserving the natural, cultural and human environment and consists of one of the major processes of an integrated spatial policy. Moreover, the spatial planning process and policies for mountain areas must be based on a thorough understanding of the spatiotemporal changes of social, economic, cultural and environmental reality as well as the inherent problems due to their particular characteristics and development constraints. Consequently, the modern decision-maker must be supported by Multi-criteria Spatial Decision Support Systems (MC-SDSS) in order to make improved spatial planning decisions. Especially for mountainous areas, the basis for an integrated development is the implementation of an effective Multisite Land Use Allocation (MLUA) plan aiming to: preserve their complex environment (natural, cultural, socioeconomic and anthropogenic), to avoid land use conflicts and to achieve a balanced spatial development simultaneously.

An integrated MC-SDSS for MLUA in mountainous areas must be characterized by the ability for both spatial and temporal analysis in order to better represent the reality by a modeling approach. The core of such a prototype system refers to the computational techniques that can help in modeling and describing complex systems for inference and decision making. Also, a key feature of such a system is the ability to predict the spatial pattern of a mountainous area for a given MLUA plan both in local and regional scale. Regarding the assumptions and the rationale behind the development of a MC-SDSS for MLUA in mountainous areas, we strongly believe that Artificial Intelligence Techniques (Fuzzy Logic, Genetic Algorithms, Artificial Neural Networks, Cellular Automata and Agent-Based Simulation), when incorporated in a MC-SDSS, provides various benefits for both spatiotemporal analysis and spatial planning in the context of an Intelligent MC-SDSS.

To deal with the above challenges, the proposed process concept of MLUAL in mountainous areas introduces a new methodological approach, by dividing the land use evaluation process into land use capability and suitability assessment. The rationale behind this approach is that, for every proposed land use plan scenario, a set of main and secondary land uses are defined. Regarding the fact that, a land use type affects, directly or indirectly, the spatial development profile of both the case study area and the neighbour areas (in the terms of land use policy), the main land use types (MUij) are equal to strategic choices of an integrated spatial development plan. Therefore, the allocation criteria (constraints and factors) of these kinds of land use types should satisfy the broader spatial strategic objectives set for the study area. In the other hand, the sub land use types (SUijk) evaluation expands the allocation analysis to a more detailed level, using special local allocation criteria. Classified maps are produced according to the capability and suitability degree of every main and sub land use type respectively and a final land use map can be resulted from an aggregation procedure.

Artificial Intelligence (AI) techniques for land analysis are incorporated in the overall process mainly in two phases: In a preliminary stage, AI techniques are suggested for performing complex spatiotemporal analyses by the decision maker. The expected results and outputs support the decisions that are need to be taken, regarding the definition of spatial problems and constraints/limitation. Furthermore, every final proposed MLUAL plan (See Fig.5.2) can be spatiotemporally evaluated using appropriate AI techniques and the results can be used as a feedback for the overall process.

Although there is a trend in coupling AI techniques with spatial modeling, there is a lack of studies concerning the incorporation of these techniques into MC-SDSS for developing hybrid systems. The latter is the main subject of our current research which is focusing on the evaluation of the described methodological approach for MLUAL in mountainous areas.

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# ESTIMATION OF A DISCRETE-CHOICE MODEL WITH SPATIAL INTERACTIONS: THE CASE OF DEFORESTATION IN WESTERN ATTICA BETWEEN 1990 AND 2000

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**Abstract**

*This paper presents an environmental application, investigating land use changes of forests and semi-natural areas in the Greek region of Western Attica. Its objective is to estimate the spatial equilibrium distribution of individual deforestation actions and determine the degree of coordination in individual behaviour. For this purpose, the paper starts by creating a virtual economic network of 156 agents, by laying an ad hoc square grid over the region. Next, the dominant forest land use changes have been determined for each land parcel, using CORINE land cover maps for the years 1990 and 2000. The economic model used is a discrete choice model, with endogenous spatial interactions. Even though spatial interactions produce multiple equilibria, the present research proposes a two-stage fixed point estimator, yielding a unique solution. Empirical findings suggest that equilibrium deforestation actions are strategic substitutes for the environment and complements for agriculture, and are characterized by a relative lack of coordination in individual behaviour.*

***Keywords***: *land use change, spatial interaction, discrete choice modeling, deforestation*
***JEL classification*: R10, R11.**

## 1. Introduction

Forests belong to an economy's physical capital and, as such, are endogenous to its economic growth rate. Despite the fact that Greek forests are public goods, protected by the constitution, the myopic pursuit of private interest in conflict with environmental welfare has led to systematic clearing of forest land located near urban, agricultural and industrial areas. According to geographical and census data concerning the Attica region in 1990 and 2000, land use changes that took place in Western Attica indicate forest clearing in favor of economic activities. These changes are the result of thriving economic activity in the region during 1990-2000, characterized by a relative lack of appropriate urban planning.

The purpose of this article is to study the strategic deforestation behaviour of individuals active in Western Attica between 1990 and 2000 and determine the degree of coordination of individual actions. In this respect, it proposes an alternative estimation method of a discrete choice model with endogenous spatial interactions, which belongs to the general class of social interactions models (Brock and Durlauf [5], [6], [7]) and has been applied in a spatial study investigating tropical deforestation in Costa Rica, where forest land is governed by individual property rights (Robalino and Pfaff [14]). The economy is a network of a finite number of interacting individuals, whose strategic actions produce spatial spillovers. The decision-making process is decentralized and has the form of a static spatial deforestation game, with complete but imperfect information, implying that individuals know ex ante the optimal strategy of their nearest neighbours up to the parameters, which determine its shape. Even though social models with local interactions produce multiple equilibria, the present paper combines fixed point theory with a statistical theorem on social networks, allowing the estimation of a unique equilibrium.

## 2. Methodology

### 2.1. The deforestation game

The spatial effects investigated in the present research paper are net environmental and agricultural externalities, arising in the context of a decentralized interdependent decision-making process. In principle, such effects arise in a decentralized economy with multiple equilibria as a result of failure to coordinate individual strategic actions (Cooper and John [9]). In particular, individual strategies produce positive (negative) externalities or spillovers, and are hence considered strategic complements (substitutes), when a positive change in an individual's strategic action increases (decreases) the strategic reactions of the other individuals.

However, non-cooperative action is characterized by spillover symmetry across individuals, implying that an individual's optimal strategic action ignores half the spillovers induced by his choice because he does not internalize the spillovers induced by his behaviour (Brock and Durlauf [6]). Equilibrium strategic actions are socially efficient in a socially planned economy, because individual action accounts for the spillovers induced by the impact of individual actions on mean behaviour. Thus, when individuals optimally choose to clear forest land without coordination (NC,NC), the spatial interaction effect should be half its magnitude than under full coordination (C,C) hence socially inefficient.

**Table 1**: Normal form of the deforestation game with spatial interactions

| | | Optimal reaction of individual *i*'s nearest neighbours | |
|---|---|---|---|
| | | Do not clear forest land (C) | Clear forest land (NC) |
| Optimal reaction of the $i^{th}$ individual | Do not clear forest land (C) | (C,C) $\rightarrow \rho_{00} > 0$ (ESC) | (C,NC) $\rightarrow \rho_{01} < 0$ (ASS) |
| | Clear forest land (NC) | (NC,NC) $\rightarrow \rho_{10} < 0$ (ESS) | (NC,NC) $\rightarrow \rho_{11} > 0$ (ASC) |
| | Net spatial effect | Environmental $\rho_0 = \rho_{00} + \rho_{10}$ | Agricultural $\rho_1 = \rho_{01} + \rho_{11}$ |

*Notes*: C stands for cooperation (coordination); NC stands for non-cooperation (lack of coordination).

According to Table 1, four types of spatial effects may be distinguished: Environmental Strategic Complementarities (ESC) and Substitutes (ESS), and Agricultural Strategic Complementarities (ASC) and Substitutes (ASS). For instance, ESS arise when neighbours have incentive to use land near forest for industrial development; ASC arise when farmers as a group improve their bargaining position by buying inputs to clear forest land and selling output produced on cleared land at better prices; and ASS arise when reduced local agricultural prices are the result of neighbour forest clearing for the production of agricultural goods (Robalino and Pfaff [14]).

### 2.2. The economic model

The economy consists of a finite number of homogeneous interacting individuals $i = 1,2,\ldots,I$ with attributes $x_i$. The decision-making process is decentralized. Each individual is faced with the binary choice $y_i \in \{0,1\}$ to clear ($y_i = 1$) or not ($y_i = 0$) forest land. The binary event $y_i$, is an independent and identically distributed (i.i.d.) Bernoulli variable. Individuals have the same number of nearest neighbours' $|N_i|$, implying regular interactions. Moreover, individuals form expectations regarding nearest neighbours' optimal reaction as a function of the latter's spatial location. Expectations are rational, hence realized actions equal their expected values in equilibrium: $y_{ij} \equiv E_i(y_j) = E(y_j)$ for every $i$ and every $j \in N_i$. Individual strategies take the form of profit functions additive in deterministic private, deterministic social and stochastic private profit:

$$\Pi_i(y_i) \equiv \pi_i(y_i, x_i) + \pi_i^S\left(y_i, x_i, \mathrm{E}(y_j)\right) + \varepsilon_i(y_i) \quad (1)$$

In particular, equations 2-3 below describe the cases of deforestation and non-deforestation, respectively:

$$\Pi_i(y_i = 1) \equiv x_i^{'}\beta + \rho_{11}\sum_{j\in N_i} w_{ij}\mathrm{E}(y_j) + \rho_{10}\left(1 - \sum_{j\in N_i} w_{ij}\mathrm{E}(y_j)\right) + \varepsilon_i(1) \quad (2)$$

$$\Pi_i(y_i = 0) \equiv x_i^{'}\beta + \rho_{01}\sum_{j\in N_i} w_{ij}\mathrm{E}(y_j) + \rho_{00}\left(1 - \sum_{j\in N_i} w_{ij}\mathrm{E}(y_j)\right) + \varepsilon_i(0) \quad (3)$$

The spatial structure is fixed. It is described by spatial weight matrix W with non-zero off-diagonal elements $0 \leq wij \leq 1$, denoting the proportion of land owned by neighbour j in individual i's neighbourhood. As a result, the summand denotes the area of individual i's neighbourhood that has been cleared. By assumption, individual errors are jointly independent standard normal or extreme value type I (or log-Weibull) distributed, hence error differences will be standard normal (whether individual errors are mutually independent or not) or logistic distributed, respectively. Defining $\varepsilon_i \equiv \varepsilon_i(1) - \varepsilon_i(0)$ and $\beta \equiv \beta 1 - \beta 0$, each individual has an incentive to clear forest land if clearing yields a net positive profit:

(4)

Parameters ρ0 and ρ1 are the net spatial interactions of Table 1. The individual strategic deforestation likelihood is defined as follows:

$$\Pr(y_i = 1) = \Pr(\Delta\Pi_i > 0) = \mathrm{F}(\varepsilon_i = 1) \equiv P_i \quad (5)$$

Indicator function $yi = 1\{\Delta\Pi i > 0\}$ summarizes the actual deforestation action, and F is a given continuous and strictly increasing distribution function, such as the standard normal or the logistic one. Individual likelihoods, Pi, make up a simultaneous system of I equations with solution equal to the probability distribution, P, which corresponds to the economy's equilibrium. Since expectations are rational by assumption, the equilibrium will be self-consistent and the system will be characterized by coherency or internal consistency. In particular:

$$y_{ij} = \mathrm{E}_i(y_j) = E(y_j) = P_j \quad \forall j \in N_i \text{ and } \forall i \in I \quad (6)$$

The fact that each element of vector P is indexed by subscript j implies that individual expectations regarding nearest neighbours' optimal reactions are a function of the latter's spatial location. According to the topology of spatial interactions (Ioannides [11]), when individuals are distinguished by their location in space, the resulting equilibria are anisotropic, as opposed to isotropic ones resulting from global interactions describing the mean filed case, where a single individual's choice automatically determines the choices of all other individuals (Brock and Durlauf [5], Blume et al. [4]). Anisotropy implies clustering hence multiple equilibria (e.g. Tamer [17]). However, uniqueness of equilibrium is possible as long as the system is fully recursive hence internally consistent (Ioannides [11], Blume et al. [4]). When interactions are spatial, the system is fully recursive when each individual's neighbourhood has the topological structure of a clique. A clique is consisting of a set of sites,

in which are all neighbours to each other (Cressie [9]). For instance, triangle or hexagons (with all edges mutually connected) are examples of cliques!

### 2.3. The spatial interactions matrix

The proposed spatial interactions matrix $W(I,1)$, is a function of the first order rook contiguity criterion $\Gamma(I,1)$. Rook contiguity is inspired by the moves of the rook in a chess game (Anselin [2]). Its algebraic representation has the form of a symmetric contiguity matrix $\Gamma(I,p)$, with connectivity order $p$. When $p = 1$, individuals are rook-contiguous with two adjacent neighbours giving rise to a linear adjacency pattern, hence $N_i = \{i - 1, i + 1\}$ and $|N_i| = 2$ for every $i$. Nevertheless, $\Gamma(I,1)$ is not fully recursive in the sense of a clique. Defining the off-diagonal elements of $\Gamma(I,1)$ as $\{\gamma_{ij}\} = \{1|i - j \leq 1|\}$ and those of $W(I,1)$ as $\{w_{ij}\} = \{(1/\lambda I) \times \min(i,j) \times \gamma_{ij}\}$ with $\lambda = p = 1$, Table 2 below describes the proposed spatial interactions structure for $I \geq 4$:

According to W(I,1), each individual landowner interacts with its two adjacent neighbours, forming a linear adjacency pattern. Moreover, the relative weight of neighbours' expected deforestation action increases with network size, hence with spatial location. Roughly speaking, spatial interactions grow stronger with network size.

**Table 2**: Algebraic representation of first-order rook interaction

| *Contiguity matrix* $W(I,1)$ | | | | | *Interactions matrix* $\Gamma(I,1)$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | … | 0 | | 0 | 0 | … |
| 1 | 0 | 1 | 0 | … | $1/\lambda I$ | 0 | $2/\lambda I$ | 0 | … |
| 0 | 1 | 0 | 1 | … | 0 | $2/\lambda I$ | 0 | $3/\lambda I$ | … |
| 0 | 0 | 1 | 0 | … | 0 | 0 | $3/\lambda I$ | 0 | … |
| … | … | … | … | … | … | … | … | … | … |

### 2.4. The econometric model

The econometric model is a discrete choice model with endogenous spatial interactions, which has the form of a dynamic system of I simultaneous equations, each one describing individual expected deforestation action (Equation 5). It is specified as follows:

$$P_i = F\left(x_i'\beta + (\rho_0 + \rho_1)\sum_{j \in N_i} w_{ij}P_j - \rho_0\right) \quad (7)$$

$$\sum_{j \in N_i} w_{ij}P_j = \sum_{j \in N_i} w_{ij}F\left(x_j'\beta + (\rho_0 + \rho_1)\sum_{k \in N_j} w_{jk}P_k - \rho_0\right) \quad (8)$$

Equation (8) serves as a selection mechanism implying that neighbours' expected deforestation actions are endogenously determined in a recursive way. Although group formation is endogenous (Moffitt [13]), its mechanism is known ex ante, since interactions matrix W, attributes x, and the parametric form of distribution F, are given.

In general, such a model is identified non-parametrically, as long as the attributes defining the reference groups (Equation 8) and those directly affecting outcomes (Equation 7) are 'moderately' related random variables, excluding the extreme cases of statistical (or functional) independence and perfect linear relationships (Manski [12]). Identification is improved if the

functional form is non-linear in a way that generates multiple social equilibria[7]. A parametric binary response model with endogenous effects, such as the proposed spatial interactions model, is such a case. Identification is owed to the following three facts: (a) its functional form is non-linear; (b) the parametric form of distribution function F derives from the exponential family (standard normal or logistic), hence it is continuous and strictly increasing; and (c) $W \neq I$ (here I denotes the identity matrix) implies that there is sufficient variability in endogenous variable WP, hence spatial interactions and the possibility of multiple equilibria improve identification.

Moreover, the parametric binary response model with endogenous effects is coherent hence there exists a solution to the system. The uniqueness or multiplicity of the solution depends on the sign of the endogenous parameter (Manski [12], Gourieroux [10]). When the endogenous parameter is negative, the estimated equilibrium will be unique and the estimated probability distribution of individual expected deforestation actions will have a single intersection with that of their nearest neighbours' in the open interval (0,1). In other words, as the distribution function of individual expected actions traverses the closed interval [0,1], their neighbours' will be continuously and strictly decreasing in (0,1), crossing the former once from below. On the other hand, when the endogenous parameter $\rho$ is strictly positive, the distribution function of neighbours' expected deforestation actions will be continuously and strictly increasing in (0,1), crossing that of the individuals from above (cf. Figure 1). However, the number of equilibria cannot be determined in that case, unless additional structure is imposed on the model. In the present context, spatial interactions matrix W provides the required structure, while uniqueness is achieved by means of the estimation method.

### 2.5. Fixed-point estimation

When the interactions are spatial, the joint probability distribution of the realized values of the Bernoulli random variable is a Markov Random Field (MRF) defined on the event set as a function of the set of the spatial sites where the latter is observed. According to the Hammersley-Clifford Theorem, as long as the MRF has the property of conditional independence, the joint probability measure has a unique representation in terms of consistent conditional probabilities defining a neighbourhood structure described by a given factor graph defined as $G = \{y_{ij} : i \neq j, 1 \leq i, j \leq g\}$[8]. Uniqueness implies a fully-recursive system (clique) which is very restrictive. When the data are discrete and the spatial dependence pairwise ($g = 2$), Pr(G) is logistic (exponential family). Hence, knowledge of the parametric form, F, is equivalent to knowledge of the joint itself up to a constant c:

$$\Pr(y) = c \exp F(y) \;\; \forall y \in \zeta \text{ or } \Pr(y) \propto \exp F(y) \tag{9}$$

As long as c is of known functional form, and finitely summable, F may be used for maximum likelihood estimation purposes. However, the presence of c complicates exact maximum likelihood estimation (MLE) of Equation 9[9]. Maximum Pseudo-Likelihood estimation (MPLE) instead is feasible and computationally simpler, since it avoids estimation of c. It relies on the existence of a 1-1 correspondence between graph models and logit models, which are uniquely identified (Strauss and Ikeda [16]). In fact, MPLE is equivalent to exact MLE of the logistic regression for independent observations. Bootstrap errors are required to correct for both the spatial dependence of the right hand side variables and the relative inefficiency owed to the use of the pseudo-likelihood.

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[7] The linear version of the social model with endogenous effects (the linear-in-means model) fails to identify the endogenous parameter when the latter incorporates a social equilibrium condition, hence the reflection problem (Manski, 1993).

[8] According to the Hammersley-Clifford Theorem, a spatial site *j* is a neighbour of site *i*, when the MRF has the Markovian property of conditional independence, i.e. when the joint probability measure may be uniquely factorized in terms of consistent factors defining a fully recursive neighbourhood structure i.e. a clique (Cressie [9]).

[9] Estimation of *c* is intractable for higher orders of dependence, namely for $g \geq 6$.

Furthermore, taking into account the endogeneity of individual expected deforestation action and the recursive nature of the model, the equilibrium probability distribution of deforestation P(θ), is indirectly determined as the fixed point of a real mapping, Ψ, in probability space, hence it is a Brouwer fixed point[10]. As a result, defining $\rho \equiv \rho 0 + \rho 1$ and $\theta \equiv (\beta', \rho')$, and assuming that xi includes a constant, Equation 7 is the individual pseudo-likelihood for estimation purposes:

$$P_i = F\left(x_i'\beta + \rho w_{i\_}' P\right) \quad (10)$$

Hence, the fixed-point mapping of the network:

$$P = F(X\beta + \rho W P) = \Psi(P(\theta), \theta) \quad (11)$$

According to the empirical literature, discrete choice models with endogenous effects are estimated in two stages (see for instance, Robalino and Pfaff [14]). The present research study proposes a two-stage fixed point estimator (Aguirregabiria [1]), with bootstrap errors instead. Given initial values for θ and P and $r \geq 1$ iterations, the estimator (FXP2S) is a two-step fixed-point algorithm maximizing the logarithm of the binary probit pseudo-likelihood over all network individuals:

$$\sum_i \ln P_i = \sum_i \ln \Psi(y_i|\theta) = \sum_i \{y_i \ln \Psi(P(\theta), \theta) + (1 - y_i) \ln \Psi_C(P(\theta), \theta)\} \quad (12)$$

$$\text{Estimation stage 1: } \hat{\theta}_I^r = \text{argmax}_{\theta \in \Theta} \sum_i \ln \Psi\left(y_i | \hat{P}_I^{r-1}, \hat{\theta}_I^{r-1}\right) \quad (13)$$

$$\text{Estimation stage 2: } \hat{P}_I^r = \Psi\left(y | \hat{P}_I^{r-1}, \hat{\theta}_I^{r-1}\right) \quad (14)$$

The initial value of P is estimated on the basis of a binary probit model without spatial interactions. The estimator sequence satisfies consistency and asymptotic normality.

Tables 3 and 4 report Monte Carlo simulation results for the proposed estimator, with a single exogenous regressor, given the proposed spatial weight matrix W. The sample size is kept relatively small in order to mimic the size of the network used in the empirical part. In fact, a square grid with cell size 3km x 3km produces 156 observations and explains the land use changes under investigation relatively well, whereas a square grid with cell size 1.5km x 1.5km produces 526 observations, but is relatively unstable in terms of estimation[11]. Unless (QML) standard errors are corrected for the spatial asymptotic bias, owed to the spatial dependence of the right hand side variables[12], inference will not be reliable.

[10] The underlying statistical model belongs to a family of parametric distributions, $\{P(\theta)\}$, whose members are continuous one-to-one mappings defined on standard unit interval $[0,1]^I$. In particular, $\Psi: F \times \Theta \to F$ is the fixed point mapping and Θ is the compact and convex parametric space.

[11] Results are not reported here.

[12] Recall that the data generating process (dgp) is spatial hence the spatial dependence and asymptotic bias.

**Table 3**: Monte Carlo simulation results

| Variable | Parameter value | Sample size | Estimate | RMSE | $\overline{P}_0$ | $W\overline{P}_0$ |
|---|---|---|---|---|---|---|
| Constant | $\rho_0=0$ | 100 | 0.010 | 0.245 | 0.617076 | 0.124504 |
| | | 150 | 0.002 | 0.188 | 0.694235 | 0.221352 |
| | | 200 | 0.005 | 0.171 | 0.714301 | 0.315057 |
| | | 300 | −0.006 | 0.148 | 0.793097 | 0.531006 |
| | | 400 | −0.003 | 0.146 | 0.845843 | 0.751273 |
| (Exogenous regressor) $X_1$ | $\beta=1$ | 100 | 1.051 | 0.223 | 0.617076 | 0.124504 |
| | | 150 | 1.052 | 0.192 | 0.694235 | 0.221352 |
| | | 200 | 1.035 | 0.173 | 0.714301 | 0.315057 |
| | | 300 | 1.027 | 0.153 | 0.793097 | 0.531006 |
| | | 400 | 1.025 | 0.153 | 0.845843 | 0.751273 |
| (Endogenous regressor) $P$ | $\rho=3$ | 100 | 3.009 | 1.593 | 0.801371 | 0.430272 |
| | | 150 | 3.099 | 0.783 | 0.694235 | 0.221352 |
| | | 200 | 3.072 | 0.560 | 0.714301 | 0.315057 |
| | | 300 | 3.090 | 0.429 | 0.793097 | 0.531006 |
| | | 400 | 3.079 | 0.398 | 0.845843 | 0.751273 |

*Notes:* #Simulations = 1000. $W(I,1)$: $\{w_{ij}\} = \{(\min(i,j)/500)\times(1|i-j\leq 1|)\}$. RMSE = Root Mean Square Error.

The results suggest that the asymptotic bias varies with sample size (Table 3) and number of nearest neighbours[13] (Table 4) given the proposed spatial weight matrix W. Sample sizes between 150 and 300 observations respond relatively better, both in terms of bias and RMSE (Table 3). Nonetheless, a bootstrap correction with 100 draws resolves the issue (cf. empirical application, next). The initial level of P is indicative of the degree of identification. Although the initial level of P increases with sample size, a weighted initial value (WP) between 0.2 and 0.3 is adequate (Table 3).

**Table 4**: Monte Carlo simulation results

| Sample size = 150 | | # Nearest neighbours $p=1$ | | | | # Nearest neighbours $p=2$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | Parameter value | Estimate | RMSE | $\overline{P}_0$ | $W\overline{P}_0$ | Estimate | RMSE | $\overline{P}_0$ | $W\overline{P}_0$ |
| Constant | $\rho_0=0$ | 0.002 | 0.188 | 0.694235 | 0.221352 | −0.014 | 0.216 | 0.839990 | 0.545561 |
| $X_1$ | $\beta=1$ | 1.052 | 0.192 | 0.694235 | 0.221352 | 1.067 | 0.241 | 0.839990 | 0.545561 |
| $P$ | $\rho=3$ | 3.099 | 0.783 | 0.694235 | 0.221352 | 3.211 | 0.676 | 0.839990 | 0.545561 |

*Notes.* #Simulations = 1000. $W(I,p)$: $\{w_{ij}\} = \{(\min(i,j)/500)\times(1|i-j\leq p|)\}$. RMSE = Root Mean Square Error.

[13] Given the rook definition of $W$, the spatial pattern remains linear despite the number of nearest neighbours.

## 3. Empirical Application

The empirical part investigates the degree of deforestation in the Greek region of Western Attica (Maps 1-2) between 1990 and 2000. The sample is a square lattice of 156 land parcels, constructed by laying a square grid with cell size 3km x 3km over the European Environmental Agency's (EEA) CORINE Land Cover (CLC) maps for the years 1990 and 2000 (Besag [3], Strauss [15]). CORINE Land Cover maps for the years 1990 and 2000 have been derived using visual interpretation of Landsat TM and ETM+ imagery (100m resolution). The cell size of the proposed square lattice captures relatively well both actual land uses as well as sample and estimated land use changes. Finer grids, say a cell size of 1.5km x 1.5km, produce noisy estimates. Administrative boundaries are at the level of municipalities according to the 'Kapodistrias'[14] project (Map 3).



**Maps 1 and 2:** Geographic location and regional division of Attica (left-right)

Western Attica is located west of the Attica region, which in turn is located at the center of Greece (Map 1), and is divided in four regions: Western Attica, Eastern Attica, Athens (Capital City) and Peiraias & Islands (Map 2). Western Attica consists of 12 municipalities: Elefsina, Ano Liosia, Aspropyrgos, Vilia, Erythres, Zefyri, Mandra, Megara, New Peramos, Fyli[15], Magoula and Oinoi (Map 3). Elefsina, Aspropyrgos, Mandra and Magoula constitute the Thriasio field. The broader area of Thriasio, Megara and New Peramos constitutes the Southern region (Map 4). Moreover, four sectors may be distinguished: the Attica County (Ano Liosia-Zefyri-Fyli), Thriasio, Megara-New Peramos, and Erythres-Vilia-Oinoi (Map 5). Some of the country's most significant industrial and commercial activities are concentrated in Thriasio, such as the Oil refinery of Aspropyrgos (Map 5), various steel industries (e.g. TITAN, the Hellenic Steel Industry), and the commercial port of Aspropyrgos. Unless economic agents internalize the environmental cost of their activities in the form of regular investment in environmental protection technology, such as bio-cleaning units and filters, environmental risks are imminent and high.

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[14] 'Kapodistrias' project: an administrative reform that took place in 1997, redefining the boundaries of the administrative units of Greek municipalities.

[15] Fyli is a semi-mountainous area (Mount Fyli is located West of Mount Parnitha) known, among others, for the historic site of the Fyli Castle (located at an altitude of 687m). The Ancient-Greek municipality of Fyli relied on the Castle for the defense of Athens against Thebans and other enemies.

Another source of pollution has been the nearby dump site in Ano Liosia (Map 5, Attica County), which served until 2011 as one of the Capital City's major landfills[16].

### 3.1. Demographic and other attributes

Western Attica covers a total area of 1004 km$^2$. According to the 2001 census, the total population of the region increased from 124,752 inhabitants in 1991 to 151,612 in 2001, an increase of 21% (Table 5). The largest part of the population is concentrated in Thriasio (53,963 or 43.3% in 1991; 70,401 or 46.4% in 2001) and the Southern region (85,893 or 68.9% in 1991; 106,076 or 70% in 2001). The population growth is mainly owed to the large concentration of economic activities in Thriasio, which raised the demand for labor and attracted workers from other Greek regions. Moreover, the relatively lower housing and land costs in municipalities located at the borders of the Capital City, such as Ano Liosia and Aspropyrgos, provided movers with additional incentives. However, the population growth was not followed by appropriate urban development.


**Maps 3-4-5:** Administrative, regional and sectoral division of Western Attica

**Table 5**: Demographic attributes and area

| Municipality | Area (km$^2$) | Population | | | Population Type | Urbanization | |
|---|---|---|---|---|---|---|---|
| | | 1991 | 2001 | Change | 2001 | 1991 | 2001 |
| Elefsina | 18.94815 | 22,793 | 25,863 | 13.5% | P | U | U |
| Ano Liosia | 38.45574 | 21,397 | 26,423 | 23.5% | SM | U | U |
| Aspropyrgos | 100.83685 | 15,715 | 27,741 | 76.5% | P | U | U |
| Vilia | 142.90266 | 3,412 | 3,215 | -5.8% | M | R | R |
| Erythres | 60.70775 | 3,519 | 3,326 | -5.5% | P | SU | U |
| Zefyri | 1.28169 | 8,985 | 8,860 | -1.4% | P | SU | U |
| Mandra | 206.42451 | 11,343 | 12,792 | 12.8% | SM | U | U |
| Megara | 325.79843 | 25,061 | 28,195 | 12.5% | SM | U | U |
| N. Peramos | 7.56726 | 6,869 | 7,480 | 8.9% | P | SU | U |
| Fyli | 69.17546 | 2,925 | 2,947 | 0.8% | SM | SU | U |
| Magoula | 18.17478 | 2,663 | 4,005 | 50.4% | P | SU | U |
| Oinoi | 13.77090 | 495 | 765 | 54.5% | SM | R | R |
| Total | 1,004.04418 | 124,752 | 151,612 | 21.5% | | | |

*Notes:* SM stands for Semi-Mountainous, M for Mountainous, P for Plain, R for Rural and U for Urban. A municipality is classified as urban when its most populated dwelling has ≥ 2,000 inhabitants and as rural otherwise.

[16] The dump site in Ano Liosia operated as an uncontrolled landfill until 2007. However, despite the lack of immediate alternatives, it continued its operation until 2011. Given its increasing saturation as well as environmental and public health concerns, it was relocated to Fyli (in the area of Mount Fyli), in order to serve Western Attica exclusively

### 3.2. Actual and sample Corine Land Cover (CLC) changes between 1990 and 2000

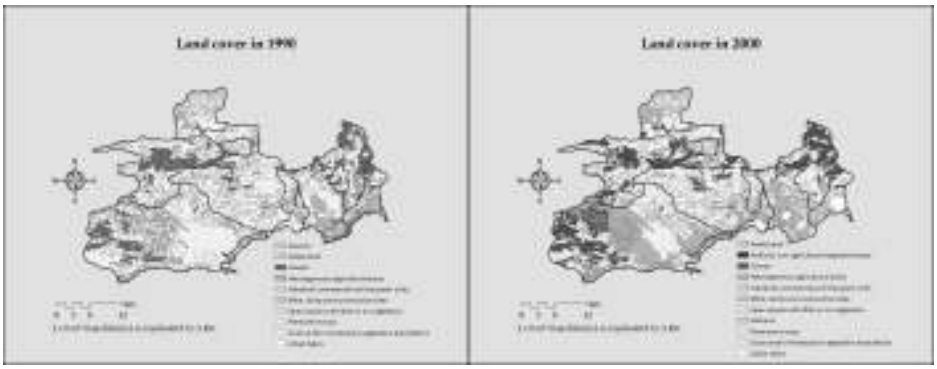
According to EEA's classification, every land use bears a 3-digit land cover code. The first digit refers to the first general class and the last one to the third and more descriptive class. The land uses observed in Western Attica during 1990 and 2000 are summarized in Table 6, codes 111-333.

Level 2 codes provide a first overview of the actual land uses in 1990 and 2000. Actual land uses (Maps 6-7) are then compared to sample changes of artificial, agricultural, forest, and forest and semi-natural areas (Maps 8-11).

There are noticeable indications of deforestation in Thriasio and in the Attica County, especially at the borders of the Capital City. A certain degree of reforestation is observed in Megara (Southern region) and Vilia. The Southern region is also characterized by an increase in agricultural activities. In fact, former arable land has been exploited for agricultural purposes in Megara and New Peramos. Moreover, significant changes may be observed at the borders of the Capital City, namely urbanization of former agricultural areas in Southern Ano Liosia and deforestation in Southern Aspropyrgos. The deforestation of both forest and semi-natural areas as well pure forest areas in Ano Liosia and Fyli are clear indications of the intensive use of the dump site in Ano Liosia between 2007 and 2011 until its final relocation in Fyli. In general, they are indicative of the growing urbanization in Western Attica and Attica.

**Table 6**: Corine Land Cover (CLC) classes observed in Western Attica in 1990 and 2000

| Class 1 | Class 2 | Class 3 | Code |
|---|---|---|---|
| Artificial surfaces | Urban fabric | Continuous urban fabric | 111 |
| | | Discontinuous urban fabric | 112 |
| | Industrial, commercial and transport units | Industrial or commercial units | 121 |
| | | Road and rail networks and associated land | 122 |
| | | Port areas | 123 |
| | | Airports | 124 |
| | Mine, dump and construction sites | Mineral extraction sites | 131 |
| | | Dump sites | 132 |
| | | Construction sites | 133 |
| | Artificial, non-agricultural vegetated areas | Sport and leisure facilities | 142 |
| Agricultural Areas | Arable land | Non-irrigated arable land | 211 |
| | Permanent crops | Vineyards | 221 |
| | | Fruit trees and berry plantations | 222 |
| | | Olive groves | 223 |
| | Pastures | Pastures | 231 |
| | Heterogeneous agricultural areas | Annual crops associated with permanent crops | 241 |
| | | Complex cultivation patterns | 242 |
| | | Land principally occupied by agriculture, with significant areas of natural vegetation | 243 |
| | | Agro-forestry areas | 244 |
| Forest and semi-natural areas | Forests | Broad-leaved forest | 311 |
| | | Coniferous forest | 312 |
| | | Mixed forest | 313 |
| | Scrub and/or herbaceous vegetation associations | Natural grasslands | 321 |
| | | Moors and heathland | 322 |
| | | Sclerophyllous vegetation | 323 |
| | | Transitional woodland-shrub | 324 |
| | Open spaces with little or no vegetation | Bare rocks | 332 |
| | | Sparsely vegetated areas | 333 |




**Maps 6 and 7**: CLC2 actual land uses in 1990 and 2000 (left-right)

These results are further confirmed by sample changes of artificial, agricultural, forest, and forest and semi-natural areas (Maps 8-11). Individual land parcel changes have been determined on the basis of the dominant land use within the parcel in 1990 and 2000. Artificial areas as a whole have increased by 10-40% in Thriasio (Aspropyrgos and Elefsina), where most industrial and commercial activities are concentrated, and in those parts of the Attica County, located at the borders of the Capital City (Ano Liosia). The 10-40% increase of artificial areas in Thriasio and in the Attica County has been compensated by a decrease in the corresponding agricultural areas (Maps 8-9). Finally, there are indications of reforestation (pure forest land) by 10-40% (or even >40%) in Western Megara (and Vilia) and deforestation in Thriasio and in the Attica County (Maps 10-11).

**Maps 8-9-10 and 11**: CLC2 sample land use changes between 1990 and 2000 (top-bottom, left-right)

### 3.3. Estimation results

The spatial interactions model is estimated in this section. The set of explanatory variables includes land cover changes of artificial (DARTS), agricultural (DAGRA) and forest areas (DFOREST), as well as changes in three census variables (Table 7). Namely, changes in the rate of primary education graduates (DELEM), changes in the employment rate of the economically active population (DEMPLR), and changes in the density of normal dwellings, derived on the basis of the total number of rooms per person (DHMR1). HMR1 is a binary variable, which equals 1 when there is at least 1 room per person and 0 otherwise.

The dependent variable (YFALL) indicates whether a land parcel was deforested or not in 2000 relative to1990. It is a binary variable, which equals 1 in case of deforestation and 0 otherwise. Its values have been determined on the basis of the change in the area of forest and semi-natural areas in 2000 relative to1990. Deforestation corresponds to negative or zero change and reforestation to positive change. The changes in YFALL correspond to deforestation for 103/156 land parcels or 66% of the sample, compared to 97/156 or 62.2% in case of pure forest areas. Table 8 reports the sample correlations of the model variables.

**Table 7**: Summary statistics of the explanatory variables

| Municipality | ELEM | | | EMPLR | | | HMR1 | |
|---|---|---|---|---|---|---|---|---|
| | 1991 | 2001 | % Change | 1991 | 2001 | % Change | 1991 | 2001 |
| Elefsina | 35.8 | 33.9 | –1.9 | 89.4 | 93.6 | 4.2 | 0 | 1 |
| Ano Liosia | 37.8 | 35.5 | –2.3 | 88.6 | 91.9 | 3.3 | 0 | 0 |
| Aspropyrgos | 35.1 | 36.6 | 1.5 | 88.1 | 94.1 | 6.0 | 0 | 0 |
| Vilia | 43.3 | 32.5 | –10.8 | 93.9 | 93.8 | -0.1 | 0 | 0 |
| Erythres | 34.2 | 30.0 | –4.2 | 90.3 | 96.8 | 6.5 | 0 | 1 |
| Zefyri | 30.1 | 35.0 | 4.9 | 90.1 | 90.3 | 0.2 | 0 | 0 |
| Mandra | 36.2 | 29.7 | –6.5 | 90.3 | 95.9 | 5.6 | 0 | 1 |
| Megara | 41.1 | 34.5 | –6.6 | 93.0 | 94.6 | 1.6 | 0 | 1 |
| N. Peramos | 29.1 | 24.7 | –4.4 | 90.9 | 97.1 | 6.2 | 0 | 1 |
| Fyli | 35.0 | 39.9 | 4.9 | 92.0 | 95.2 | 3.2 | 1 | 0 |
| Magoula | 39.7 | 35.3 | –4.4 | 88.7 | 98.1 | 9.4 | 0 | 1 |
| Oinoi | 40.0 | 35.2 | –4.8 | 98.1 | 97.2 | –0.9 | 0 | 1 |

**Table 8**: Sample correlations of the model variables

| DELEM | DEMPLR | DHMR1 | DARTS | DAGRA | DFOREST | YFALL |
|---|---|---|---|---|---|---|
| –0.362*** | 0.104*** | 0.220* | –0.272** | –0.094** | 0.222* | DELEM |
| - | 0.356*** | –0.680*** | 0.551*** | –0.048* | –0.391*** | DEMPR |
| - | - | –0.262** | 0.293** | –0.355*** | –0.519*** | DHMR1 |
| - | - | - | –0.452*** | 0.180** | 0.358*** | DARTS |
| - | - | - | - | –0.360** | –0.271** | DAGRA |

*Notes:* *** means P<0.001; ** means P<0.005; * means P<0.010 (P indicates the rejection probability).

Table 9 reports the parameter estimates of the spatial interactions model on the basis of the fixed point algorithm (FXP2S1) with the standard normal distribution function and one nearest neighbour along with estimates based on alternative estimation methods, for robustness. Namely, estimation in two stages without iterations as if the dependent variable were strictly exogenous (Naïve), two-stage fixed point estimation with none and two nearest neighbours (FXP2S0, FXP2S2), estimation of the generalized linear model with standard normal link function (GLMBP), and estimation of a mixed regressive spatially autoregressive lag model (MRSAL) with continuous dependent variable (Anselin [2]).

### 3.4. Discussion

Among the reported FXP2S estimates, only FXP2S1 maximizes the pseudo-likelihood function (lnL=–0.231) and yields the largest spatial spillovers. Estimates of the net spatial interactions parameters are reported in Table 10. The estimate of ρ0 is negative everywhere, while that of ρ1 positive, despite the fact that the estimate of ρ, which measures the aggregate spatial spillover, indicates positive action. This implies that equilibrium actions are strategic substitutes for the environment (ESS) and complements for agriculture (ASC), accordingly (Table 1). In other words, the aggregate positive action is in favor of agricultural activities.

**Table 9**: Model estimates

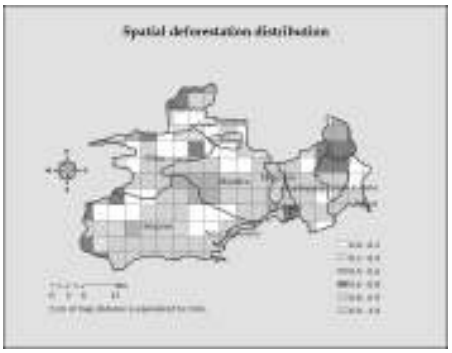
| DELEM | MRSAL | Naïve | FXP2S0 | FXP2S1 | FXP2S2 | GLMBP |
|---|---|---|---|---|---|---|
| CST $(-\hat{\beta}_0)$ | 0.614 (6.28) | 1.382 (2.64) | 1.357 (36.73) | 1.240 (33.50) | 1.350 (36.29) | 1.263 (2.72) |
| DELEM | 0.009 (0.71) | 0.158 (2.36) | 0.149 (31.33) | 0.161 (31.23) | 0.153 (30.01) | 0.210 (2.48) |
| DEMPLR | –0.034 (1.64) | –0.280 (1.95) | –0.229 (27.90) | –0.306 (28.99) | –0.241 (21.72) | –0.413 (2.21) |
| DHMR1 | 0.107 (1.22) | 1.037 (2.17) | 0.953 (27.41) | 1.150 (31.54) | 0.993 (26.49) | 1.562 (2.29) |
| DARTS | 0.018 (4.90) | 1.774 (3.36) | 1.800 (32.70) | 1.799 (33.23) | 1.790 (37.71) | 1.866 (2.09) |
| DAGRA | 0.014 (5.29) | 1.719 (3.40) | 1.747 (33.02) | 1.743 (33.55) | 1.737 (37.92) | 1.800 (2.09) |
| DFOREST | –0.002 (1.12) | –0.007 (1.04) | –0.006 ( 9.50) | –0.009 (11.99) | –0.007 (12.53) | –0.010 (1.00) |
| ENDOG $(\hat{\rho})$ | 0.379 (2.00) | 0.679 (0.60) | 0.000 ( 0.00) | 1.807 (14.01) | 0.138 ( 1.87) | 2.812 (1.28) |
| lnL | –614.9 | –0.233 | –0.234 | –0.231 | –0.235 | - |

*Notes:* |t|-values in brackets

FXP2S1 estimates are used in the estimation of the spatial probability distribution of equilibrium strategic actions (Map 12) and the qualification of the type of spatial equilibrium, dictated by the expected strategic behaviour of the network individuals (Figure 1).

**Table 10**: Model estimates of the net spatial effects

| Estimate<br>Spatial effect type | $\hat{\rho} > 0$<br>Aggregate | $\hat{\rho} - \hat{\rho}_0 = \hat{\rho}_1 > 0$<br>Agricultural | $\hat{\rho}_0 < 0$<br>Environmental |
|---|---|---|---|
| MRSAL | 0.379 | 0.989 | –0.614 |
| Naïve | 0.679 | 2.061 | –1.382 |
| FXP2S0 | 0.000 | 1.357 | –1.357 |
| FXP2S1 | 1.807 | 3.047 | –1.240 |
| FXP2S2 | 0.138 | 1.488 | –1.350 |
| GLMBP | 2.812 | 4.075 | –1.263 |




**Map 12**: Spatial deforestation equilibrium distribution

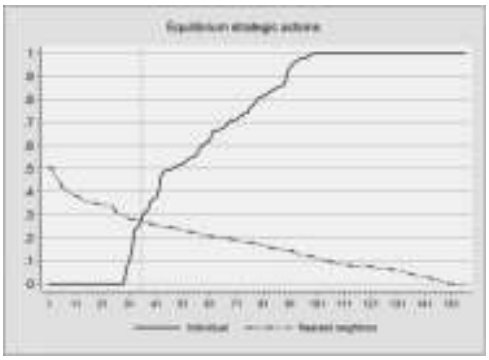


**Figure 1**: Strategic actions using NFXP2S estimates

The estimated spatial probability distribution is the fixed point of the mapping approximating the joint distribution function. The slope of the individual reaction function (in ascending order) is positive, according to the sign of the aggregate spatial effect ($\hat{\rho}$ = 1.807), and intersects that of nearest neighbours at a single point with value 0.3 < 0.5, that is below indifference. The low value of the spatial equilibrium indicates lack of coordination of strategic actions. In particular, the following behavioural pattern is observed: when the majority of individuals tend to deforest (individuals with values > 0.3), their nearest neighbours tend to choose opposite strategies (nearest neighbours with values < 0.3). According to the spatial deforestation game (Table 1), the estimated behaviour implies lack of coordination of individual environmental actions when their neighbours coordinate their actions in favor of the environment ($\hat{\rho}_0 < 0$ , ESS, (NC,C)), hence deforestation, and on the other hand, lack of coordination of agricultural activities ($\hat{\rho}_1 > 0$ , ASC, (NC,NC)). This confirms actual and sample land use changes between 1990 and 2000 (Figures 3 to 8). In particular, $\hat{\rho}_0 < 0$ (ESS) is characteristic of deforestation in Thriasio and the Attica County, while $\hat{\rho}_1 > 0$ (ASC) of agricultural activities in Megara and New Peramos (Southern region), and to a lesser extent in Thriasio and the Attica County.

## 4. Concluding Remarks

The present paper is an environmental application with focus on deforestation in the Greek region of Western Attica. It relies on methods of spatial statistics and econometrics to determine the degree of coordination of strategic clearing of forest and semi-natural areas by individuals active in Western Attica between 1990 and 2000, on the basis of land use changes. Empirical results are summarized as follows:

- Individual equilibrium strategies are net strategic substitutes for the environment and complements for agriculture, whereas the aggregate spatial spillover is positive and equal to 1.807, implying that expected individual actions produce a positive spillover in favor of deforestation.
- Equilibrium strategic actions are environmental substitutes in Thriasio and the Attica County, where most industrial activities are concentrated, and agricultural complements in the Megara and New Peramos (Southern region), which supply the Capital City with agricultural products.
- The spatial distribution of equilibrium deforestation actions is characteristic in Thriasio, the Attica County, and the municipalities of Megara (Southern region) and Vilia.
- The degree of coordination of individual expected actions is relatively low, implying a relative absence of appropriate central planning on the part of the local government.

Moreover, the proposed estimator is conceptually simple and methodologically credible. It is applicable to both small-sized social networks, with given dependence structure and large random samples.

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# THE GEOPOLITICAL IMPACT OF THE SYRIAN CRISIS ON LEBANON

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**Abstract**

*This paper identifies and analyses the geopolitical impact that the Syrian crisis has on Lebanon. This impact is manifested in two forms: a subsystemic one (within the Syria-Lebanon subsystem) and a systemic one (exerted from the system of the wider Middle East). The first refers to the direct repercussions that the increasing instability of the Syrian part has on the Lebanese part of the subsystem. More specifically, the impact that have some factors of the Syrian crisis –namely, increasing sectarianism and Islamic radicalism- on the internal political and religious power relations of Lebanon.*

*The second form of impact refers to the indirect yet critical repercussions that the instability at the centre of the Middle Eastern system has on Lebanon. As a state of proxy actors through which the regional powers project power and as an integral part of the Syria-Lebanon subsystem, Lebanon is the primary point on which the systemic pressure is applied. As a result of this systemic impact, the internal politico-religious power relations of Lebanon become a micro-level representation of the regional power relations of the wider Middle Eastern system.*

***Keywords:*** *Syria-Lebanon subsystem, Hezbollah, Sunni militia, shabiha*
***JEL classification*: R10, R11, R30, R40**

## The Syria-Lebanon subsystem: from Syrian hegemony to the Syrian crisis

The Syria-Lebanon subsystem possesses a pivotal geopolitical role within the wider system of the Middle East. Syria constitutes a state that lies at the centre of the intertwined web of the power relations that define the Middle Eastern system. The other part of the subsystem, Lebanon, has been a state where the major regional powers have been projecting power through their proxy Lebanese actors for decades.

At the subsystemic level, the power relation between Syria and Lebanon has been a rather unbalanced one. For three decades -from 1975 to 2005- Lebanon was transformed to an imperative geopolitical asset for Syria. This was due to the geopolitical objectives that Damascus had set regarding the Syria-Israel subsystem, as well as within the system of the wider Middle East. Among them the sustainment of any advantage vis-a-vis Israel and the checking of any geostrategic aspirations of other competitive Arab states in Lebanon, primarily Iraq and Saudi Arabia.

After the assassination of former PM Rafik Hariri and the Syrian military withdrawal, Lebanon entered a new phase of power antagonism between the pro-Syrian March 8 Alliance (Shiite Hezbollah and its allies) and the anti-Syrian March 14 Alliance (Saad Hariri's Sunni party and its allies). Subsequently, a series of key events have played a prominent role in the formulation of the current political power balance. The Second Lebanon War in 2006 enhanced Hezbollah's internal and regional status. The 2008 armed confrontation between Hezbollah and the Sunni militia ended in absolute victory for Hezbollah. It was a statement of intent by the Shiite organisation, which asserted its military superiority in Lebanon. In 2010 Hezbollah withdrew its ministers from the unity government and in January 2011 it supported, along with other March 8 allies, the formation of a new government under the premiership of Sunni politician Najib Mikati.

In the beginning of 2011 Syria experienced the first popular protests that swept, since 2010, the Arab world. The violent reaction of the Assad regime against the first peaceful protests in the south of the country (in the city of Deraa) set the motion for the spiral descent of Syria towards a climactic conflict. From Deraa the protests moved swiftly to other parts of the country, notably Hama, Deir az-Zur and Homs.

Gradually, within weeks, and primarily in reaction to the initial violent suppression of the Syrian security forces, the protests and demonstrations were transformed into a full armed insurgency against the Assad regime. The Syrian conflict escalated and was soon characterised by sectarian violence between the Sunni opposition and the Alawite (which is an offshoot of Shiite Islam) regular and irregular forces (shabiha) that support the Assad regime. Within 2012 the Syrian crisis was spread into the main cities of the country, Aleppo and Damascus[1]. As the hard-liners of the regime lead the escalation of violence, many reports were providing evidence that segments of the opposition were increasingly composed of Islamic radical groups (with some of them connected with Al Qaeda elements).[2]

By the end of the first half of 2012, the Syrian crisis had also been firstly regionalised and then internationalised, with the formation of a loose anti-Assad 'coalition' consisting of Qatar, Saudi Arabia, Turkey, France and the US and an equally loose pro-Assad supporting bloc composed by Iran, Russia, China and partly Iraq[3]. It was only a matter of time before Lebanon, so closely intertwined with Syria, begun to feel the multiple impact of the escalation of the Syrian crisis.

**The geopolitical impact of the Syrian crisis on Lebanon**

The length and the ferocity of the current Syrian conflict have a major and multiple impact on Lebanon. The Syria-Lebanon subsystem constitutes a particularly integrated one, where any major political and military action, development, shift or change on one part of the subsystem has a direct effect on the other part.

At the systemic level, that of the wider Middle East, Syria possesses a most central role. It lies at the heart of the Middle Eastern system: It constitutes a "bridge" through which its ally Iran projects its own influence in the Levant. It has a long common border with Iraq, Turkey and Jordan. It has an ongoing dispute with Israel regarding the Golan Heights. And of course, it almost engulfs geographically the much smaller state of Lebanon. In a way, Syria, by providing strategic depth to both Iran and Hezbollah[4], is the 'lung' of the Middle East.

At the current stage of the Syrian crisis, it is possible to identify and analyse two different forms of the geopolitical impact the Syrian crisis has on Lebanon: a subsystemic one (Syria-Lebanon) and a systemic one (wider Middle East):

a. The subsystemic impact refers to the direct repercussions that the increasing instability of the Syrian part has on the Lebanese part of the subsystem. Specifically, the impact that particular factors of the Syrian crisis which belong to the culture pillar of power[5], such as sectarianism and radicalism, have on the internal politico-religious power relations of Lebanon.

b. The systemic impact refers to the indirect repercussions that the instability at the centre of the Middle Eastern system (in Syria) has on Lebanon. As a state of proxy actors through which the regional powers project power and as an integral part of the Syria-Lebanon subsystem, Lebanon is the primary point on which the systemic pressure is applied. As a result of this systemic impact, the internal politico-religious power relations of Lebanon become a micro-level representation of the regional power relations of the wider Middle Eastern system.

**Subsystemic impact**

The first major manifestation of the subsystemic impact is the reactivation of the sectarian confrontation in Lebanon, between the Sunnis and the Shiites/Alawites. On a first level it is a direct, almost automatic, metastasis of the increasing sectarian nature of the Syrian crisis on the Lebanese politico-religious space. The main geographical locations where this sectarian confrontation has been mostly reactivated is the city of Tripoli in north Lebanon and the Bekaa Valley, two areas that are of close proximity to Syria and consist of a mixed religious composition.

Tripoli, the second largest Lebanese urban centre, is in close geographical proximity not only to Syria, but especially to major spots of armed confrontation between the Syrian regime forces and the Free Syrian Army forces, particularly Homs

and Hama. The Sunni dominated Tripoli and its surrounding area has been a logistics support centre for the Syrian opposition. Tripoli is also residence of the small community of Alawites in Lebanon and the part of the city where the Sunni and the Alawite neigbourhoods are adjoined has been in a state of low-intensity conflict since May 2012. The Alawite party in Tripoli, the Arab Democratic Party, is also believed to have been receiving funds and arms from the Alawite regime of Bashar al-Assad[6].

The arrest in May of anti-Assad Sunni activist Shadi al-Moulawi by the pro-Hezbollah *General Security Directorate (GSD)* and a few weeks later the killing of a prominent anti-Assad Sunni cleric Sheikh Ahmad Abdul Wahed in the northern region of Akkar by the Lebanese Armed Forces lead to the start of the sectarian clashes in Tripoli. This low intensity conflict has been mostly contained between the Sunni neighbourhood of Bab al-Tannaneh and the Alawite neighbourhood of Jabal Mohsen, that are separated by a single main street –the appropriately called Syria Street- that has been turned into an actual frontline. Its were the Syrian civil war is re-enacted in a micro-scale between the anti-Assad Sunnis of Tripoli and the pro-Assad Alawites of Tripoli[7]. Tens of people have been killed from both sides in a confrontation that has at times involved heavier weaponry, such as RPGs. The Lebanese army has been deployed in Tripoli and has often been engaged against militiamen of both sides.

The Bekaa Valley has also seen early sparks of sectarian violence, though not to the extent that Tripoli has. The Bekaa, traditionally the main transit route of legal and illegal activity, has become a transit point and logistical base for the Free Syrian Army. This has created friction between the adjoining Sunni and Shiite towns and villages, which resulted to sporadic violence and a number of abductions. Also, there are reports from journalists that refer to training camps within the Sunni controlled areas of the Bekaa that have been recently organized to train Sunni fighters destined for the Syrian war[8]. Abductions and violent incidents have also spread to the region of Wadi Khaled, north from Bekaa, in the Akkar district of north Lebanon[9]. In the midst of August 2012, sectarian violence spread also to the capital Beirut, when members of the powerful Shiite Meqdad clan of Bekaa Valley abducted more than 40 Syrian nationals (as well as a Turkish citizen) and held them in Dahiye, the Hezbollah-controlled southern suburb of Beirut. The mass abduction was a retaliation for the abduction of Shiites in Syria by the opposition forces of the Free Syrian Army[10].

The second subsystemic impact is the radicalization of certain Sunni segments within Lebanon. One of the reasons for this is the increasing religious radicalization of parts of the Syrian opposition. Reports from the field indicate that as the Syrian conflict becomes longer and even more violent, the number of salafi and Sunni-wahabi jihadi groups that are drawn into the combat operations increases. In consequence, the increase of radical Islamic elements in Syria has also increased the radical Sunni-Islamic elements within Lebanon. This is particularly evident in Tripoli, which has a long history of Islamic radicalism, as well as close historical connections with the Syrian Muslim Brotherhood (*Ekhwan al-Islameyia)*[11]. In fact, the Islamic organization *Harakat al-Tawhid al-Islami* (Islamic Unity Movement) had transformed Tripoli into an Islamic Emirate, from 1983 to 1985. The more recent major incident of Sunni Islamic radicalism in Tripoli, was the take over of part of the Palestinian camp of Naher el Bared, by the organization *Fatah al-Islam* in 2007 and its confrontation with the Lebanese army. But this was an isolated event, instigated by an obscure jihadi organization with opaque roots and funding. Since the eruption of the Syrian crisis, Tripoli has been experiencing a renewed wave of Sunni Islamic radicalism, which is closely associated with the increased radicalism across the border, in Syria. One salafi cleric in Tripoli compared in a recent interview the north Lebanese city with the Pakistani frontier city of Peshawar, for the role that it had played in providing support and fighters to the Islamic resistance in Afghanistan against the Soviets. The same, argued the cleric, happens now in Tripoli against the Assad regime[12].

One other reason for the radicalization of sunni elements in Lebanon is the political void that has been created during the last two years at the high echelons of Sunni political power. In the most high profile case, Saad Harriri, has been recently living in Geneva due to a series of assassination threats against him. This void is enhanced by the fragmentation of the Sunni leadership, particularly expressed in the political and economic competition between the Hariri family and the Mikati circle[13]. This void has given the opportunity to more activist and radical elements to emerge to the forefront. These elements utilise the rising sectarianism of the Syrian crisis in order to achieve higher mobilization of followers and supporters in Lebanon. The most characteristic cases are those of Sheikh Ahmad al-Assir in Sidon and the imam Selim al Rafei in Tripoli[14].

**Systemic impact**

The most evident manifestation of the systemic impact of the Syrian crisis in Lebanon is the overall pressure that it applies on an already fragile political system and its existing power structure. Lebanon's political power balance has been, during the last four decades, a micro-level representation of the balance of power of the wider Middle East system, and particularly of the regional power play between the Iran/Syria alliance against the different security and regional aspirations of Israel, Saudi Arabia, lately of Qatar and until a few years ago of Iraq. In other words, after 1975 and the start of the Lebanese civil war, Lebanon's sectarian and confessional "mosaic" composition has transformed the country into a proxy war battleground for the projection of political and military power by Teheran, Damascus, Riyad, Baghdad and Tel Aviv. This nexus of regional interests has acquired further importance, after the eruption of the Syrian crisis, within the power dynamics of the system of the wider Middle East. Old actors have receded (Iraq) and new actors (Qatar) have entered the frame along the "traditional" systemic actors (Iran, Saudi Arabia) who compete for influence in the Levant and the subsystem of Syria-Lebanon[15].

Hezbollah, the powerful Shiite organization (that controls the southern suburbs of Beirut, parts of the Bekaa Valley and the south of Lebanon), is the most clear example of this pressure that the system applies on the proxy actors on the Lebanese ground. By being heavily relied on Iranian funding and weapons, as well as on Syrian logistical and weapons support, Hezbollah has been feeling more than any other Lebanese political/military actor the pressure exerted by the current Syrian crisis. Since its founding (in 1982 in Bekaa), Hezbollah has been the main proxy actor of Iranian and Syrian power projections in Lebanon and also a checking force of Saudi Arabian Levantine aspirations. Under that prism, the current Syrian crisis that threatens the viability of the Syrian Assad regime constitutes also a threat to the sustainment of the Syria-Iran-Hezbollah anti-Israeli, strategic, subsystemic axis. This systemic threat has led the leader of Hezbollah, Hassan Nasrallah to express in numerous occasions his vocal support for the Assad regime. Furthermore, reports from both Syria and Lebanon have claimed that Hezbollah has sent highly trained units to fight alongside the Syrian regime, especially in urban warfare environments where Hezbollah fighters have extensive experience[16]. The Shiite party has denied these claims.

On the other hand, it is also evident that within Lebanon, Hezbollah has attempted to maintain a relatively low profile in order not to further aggravate the subsystemic sectarian and Sunni Islamist factors that have been reactivated by the ongoing Syrian crisis. This may also be explained by the fact that Hezbollah controls the fragile Mikati government, which in its turn translates as a positive, if only temporary, political advantage for the pressurised Syrian and Iranian regimes.

The centrality of Hezbollah within the Lebanese power balance is of such political and military importance that any major shift in its course of action that its leadership may decide to take, whether to support more actively and openly the Assad regime or be forced to disengage from it, will have serious repercussions within the Lebanese power space but also for the Shiite organization itself.

The way that Hezbollah will react to this pressure within the Lebanese politic-religious context is part of the second systemic impact on Lebanon, namely the gradual regionalization of the Syrian conflict by proxy means on the Lebanese space. The recent assassination of the head of the Information Branch of the *Lebanese Internal Security Forces*, Wissam Hassan, on the 19th of October 2012, by a remotely detonated bomb in the Christian neighbourhood of Achrafiye in central Beirut, is a first trace of this regional war by proxies on the Lebanese ground. Hassan was head of the investigation for the 2005 assassination of Rafik Harriri and he was also responsible for the arrest, in August 2012, of former minister and pro-Syrian Christian Lebanese politician Michel Samaha. Samaha was arrested and accused of preparing a series of bomb attacks in Lebanon under the directions of the Syrian regime[17]. Whether all these cases are connected with Hassan's assassination remains still a speculation.

The *Internal Security Forces* is the only Lebanese security institution that is not controlled by Hezbollah and since 2005 and the Syrian withdrawal from Lebanon has been receiving substantial funding from the US. Furthermore, Wissam Hassan was in close contact with US, French and Saudi officials and was considered a key person in monitoring and checking the activities of Hezbollah and other Syrian and Iranian agents in Lebanon[18].

**Conclusion**

The more the Syrian conflict destabilizes the current power balance of the Middle Eastern system, the higher will be its degree of regionalisation. Lebanon is the first subsystemic space which is affected by any major such shift on the systemic level. The subsystemic impact of the Syrian crisis has already started to destabilise the internal politico-religious balance of Lebanon. The growing sectarian character of the Syrian conflict, along with the increasing Islamic radicalisation of parts of the Syrian opposition, have reactivated the already existing sectarian and Islamic politics in Lebanon, which were, until the eruption of the Syrian crisis, in a state of fragile containment (with only rare and quickly resolved exceptions, such as the *Fatah al-Islam* activities in North Lebanon and the Shiite-Sunni armed confrontation in 2008 in West Beirut). This destabilisation is further enhanced by the influx in Lebanon of many thousands of Sunni refugees from Syria, a fact which also has the ability to transform the critical demographic balance of Lebanon, always a factor of central importance within the nexus of the Lebanese sectarian political antagonisms.

Yet, based on all current indications, this subsystemic impact does not possess the adequate dynamic to destabilise decisively the Lebanese politico-religious power balance. In effect to create the conditions for a full-scale metastasis of the Syrian conflict within the Lebanese territory. It is only the increasing interaction of the subsystemic impact with the systemic impact that appears to be able to create such a dynamic that could set in motion the conditions for a possible power re-shuffling within Lebanon. The initial existence of such a dynamic would then be adequate to energize in full extent the opposing forces within Lebanon.

As these lines were written, the growing regionalisation of the Syrian crisis had already started to increase the systemic impact on Lebanon. This is due to the fact that the activities of the systemic actors involved in the Syrian crisis have also started to increase. Specifically, the activities of the systemic actor of Iran have a two-fold target: the support of the Assad regime and the preparation for the day after the fall of the Assad regime. The possible covert operations by Hezbollah within the Syrian territory, along with its increasing re-armament within the Lebanese territory, are without doubt in accordance with the preparations that the Iranian leadership is crafting for a possible post-Assad Syria. Israel's military intelligence chief, Major General Aviv Kochavi, stated recently before the Israeli Knesset's Foreign Affairs and Defence Committee that «*Iran and Hezbollah are preparing for the day after Assad's fall from power*». And he added that «*in Lebanon, there are today between 70-80.000 rockets that could hit Israel. The smuggling of rockets from Iran to Lebanon continues*»[19].

Nevertheless, it is not at all certain that the rise in power of a Sunni radical movement, which embodies the opposition insurgency in Syria, will offer a higher degree of security to the Israeli state. On the contrary, the activities of radical Islamic elements, (such as various groups that are connected or affiliated with Al Qaeda[20]) within the core of the, only by name, "*Free Syrian Army"* promises exactly the opposite outcome.

The systemic actors of Saudi Arabia and Qatar are also appear to have recently increased their activities within Lebanon (various, though mostly unconfirmed, reports of funding of Sunni radical militia groups from the two GCC states have been recently published), with the double target of undermining the Assad regime and counter-checking Hezbollah, the main proxy actor of Iranian influence in the Levant. The recent assassination of Wissam Hassan (key ally of Saudi Arabia and the US and equally key opponent of Hezbollah, Syria and Iran) was part of this new regionalized dimension of the Syrian crisis that has started to be conducted –albeit with covert operations- within the Lebanese territory.

Conclusively, Lebanon appears to be currently in a threshold. It has up to now managed to sustain the pressure from the subsystemic impact originating from the Syrian crisis. However, the increasing regionalization of the Syrian conflict has in the recent few months resulted to increasing pressure on Lebanon by the systemic impact originating from the main actors of the Middle Eastern system. As a consequence, the first critical traces of this impact have started to appear on the Lebanese geopolitical space. The degree of the increase of the regionalized dimension of the Syrian crisis on the Lebanese geopolitical space will determine whether Lebanon will manage to sustain, with minimum effect, the pressure from the double impact (subsystemic and systemic) or it will instead be turned into the second major crisis after Syria.

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# IN SEARCH OF THE POLICY APPLIED AND SPATIAL CORRELATIONS OF ELECTRONIC GOVERNMENT APPLICATIONS IN GREECE

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**Abstract**
*Following the demands of contemporary economy, public administration gradually adopts the applications of information and communications technology. This paper deals with the policy concerning the development of electronic governance (eG) applications and how their use is affected by and determines spatial correlations. The adopted methodology includes a bibliographical approach and a case study analysis based on the use of taxation electronic applications, particularly popular as eG applications, in Greece.*
*In the EU, ICT in fact functions merely as a means of realisation within pre-existing political, social and economical structures a fact posing restrictions in terms of the results of their potential use. E-Government applications are a more immediate way for the citizen to get in contact with public services and a mechanism of accelerating administrative procedures. There is a lack of contribution to the cohesion of policies and actions.*
*The constitution of telematic nets and the use of technological applications are the main mechanisms leading to the notion of "electronic space" challenging at the same time the traditional view of accessibility and the functional organisation of space. The inferior position concerning conventional accessibility as well as the multifragmentation of a spatial unity are distinguished as major factors for the development of eG applications together with the existence of a major urban centre. Moreover there is at least some evidence that the use is related to the predominant activity of the area in question with tourism acting as a familiarisation tool with the internet and its applications.*

**Key words:** e-government, governance, accessibility, Information & Communication Technology, electronic city
***JEL classification*: R10, R11.**

## 1. Introduction

This paper is about the contribution of ICT and more specifically the e-Government (eG) applications to the function of public administration and the process of space networking. Initially, the possibilities of ICT contribution to the function of public administration are investigated, in order to analyse and evaluate the respective policy and the use of services in the E.U and especially in Greece. Secondly, there is an attempt to identify geographical parameters in the use of eG applications in order to reach an overall evaluation of the spatial dimensions of the immaterial flows that the development of the ICT applications results in. This evaluation will be achieved through the case study of taxation electronic applications in Greece and the identification of the geographical distribution of their use.

## 2. A new approach of space organisation and public administration function

Back in 1990' Nicholas Negroponte (1996) argued that the telecommunications technologies will remove the limitations of geography driving to an era of digital living which will include less and less dependence upon being in a specific place at a specific time eliminating the need for a physical presence and spatial proximity. Forming a different view of the same notion Kotkin (2000) sees the "death of distance" as a chance people will have for more spatial options concerning residence establishing.

Communications consist of carriers of spatial networking, overcoming the handicaps imposed by physical space. Kellerman (2004) assumes that high levels of internet access and penetration, presented by the city of Halifax, Canada, are related to its remote location from major urban centres. However, the findings of research related to the internet presence in Portuguese cities (Nunes, 2006) question advanced communications' role in increasing accessibility to The Web and the Local Economy peripheral areas, since they suggest that the role of the internet in the struggle against traditional spatial inequalities in the country is less relevant than expected.

**Table 1: "Space of flows": the three layers of material supportive structures**

| | |
|---|---|
| The transportation and telecommunications network. | The infrastructure based on advanced technology defines the new space in a way similar to the process of economic space formation by the railways in the industrial economy. |
| Nodes and hubs. | The space of flows is based on an electronic network which links up specific places with self - defined social, cultural, physical and functional characteristics. Some places function as hubs of coordination for the network's elements and others are nodes which accommodate key activities and functions. |
| The spatial organisation of the dominant, managerial elites. | The space of flows is presented as the dominant spatial logic expressing the dominant functions and interests of society. |

M. Castells, (1996)

The advanced potentials and the reduction of the cost of ICT applications is expected to alter the way economy functions, society is structured and civilisation is developed, redefining, in this way, their spatial dimensions (Winger, 1997; Crang, 2000; Graham, 1995, 1997). The effect of the ICT applications on the networking of the economic space should be considered significant in terms of its contributions in the function of economy as a whole (Asprogerakas & Ioannou, 2007). Through the development of telecommunication infrastructures, the constitution of telematic nets and the use of technological applications, a different way of viewing space seems to be imposed, which was deconstructed so as to be reconstructed and reorganised through the nets, thus forming the notion of "electronic space". The position in space is not significant; the position in the net hierarchy or better access potentiality is what matters (Asprogerakas, 2002; Graham & Marvin, 2002; Little, 2000).

A dynamic construction system is gradually developed, which, according to M. Castells (1996: 412) is defined as the "space of flows" or, in other words, a "material composition of simultaneous social practices which function through flows". According to M. Castells, this system consists of three layers of material supportive structures (1996: 412-413):

But in this space of flows the new geographic space continues to require a space of places (Castells, 2000). Which are the nodes of this network? Technological networks as a whole and especially information networks seem to have a tendency to spatial selectivity which favours a series of powerful nodes mainly important urban centres (Hall, 2002; 2000). Related research (Asprogerakas & Ioannou, 2007) argues that the most important administrative centres of the urban network have an advantage especially when they play the role of dynamic, economic nodes of their region. This advantage is directly connected to the choice criteria of the web access providers and the fact that the main target is not the relevant services' spatial balanced provision but the maximisation of the profit from their investment. Moreover, differences of the spatial types of urban

nodes based on allocation, size and role create a corresponding range of differences in accessibility and activity of the internet in these centres (Asprogerakas & Ioannou, 2007).

In any way, adopting technological innovations is directly linked to the effort made to improve productivity and increase profits in a competitive economy (Castells, 1996). The significance of the competitiveness of public administration itself was also recognised in an attempt to provide services accurately and effectively and thus to promote innovation as its policy (IDABC, 2005).

There has been a general delay in improving the technological infrastructure of the public sector and more specifically in exploiting ICT and using internet as the basic tool. The causes can be identified in the way public administration functions. The services provided by the public sector are usually of monopolistic nature as public organisations are never in danger of becoming non-competitive and losing their "customers".

At the same time, the adoption of practices related to the use of technologically developed applications requires the public's acquaintance with technology. As public organisations usually address all citizens or wide groups of population, acceptance of technological applications introduced in everyday life and their use by the majority of the population seems to be a necessary prerequisite. Digital Divide is an important research filed (Compaine, 2001, Hoffman et. al. 2000, Servon 2002) although the main issues assessed were related more to the existence of gaps than the difference they make. The computer and internet gap can be closed rapidly but it cannot be eliminated (Powell, et. al. 2001). Although lack of access to ICTs and the internet is not the cause of social exclusion it has the potential to exacerbate individuals' isolation (Foley, 2004).

**3. Points of the EU policy on eG into Public Administration**In the case of public administration in Europe (EPAN, 2004; IAP, 2002) and in the USA (IAB, 2003) it has been obvious, since the decade of 1990, that the ICT can be a significant tool to achieve its overall improvement (CEC, 2004). After identifying the need for improving competitiveness in European economy - the main objective of the Lisbon agreement - all governments took a great deal of action towards this objective. They initially tried to make better use of the traditional means of improving competitiveness, taxation, R&D, education, infrastructures and the regulatory principles of the function of economy.

Both EU and OECD have been widely concerned about the introduction of practices based on ICT in the function of public administration and thus they invested large amounts of funds on promoting specific programmes (Dai, 2003). Electronic Government practices were initially mentioned in the European council of Lisbon (March, 2000), during the "eEurope" initiative, placed within the wider framework of "Information Society". The "eEurope 2005" initiative presented in the European Council of Seville followed as part of the effort. One of the most important points of the application plan (CEC, 2002) is the need for making the best use of the accumulated information in the public sector, as it was pointed out. As a whole, the "eEurope" initiative produced a specific strategy in terms of the EU goals towards the development of eG practices; however, no regulative frame of applications was made while the funding of the actions suggested remained independent of this specific initiative (Alabau, 2004).

At the end of 2003, EU made an attempt to form a specific policy on eG (CEC, 2003). This policy included both a cohesive map of actions which were either programmed or currently put into practice and also new actions which aim at the support and reinforcement of the project in the direction of any new relevant initiative. At this stage eG is defined as (CEC, 2003: 7): "the use of information and communication technologies in public administrations combined with organisational change and new skills in order to improve public services and democratic processes and strengthen support to public policies." It is presented as the means to achieve a "better and more efficient administration" with its basic directions being the improvement of productivity and the provision of personalised services in an open and transparent manner. In April 2006 the "Action Plan" (CEC, 2006) introduced the major objectives for eG emphasising on convenient and secure access to public administration for all European citizens through e-applications (CEC, 2006: 4). The implementation of the first Action Plan has seen governments across all Member States exchange good practice, and has resulted in a number of large-scale pilot projects which are developing concrete solutions for rolling out cross-border eG services. In 2010 the Commission proposed a second eG Action Plan which aims to "realise the ambitious vision contained in the Declaration made at the 5th Ministerial Government Conference ("Malmö Declaration", 2011). According to this ambitious vision, by 2015 European public

administrations will be "*recognised for being open, flexible and collaborative in their relations with citizens and businesses. They use eGovernment to increase their efficiency and effectiveness and to constantly improve public services in a way that caters for user's different needs and maximises public value, thus supporting the transition of Europe to a leading knowledgebased economy."* (EC 2010: 4):

**Table 2: Principles of good governance**

| | |
|---|---|
| Openness | The Institutions should work in a more open manner, using accessible and understandable by the general public language. This is of crucial importance when it comes to improving confidence in complex institutions. |
| Participation | The quality, relevance and effectiveness of EU policies depend on ensuring wide participation throughout the policy chain – from conception to implementation. |
| Accountability | Roles in the legislative and executive processes need to be clearer. There is a need for greater clarity and responsibility on the part of Member States and all those involved in developing and implementing EU policy at whatever level. |
| Effectiveness | Policies must be effective and timely, delivering what is needed on the basis of clear objectives, an evaluation of future impact and, where available, of past experience. Effectiveness also depends on implementing EU policies in a proportionate manner and on making decisions at the most appropriate level. |
| Coherence | Policies and actions must be coherent and easily understood. The need for coherence in the Union is increasing due to the diversity expansion through enlargement and the increase of the related policy tasks. Coherence requires political leadership and a strong responsibility on the part of the Institutions to ensure a consistent approach within a complex system. |

Source: White Paper on European Governance (CEC 2001: 10-11)

In Greece the term ‘‘electronic governance’’ established (MEF, 2002; MEF, 1999) in reference to the introduction of electronic applications in the function of public administration. It is presented as a process of Public Administration’s adjustment to the frameworks of wider socio-economic changes of the post-fordism production model (Piore & Sabel, 1984). The term ‘‘government’’ describes the prevalence of state authority, institutionally and hierarchically structured through the function and operation of public sector organisations and bureaucratic procedures. The term ‘‘governance’’ refers to the emergence of overlapping and complicated relations which involve sectors and organisations outside the political system (Painter & Goodwin, 1995). The main principles of good governance are proposed in the White Paper on European Governance (CEC 2001: 10-11) (Table 2). Each principle is important for establishing more democratic governance, and it applies to all levels of government. Although each principle is important by itself, they cannot be achieved through separate actions. It is stated that policies can no longer be effective unless they are prepared, implemented and enforced in a more inclusive way. An arising question is whether and to what extent public administration electronic applications reflect these principles or are simply a more immediate way for the citizen to get in contact with public services and a mechanism of accelerating administrative procedures.

**4. Effectiveness and Prospects**

A research on specific case studies in EU countries (EPAN, 2004) reached the conclusion that as a whole the use of ICT in public administration can improve the services offered by reducing their production cost. Public organisations are directly benefited from the adoption of eG applications, without having to make any great improvement especially in the case of services of great demand. Currently, joint action on eG raises as a means of contribution to overcoming the economic crisis by using public resources more efficiently and reducing public expenditures. eG services can be developed more economically by coordinating and pooling public and private resources. (EC 2010). For individual citizens the benefits from the investments made on eG applications are still limited. Enterprises benefit more as they are usually in regular contact with public administration, while, at the same time, the expected reduction of administrative restrictions and bureaucratic delays equals to an immediate reduction of the production cost (EPAN, 2004). Independent research (Pina et. al., 2006; Dai, 2003; Komito, 2005) on the ICT practices in public administration emphasises on the existing restrictions in terms of the results of their potential use. ICT in fact functions merely as a means of realisation within pre-existing political, social and economical structures and it cannot be viewed as a means of promoting democratic procedures or affecting, directly or not, the citizen-administration relation. For example, the V. Pina (et. al., 2006) research comes to the conclusion that ICT cannot possibly reinforce fiscal reliability on the public sector more than expected from compatible procedures due to legal and institutional restrictions. E-Government effectiveness is going to depend on its accession into the process of administrative structures reformation and on how intense this will be. It is obvious that the procedures involved in the change of administrative organisation and function are time consuming (CEC, 2003b: 9). When the use of such applications is not combined with relevant changes in the way office work is organised, any benefits gained are rather limited and they mainly concern the immediacy and the cost of the services provided (IDABC, 2005; EPAN, 2004).

Gil-Garcia (2007) indicates two basic characteristics of the eG development process: (a) The internet presence of public administration is developed into more complete and interactive applications. (b) As a general principle, local authorities follow the central administration concerning the adoption of technologically developed applications.

The development of eG applications is referred to by Fingerm & Pecoud (2006: 8) as a dynamic process of reinforcing the interaction among various agencies (civilians and administration) at different levels (local, national, international) and different functions (development of rules, control, policy formation). Gradually the whole effort made to develop new applications is oriented towards such procedures which allow the participation of non-government agencies in the decision – making process and in the formation of policy at any levels of administration through the use of deliberations software and electronic voting (Keskinen, 2004; Bouras et. al., 2003; Garlitz & Gunn, 2002). There can be found some relevant examples of applications in the United Kingdom (Liptrott, 2006) and Ireland (Komito, 2005b), but still, as a whole, the efforts remain to be at a research or piloting stage of development and use.

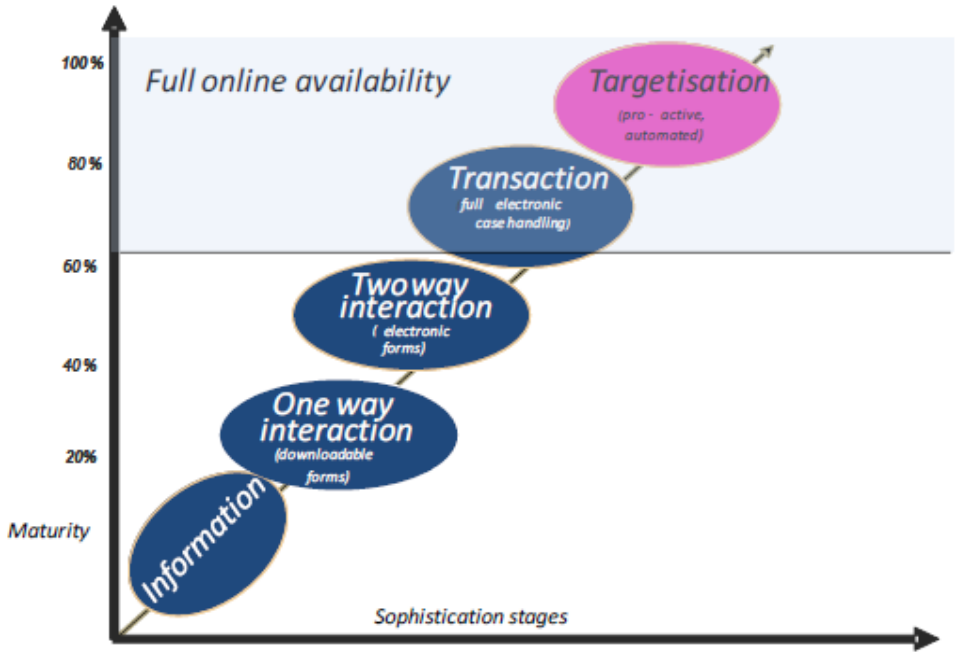
In order to achieve these goals there is a basic requirement apart from the change of the structures and relations within public administration; that is, the human – centred structure of the system in contrast to the initial approach which mostly stresses the role of technology. This role has to focus on the development and use of knowledge and not on the use of information; it has to support, in other words, interaction of knowledge and not merely automatic procedures (EIPA, 2003). All these goals are of no business nature; however, they are a standard direction towards the final formation of eG mechanisms, on a long term base. It must also be stressed that according to the EU "the benefits of electronic governance exceed the very first achievements of the electronically provided public services" (CEC, 2003b: 29). In this way, the process of adopting eG practices is differentiated from simple ICT applications in public administration. **5. Availability of eGovernment applications in Greece**

Electronic Government in Greece is part of a wider information society strategy to enhance Greece's competitiveness and improve quality of life under the Ministry of Finance. The Digital Strategy 2006-2013 is compatible with the "Growth and Jobs" Lisbon Strategy and the i2010 policy. It utilises financing instruments, such as the Operational Programme for "Information Society" in the context of the 3rd Community Support Framework, and the Operational Programme "Digital Convergence" which is within the National Strategic Reference Framework (NSRF) 2007-2013. It comprises two main strategic objectives: (a) Enhanced business productivity through the use of ICT and new skills and (b) Improved Quality of Life through ICT.

However eG policy belongs to the remit of the Ministry of the Interior suggesting that it is also seen as an instrument for government reform. The national Government's Information Technology Committee is the highest policy making authority for Information Technology strategy development. The eG Forum of the Ministry of Interior is a multi-stakeholder forum specific to eG. eG is deployed in a prescriptive manner, by legally defining what services should be developed. Implementation support across levels of government is provided by two agencies, Information Society S.A. and Digital Aid S.A.

The development process of eG applications by the Greek administration has presented steady progress during the last decade although there is belatedness in the progress of the local authorities in relation to the central government (Hahamis et. al., 2005), a fact in conformity to Gil-Garcia's (2007) observations. In the same report (Hahamis et. al., 2005), the lack of familiarisation of the personnel with new technologies and the lack of financial resources and support from the leadership are mentioned as the basic barriers.

**Figure 1 : Availability stages of public services online**




Source: EC, 2009

It has to be mentioned that Greek households have internet access at 39%, which is rather low compared to the equivalent percentage in EU27 (60%) As particularly positive has been considered the fact that the compound annual growth rate in the period 2005-2008 in the country has been 17.6 % compared to 7.7 % at European level (ISO, 2010). Analysing their spatial distribution it becomes obvious that Athens (59%) and Thessaloniki (57%) present significantly high rates compared to the rest of urban areas (39%) and rural ones (33%) although the rural areas feature the biggest growth rate compared to the past. Among the thirteen Regions (NUTS II level), Attica (57.0%) is first and South Aegean (47.2%) and Crete (43.8%) follow. The percentage of households with Internet access was almost doubled compared to the year 2005, in 9 out of the 13 Greek Regions. Particular increase has been observed in the Regions of Attica (56 %), North Aegean (38.9 %) and South Aegean (44.1 %). The lowest increase is observed in the Regions of West Macedonia (21.6 %), Thessaly (25.3 %) and Epirus (26.2 %). These results are directly related to the GDP per inhabitant in the Greek Regions. As expected, citizens of areas with higher standards of living are most likely to invest on an Internet connection (ISO, 2010).

In order to evaluate the extent of citizens and enterprises service by the electronic applications of public administration, E.U. has some annual relevant research related to twenty basic public services using a five-stage framework (Figure 1). The online availability of public services will thus be determined by the extent to which it is possible to provide the service electronically, or, in other words, the sophistication of the online service provision (Table 3).

Greece achieves 45% in the full online availability indicator ranking 27th among EU27+ countries (EU Member States, Croatia, Iceland, Norway, and Switzerland) which present an average of 71%. This score comprises a full online availability of 33% for citizens and 63% for businesses. In terms of online sophistication, Greece achieves 68% for all services (83% for EU27+), 62% for citizen services and 78% for business services. Greece's figures have remained largely unchanged compared to the 2007, indicating that eGovernment development is stagnating. The availability of eGovernment services, for both citizens and enterprises, is below the EU average, though it has grown substantially in recent years. There is a series of initiatives under way to further e-enable governmental processes and services, among them, a project to e-enable the start-up procedure for businesses (EC, 2009, 2009b).

**Table 3: Availability stages of public services online**

| Stage | | description |
|---|---|---|
| 5 | Targetisation | The fifth level provides an indication of the extent to which front- and back-offices are integrated, data is reused and services are delivered proactively. |
| 4. | Full electronic case handling | The publicly accessible website offers the possibility to treat the public service completely via the website, including decision and delivery. No other formal procedure is necessary for the applicant via "paperwork". |
| 3. | Two-way Interaction: | The publicly accessible website offers the possibility of an electronic intake with an official electronic form to start the procedure to obtain this service. This implies that there must be a form of authentication of the person (physical or juridical) requesting the services in order to reach stage 3. |
| 2. | One-way Interaction | The publicly accessible website offers the possibility to obtain, in a non-electronic way (by downloading forms), the paper form to start the procedure to obtain this service. |
| 1. | Information | The information necessary to start the procedure to obtain this public service is available on-line. |

Source: EC, 2009

**6. Geographical distribution of the e-Government applications use**6.1 TAXISNET electronic service

Electronic services for taxation are particularly popular as eG applications. They are addressed to a specific citizens group with consistent and constant transaction with public administration, a fact that makes them a stable, crucial team of users. In Europe there is a constant widening of the rates of the function of the applications which generates income for the public sector. Tax services have been among the first to be made available online in all European Union Member States and the first to reach the fully transactional stage of sophistication. Greece is no exception to this trend and ever since the end of 1999, with the launching of the online transmission of periodic VAT declarations, it has steadily moved to the digitalisation of all processes related to taxes, reaching later the fully transactional stage in almost all of them (ISO, 2008). Currently, the services related with the citizens and enterprises' taxation are available through the TAXISnet website (www.taxisnet.gr) developed by the General Secretariat for Information Systems (GSIS) of the Ministry of Finance (MEF).

The relevant research conducted targeted at defining spatial factors in the use of TAXISnet applications. The data used derives from the General Secretariat of the Ministry of Finance and it includes (MEF, 2006):

- The enrolled users of the electronic services of each Public Taxation Services office (Dimosia Oikonomiki Ypiresia - DOY)
- VAT statements submitted within April 2006
- The number of statements electronically submitted (per DOY).

The data concerns 280 DOYs from all over Greece. Sixty-nine DOYs are in the prefecture of Attica (Greater Athens Area) accounting for around the 40% of the taxation electronic services users and 18 DOYs are in the prefecture of Thessaloniki (12% of the users).

**Table 4: Use of TAXISnet applications**

| TAXISnet Services Users (VAT application users included) | VAT application users | Total VAT statements (31/03/2006) | VAT statements submitted electronically | |
|---|---|---|---|---|
| | | | number | % |
| 1.492.140 | 744.364 | 832.487 | 429.771 | 51,62 |

Source: MEF, 2006

From the enrolled users in the TAXISnet application (1.492.140, March, 2006) almost 50% are enrolled in the service concerning VAT statements application. From the total VAT statements that were to be submitted in April 2006, 51.62% were electronically submitted (Table 4).

6.2 Users' distribution inside the prefecture

The research included the estimation of an index of users' accumulation (users' percentage of the total population) which is indicative of the general inflow of the use of the application in the population. Another relevant figure was specified by those VAT statements which were electronically submitted operating as an index of the use of the application by the professionals and enterprises.

Except for Magnesia and the prefecture of Larissa, those prefectures that include the major urban centres of the country (Thessaloniki, Heraklion, Kavala, Attica, Ahaia) present a users accumulation index well above the average. This is also the case with 8 out of 12 purely insular prefectures of the country, whereas the most popular tourist destinations such as Cyclades, Zakynthos, Corfu, Dodekanissa, Halkidiki and Crete, have a percentage equal and even greater than the average one. Lower percentages are mostly found in mountainous prefectures of the mainland (Florina, Grevena, Arcadia, Karpenissi) and also in regions which promote the primary sector (Fokida, Aetoloakarnania, Helia). In the case of the percentage of VAT statements, the parameters which help ensure excellent performance are, apparently, not differentiated to any significant extent. Index above the average is presented by the prefectures of the major urban centres and six out of 12 purely insular ones. There is also a profound stability concerning the indexes in Crete, where electronic services have been making a substantial contribution to the production process (Asprogerakas, 2004).

It is also interesting to view the inner prefectural differentiations. The prefectures of the Medium Sized Cities (Patra, Heraklion, Ioannina, Volos, Larissa, Kavala as defined by E. Asprogerakas, 2005) were chosen as case studies for this task and then the data on urban and non-urban regions was collected and analysed. In all cases, except for the Larissa prefecture, the urban centre has an indicator higher than the average one of the prefecture. However, the higher percentages per specific DOY is presented by DOYs outside the capital of the prefecture. In the prefectures with tourist economy oriented areas (Hersonissos of Heraklion, Skiathos in Magnessia) DOYs have the highest percentage. There is an additional view that should not be excluded: The particular part of the research is mainly about the behaviour of the professionals and the enterprises. A major part of this category of users is possible to be served in accounting services by professionals of the main urban centre of the region. These professionals have no immediate access to the local DOY and as a result, it is more probable that they will use the internet. In any case, it becomes widely obvious that internet helps in the increasing of the services' mobility.

**. Table 5: TAXISnet applications users in Cyclades Prefecture Islands**

| DOY | TAXISnet Services Users | Population (ESYE, 2001) | index | VAT statements submitted electronically (%) |
|---|---|---|---|---|
| Milos | 2.739 | 9.396 | 29,15% | 57,91 |
| Paros | 3.791 | 13.890 | 27,29% | 64,33 |
| Keas | 1.010 | 4.025 | 25,09% | 85,40 |
| Thera | 4.144 | 16.738 | 24,76% | 61,45 |
| Mykonos | 2.247 | 9.320 | 24,11% | 70,50 |
| Naxos | 3.947 | 20.933 | 18,86% | 23,36 |
| Syros | 3.559 | 19.782 | 17,99% | 51,69 |
| Tinos | 1.374 | 8.574 | 16,03% | 72,91 |
| Andros | 1.437 | 10.069 | 14,27% | 68,13 |

Source: MEF, 2006; elaboration by the author

Discovering that the multifragmentation of an area is a major factor of differentiation concerning the use of the services in question, the demand in the interior of the Cyclades prefecture was investigated. The highest indicator concerning services by the electronic applications of TAXISnet is that of the Milos DOY (29,15%) in which 49% of the population served lives permanently on another island from the one offering the service (Serifos, Syfnos, Kimolos). Similar is the case with the Kea DOY in which the island of Kythnos belongs, though 40% of the served population live there (Table 8). The use of eG services by professionals and services seems to depend less on the factor of fragmentation, despite the fact that the DOY of Kea ranks first in this category (see Table 5, VAT electronically submitted). It is estimated that what determines the use of the applications by the professionals on the islands, has to do with the peculiarities of the locally offered accounting services. There is also an arising speculation related to how active the users enrolled in the system are. It is also pointed out that the users indicator is illustrative of the resident's general interest on the residents' part in new applications while the percentage of VAT electronic submissions corresponds to very recent active users and thus, presents a more reliable use indicator.

6.3 Users distribution in urban centres

From the 30 DOYs with the highest percentages concerning electronic submission of VAT, seventeen are in the economic area of Athens and Thessaloniki. Outside the wider area of the two metropolitan centres the average percentage of electronic submission decreased (44.64%). Among the 30 DOYs outside the metropolitan centres with the highest percentage of electronic VAT submissions, sixteen serve insular areas and six of them serve areas of Crete. From the 30 DOYs with the lowest percentage of electronic submissions only 2 serve insular areas (Kythira, Ithaka).

Cities of Medium Size (CIMES) concentrate almost 19% of the users (138,953) outside metropolitan centres with an average use of 49%. The highest ranks are found in the one and only insular centre of the category (Heraklion), in a remote from the metropolitan centres one (Kavala) and finally in the centre wit the highest population (Patra). Viewed from an intraurban perspective, the differences among the DOYs, are not considered to be great in the case of Kavala, Patra, and Ioannina. The centres in Thessaly (Larissa, Volos) rank last with their local DOYs being the only ones with percentages below the average. These is no relation arising between the size of the DOY and the indicator's percentage, although Heraklion, which ranks first, has the biggest DOY and presents the greatest number of submissions. Socio – economic characteristics of urban centres have to be analysed in order to specify other than spatial factors which determine the use of eG services (see Kellerman, 2004).

## 7. Conclusions

Electronic services availability in Greek public administration is overwhelmingly inferior to the EU average equivalent. However there is a series of positive initiatives under way. As for the use of electronic public services, it is satisfactory especially in the case of enterprises.

The formulation of the operational framework of eG applications follows the general attitude of the country's adjustment to the basic principles of the EU initiatives. Besides, the immediate expected consequences of the eG application (cost reduction, quality enhancement of services), the reinforcement of democratic principles and transparency in public administration as well as the general improvement of competitiveness in the field of economy are the supreme and upper goals of the policy followed by the EU.

The goals are compatible with the basic principles of "good governance". These applications mostly serve the objective of "open" and "responsible" governance and, thus, facilitate transparency and immediacy during contact with citizens or in the function of public organisations.

There is an apparent lack of contribution to the cohesion of policies and actions, together with the participation in the process. Participation could be achieved through improved applications which constitute part of the decision - making mechanism, a process of a rather not systematic or regular use. In fact, developed electronic applications concerning administration not only in Greece but also in Europe, in general, mainly serve mere bureaucratic procedures or information giving. The most popular ones concern taxation services which ensure income for the public sector. These are services that could be more accurately termed as "electronic government" or "electronic administration" ones.

Apparently, the nature of the application which was used as a case study by the research narrows significantly the potential conclusion, as far as both the development of eG applications at the level of spatial entities and the interrelation with specific local formed governance structures are concerned. However, it has become obvious that the existence of a major urban centre is a significant factor of formulating the demand for electronic services of governance. Moreover, the examination of the intraprefectural differentiations has proved that the highest indicator can be found, apart from the area of the prefecture capital, at least in the case of medium sized cities. This is a fact that reinforces the attitude according to which internet functions as a means of improving accessibility.

The inferior position concerning conventional accessibility as well as the multifragmentation of a spatial unity are distinguished as a major factor for the development of eG applications. Such an ascertainment was the result of previous research (Asprogerakas & Ioannou, 2007; 2008) and it is an element of reinforcing the democratic nature of the particular mechanisms allowing the uniform distribution of the services in problematic, in terms of accessibility, spatial unities. The factors determining the percentage of electronic services use are not limited only to accessibility but are also related to the structure and composition of the regions economy. The predominant activity plays a major role in the use of these particular applications with tourism and the relevant activities acting as a familiarisation tool with the internet and its applications. On the contrary, areas specialised in the primary sector present a rather low use of electronic services.

Further future research could focus on space correlations concerning the inner cities in an effort to access the peculiarities related to the use of these specific services, determined by the socio-economic profile of the regional unities inside urban centres and the citizens' potential concerning mobility and access.

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# NEW INDUSTRIAL STRUCTURE COPING WITHTHE ECONOMIC IMPACTS OF SHIFTING PRODUCTION TO BATTERY-BASED ELECTRIC VEHICLES IN TOYOHASHI IN JAPAN – A CGE MODELING APPROACH-

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## Abstract
*After nearly a century with the internal combustion engine dominating the personal transportation sector, it now appears that the demands of Battery-based Electric Vehicles (BEVs) production are on the verge of experiencing rapid growth in Japan vehicle market. The broad-scale adoption of the BEVs could bring significant changes for our society in terms of moving the economics away from petroleum and lessoning the environmental footprint of transportation. However as Japanese economy strongly depends on the automobile industry, shifting production systems in the automobile industries influence not only the automobile industry but also other industries. Especially industrial regions where automobile firms are concentrated like in Toyohashi city in Japan will be affected by new production system. Thus, it is worth to acquaint with a new industrial structure for preventing the shortcoming by shifting production. In essence, this paper provides a computable general equilibrium (CGE) model to investigate the economic repercussion of BEVs production in the automobile industries, afterward suggests a new industrial formation to cope with the change of production system to BEVs in Toyohashi city in Japan. The most important database for CGE model calibration is a social accounting matrix (SAM). However input-output (I-O) table and the SAM are not available in Toyohashi city, thus the I-O table and SAM are also estimated in this study.*

**Keywords:** *CGE model, BEVs, gasoline vehicles (GVs), greenhouse gas (GHG), carbon dioxide ($CO_2$), Toyohashi city, Japan*
***JEL classification*: R10, R11.**

## 1. Introduction
Since the industrialization, the appearance of cities has been enhancing great changes of people's lives by mass production and mass consumption, Shibusawa & Miyata [13] (2008). On the other hand, industrialization causes many environmental issues such as GHG emissions, climate change, freshwater scarcity, deforestation, global warming, pollution, etc. due to the anthropogenic activities for example fossil foul combustion (e.g, natural gas, coal and petroleum) is used in power industrial process and motor vehicles. Several studies in natural sciences including e.g. Houghton et al., [5] (1996), have warned us of a possible future significant damage on our society due to global warming. Looking at the global environmental issues from the viewpoint of regional competition, it has become a serious problem as to which countries/ regions

and how much they should share the environmental burdens shedding another light on the North and South problem.

To curb the regional problems two major environmental summits: Kyoto Protocol (1997) and Copenhagen Summit (2009), have taken major feature that set binding targets for the industrialize countries including Japan for reducing GHG emissions. Japan had set an object that between 2008 and 2010, and by 2020, GHG emissions will be slashed by 6% and 25% respectively. Thus, GHG emissions diminutions have become one of the main priorities to Japan. Therefore, for an immediate reduction of $CO_2$ emissions, transportation sector is targeted for Japan to achieve the goal of GHG emissions reduction as per Kyoto Protocol. As the largest and growing fraction of GHG emissions mostly in the form of $CO_2$ from transportation sector, present a major challenge to global climate change mitigation efforts, Valerie et al., [22] (2010).

Worldwide transportation ranks second after electric power as the largest source of emissions, contributing about 20% of the total in recent trends and future projections, IEA [7] (2006). In the case of Japan similar to the world trend transportation accounts for more than one-fifth of en-use sector $CO_2$ emissions, MOE [11] (2007). Especially, emissions generated from passenger and freight cars dominate 90% of the sector, MOE [10] (1997), and alone personal vehicles contribute 50% of transportation emissions in Japan, GGIOJ [4] (2008). In addition, it is expected that $CO_2$ emissions will be increasing because of expending personal vehicles fleets especially in the sub-urban areas like Toyohashi city in Japan (see Table 1). In Japan, environmental consideration lately are bringing pressure on car manufactures to produce BEVs in order to spread of environmentally friendly vehicles hopping $CO_2$ emissions reduction from transportation sector.

However the problem of global financial downturn in forcing Japan to rethink about the economic development as well as the global economic recessions has also result the collapsed in domestic demand shrunk Japanese economy 1.2% and 5% in the year of 2008 and 2009. These situation putting Japan's national budget into a situation where, the demand for investment social welfare sectors like medical expenses, pension, and nursing care are increasing.

As a result, the proper forecast of the economic impacts of BEVs production seems prior considering the current Japanese economic situation. Because it is expected that the new generation automobiles will become popular in several decades, so the industrial structure may be affected by the new production system. Since the Japanese economy strongly depends on the automobile industry, shifting production system in the automobile industries influence not only the industries related to car manufacturing but also other industries. Especially industrial regions where automobile firms are concentrated like Toyohashi city will be affected by new production system. Therefore, it is worth to acquaint with a new industrial structure for preventing the shortcoming by shifting production. In this paper, we suggest a new industrial structure to cope with shifting production to BEVs in Toyohashi city of Japan, leaving the environmental impact, popularization of BEVs and new energy supply as future research area. In essence, this study provides a CGE model to investigate the economic repercussions of BEVs production in automobile industry of Toyohashi city in Japan, afterwards we suggest a new industrial formation to deal with the new production system of Toyohashi city in Japan.

The city is considered as a study region for three reasons: (1) the numbers of vehicles in the city are increasing rapidly, thus $CO_2$ emissions are seen an increasing trend, (2) the city has many motor vehicle industries including Toyota Motor Company, one of the world's largest automobile manufacturers by production, and (3) most importantly the GDP of the city is heavily depends on the car export.

The rest of the paper is organized as follows. In section 2, material and methodology of the study are described. Section 3 explains the assumptions of the model and behaviors of the economic agents. In section 4, parameter settings and simulation cases are given whereas Section 5 the results of the simulation are discussed, and finally in Section 6 summarizes the conclusion.

**Table 1**. Increase in number of personal vehicles and $CO_2$ emissions in Toyohashi city, Japan (*source*: [21]).

| year | total number of personal vehicle | total emissions mt/CO2 |
|---|---|---|
| 1990 | 189,413 | 58 |
| 1995 | 226,839 | 69 |
| 2000 | 251,433 | 70 |
| 2005 | 264,169 | 71 |

## 2. Material and Methodology

### 2.1. Study Area

Toyohashi city (see Figure 1) is situated on the southern edge of Aichi Prefecture in Japan. The city borders Shizuoka Prefecture and the Yumihari Mountains. The Pacific Ocean is in the south of the city and the city opens onto Mikawa Bay in the west. Mikawa port is a major port for worldwide trade, and its presence has made Toyohashi an important city as the biggest import and export hub in Japan for automobile, in volume term. Compared to other parts around the world, Mikawa port is roughly on a par with the Garman port of Bremerhaven. There are many motor vehicle industries in Toyohashi city including Toyota Motor Company (one of the world's largest automobile manufactures by production), Mitsubishi, and Suzuki Motors etc. The economy of the city mostly depends on car manufacturing and export. The city has an estimated population of 383, 691 (*source*: [21]).

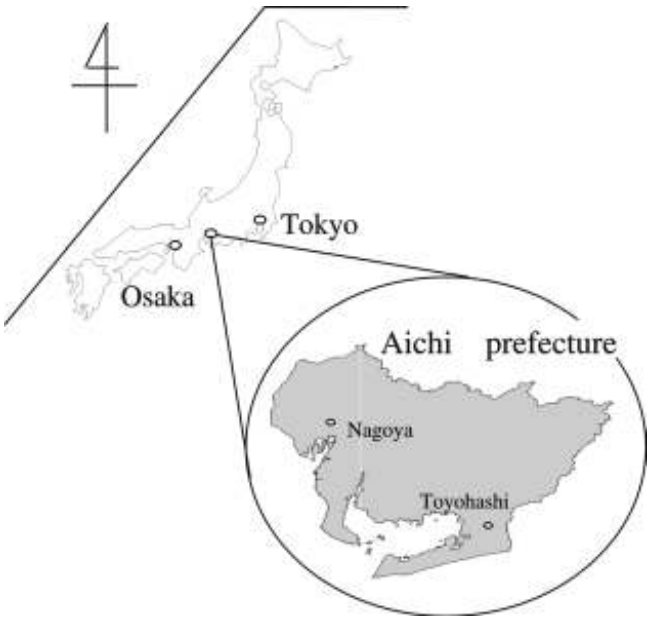


**Figure 1**. Location of Toyohashi city in Japan (*source*: Naohiro et al., [12] (2005)).

### 2.2. Methodology

The underlying approach of this study is CGE model. CGE models (both simple and standard) primarily rely on the basic assumptions of microeconomics as their foundations. These models assume one representative household, which consumes goods, and two representatives firm, each of which produces a certain goods. The household is supposed to maximize its utility subject to its budget constraints, while the firms maximize their

profits subject to given constraints on production technology. The household and all the firms are price takers, Hosoe et al., [6] (2010). A CGE model describes the whole circular flow of such market economy, while maintaining accounting consistency both at the macro level of individual actors, Abbink, G. A. et al., [1] (1995).

The model presented in this paper is a static CGE model (see Figure 2), thus, there are no time-related elements such as investment and savings, and it is closed economy; that is, no international trade is included. For constructing the model authors referred the literature of Miyata & Shibusawa [9] 2009; and Shoven & Whally [14] (1992).

As a common procedure for constructing the model involves the compilation of a database that describes the economy and is used to assign values to the parameters of the mathematical equations. This process is called the 'calibration' of the model, Thurlow, J. [19] (2004). The most important database for CGE model calibration is a SAM. However the I-O table and the SAM are not available in Toyohashi city, thus the I-O table was firstly estimated. The I-O table was estimated by breaking down 2005 Aichi Prefecture's I-O table which is the most recent table that is available. The original Aichi Prefecture's I-O table consists of 40 industrial sectors. This table is aggregated into a 31 industrial sectors table corresponding to the classification of industrial production. Following this procedure, the 31 (see Table 2) sector table is broken down as Toyohashi city's table by applying FRATAR method, and by using several statistics including the national population census, agricultural census, manufacturing census, and commerce census though the description of the method is skipped.

**Table 2**. Classification of industries (*source*: [21]).

| industries | industries |
|---|---|
| 1. agriculture, forestry & fishery | 17. electronic component |
| 2. mining | 18. automobile |
| 3. beverage & food | 19. aircraft |
| 4. textile | 20.other transportation equipment |
| 5. pulp, paper & wooden | 21. precision instrument |
| 6. chemical | 22. other manufactured |
| 7. petroleum & coal | 23. construction |
| 8. plastic | 24. electricity, gas & heat supply |
| 9. ceramic | 25. water supply & waste disposal |
| 10. other ceramic, stone & clay | 26. commerce |
| 11. iron & steel | 27. finance & insuance |
| 12. non-ferrous metal | 28. reale state |
| 13. metal product | 29. transport |
| 14. general machinery | 30. information & telecommunication |
| 15. electrical machinery | 31. service |
| 16. information & communication electronic equipments | |

And developing SAM of Toyohashi city is an extension of I-O table of this city. The estimated results are shown below (see Table 3). From the table, it can be seen that industries produce 3,152 billion yen of commodities and services. However it is a characteristics nature that the external sector's net demand for goods and services produced in the study area shows 251,395 million yen, which seems high. The population of the study area is small, thus the commodities and services must exports to the rest of the world. Looking at the government sector, it obtains its revenue of 567, 985 million yen from net indirect tax, direct tax, and current transfer from the external sector. It is a specific fact that the revenue from the external sector is large. In expending side, it is characteristic that the government savings are small. In the household sector, household

obtain 1, 616,800 million yen of income, and then consume 9, 347 million of commodities and services. In the external sector, current transfers between the external sector and the government, and those between the external sector and households a large.

Previous innovation studies using this approach have been rooted in the field of transportation research analysis studying the prospects for transportation and energy systems dynamics. Some of the recent studies have focused on the new generation automobile with technological innovations using the similar approach, Shibusawa & Sugawara [15] (2011); Valerie et al., [22] (2010); Thomas, C. E. [17] (2009); Simon et al., [16] (2012); and Thomas, C. E. S. [18] (2009). Other studies have focused the importance of government policy, infrastructural change for spreading EVs in Japan, Ahman, M. [2] (2006); Brown et al., [3] (2010); and Willett & Toru [23] (2000). The study of Tokunaga et al., [20] describes details of EVs in Japan.

**Table 3**. Social accounting matrix of Toyohashi city in Japan.

| economic sectors (in million yen) | | production activities | institutions | | production factors | | capital accumulation | external sector | total |
|---|---|---|---|---|---|---|---|---|---|
| | | 31 industries | government | households | capital | labor | | | |
| production activities | 31 industries | 1,298,045 | 230,576 | 934,725 | 0 | 0 | 437,666 | 251,395 | 3,152,407 |
| institutions | government | 115,703 | 0 | 352,756 | 0 | 0 | 0 | 99,526 | 567,985 |
| | households | 0 | 162,866 | 0 | 446,247 | 920,522 | 0 | 87,165 | 1,616,800 |
| production factors | capital | 498,892 | 0 | 0 | 0 | 0 | 0 | 0 | 498,892 |
| | labor | 922,275 | 0 | 0 | 0 | 0 | 0 | 48,129 | 970,404 |
| capital finance | | 317,492 | 4,302 | 296,854 | 0 | 0 | 0 | 0 | 618,648 |
| external sector | | 0 | 170,241 | 32,465 | 52,645 | 49,882 | 180,982 | 0 | 486,215 |
| total | | 3,152,407 | 567,985 | 1,616,800 | 498,892 | 970,404 | 618,648 | 486,215 | 8,019,616 |

## 3. Assumptions of the Model

### 3.1. Main Assumptions

Main assumptions made in our model are as follows:

(1) 2005 Toyohashi city's economy is examined. Economic agents are households, firms in 31 industries, the government and the external sector.

(2) 33 markets are considered. They are 31 commodity markets, one labor market and one capital market. These are assumed to be perfectly competitive, and in equilibrium in 2005.

### 3.2. Behavior of Industries

In industries intermediate input, labor and capital are invested to produce goods. Industries have *Leontief* technology with respect to intermediate input and value added inputs and *Cobb-Douglas* technology for labor and capital inputs (see Figure 2).

Constant returns to scale are assumed in the technology, cost minimization problem can be written as,

$$min \sum_{i=1}^{31} p_i x_{ij} + (1+tp_j)(wL_j + rK_j)(j = 1,...,31) \quad (1)$$

*with respect to* $X_{ij}$, $L_j$ and $K_j$

$$X_j = min\ [\frac{1}{a_{10j}} f_j(L_j, K_j), \frac{x_{1j}}{a_{1j}}, ..., \frac{x_{31j}}{a_{31j}}] \quad (2)$$

$$f_j(L_j, K_j) \equiv A_j L_j^{aj} K_j^{(1-a_j)} \quad (3)$$

where

$w$ : wage rate

$r$ : capital return rate

$L_j$ : labor input in industry $j$

$K_j$ : capital input in industry $j$

$X_j$ : output in industry $j$

$a_{0j}$ : value added rate in industry $j$

$a_{ij}$ : share parameter on intermediate input

$x_{ij}$, $A_j$ ,$\alpha_{ij}$ : technical parameters in industry $j$

$p_i$ : price of commodity $I$

$x_{ij}$ : intermediate input of industry $i$'s product in industry $j$,

$tp_j$ : net indirect tax rate imposed on industry $j$'s product (indirect tax rate - subsidy rate).

Cost minimization problem (1) to (3) yields conditional demands for intermediate goods, labor, and capital in production process

$$X_{ij} = a_{ij} X_j \quad (4)$$

$$LD_j = [\frac{(1-\alpha_j)r}{\alpha_j w}]^{\alpha_j} \frac{a_{0j} X_j}{A_j} \quad (5)$$

$$KD_j = [\frac{a_j w}{(1-a_j)^r}]^{(1-a_j)} \frac{a_{0j} X_j}{A_j} \quad (6)$$

where

$LD_j$ : conditional demand for labor in industry $j$

$KD_j$ : conditional capital demand in industry $j$

Zero profit condition is realized in industries under perfect competition.

$$profit = p_j X_j - \sum_{i=1}^{31} p_i x_{ij} - (1+tp_j)[w.LD_j + r.KD_j] = 0 \quad (7)$$

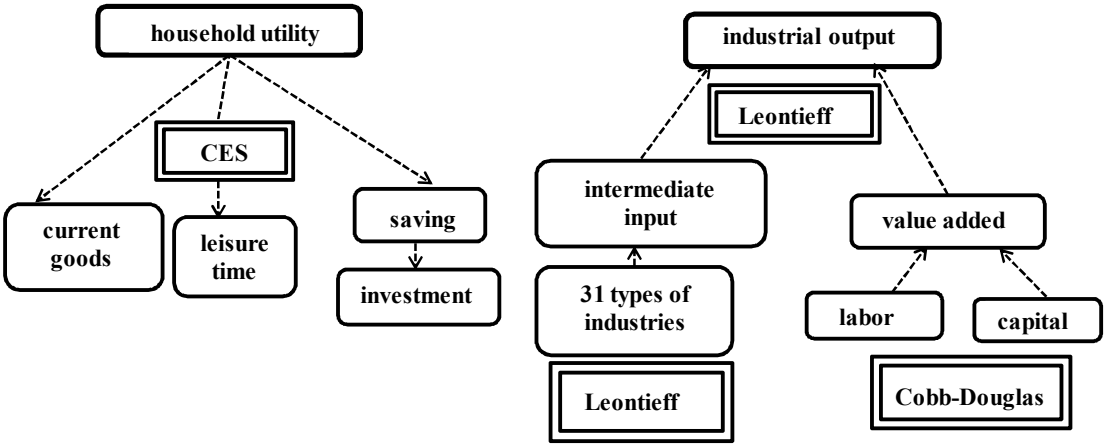


**Figure 2**. Hierarchical structure of the CGE model.

### 3.3. Behavior of Households

Households in Toyohashi city are assumed to be homogeneous with the fixed number of households. Thus one can consider that households share an aggregate single utility function.

To explain the household behavior, first, derivation of future good is described here. The future good implies the future consumption which derived from household saving, however, the saving formulates capital investment. Therefore capital good can be regarded as saving good. Investment is made by using produced goods, and let their portions in investment be denoted by $b_i$ Denoting the price of investment good by $p_I, p_I I = \sum_{i=1}^{31} p_i I_i$ is realized. Then the price of investment good is expressed as $p_I = \sum_{i=1}^{31} b_i p_i$ . This can be regarded as the price of saving good $p_s$. Since the capital returns after direct tax by a unit of capital injection is expressed by $(1\text{-}ty)(1\text{-}k_o)(1\text{-}k_r)r\delta$, the expected return rate of the price of saving good $p_s$, that is, the expected net return rate of household saving $r_s$ is written as follows

$$r_s = (1-ty)(1-k_o)(1-k_r)r\delta / p_s \tag{8}$$

where

$ty$ : direct tax rate imposed on households

$k_o$ : rate of transfer of property income to the external sector

$k_r$ : capital depreciation rate

$\delta$ : ratio of capital stock measured by physical commodity unit to that by capital service unit.

Then we describe the derivation of demands for composite consumption and leisure time from the current good $G$. The current good $G$ is a composite of consumption and leisure time, and $G$ is obtained from the following optimization problem.

$$\max_{C,F} G \equiv \{\beta^{1/\nu_2} C^{(\nu_2-1)/\nu_1} + (1-\beta)^{1/\nu_2} F\}^{\nu_2/(\nu_2-1)} \tag{9}$$

subject to

$$p \cdot C + (1-ty)(1-l_o) w \cdot F = (1-ty)FI - TrHO - SH \tag{10}$$

Solving this utility maximization problem, demand functions for composite consumption, leisure time, and labor supply are obtained.

$$C = \frac{\beta[(1-ty)FI - TrHO - SH]}{p^{\nu_2} \cdot \Omega} \tag{11}$$

$$F = \frac{(1-\beta)[(1-ty)FI - TrHO - SH]}{[(1-ty)(1-l_o)w]^{\nu_2} \cdot \Omega} \tag{12}$$

$$LS = E - F \tag{13}$$

$$\Omega = \beta p^{(1-\nu_2)} + (1-\beta)[(1-ty)(1-l_o)w]^{(1-\nu_2)} \tag{14}$$

where
$LS$ : household labor supply
$\beta$ : share parameter
$v_2$:elasticity of substitution between composite consumption and leisure time
$C$ : composite consumption
$F$ : leisure time
$p$ : price of composite consumption good
$SH$ : household nominal saving ($=P_S \cdot S$ )

Substituting composite consumption (11) and leisure time (12) into (9), the price index of the present good is derived as follows:

$$p_G = \{\beta\, p^{1-v_2} + (1-\beta)[(1-ty)(1-l_o)w]^{1-v_2}\}^{1/(v_2-1)} \tag{15}$$

Moreover composite consumption good is disaggregated into produce goods through the maximization of a Cobb-Douglas sub-utility function given the household income and leisure time.

$$max \quad C \equiv \prod_{i=1}^{31} C_i^{\gamma_i} \qquad (\sum_{i=1}^{31} \gamma_i = 1) \tag{16}$$

*subject to*

$$\sum_{i=1}^{31} p_i \cdot C_i = (1-ty)Y - TrHO - SH \tag{17}$$

where
$C_i$ : household consumption good produced by industry $I$
$p_i$ : price of good $I$
$Y$ : household income
( $=(1\text{-}l_o)w \cdot LS + LI + (1\text{-}k_o)(1\text{-}k_r)r \cdot KS + KI + TrGH + TrOH$ )
From this optimization problem, consumption good $i$ is derived.

$$C_i = \frac{\gamma_i}{p_i}[(1-ty)Y - TrHO - SH] \quad (i = 1,\cdots,31) \tag{18}$$

The price of composite consumption is calculated as follows:

$$p = \prod_{i=1}^{31} \left[ \frac{p_i}{\gamma_i} \right]^{\gamma_i} \tag{19}$$

### 3.4. The Government

The government sector in this study consists of the national and local governments activities in Toyohashi city. So the concept of the government corresponds to the definition of SNA framework. The government obtains its income from direct and net indirect taxes of Toyohashi city, and current transfers from the external sector, and then it expends the income on government consumption, current transfers to households, and current transfers to the external sector. The difference between income and expenditures are saved. Nominal consumption expenditures on commodities/services are assumed to be proportional to the government revenue with constant sectorial share. These are expressed as the following balance of payments.

$$\sum_{i=1}^{31} p_i \cdot CG_i + TrGH + TrGO + SG = ty \cdot Y + \sum_{i=1}^{31} tp_i (w \cdot LD_i + r \cdot KD_i) + TrOG \tag{20}$$

where
$CG_{i:}$ government consumption expenditures on commodity $I$
$TrGH$: current transfers to households
$TrGO$: current transfers to the external sector
$SG$ : government savings
$TrOG$ : current transfers from the external sector

### 3.5. The External Sector

The external sector gains its income from Toyohashi city's imports, current transfers from the government, labor income transfers, and property income transfers. And then it expends the income on exports and transfer of Toyohashi, current transfers to households and the government, labor (employees to the city of Toyohashi) and property income transfers. These are also described as the following balance of payments.

$$\sum_{i=1}^{31} p_i \cdot EX_i + TrOH + TrOG + KI + LI + SO = \sum_{i=1}^{31} p_i \cdot EM_i + TrHO + TrGO + KIO + LIO \quad (21)$$

where
$EX_i$: export of commodity $I$,
$EM_i$: import of commodity $I$,
$SO$: savings of the external sector (=-national current surplus)
$LIO$ : labor income transfers to the external sector (= $l_o \cdot w \cdot LS$ )
$KIO$: property income transfers to the external sector (= $k_0 \cdot r \cdot KS$)

### 3.6. Balance of Investment and Saving

Household, government, area department`s savings, the total consumption of fixed capital, which determines the total investment.

$$\sum_{i=1}^{31} p_i \cdot I_i = SH + SG + SO + \sum_{i=1}^{31} DR_i \quad (22)$$

where
$I_i$: demand for commodity $i$ by other investments,
$DR_i$: consumption of fixed capital amount of industry $i$

### 3.7. Prices of Commodities

Cost consists of the following is derived from the Zero profit condition of the industry.

$$p_j X_j = \sum_{i=1}^{31} p_i x_{ij} + (1 + tp_j)[w \cdot LD_j + r \cdot KD_j] \quad (23)$$

Given a wage and a capital return rate, we can formally calculate commodity prices as follows:

$$P = (I - A')^{-1}[(1 + tp_j)(w.ld_j + r \cdot kd_j)] \quad (24)$$

where
$P$: vector of commodity prices,
$A'$: transposed matrix of industries' input coefficients,
[ • ] : column vector whose elements are in parentheses $ld_j \equiv LD_j / X_j$ and $kd_j \equiv KD_j / X_j$

### 3.8. Derivation of Equilibrium

The equilibrium condition in the model can be summarized as follows,

***Commodity market***

$$\begin{bmatrix} X_1 \\ \vdots \\ X_{31} \end{bmatrix} = \begin{bmatrix} a_{11} & \cdots & a_{131} \\ \vdots & \ddots & \vdots \\ a_{311} & \cdots & a_{3131} \end{bmatrix} \begin{bmatrix} X_1 \\ \vdots \\ X_{31} \end{bmatrix} + \begin{bmatrix} C_1 \\ \vdots \\ C_{31} \end{bmatrix} + \begin{bmatrix} CG_1 \\ \vdots \\ CG_{31} \end{bmatrix} + \begin{bmatrix} I_1 \\ \vdots \\ I_{31} \end{bmatrix} + \begin{bmatrix} EX_1 \\ \vdots \\ EX_{31} \end{bmatrix} - \begin{bmatrix} EM_1 \\ \vdots \\ EM_{31} \end{bmatrix} \quad (25)$$

***Labor market***

$$LS = \sum_{j=1}^{31} LD_j \quad (26)$$

***Capital market***

$$KS = \sum_{j=1}^{31} KD_j \quad (27)$$

## 4. Parameter Setting and Simulation Cases

### 4.1. Parameter Setting

For numerical experiments, it is necessary to estimate parameters in functions specified in the model. Parameters in the model are calibrated by employing 2005 actual data of Toyohashi city IO table. The technological parameters in the production functions in industries are specified as Leontief-Cobb-Douglas type, they can easily be estimated by applying the benchmark data set in a usual CGE- modeling framework. The detailed results of parameter estimation are beyond the scope of this paper, therefore, they are skipped. For the parameters in the utility function, estimation of them is made in a standard way with results shown in Table 4 though the description of the estimation method is skipped as well.

**Table 4**. Utility function parameter.

| | share parameter |
|---|---|
| current good | 0.78153 |
| future good | 0.21847 |
| elasticity of substitution between current and future goods | 1.11836 |
| composite comsumption | 0.52393 |
| leisure | 0.47607 |
| elasticity of substitution between composite consumption and leisure time | 0.91135 |

### 4.2. Simulation Cases

In this section, two cases are simulated and they are as follows:

(1) Business as usual case (Base case) and

(2) Case 1 (where 100% BEVs are produced)

Base case assumes that the automobile industry in Toyohashi city produces motor vehicles following the current system, i.e. most of produced vehicles are GVs. Case 1 assumes that the automobile industry produces 100% BEVs. The difference between the two cases is input coefficients in IO table of Toyohashi city. The simulation is conducted by changing the input coefficient of GVs and BEVs (see Table 5). Our main source for the input coefficient was the work of Japan Energy Economics Research Institute [8] (2006), where modeled the demand of input coefficient in the Japan market.

**Table 5**. Input coefficient of gasoline and battery-based electric vehicles.

| industries | gasoline vehicles | battery-based electric vehicles |
|---|---|---|
| 1. agriculture,forestry & fishery | 0 | 0 |
| 2. mining | 0 | 0 |
| 3. beverages & foods | 0 | 0 |
| 4. textile | 0.004 | 0.003 |
| 5. pulp, paper & wooden | 0.00005 | 0.00005 |
| 6. chemical | 0.004 | 0.003 |
| 7. petroleum & coal | 0.001 | 0.001 |
| 8. plastics | 0.032 | 0.025 |
| 9. ceramics | 0 | 0 |
| 10. other ceramic, stone & clay | 0.016 | 0.015 |
| 11. iron & steel | 0.07 | 0.07 |
| 12. non-ferrous metal | 0.003 | 0.004 |
| 13. metal products | 0.001 | 0.001 |
| 14. general machinery | 0.002 | 0.002 |
| 15. eectrical machinery | 0.048 | 0.03 |
| 16. information & communication electronic equipment | 0.000048 | 0.000048 |
| 17. electronic components | 0.000096 | 0.000096 |
| 18. automobile | 0.605 | 0.35 |
| 19. aircraft | 0 | 0 |
| 20. other transportation equipment | 0 | 0 |
| 21. precision instruments | 0.0004423 | 0.0004423 |
| 22. other manufactured | 0.0009 | 0.0009 |
| 23. construction | 0.001 | 0.001 |
| 24. electricity, gas and heat supply | 0.005 | 0.01 |
| 25. water supply & waste disposal business | 0.001 | 0.001 |
| 26. commerce | 0.016 | 0.016 |
| 27. finance& insuance | 0.008 | 0.008 |
| 28. reale state | 0.001 | 0.001 |
| 29. transport | 0.016 | 0.02 |
| 30. information & telecommunications | 0.002 | 0.002 |
| 31. services | 0.072 | 0.072 |

## 5. Simulation Results

In this section we present the simulation results referring to some important economic variables.

### 5.1. Amount of Industrial Production

Changes in industrial outputs are shown in Figures 3 and 4. After BEVs being put into operation, the total industrial production slightly increases. Particularly a large increase is found in non-ferrous metals (increase rate of 74.1%), because a lot of non-ferrous metals are necessary for producing batteries used in BEVs. Increases in outputs are also found in mining (10.3%), construction (9.4%), precision machine (7.0%), general machine (5.6%)

and electricity, gas and heat supply (4.8%). The increase in output of non-ferrous metals might be a little large, however the batteries used in BEVs should be much produced demanding a lot of non-ferrous metals. This result has also been confirmed by the IO analysis of Japan's economy, and can be concluded as that it is qualitatively plausible. The impact on mining is attributed to an increase in non-ferrous metal output. Regarding the impact on construction, the capital outflow from Toyohashi city decreases due to an increase in output of import oriented industries resulting in an increase in city savings. Thus the capital investment grows leading to an expansion in the construction sector. Increases in precision machine, general machine and electricity, gas and heat supply are obtained from the difference in the component of parts and/or processing in the BEVs production.

The output of automobile industry shows a decrease of -9.3% which is interesting. The reason is attributed to the fact of the less number of parts in BEVs. That is, the economic repercussion of producing BEVs on other relating industries becomes less as compared with GVs. Producing BEVs once give a negative impact on Toyohashi's economy, but it suggests the necessity of transformation of the current industrial structure to compensate the negative impact.

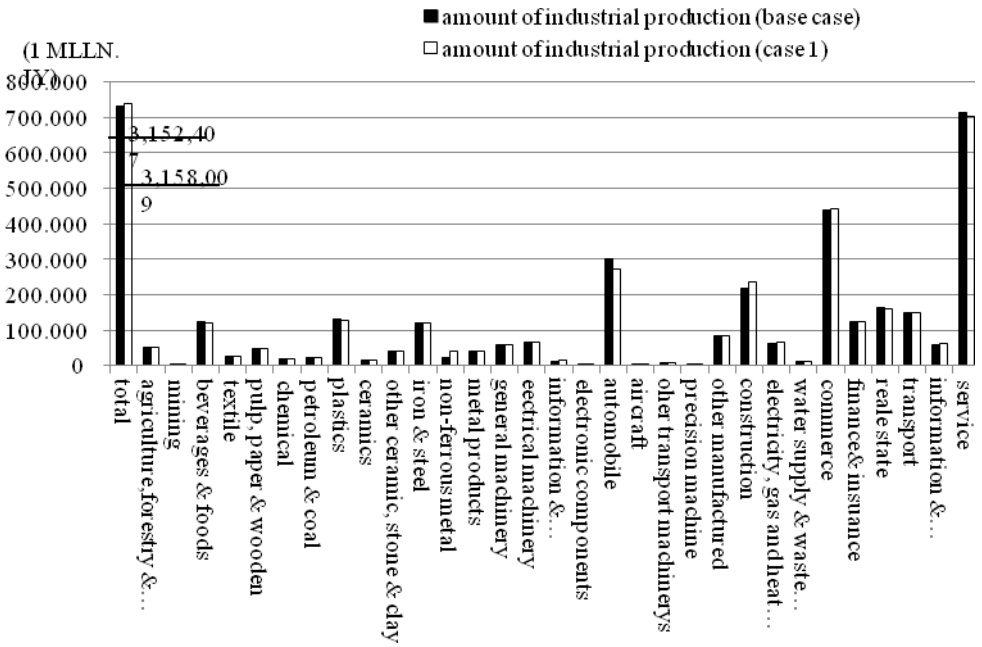


**Figure 3.** Amount of industrial production.

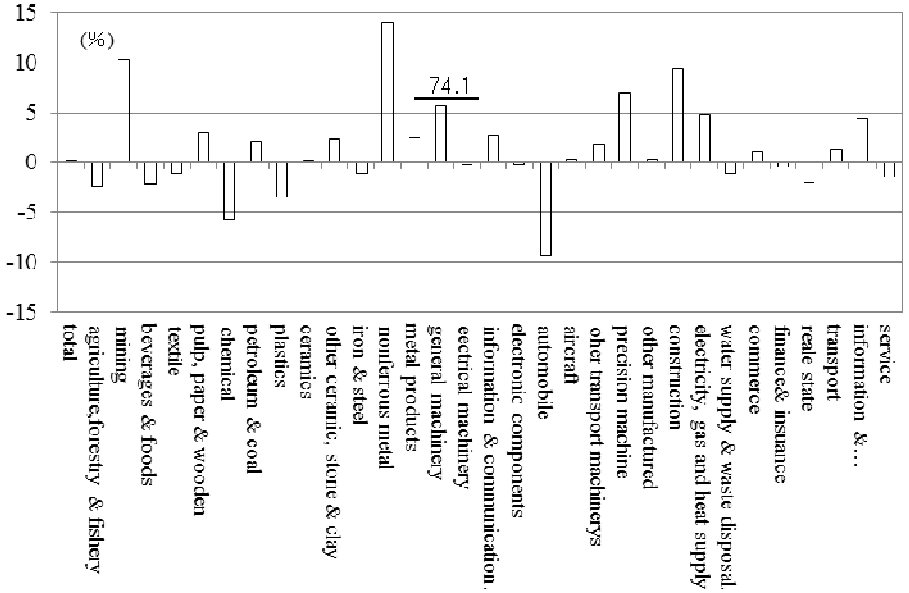


**Figure 4**. Change rate of industrial outputs.

### 5.2. City GDP

The city GDP is defined as gross value added in the city. Value added rates are adjusted in order that the sums of coefficients in the column in the automobile industry become the unity. As shown in Figures 5 and 6, the manner of changes in the city's GDP by sector is similar to that of industrial outputs. It is interesting to see an increase in GDP of automobile industry by 4.1%. This is because the value added rate in automobile industry rises resulting from the less number of parts is BEVs. Thus increases in wage rate and/or in firms profit are observed in BEVs production resulting in stimulating to household consumption expenditures as a general equilibrium effect, while the repercussion effect of GVs manufacturing goes to automobile industry itself. However despite the fact of increases in wage income and operating surplus, the capital return rate shows a growth resulting from raises in demands for capital and labor. Thus commodity prices go up leading to a decrease in the real wage rate. And household consumption expenditures decrease due to the income effect caused by a fall in the real wage rate. However Toyohashi's total real GDP grows by 0.9%.

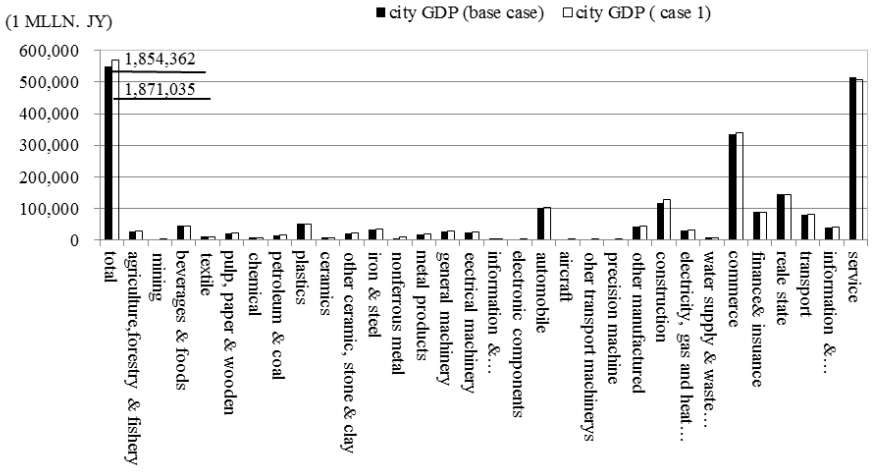


**Figure 5**. City GDP.

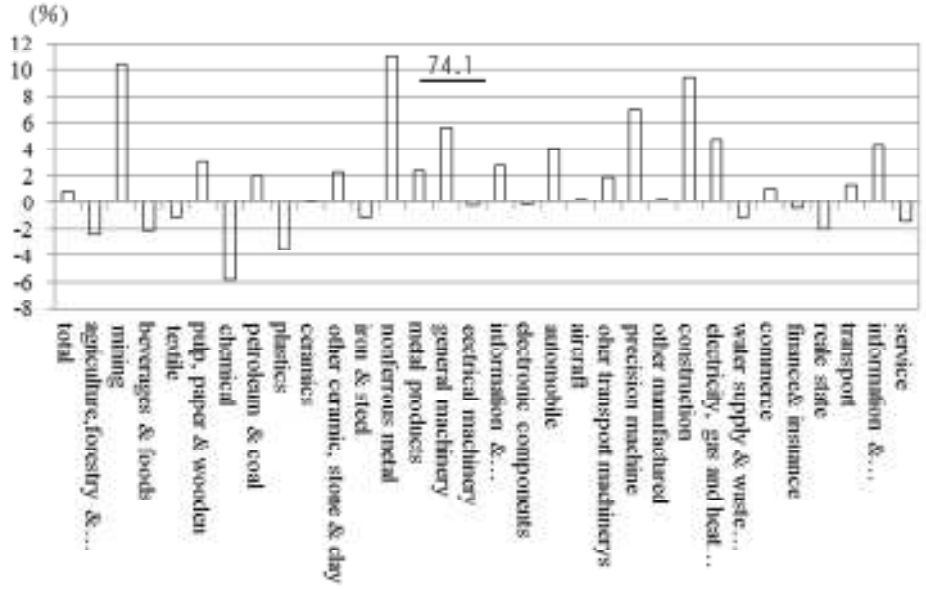


**Figure 6.** Change rate of city GDP.

### 5.3. Labor Demand

Looking at changes in labor demands by sector in Figures 7 and 8, it can be seen that changes in labor demands are similar to those in GDP's by sector. That is, although the output of automobile industry shows a decrease, the labor demand in that industry depicts a rise of 4.3%. This is caused by an increase in the gross value added rate in automobile industry. The growth in the total labor demand shows 1.6% which is higher than 0.9% growth in the real GDP. Taking into account the current serious situation of job opportunity in Toyohashi city, the increase in labor demand may be interpreted as a positive fact. However this reduces leisure time implying that the household utility would show a decrease in some case.

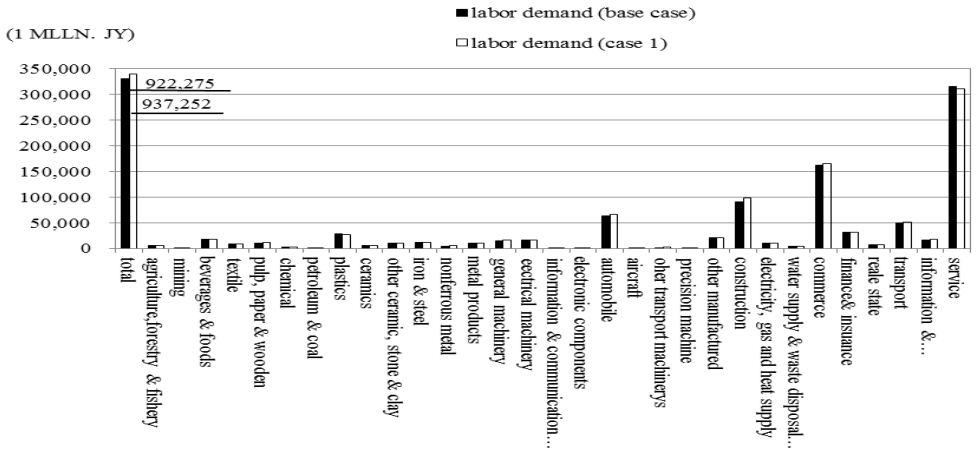


**Figure 7**. Labor demand in industries.

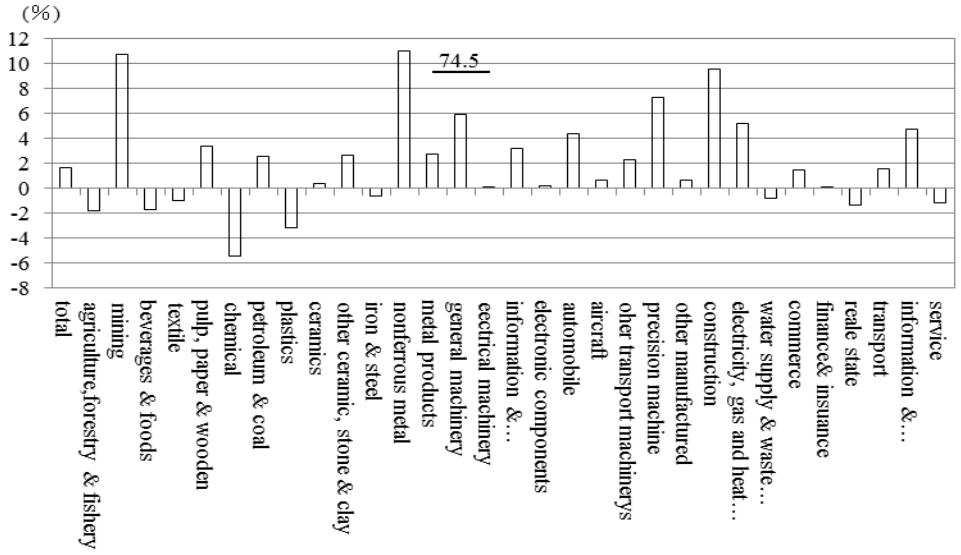


**Figure 8**. Change rate of labor demand in industries.

### 5.4. Capital Demand

Since the total capital endowment by households is fixed in this model, the total demand for capital is not changed after the introduction of BEVs. Looking at changes in capital demand by industry in Figures 9 and 10, the manner of changes are similar to that of industrial GDP's. However due to the fixed capital supply, positive growths in capital demands by sector are slightly depressed, and negative growth are enhanced. Particularly the capital demand in automobile industry illustrates an increase of 3.6% while that of labor demand is 4.36% showing a slightly depressed rise.

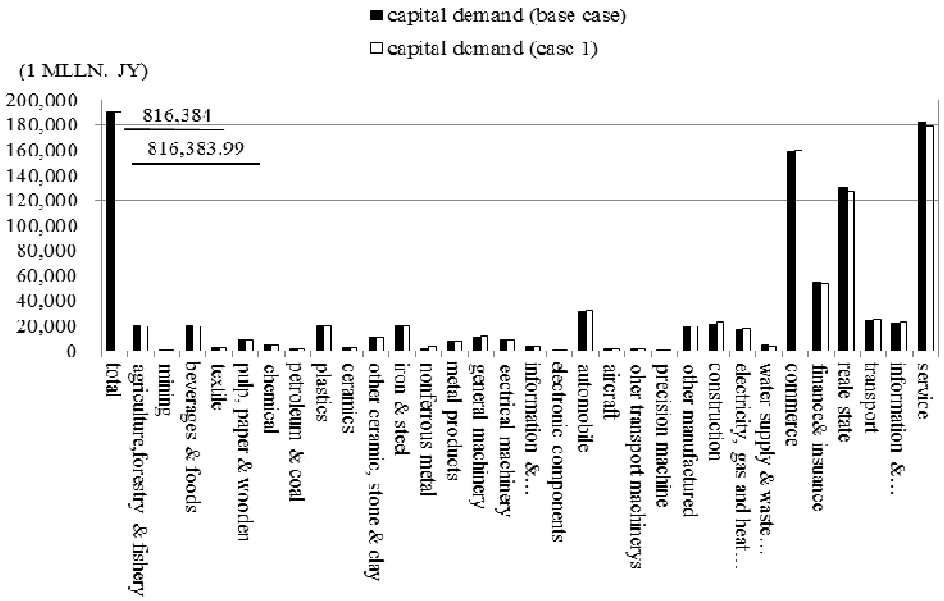


**Figure 9**. Capital demand.

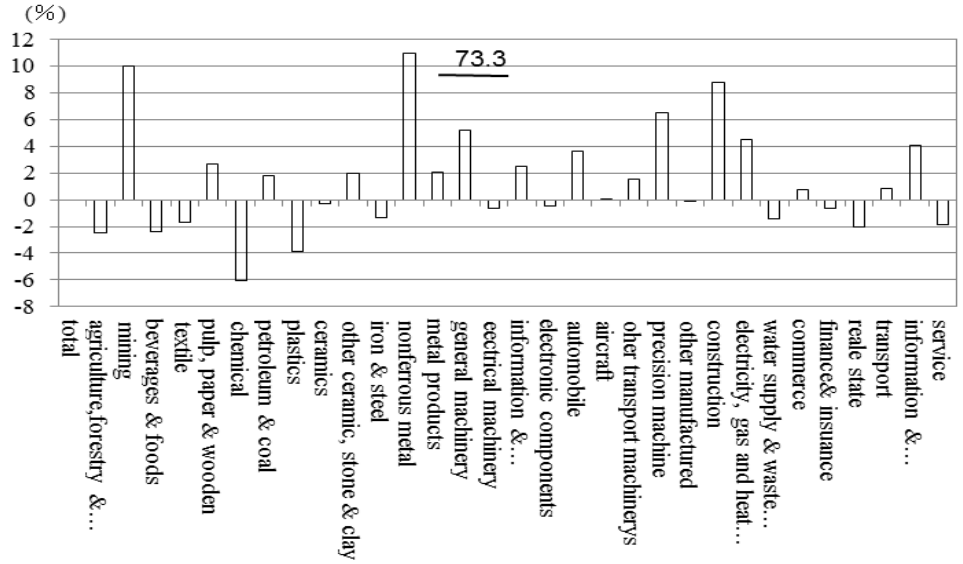


**Figure 10**. Change rate of capital demand.

### 5.5. Commodity Prices

Commodity prices are determined by factor prices. Since the numerare is set up as labor in this model, the capital return rate is adjusted for equilibrating the markets. The capital return rate is determined so as to equilibrate the total capital supply and demand. After introducing the BEVs production, the demand for capital tends to increase resulting in an increase of 0.7% in the capital return rate. Reflecting this rise, all commodity prices go up ranging in the interval of 0.22% to 0.63%. Observing Figures 11 and 12, the highest up is 0.63% in real estate industry, while the lowest one is 0.22% in construction industry. This result is attributed to that the capital input ratio in real estate is largest across industries, and conversely in construction the large part of gross value added consists of labor income. In many cases, increases in commodity prices get lower the real the real wage rate leading to welfare loss.

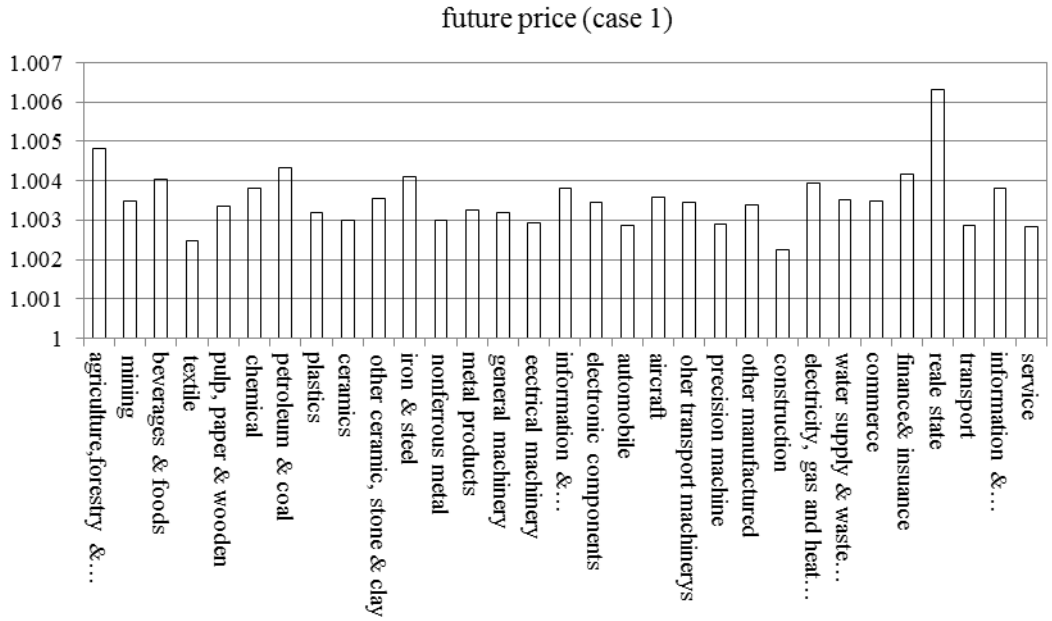


**Figure 11.** Commodity price.

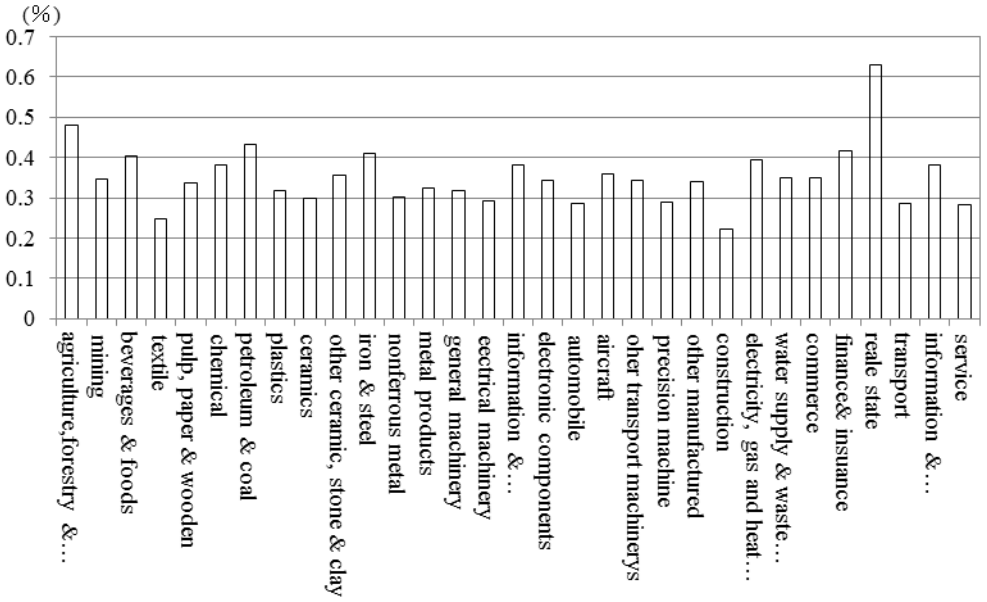


**Figure 12.** Change rate of commodity price.

### 5.6. Other Variables

Let us look at Figures 13 and 14 to see changes in other variables. Large increase rates are found in the total investment, net indirect tax, labor supply, capital return rate and the price of composite consumption good. The reason of the large growth in the total investment is that outputs of import oriented industries grows, the capital outflow to the rest of the world decreases, and then finance to investment increases. The reason of the increase in indirect tax is due to a rise in the gross value added. The increase in the labor supply corresponds to a growth in the labor demand associated with up in the gross value added rate. The increase in the capital return rate is due to a growth in capital demand by an increase in the gross value added rate as well. The up in the price of composite consumption good results from the increase in the capital return rate.

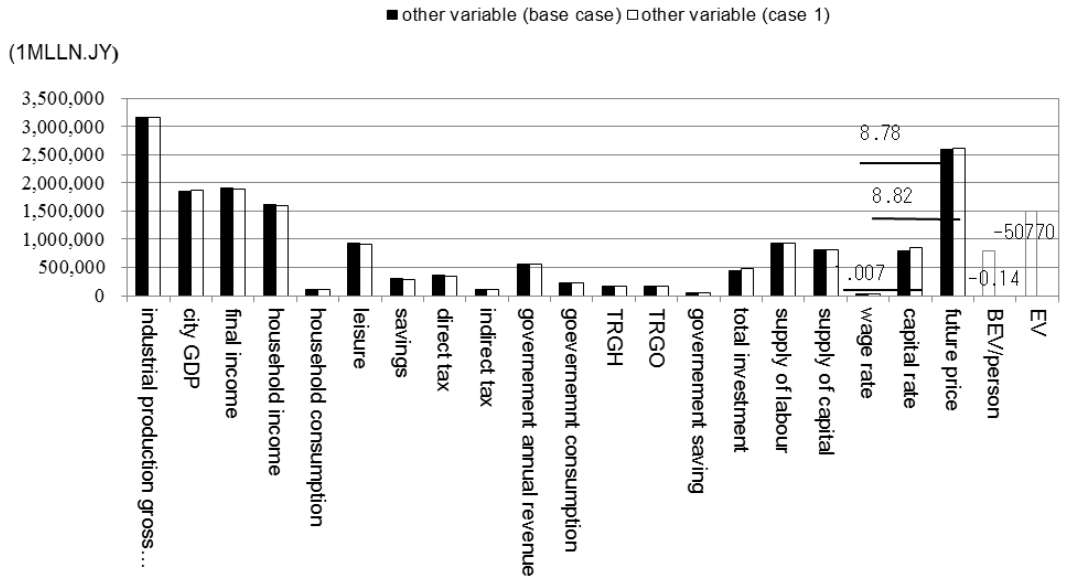


**Figure 13**. Other variables.

Note: *TRGH* - current transfer from the government to households, *TRGO* - current transfers from the government to the rest of the world, *EV* - equivalent variation, which is

$EV=e(p_G,p_H,u_1)-e(p_G,p_H,u_0)=(u_1-u_0)[\alpha p_G^{1-\nu_1}+(1-\alpha)p_H^{1-\nu_1}]^{1/1-\nu_1}$ where $e(p_G, p_H, u)$ - expenditure function, $p_G$ and $p_H$ - prices of present and future goods in the base case, $u_0$ and $u_1$ - utility levels before and after the BEVs production

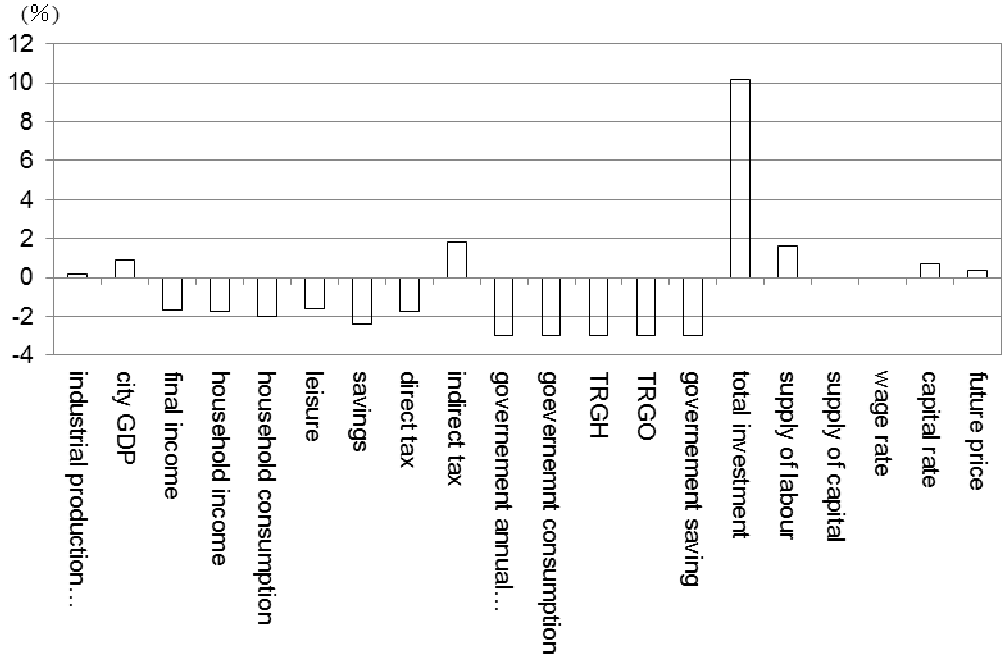


**Figure 14.** Change rate of other variable.

## 6. Concluding Remarks

In this paper, we have developed a CGE model to investigate the economic repercussions of BEVs production. We also have focused on a new industrial structure to cope with the change in the BEVs production system of Toyohashi city in Japan. Moreover, we have introduced an I-O table and a SAM for Toyohashi city in this study. By employing the CGE model, the two numerical simulations have been implemented. From the simulation results, some interesting conclusions have been obtained. For example, the output of automobile industry has shown a decrease of -9.3% though the labor demand in that industry depicts a rise of 4.3%. Taking into account the current serious situation of job opportunity in Toyohashi city, the increase in labor demand may be interpreted as a positive fact, however this reduces leisure time implying that the household utility would show a decrease in some case. Moreover, it is interesting to see an increase in GDP of automobile industry by 4.1%. This is because the value added rate in automobile industry rises resulting from the less number of parts is BEVs. Thus increases in wage rate and/or in firms profit are observed in BEVs production resulting in stimulating to household consumption expenditures as a general equilibrium effect, while the repercussion effect of GVs manufacturing goes to automobile industry itself. That is, the economic impact of producing BEVs on other relating industries becomes less as compared with GVs. Producing BEVs once give a negative impact on Toyohashi's economy. Therefore it suggests the necessity of transformation of the current industrial to compensate the negative impact. At this point, this study highlights on a new industrial structure to cope with a change of production system. Particularly it is suggested to promote industries such as non-ferrous metal (increase rate of 74.1%) manufacturing where a large economic impact appears and to attempt to incorporate such impact into Toyohashi city's economy. The reason is that a lot of non-ferrous metals are necessary for producing batteries used in BEVs. The increase in output of non-ferrous metals might be a little large, however the batteries used in BEVs should be much produced demanding a lot of non-ferrous metals. This result has also been confirmed by the IO analysis of Japan's economy, and can be concluded as that it

is qualitatively plausible. Thus it is claimed that this study confines itself to explain the features that have bearing on the development of BEVs.

Moreover, this paper focused on the production process of BEVs, however socio-economic impacts of spread of BEVs seem to be also very important. In this paper we have not considered the importance of subsidies, whilst subsidies may be required to overcome the initial price differential, BEVs will be expensive until a market emerges. It can be expected that spread of BEVs would greatly reduce the $CO_2$ emissions, however it is also strongly depends on internalizing electricity generated from renewable sources of energies, like solar or/and wind. In addition, lately security in electricity generation is a great concern as Japan has been experiencing nuclear crisis after the Tohoku earthquake and tsunami hit in March 2011. Japan has one of the lowest energy intensities (energy- use per unit of GNP) in the industrialized world, but its aggregate energy-use is still rising. Moreover, new technologies like smart grid must be internalized in our model to stabilize demand and supply of electricity generated from renewable sources of energies. Therefore, our future study will include the popularization of BEVs, and introduce a Battery-based Electric Vehicle society with renewable energies and smart grid technology in Toyohashi city in Japan.

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# Environmental Sustainability, Energy Use and Economic Growth: an Analysis of Toyohashi City Energy-Economy Interaction

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## Abstract
*Manufacturing and trading concentration, elevated economic activities and rise in urban population are the driving forces of city growths in the central part of Japan. Toyohashi city, locating between Tokyo and Nagoya, Osaka, is facing rapid growth for its industrial and port related economic concentration. As a result, use of natural resources and energy in the city is increasing. Recent trends show that to ensure economic growth, the City level energy use increased significantly. On the other hand, after the great disaster of 2011, Japan is concentrating more on natural resources to produce energy. The outcome would end in a higher use of natural resources like fossil fuel and natural gas. Finding an optimum solution to address energy-economy interactions is, therefore, becoming complex and difficult. Under the circumstances, this paper attempts to study the growth of Toyohashi city over time and resultant increase in consumption of electricity and gas. Another objective of the paper is to find features of effect of technological yield in use of energy. The results of the study show that manufacturing and trading sector of the economy are causing expansionary pressure on use of combustion energy. The study also finds that contribution of technology to reduce use of energy in production side of the economy yet a dormant factor. Hence, introduction of technology to ensure improved and efficient use of energy has been recommended by the findings of the paper. The limitation of the study can be described as the limitation in research sample and data influence on the results coming out from market orientation. Difference in technology and direction toward the energy use was not taken care of by the study too.*

**Keywords:** *Economic growth of city, energy use, environmental Kuznets curve, Toyohashi city, Japan.*
***JEL classification*: R10, R11.**

## 1. Introduction

Faster urbanization and increasing economic activities in city areas are causing greater challenges to address better energy- technology -environmental management. Cities are emerging as the driving factor for economic activities and are supplying essential knowledge of production and innovation. The future cities are therefore a critical element of the global future. The typical structure, scale and scope of city economic development are creating unwanted impact on the protection of the natural resources. As a result, understanding the relationship between city development and environmental collision is critical. Jollands (2008) recognized that cities are the main user of world's energy. Since cities are vibrant and essential element of global development in terms of social, economic and technology, they need to offer their populations several services. Ensuring services need energy and, source of such energy is mainly based on fossil fuel. For example, Tokyo metropolitan area for her 12 million people consumes approximately 20Mtoe annually –which is equivalent to the total annual energy consumption of Bulgaria (International Energy Agency, 2007).

The relationship between energy consumption and economic growth has been described in many literatures. The general framework for determining the growth lies in the extended account of neoclassical approach represented by Dy= f(y, y*), where Dy: growth rate of per capita output, y:

current level of per capita output, and y*: long run per capita output. The growth rate is diminishing for a possible output y and rising in y* for given y. Economic growth y* depends on choices of environmental and economic variables of the economy (Hwang, 2008). Yet the directions of causation of the relationship remain controversial when relationship between natural environment and economic growth is taken into account. Chang (2007) suggest that different orders of causality exist between GDP and energy consumption. Kahn (2006) found pollution as emergent byproduct of three factors in a city: (1) scale, (2) composition, and (3) technology. He advocates that in developing the concept of ''Green City'', establishing local and global level benchmark for air, water quality, and greenhouse gas emissions are necessary. Sansoni, et al. (2010) decomposed change in the environmental pollution by city growth into three effects: (1) demand composition shift effects, (2) output growth effects, (3) eco-efficiency change effects. They imply that the first effect can be positive or negative in the sense that the continued use of natural environment are increased or reduced. The second effect is negative, because more output means generally increased use of the natural environment. The third effect is positive, owing to technological progress. Overall ability of Japan's energy conversion (usually measured as the amount of primary energy used to generate a unit of GDP) was high before the first oil price crisis of 1973-74. During the early 1970s it took as much as twice energy to produce a dollar of GDP both in the US and in Japan. But by 1990 the US required about 30% less energy to produce a dollar of GDP than it did in 1974 and Japan had lowered the average energy to its economy by 35% (Zachariadis, 2007). Moreover, despite the appreciation of its currency, Japan was even more forward of the US in energy conservation than it had been before the first oil price crises of the early 1970s. After that an unexpected setback took place and between 1990 and 2005, the energy intensity of the US economy (inflation-adjusted) fell by 12%, but the energy intensity of the Japanese economy first stood still and then, by the year 2000, was actually about 6% above the 1990 level. By the year 2005 it was about 3% higher (Smil, 2007). Two factors can be recognized as the reasons for this reversal state: first, rising of demand for higher industrial energy and second, energy intensities of all major industries, after falling by 20-50% between 1973 and the late 1980s, had reached their lowest levels between 1988 and 1990, and had risen and became flat subsequently. By the year 2000, the energy intensity for the iron and steel industry, manufacturing, and ceramics were about 12%, 15%, and 17% above the 1989 level respectively (Roney, 2011).

Environmental Kuznets Curve, EKC hypothesis provide empirical evidences that some pollutants follow an inverse-U-shaped pattern relative to income or growth of economy, as for many forms of pollution, environmental damage increases up to a certain level of GDP per capita, and then start decreasing as income increases further. Since the shape of EKC depends on the pollutant and income growth stage, different studies have found different shapes of the EKC (see Grossman and Krueger, 1991; Shukla and Parikh, 1992, Shafik and Bandyopadhyay, 1992; Beckerman, 1992; Stern, et al 1996; Stern and Common, 2001; and Dinda, 2004. The intensity of the argument in favor of different shaped EKC is crucial. The major argument is that, if the EKC hypothesis appears robust, then the perspective of an infinite accumulation of wealth is possible. Theoretically, the EKC relationship can be divided into three parts: scale, composition, and technology (Brock and Taylor, 2005). If an economy grows in *scale*, all activities including pollution increase proportionally. If growth is not proportional but accompanied by a change in the composition of goods and services produced, then pollution may decline or increase with income. Finally, if richer countries introduce less pollution-intensive production technologies, considering environmental quality a normal good, growth can lead to reduction in pollution. Of the empirical findings, inverse U-shaped by Shafik and Bandyopadhyay (1992), Panayotou (1993), Grossman and Krueger (1995) provide evidences in the line of EKC hypothesis. On the contrary, findings of Vincent (1997), Grossman and Krueger (1993), Grossman and Krueger (1995) show an N-shaped EKC.

Most important concern of energy consumption is the resultant impact on the natural environment as well as finding proper remedy of such impact. This paper, therefore, attempts to find a relationship between economic growth of Toyohashi city and level of use of electricity and gas (as proxy variable) by manufacturing and trading sectors of the economy. The structure of this paper is as follows: in section 2 energy consumption situation in cities of Japan has been described. The section also contains a brief description of study area or Toyohashi city. Objective and methodology of empirical testing model and explanation of major variables are illustrated in section 3. Econometric results of regression

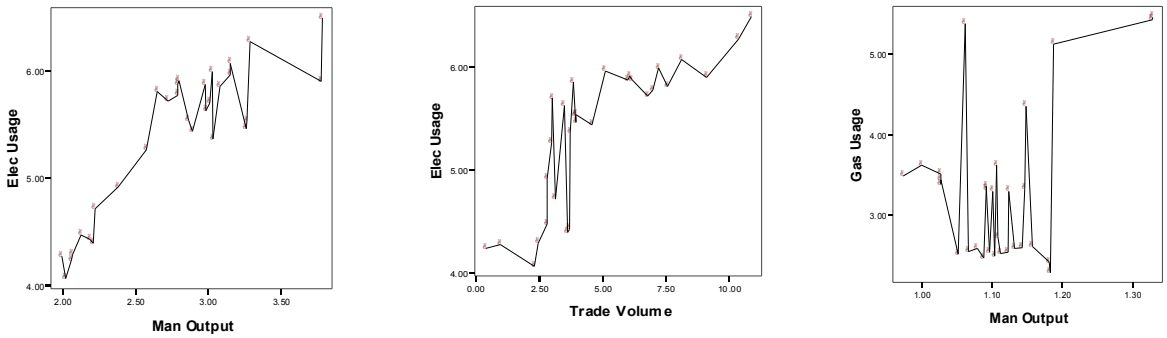
analysis and relevant discussions are set in section 4. Concluding remarks and policy implication are drawn in section 5.

## 2. State of Energy Use in Japan and Toyohashi City

Japanese cities are experiencing rapid population growth causing graying of rural areas. Regional concentration of certain economic activities is contributing growth of certain regions. In the presence of shrinking population, declining 12.5 million by 2030 and 25 million by 2050, Japanese cities are growing in population. Data of Statistics Bureau, Japan, 2011, show that between 2005 and 2010 city population in Japan increased by 0.6% against national increase of by 0.2% leaving a decrease of 3% in the rural areas. Japanese success to achieve efficient use of industrial energy keeps the nation over any other developed country. Japanese manufacturers reduced energy consumption per unit of output by 40% between 1973 and 2003 (Agency for Natural Resources and Energy, 2008). France and Germany burn up nearly 50 %t more energy than Japan to produce equivalent level of economic output. By the same scale, Britain's energy use is nearly double, the United States nearly triple, and China's almost eight times of Japan's level (Brooks, 2005). Japan also ranks near the bottom among developed countries in $CO_2$ emission per capita and GDP ratio. In the OECD, only Sweden has lower $CO_2$ emissions to GDP ratio than Japan (Agency for Natural Resources and Energy, 2008). On the contrary, Japan's growing reliance on coal as a source for electricity production is threatening the situation. As of 2006, $CO_2$ emissions (from fossil energy) were 111.8% of 1990 levels, 104.3% of 1995 levels, and 101.5% of 2000 levels. Final energy consumption in 2006 was 114.6% of 1990 levels, 103.4% of 1995 levels, and 100.1% of 2000 levels. Primary energy supply in 2006 was 115.6% of 1990 levels, 104.3% of 1995 levels, and 100.4% of 2000 levels (Takeuchi and Sugiyama, 2008). These statistics reflects that final energy consumption and/or primary energy supply in Japan were rising sharply in the 1990s and appeared to have more or less stabilized since 2000. However, in 2006 higher amount of final energy was consumed or primary energy was supplied than that of 2000 levels. The larger part of such energy supply was met by coal power generation. On the other hand, after the great disaster of 2011, Japan is concentrating more on natural resources to produce energy. The outcome would end in a higher use of natural resources like fossil fuels and natural gas (Yaguchi et al, 2007). Finding an optimum solution to address energy-economy interactions is, therefore, becoming complex and difficult.

Toyohashi city is located in the central part of Japan and falls in the prefectural boundary of Aichi. Area and population size of the city at founding in 1906 was at 19.69 square kilometers and 9,900 persons (Toyohashi City Statistics, 2011). At present the city size is 261.35 square kilometers with population of 381,977 (density stands at 1462 persons per square kilometer) (Toyohashi city web page, 2011). Attractive economic activity, especially concentration of heavy industries and a large scale sea-port, is attracting migration to the city and data of Statistics Bureau, Japan provide that 10,749 persons migrated to Toyohashi in 2008, 9,779 persons in 2009, and 8,577 persons in 2010. As a result, the city is experiencing vertical expansion as the land area is remaining unchanged since 1960 (Toyohashi city statistics, 2011). Figure 1 show the trend of per capita manufacturing output in million yen and level of energy consumption of the city during the periods 1980- 2009.

**Figure 1**: Trend of per capita manufacturing output and trade volume in million yen and level of energy consumption of Toyohashi City during the periods 1980- 2009.




Source: Compiled by authors from Toyohashi City Statistical Year Book, 2011

Figure 1 implies that during the periods of 1980-2009, with the growth of Toyohashi city economic activities use of electricity and gas increased steadily. In October 1997, Toyohashi Port, Gamagouri Port and Tahara Port were united and constituted present Mikawa Port and it became a hub of international port and industrial activity. As a result, a rapid increase in the use of electricity has been found in trade sector. Advancement of technology and concern on environmental safety promoting efficient use of energy and as a technologically advance country Japan's success is noteworthy. Under the circumstances, it is expected that energy usage in Toyohashi city has been decreasing.

## 3. Objective and methodology of the study:

The purpose of this paper is to find out the relationship between technological contribution on the energy using sectors of an economy and consequent effect on the level of energy use. The broad objective of the paper is to find the links between urban economic growth or the scale of economy and environmental sustainability. The broad purpose of this paper thereby is to:

1. Outline city economic level- energy use pattern,
2. Examine technological contribution on efficient use of energy, and
3. Design potential plan for future energy use.

The present study aims to focus on following research questions:

1. Which production sector of the economy play pivotal role in using energy?
2. What is the effect on the use of energy while city economy grows?
3. How could Toyohashi city manage city growth and energy use dilemma?

Multiple regression models have been considered for the purpose of research. The relationship among the variables has been considered as linear. The basic idea of model formation comes from Grossman and Krueger's (1995). Consumption of energy has been considered as a function of manufacturing output, trade volume and population of Toyohashi city. The study pursues following hypotheses:

Hypothesis 1: *With the growing concern of energy efficient production system, level of energy use in manufacturing and trading sector of a city in Japan is falling.*

Since, better technological administration can open opportunities to make use of reduced level of energy, our study accounts following hypothesis:

Hypothesis 2: *The energy efficient technology can shrink level of energy use while keeping growth of city economy.*

Multiple regression models have been considered for the purpose of research. The strength consumption relationship among the variables has been considered as linear. We consider following relationship between economy and level of energy use:

$$EnergyUse \equiv f(EconomicLevel : ManufacturingOutput, TradeVolume, Tech.Base)$$

Using city level panel data, ordinary least square method is applied to estimate the implication of EKC for the city. Grossman and Krueger's (1995) econometric model has been formulated to quantify the EKC. The reduced form of OLS regression equation takes the form:

For level of electricity consumption: equations are,

$$E_i = \alpha_i + \beta_1 \ln M_i + \beta_2 \ln M_i^2 + \beta_3 \ln M_i^3 + \beta_4 \ln T_i + \beta_5 \ln T_i^2 + \beta_6 \ln T_i^3 + \varepsilon_i \quad (1)$$

$$E_i = \alpha_i + \beta_1 \ln M_i + \beta_2 \ln M_i^2 + \varepsilon_i \quad (2)$$

$$E_i = \alpha_i + \delta_1 \ln T_i + \delta_2 \ln T_i^2 + \varepsilon_i \quad (3)$$

where E: level of electricity consumption, M: per capita manufacturing output of the city, T: per capita trade volume, *i* represents *i*-th period and ε is the error term.

For level of gas consumption: equations are,

$$G_i = \alpha_i + \beta_1 \ln M_i + \beta_2 \ln M_i^2 + \beta_3 \ln M_i^3 + \varepsilon_i \quad (4)$$

$$G_i = \alpha_i + \beta_1 \ln M_i + \beta_2 \ln M_i^2 + \varepsilon_i \quad (5)$$

where G: volume of gas consumed in manufacturing, M: per capita manufacturing output of the city, *i* represents *i*-th period and ε is the error term.

The inverse-U shaped EKC is supposed to exist if $\beta_1$ has a positive sign and $\beta_2$ has a negative sign. The cubic part provides a more accurate measure of the relationship. If certainly an inverse U-shaped EKC exists, $\beta_3$ will have the similar negative sign as $\beta_2$- meaning steady decrease in the pollution levels.

### 3.1 Data description

Data used in this study try to analyze empirical evidence of EKC considering per capita manufacturing output, per capita trade volume, and volume of electricity and gas consumed for the specific purposes (manufacturing and trade) of Toyohashi city. The explanatory variables applied for the analysis are electricity consumed in KWh, gas consumption in $M^3$, manufacturing output and trade volume in million Yen. The data set covers the periods from 1980 to 2009 and the panel data of the study collects all the relevant data from Toyohashi city annual statistics. So in this study we have 30 year time period and we have 120 observations.

## 4. Empirical results and discussion:

The model OLS regression analysis results are provided in table 1. The regression coefficients estimated from the panel data are statistically significant, as indicated by the *t*-statistics. The results of table 1 show that level of electricity and gas use can be explained by the growth of manufacturing and trade volume. The effect of EKC hypothesis has been confirmed squared coefficient of *ln_M* of equation (2). The squared coefficients of *ln_T* and *ln_M* of equation (3) and (5) do not confirm EKC hypothesis. On the closer look, the cubic part of *ln_M* for level of electricity consumption has the similar sign of the squared part of the same variable. In contrary the cubic part of *ln_T* for level of

electricity consumption and *ln_M* for level of gas consumption have opposite signs of the squared part of the same variable.

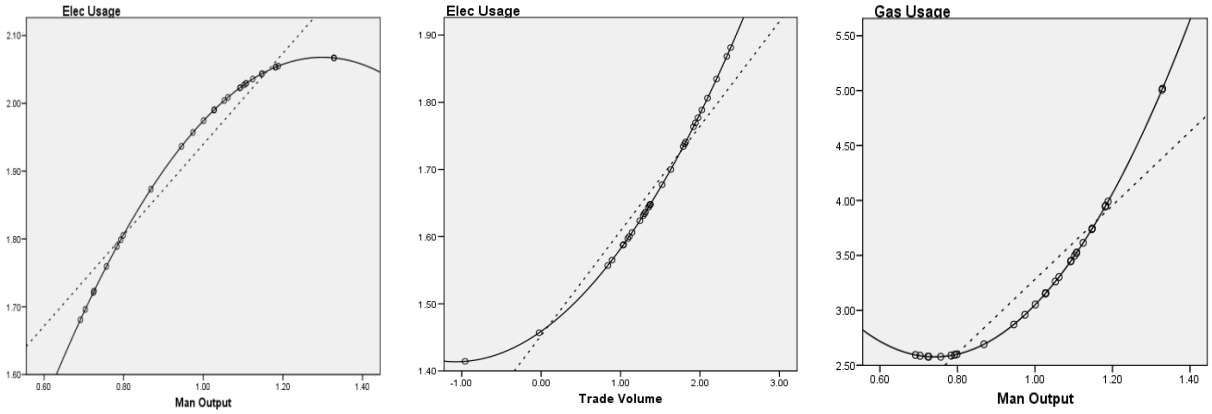
**Table 1**: Regression results of the study equation 2, 3 and 5.

| | ln_E | ln_G |
|---|---|---|
| Constant | -0.018 | 6.462 |
| VAR1 | 2.871*** | -10.483*** |
| | (7.617) | (1.332) |
| VAR2 | -1.206** | 7.071** |
| | (6.353) | (1.767) |
| VAR3 | -13.775 | -23.376 |
| | (1.101) | (0.96) |
| VAR4 | -0.013*** | |
| | (1.197) | |
| VAR5 | 0.034** | |
| | (2.278) | |
| VAR6 | -0.040 | |
| | (1.666) | |
| $R^2$ | 0.961 | 0.364 |

***. Correlation is significant at the 1% (2-tailed).
**. Correlation is significant at the 5% (2-tailed)
*. Correlation is significant at the 10% (2-tailed)
Numbers in the bracket denotes t-statistics
VAR1: ln_M, VAR2: $ln\_M^2$, VAR3: $ln\_M^3$,
VAR4: ln_T, VAR5: $ln\_T^2$, VAR6: $ln\_T^3$

The results for economic level analysis are comparable to our priori expectations for growth of manufacturing sector and electricity consumption only. In case of growth trading sector and electricity use as well as growth of manufacturing sector and gas use priori expectation of the hypothesis does not correspond. While constituting EKC, the simulation results forms an inverse U-shaped EKC curve for electricity use only. The outcomes of simulation results are explained in figure 2. The figures show the EKC for the periods of 1980 -2009 for Toyohashi city. The foremost outcome is that the signs of $\beta_5$ and $\beta_6$ for *ln_E* and *ln_T*; $\beta 2$ and $\beta_3$ for *ln_G* and *ln_M* are opposite in nature.

**Figure 2**: Simulation results of correlation between economic activities- electricity and gas consumption of Toyohashi City for the periods 1980-2009.




The study empirically examined the relation between city economic growth, technological competence and resultant effect on use of energy. As city grows, demand for electricity and gas as source of energy is expected to grow. Various sectors of the city contribute to allocate the demand. Our study found that during the period of 1980 to 2009, manufacturing output and trade volume of

Toyohashi city grew steadily. As a result of such growth consumption of energy was increased too. Expansion in manufacturing and trade sectors contributed more on demand for electricity and gas. The squared coefficient between manufacturing and electricity use was positive, which means technological advancement could play significant role in decrease of electricity use while keeping growth of the sector. Significantly cubic part of the coefficient has the same sign of the squared coefficient, which means electricity use will continue to fall in manufacturing sector. On the other hand, squared coefficients between trading sector and electricity use as well as manufacturing sector and gas use are positive. The results demonstrate that technological efficiency in use of electricity and gas of the respective sectors fails to contribute efficiently. The findings are significant and have been demonstrated in figure 2. The results provide theoretical and practical implication and proposition. As city grows, consumption of natural resources grows. The various sectors of the city contribute in different ways toward the situation and city energy planners need to highlight sector-wise usage of energy.

## 5. Conclusion

In the path of recovering and rebuilding from the disastrous earthquake and tsunami, Japan will have to decide whether to rely more heavily on inherently risky nuclear power and imported fossil fuels. Turning to renewable energy source instead of fossil fuels and nuclear power, would lead to healthier energy security, and economic well-being of its people (Roney, 2011). Our study suggests that even a city in Japan could play significant role in rearranging energy consumption level. Firstly, even the manufacturing and trading sectors of city grows, better innovation could contribute to improved energy input- output ratio. Since future direction of Japan's energy use remains fundamentally uncertain, our findings are suggestive. The inverse U-shape EKC of manufacturing output and electricity usage confirm that technological improvement is able to reduce use of energy usage and/or energy-output efficiency can be obtained by introducing better technology even economy continues to grow. The results follow the EKC hypothesis (Grossman and Krueger, 1995). On the other hand, EKC of trading and electricity usage and EKC of manufacturing and gas usage show an increasing trend. As a result, in future energy use in the said sectors tends to increase. The EKC interpretations of such outcome is significant in the sense that Japan need to address sector wise technological intervention to ensure efficient use of energy. The EKC of Toyohashi city demonstrates that idea of technological innovation could play a vital role in the management of efficient use of energy. The present EKC can be viewed as the hypothesis on the interaction between economic growth, use of energy and environmental sustainability. However, the shape of the relationship is not uniform across sectors of the economy and differs in shape. The outcome is importance as public investment in energy consumption tie the process of improving environmental sustainability.

Our study is one of the primary attempts to assume EKC for analyzing a city economy of Japan. In spite of the implications, our study is not out of limitations. First, market orientation of the data would influence the results. The degree of correlation and influence differs according to the type of sector of the city. Second, sectors influencing energy consumption might have different technology and direction toward the state. This study did not count the difference in state of affairs. Thirdly, cross-city analysis was not done by the study. Analysis of other cities or neighboring cities is important to draw firm statistical benchmark. Lastly, this research did not cover the impact of technological improvement and competitiveness performance. Therefore, the effect of technology innovation and its competitiveness is left for future task. Comprehensive research outline considering wider factors and directions toward the research problems has also been kept for future scope.

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# FARM SMEs SUSTAINABILITY ASSESSMENT BASED ON BELLAGIO PRINCIPLES.THE CASE OF MESSINIAN REGION, GREECE

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***Abstract***

***Purpose:*** *Sufficient support of the sustainability of farm products embedded in a region (such as Products of Designated Origin / PDOs) to overcome significant obstacles to access domestic and remote markets. Main research question is how to overcome such inherent difficulties and transform them into challenges and opportunities to the new market environment.*

***Design/methodology /approach:*** *Combination of simplicity with the complicated issue of sustainability for awareness of small farmers SMEs and their collective representatives. Improve the understanding of the Sustainable Supply Chain Management (SSCM), to facilitate sustainability through use of the 'Bellagio Principles' for assessing sustainability of local farm products and facilitating further enhancement. Use of certain PDOs farm products of the Messinian region of Greece, such as local Sfela Feta cheese, olive oil, olives and raisins, to assess sustainability and improvement. Formation of a conceptual constructive action R&D framework of broader use in building-up and performing implementation of holistic supply chain strategy.*

***Expected Findings:*** *Providing better understanding of the SSCM. Insights on how SMEs co-operatives can collectively apply holistic strategies concerning local farm PDOs to fulfil competitiveness and sustainability requirements, under variant product and market conditions.*

***Originality / Value :*** *Improving the know-how, focusing on the sustainability of regional, traditional products and its effects upon supply chain performance and market access. Practical implications for regional-based farm SMEs in the design of holistic value creation strategies to produce sustainable competitive advantage. Interactive cause and effect dynamic implications of sustainable development on social, economic and physical environment.*

**Keywords** : Products of Designated Origin (PDOs). Sustainable Supply Chain Management (SSCM). Sustainable Development (SD). Belagio Principles (BP). Small and Medium Enterprises (SMEs).
***JEL classification*: R10, R11.**

## 1. Introduction

The issue of improving sustainability performance in meeting the 'historical challenge' of adjustment to the new, irreversible and ever changing business, economic, social and physical environment, has increasingly attracted the interest of many academics, management practitioners and policy makers. Meeting the sustainability challenge seems yet a largely unsettled actual problem, calling for collective use of all available resources, know-how and continuous study. This has critical importance for farm Small and Medium Enterprises (SMEs) that produce traditional premium agricultural products and seek for promoting them in local and foreign markets. In particular, supporting the building-up value-chain networks by regional farmers has been the main issue addressed in this paper. The structure of this study is presented in figure 1.

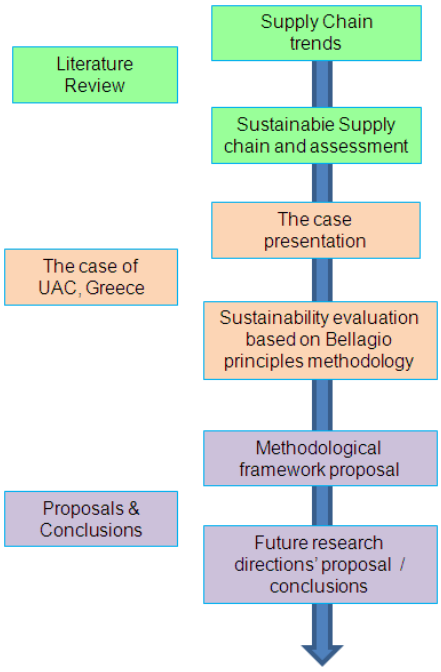
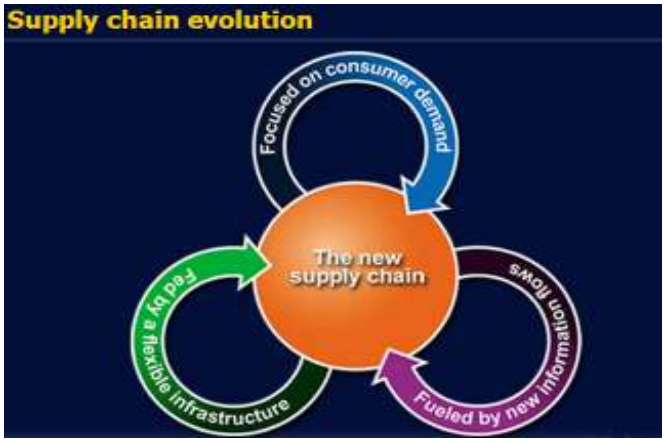



**Figure 1** – The study structure

This paper starts with a literature review of the sustainable supply chain management (SSCM), in order to help better understanding of the sustainability issue in respect to its alignment with the integrated character and principles of supply chain management (SCM).
The next section is engaged with 'Bellagio Principles' methodological tool that links theory and practice, through assessment of sustainability and provision of useful directions towards the goal of SD. This methodology is applied in the case of a cooperative scheme of SMEs in the Messinia Region, Greece, which represents a interesting example of SMEs in regional areas that manage, among others, products with designation of origin (PDO).
In view of the yet unsettled issues concerning the challenge of sustainability, the formulation of a simple R&D framework follows, addressed mainly to small size farmers and based on the literature review and the sustainability assessment case. This conceptual constructive action framework has a broader use in building-up and performing implementation of holistic supply chain strategy, under variant case conditions.
The paper ends with discussion of the conclusions, and direction of future research, along with main study's paper limitations.

## 2. Supply Chain Management trends

During the last decade there has been a trend of increasing number of articles and studies that have been published in top scholarly journals in the fields of operations management, logistics, purchasing and SCM. The literature has been dominated with the advance from firm's logistics distribution functions to the integrated character of Supply Chain Management (figure 2), evolved into a more prominent area of research (Guinipero et al., 2008).




Source : Walker (2004)

**Figure 2** - Integrated processing of the Supply Chain Management

The rise in the research on SCM, especially over the last decade, has been accompanied by special attention to realignment in the 'strategy-structure relationship' and further connection among strategy, structural planning and operational processes at supply chain level may lead to maximum improvement of the financial performance, with increasing role of the strategy and strategic planning has an increasing merit in the literature on SCM. Moreover, the existence of 'relational flows' of planning and measurable integration of the structural, technological and operational flows has been supported, including all activities that touch the product or add value by the time of delivery to the end users (Bowersox and David, 1996; Miller, 2002). However, concerning the application of strategic theories in the SCM, there still remain significant possibilities for research (Cheng et al., 2006).

The systematic and strategic coordination of the SCM, aiming at improving long-term performance of the participating companies and the supply chain as a whole (Mentzer et al., 2001), addressed research attention to the relevant concepts and corresponding issues, particularly, 'system' , 'strategy' and 'processes'. The supply chain issue has also been connected with the 'value-chain concept' as a chain of activities for a firm operating in a specific industry, introduced by Porter (1985). This concept has been extended to whole supply chains and distribution networks and has become a powerful analysis tool for strategic planning. In general, supply chain strategies require a total systems view of the linkages in the chain that work together efficiently, for value creation, customer satisfaction and competitiveness (Hines, 2004). Also, although the management has been inventive in use of more advanced techniques and tools like Simulation, Artificial Neural Network, Fuzzy logic and 'mystery methodology', for optimization and decision making in SCM, analyzing and monitoring performance, has not to undervalue the critical importance of collaborative relations between the participant agents (Chiu and Lin, 2004; Koh and Tan, 2006; Shukla et al., 2011; Borgström, 2012). Thus, as firm's survival lies on value network integration, a good understanding of the integration process is a key aspect in SCM (Gunasekaran and McGaughey, 2003). However, Mouritsen et al. (2003) has doubted that the basic hypothesis that 'the more integration (wider the scope) – the better the management of the chain', since this depends very much on the 'environment' and the power relations between the participants in the chain.

Special attention has been attributed to the processes of the SCM, as well as to presence of misalignment of SC processes, structures and major differences in SCPs' business culture, expressing managerial complexities (Fawcett et al., 2008).

Concerning the viability of supply chains by SMEs collaboration, a 'perplexing paradox' has been confirmed, using contingency, resource-based-view assessment paradigm. In particular, managers of small firms as a rule suggest that the majority of the benefits of SCM are within their reach and that the barriers to implementation do not intimidate them. However, they are not actively pursuing SCM as a strategic weapon. The best way to avoid this is to create the 'collaborative capabilities' for promoting SCM, for the choice among alternative holistic SCM strategies based on the small firm's participation (Fawcett et al., 2009). It is noticed that the majority of research in SCM in the past focussed on large organizations and the benefits of SCM can be realised by small businesses are not clear enough. Arend & Wisner (2005) have argued that SCM can provide quality, cost, customer service, leverage and even

risk reduction benefits for the SMEs. On the other hand, SCM can expose the SME to greater management and control hazards while reducing its private differentiation advantages. However, although the SMEs have been neglected in the value chain research, the chance to introduce innovative value added services and/or products by leveraging supply chain can create significant value for SMEs. Provided properly integrating SMEs, barriers to internalization and competitiveness maybe eliminated and pave way for collaboration among supply chain partners. A road-map has been proposed to integrate supply chain strategies with the competitive strategies of SMEs for effective value chain management (Susanu et al., 2009). In the increasingly globalizing market, innovation is an important strategic tool for SMEs to achieve competitive advantage. Use of appropriate methods and processes with trustful co-cooperation can contribute overcome the barriers chain networks of SMEs and to the enhancement of the innovation capacity (Kühne et al., 2010). To increase the small share due to lack of efficiency, 'the choice to implement supply chain and supply chain management by SMEs will lower costs and increase efficiency, which will eventually help in lowering costs and increase gains to both SMEs and the country' (Katunzi & Zheng, 2010).

A review of the literature relating to Interpretive Structural Modelling (ISM) and its deployment for modelling variables of supply chain management (SCM) has shown that SMEs can be benefited by use of IT enablers for Indian SMEs, by supporting other enablers ("driving enablers") and those which are most influenced by others ('dependent enablers') (Shahabadkar et al., 2012). This is in line with prior research finding that using ISM and fuzzy analysis 'information sharing' can become key criterion and the main enabler that influence trust and innovation in SCM (Welker et al., 2007; Khurana et al., 2011). Similarly, a structured literature review used a three-stage refinement, with 'agency theory' and 'principal-agent relationships' reduced the number of articles from 86 to 19. This is helpful to 'our understanding of the dynamics surrounding supply chain behaviours and relationships' and the need 'to understand and mitigate abnormal behaviours across the supply chain' (Fayezi et al., 2012). Apparently, more recent literature comes up to the need to overcome 'asymmetric information' and consequent 'adverse selection' and 'moral hazard', though advancement of information technology eases information integration, effective innovation and development of SCM. This is compatible with the literature review on supply chain risk management (SCRM), which has classified 82 articles covering the period after 2000. As SCRM is a growing area, technology was the first of four research directions, besides managerial and organizational perceptions, influence on decision making and collaboration among companies in the supply chain. With many areas still unexplored, and thus, there is plenty of research opportunities for the future (Vanany et al., 2009). More particularly, attention has been to e-SCM especially after year 2000, acknowledged as an outstanding topic in the supply strategies field (Gimenez, 2008).

Interest in green and now sustainable supply chains has been rapidly growing for over a decade and the topic is becoming mainstream (Corbett and Kleindorfer, 2003; Corbett and Klassen, 2006; Srivastava, 2007; Linton et al., 2007). Supply chain managers have seen the integration of environmental and social issues, including those embedded in related standards (e.g., ISO 14001) into their daily tasks (Beske P. et.al, 2008). The so more clearly identified sustainability issues are better integrated with SCM through amendments to the purchasing process and other opportunities (Min, and Galle, 2001; Carter and Jennings, 2004; Storey et al., 2006) (figure 4). Finally, there are still numerous opportunities available to extend and enrich what is known about supply chains, given the breadth and scope of SCM (Stock, 2009).

## 3. Sustainable supply chain management content and assessment

Globalization has initiated the SCM to reach, beyond pure economic issues, direct link with the 'sustainable development' (SD), which is usually comprehended in an economic, an environmental and a social dimension (Lemonic, 2009; Fauzi and Rahman, 2010). The term 'sustainable development' has been dominantly defined as an ongoing process of evolution in which people take actions leading to development that meets their current needs without compromising the ability of future generations to meet their own needs (Brundtland Commission Report, WCED, 1987). There have framed roughly three dimensions of sustainability as the business case (economic), the natural case (environmental), and the societal case (social) (Dyllick and Hockerts, 2002).

Attempting to combine sustainability and supply chain management goals a more explicit definition has been the following: *sustainable supply chain management (SSCM) is the management of material,*

*information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements* (Seuring and Müller, 2008a). The term 'value-adding' has been used in a broader sense than the firm's 'customer' met the main concern in the supply chain and logistics literature.

A relevant literature review for the period 1990 to 2007 included a total of 191 papers in significant scientific journals, revealed a clear deficit in SCM and purchasing literature concerning social issues as well as on the amalgamation of the three dimensions of sustainable development (Seuring and Müller, 2008b). The sample of this literature review has been more recently extended to 309 papers related to green and sustainable supply chain management (Seuring, 2012). The paper summarizes research on quantitative models and points out that the social side of sustainability is not taken into account and that life-cycle assessment based approaches on the environmental side, and impact criteria clearly dominate. The central role of integration with the social dimension is in more need for better integration, while there is further strengthening the prior research results about the role of inter-organizational resources in the SSCM (Gold, Seuring and Beske, 2010a), alongside a wider set of constructs in SCM (Gold, Seuring and Beske, 2010b). It is also supported the need of closer link to lean management and globalization issues (Mollenkopf et al., 2010), and re-evaluating particularly related to empirical research (Carter and Easton, 2011).

The design of SD depends on an operating set of values, which may change over time and vary within communities and from place to place. Today, communities, governments, businesses, international agencies, and NGOs are increasingly concerned with establishing means to monitor performance and to assess progress toward SD. It presumes corporate social responsibility (CSR), public awareness and involvement and commitment of decision-makers (Ghoshal et al., 1999). Particular care must continually be taken to ensure that substantive conceptual and technical issues are considered within the context of value-driven processes in real, day-to-day decision-making. This consolidates new innovative insights in a feedback process of disruptive "technological and strategic innovation" (Markides, 2006; Bhan, 2010).

While diverse comprehensions of sustainability exist, one central concept helping to operationalize sustainability is the 'triple bottom line' approach (3BL), where a minimum performance is to be achieved in the environmental, economic and social dimensions (Elkington, 2002). Succinctly describing the 3BL delineates three critical factors to the goal of sustainability (3ps: people, planet and profit). Some important models that have been developed internationally for the sustainability goal, are the Dashboard of Sustainability (IISD, 2001), the Sustainability Assessment Model (Baxter et.al, 2002), the ABCD four steps method (Robert et al., 1997).

At any rate, there are still fundamental issues researchers need to address in order to offer managers prescriptive models of how to create sustainable supply chains (Pagell and Zhaohui, 2009). There are certain areas of increasing admission in that: (1) the firm performance and competitive advantage is to be linked anymore to performance at sustainable supply chain level; (2) there is broader turning of research attention to the role of social and institutional factors of sustainable development; (3) the importance of the human resource development and networking activities is still lacking in the literature; (4) executives in many companies need sufficient understanding of the supply chain business processes--and the linkages necessary to integrate those processes; there is still enough room to expedite development and adoption of information systems for sustainability and improve understanding of salient issues (Melville, 2010).

In retrospect, the literature converges to the conclusion that empirical research for increasing collective capabilities regarding SD has to obey to the principles of the SCM and of Sustainability. For the purpose of supporting the building-up a business plan and adopting a holistic strategy of performing implementation, the so called 'Bellagio Principles' (BP) for assessing SD have been more recently proposed under the aegis of the IISD (Hardi and Zdan, 1997). It is reminded that the main purpose of SSCM is not just the blind pursuit of cheap labour and material resources, as competitors can join the market and use the same labour and materials (Chopra & Meindl, 2001). The overarching of the BP were sought that would improve the link between theory and practice, for increasing collective capabilities in performing reaching the goal of SD.

The proposed ten BP serve as a set of practical guidelines for the whole of the assessment process from system design and identification of indicators, through field measurement and compilation, to interpretation and communication of the result (figure 4).

In any case, the frameworks, the categories of data, the information and the choice of specific measures, reflect the values, biases, interests, and insights of the participant designers. In addition, value-driven principles are often developed as part of strategic planning exercises linked to such interests and various initiatives. The provision of insights and guidelines for attaining competitiveness and sustainability requirements, under variant product and market conditions, is critical for regional SMEs that produce high quality agricultural products, like the following case of Union of Agricultural Cooperatives, in the Messinia region, Greece.


**Figure 4** – The Bellagio Principles towards sustainability

## 4. Sustainability assessment of the Union of Agricultural Cooperatives

### 4.1 Location and Products

The Union of Agricultural Cooperatives (UAC) is located in Messinia region, Greece. Lying at the south-western most tip of the Peloponnese, Messinia covers an area of 2.991 square kilometres, has 210.000 residents and is administratively separated into 29 Municipalities and 2 communities (Map 1). It enjoys favourable climate conditions, in combined temperature, humidity, etc. for producing high quality farm products for health and special flavour, and recognition by the EU as PDOs for these reasons. The capital of the region is Kalamata, the most important harbour of the Peloponnese after Patras.


**Map 1** - Messinia region , Greece

In Greece, as shown in Table 1, 96 products registered as Protected Geographical Status/ Protected Denomination of Origin (PDOs/PGIs), while 12 more products have applied for registration of which 6 have been already published (EU, 2012). Three (3) of them have Messinia as designation of origin: the

Olive oil of Kalamata and Olives of Kalamata are produced exclusively in Messinia, while the Sfela Feta cheese, a traditional Greek cheese, is also produced in other places in Greece. Olives and Olive oil of Kalamata (PDO), produced in the greater area of Kalamata, are top world quality products, associated with special climate conditions of this area. In addition, the Sfela Feta cheese (PDO) is also produced by genuine fresh Messinian sheep milk and characterized by outmost spicy and salty taste in a variety of version flavours. Characteristically, it has been acknowledged the brand name known as "Feta of fire".
Greece is the third largest olive oil producing country worldwide (after Spain and Italy) with production between 300 and 400 thousand tonnes annually (20% EU oil production). About 2/3 of domestic production is covered by Crete and the Peloponnese (especially Messinia). About 25% of olive oil production is sold in bottles and 75% is offered in bulk, with producers themselves trading up to 33%. About one half of the annual olive oil production in Greece is exported. There are a number of trading companies (wholesalers), while a number of cooperatives are involved only in production. The competitive advantage of Greek olive oil in relation to that of other countries is its fine quality: 80% of the olive oil produced in Greece is extra virgin (compared with only 50% of Italian and 20% of Spanish). In terms of bottled olive oil, Italy and Spain hold first place in the international market: Italy is the first in the oil marketing promotion, while Spain has become the largest industrial producer.

**Table 6** - PDO products in Greece-total and Messinia region

| | GREECE | | | | | | | | | Messinia | GREECE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Applied | | | Published | | | Registered | | | Registered | Total |
| **Product Categrory** | **PDO** | **PGI** | **Sum** | **PDO** | **PGI** | **Sum** | **PDO** | **PGI** | **Sum** | **PDO** | |
| Class 1.1. Fresh meat (and offal) | | | | | | | 2 | | 2 | | 2 |
| Class 1.3. Cheeses | | | | 1 | | 1 | 21 | | 21 | Sfela Feta | 22 |
| Class 1.5. Oils and fats (butter, margarine, oil, etc.) | 3 | | 3 | 3 | | 3 | 16 | 11 | 27 | Kalamata | 33 |
| Class 1.6. Fruit, vegetables and cereals fresh or processed | 2 | 1 | 3 | 1 | 1 | 2 | 25 | 14 | 39 | Elia Kalamatas | 44 |
| Class 1.7. Fresh fish, molluscs, and crustaceans and products derived therefrom | | | | | | | 1 | | 1 | | 1 |
| Class 1.8. other products of Annex I of the Treaty (spices etc.) | | | | | | | 2 | | 2 | | 2 |
| Class 2.4. Bread, pastry, cakes, confectionery, biscuits and other baker's wares | | | | | | | | 1 | 1 | | 1 |
| Class 2.5. Natural gums and resins | | | | | | | 2 | | 2 | | 2 |
| Class 3.2. Essential oils | | | | | | | 1 | | 1 | | 1 |
| ***Total*** | ***5*** | ***1*** | ***6*** | ***5*** | ***1*** | ***6*** | ***70*** | ***26*** | ***96*** | | ***108*** |

Source: DOORS database (http://ec.europa.eu/agriculture/quality/door/list.html)

Olive trees have been cultivated since the 12th century BC in Messinia, which is a vast Olive Grove, in a propitious climate of mostly sunshine and small holdings, which allows each grower to take loving personal care of each olive tree and to pick the olive fruit of superior quality.
Olive collection in Messinia Region starts by the beginning of October and goes on until Christmas. The olive oil supply chain includes the phases presented in figure 5.

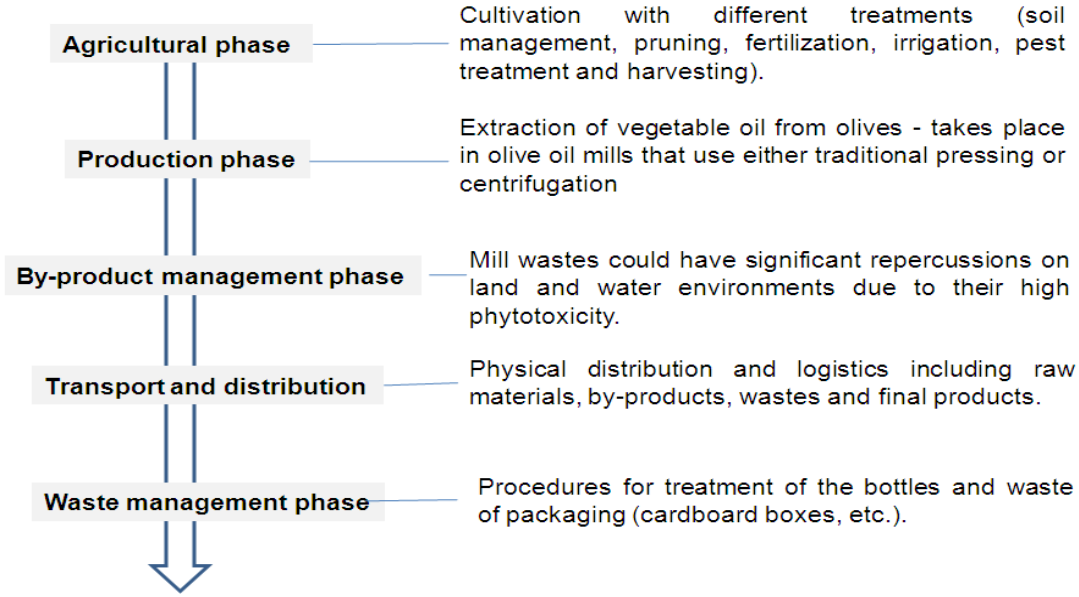



**Figure 5** – Olive oil supply chain

Eight (8) companies in Messinia produce Sfela Feta cheese and fifty two (52) companies produce, process and market the Olive oil of Kalamata (PDO) and the Olives of Kalamata (PDO). Among these there are seven (7) companies that process only olive oil. Three (3) of them process only olives and the remaining four (4) process both the olives and the olive oil. Therefore, 45 companies are involved in trading olive oil. All in all, the olive oil of Kalamata is produced and processed in 86% of the total companies (45 out of the total 52).

### 4.2. The Union of Agricultural Cooperatives

The Union of Agricultural Cooperatives (UAC) of Messinia region is a second instance cooperative of farmers founded in 1987, when seven first instance farmers' cooperatives have joined together voluntarily and now it numbers 244 first instance cooperatives and 26,000 physical persons as members. It established as a NGO of social aim to protect collectively the interests of its members and to ensure superior quality of the crops produced in Messinia (http://www.messiniaunion.gr/en/theunion).
The farming and harvesting has previously used to continue traditional downstream, as it happens with the distribution system: traditional and extremely fragmented channels, without a collaborating wholesaling sector, and selling the produced olive oil largely directly to consumers using personal relationships, such as friends and relatives. However, since the establishment of UAC, this distribution channel was replaced by taking all the responsibility of the wholesaling and retailing processes by the UAC. In doing so, the UAC took a leading role in the regional supply chain. More specifically, the UAC has the responsibility of managing and operating the warehousing, the inventory control keeping and the transportation system. The UAC has nine regional centres that operate as a network of warehouses, packaging factories, and distribution centres. Recently, UAC has also impose control before the farm gate: it has developed a set of good agricultural practices to help farmers in controlling diseases and stop over-fertilisation, in applying common, simple accounting practices, and harvesting techniques.

Furthermore, the cooperative has started to apply advanced technologies (i.e. e-farmer, iknow visibility solutions to solve supply chain anomalies) using palm-pcs and smartphones to automate the information flows and support tracing and tracking. By doing so, UAC aims to extend its governance dominance from distribution channels to the farmers, which allows it to compete better with local commercial firms. The UAC is also attempting to extend its control to the other end of the supply chain: the consumer. For this purpose, it tries to take advantage of every possible marketing channel: own 2 retail outlets in the region of Messinia, exporting olive oil around the world, and selling it to wholesalers and retailers in Greece. In summary, the UAC has managed to expand its control and power to all stages of the supply chain: farming, olive oil extraction, distribution & warehousing, and marketing.

Today the Messinia UAC has three processing & packaging plants for olive oil, table olives and currant and separate covered storage and service spaces. Due to the special emphasis placed on the sector of foodstuffs, the Messinia UAC has created a fully equipped chemical laboratory. The Messinia UAC only uses the produce of Messinia and specifically that of its members in order to ensure the highest quality for the final product. It is one of the first Unions in Greece to have been awarded ISO 9001 and HACCP file.

In 2009, Messinia UAC developed the first cooperative climate neutral olive oil. Since it is not possible to create a product, even the olive oil, without releasing carbon dioxide emissions, Messinia Union decided firstly, to learn how much these emissions are. Calculations were made therefore from specialized advisors, in order to estimate what is called internationally "Carbon Footprint" of a product. Research showed that from the production of one litre of extra virgin olive oil of Messinia Union (from olive grove cultivation, olive oil production, bottling and delivery to the final consumer) approximately 2 kilos of carbon dioxide are being emitted. Therefore, Messinia union decided to inform consumers by printing the exact carbon footprint of the product on the back side of each bottle. Then, Messinia union voluntarily compensate the amount of emissions that correspond to the production of 200 tons extra virgin olive oil, according to the calculation of the carbon footprint. In this way it offsets the unavoidable effects of the product (http://www.messiniaunion.gr/en/news). The financial gains of the offsetting will support the development of certified projects that help the protection of the climate according to the Kyoto Protocol. For the 200 tons extra virgin olive oil, the union has acquired a certification by climatepartner a climate protection consultancy, which assessed that carbon emissions have been offset to the value off: 962,000 kg CO2 equivalents.

### 4.3 Assessment according to Bellagio Principles

The single-case research methodology was selected in order to examine the degree to which a sustainable regional strategy is effective, with multiple sources of information (such as documents, archival records, interviews, observation and artefacts) that devoted to intensively examine the relevant variables of the research. The information collected was then classified and assessed, according to the content of the principles addressed by the Bellagio methodology, in simple language (Table 2).

**Table 2 -** BP Assessment of Messinia UAC

| BELAGGIO PRINCIPLE | | ASSESSMENT |
|---|---|---|
| **1** | **Vision & goals** | Managers of the UAC – a second degree farm co-operative in the Messinia locality- foresee that the sustainability goal is within their strategic vision. However, they face two critical problems to overcome: relating to the history of the cooperative movement in the administration of the managing the CAP funds; communicating trustfully the new vision to individual small farm producers, particularly in view of the pressing adjustment requirements of the sustainability goal. As a result a main challenge of the UAC management is to overcome the resistance and postponement of the structural changes involved in the new strategic goal and to encapsulate the need of transforming the day-to-day operations. |

| | | |
|---|---|---|
| **2** | **Holistic Perspective** | Holistic perspective of the case of UAC refers to the lead ahead at top level in acknowledging the need for rethinking about a whole system change and an holistic value creation strategy of PDO farm products, as a social responsibility of the primary farm cooperatives to proceed in product interactive feed-back process of continuous assessment for performing collective facing hard global markets competition. Pointing out the need to convince small farm members of the expected costs and benefits for human and ecological systems, in monetary and non-monetary terms. It presumes discipline in the built-up overall UAC supply chain and coordination of inter-firm collaboration, in search of new innovative communal ways to improve and promote the high physical quality products with favorable climate conditions of Messinian region; proceeding to design and building-up product supply chains, use of benchmarking and looking for ways of acquiring brand name, in the promotion of identified quality exclusive farm products to foreign markets, of a holistic strategic perspective of local regional supply chains. |
| **3** | **Essential Elements** | The UAC has more cleared-up the sustainability goals, while it goes on to detailed specification of the essential elements for their performing implementation. Turning to the essentials of sustainability as it regards to PDOs farm products of the Messinian region, it has acknowledged the need for reassessment by the small farmers that the attention to PDOs protection is over with the new globalized markets environment. Attention has therefore turned particularly: to terms that are considered self-evident like strategy, goals, system, sincere equal collaboration, vision, social values and corporate mission and responsibility. Secondly, to look at the disparities and gaps that need closing-up, particularly, intergeneration equity; equal chances to knowledge (farm and supply chain education system, in relation to labor market conditions); right to equal information overcoming 'information asymmetry' and the consequent market distortions and moral hazard (information system and inter-firm communication for 'information sharing'). Thirdly, concern over efficient total resources use, for turn to use of local renewable resources, ecological conditions and protection of physical environment. In addition the UAC has shown interest in adoption of a long term commitment to sustainability and get more active involvement of producers and suppliers, e.g. by producing and marketing the neutral-olive oil. In doing so, UAC aims to give a message to producers that resources need responsible management and coordination for monitoring performance and exchange experiences in search of collective innovations in farming techniques, including processing harvesting and distribution towards innovation and maximizing the collective capabilities. |
| **4** | **Adequate Scope** | The UAC has paid special attention in convincing the farmer members that by commitment and all agents' participation can ensure performance at a long-term horizon and its own leadership. It can capture both human and ecosystem time scales, thus responding to needs of future generations. In addition, it is assessed that the member farmers as being largely villagers of the same region, are known to each other, locality will facilitates the adoption the same vision and favours trust, the common scope and the collaboration, moreover as a matter of local pride. The clearance of the UAC long-term scope makes easier the communication, the commitment to sustainability. |
| **5** | **Practical Focus** | The UAC management has given particular emphasis to the empirical aspects of the sustainability issues altogether. Following collaboration with an environmental consultant in setting feasible goals, it proceeded to specification of performance measures in the case of the olive oil production, taking account of trade-offs for emissions. The clear sustainability vision set up by the UAC management has directed attention in its diffusion to the first degree product cooperatives and to individual farmers and to link with the practical indicators and assessment criteria. There is strong willingness to standardize the measures for facilitating comparison with achievements, as appropriate |
| **6** | **Openness** | The UAC is prepared for accessing to foreign markets by overcoming past cooperative introversion while keeping intact the superior quality of the Messinia oil. Otherwise stated, the UAC of Messinia has put the openness as primary goal to compromise the social character of the co-operatives with the economic imperative of sustainability in the new business environment of globalised competition |

| | | |
|---|---|---|
| | | markets. For this purpose, it turned attention to a marketing study, with special attention to benchmarking of Italian exporting methods; it has put forward to make known and changing vision of the product co-operatives members; addressing local and national authorities about the cost and the social benefits of its initiative. |
| **7** | **Effective Communication** | The performance in implementation of the openness goal, driven the UAC to proceed in a program of effective communication, addressed to the needs of the audience and set of users. Using modern ICT it has looked forward: a system of 'information sharing' to remove 'information asymmetry' and consequent 'adverse selection and moral hazard' undermining markets efficiency; using from the outset simplicity and any indicator useful in stimulating mobilization of co-operatives and small farmers members; making every effort to acquire differentiation as an organization to sustainable olive oil in Greece. |
| **8** | **Broad Participation** | The priority of the goal of sustainability by the management of the Messinian UAC has been based on inter-firm and inter disciplinary collaboration has been founded on equal active participation at network value supply chain level. Small farmer and family members will collaborate with agriculturalists and other professional and technical specialists in support of constant high quality of olive oil and other products, while keeping down cost and promoting their packaging and distribution up to delivery center and to retailers. There will be also care for customers complaints, provided awareness and new vision of common benefits to be gained from efficient use of all resources, including turning to renewable resources and eco-system preservation, etc. |
| **9** | **Ongoing Assessment** | The continuous follow-up, assessment and modifications are the leverage of a feed-back process necessary for the goal of SD adopted by the Messinia UAC. The UAC management is on the way to get familiarity with processing monitoring and co-ordination based on appropriate performance measures used in complementary ways. |
| **10** | **Institutional Capacity** | The management of the UAC commitment to sustainability is aware of the role of institutional flexibility for its sustainability goal and has expressed its willingness to persist in reform actions to elevate institutional capacity. As a part of its integrated SD plan, UAC aims to a leading role in sustainability of farming in its region and beyond this to become a powerful marketing tool. To achieve this end, UAC has clearly assigned responsibility and provide support in the managers involved in the decision-making process. Furthermore, the members of the sustainability team are also involved in marketing, production, and operations, therefore there is seamless integration with other functions of the organization that allows the exchange of data and information and its documentation to support development of local assessment capacity. The UAC has acknowledged the need for top/down and bottom-up approach, by complementary fourth party logistics (4PL) function of and consulting servicing the first degree cooperatives by product, in the goal of SD. |

## 5. A conceptual integrated research and development framework

In historical perspective, the system of national accounts measuring gross domestic (or national) product (GDP or GNP) flows since 1940, 'development' and 'progress' are broader terms according to Barbier et al. (1990), that incorporate the three above-mentioned sustainability dimensions, including stocks of assets and resources and 'social capital' and a real wealth balance sheet which are important to value chain analysis of sustainability. The most critical commitment governments around the world could make to sustainability is to formulate a scorecard that would account for the physical, qualitative and financial well-being conditions of 'the five capital assets of a nation: human, social, natural, built and financial capital' (Anielski, 2010). An even more sophisticated view has maintained that measurement methods should be advanced towards not only helping the economy, society and the environment get back on track, but moreover in redefining what the right track is (Pinter, 2010).

In view of the yet unsettled issues concerning the challenge of sustainability, the formulation of a simple R&D framework would contribute in the understanding and effective collective participation of all involved parts within the value chain. Of course, taking into account that

'*few companies take the right approach*' when it comes to improving their supply chains (Lee et al., 2004; Ho et al., 2002), knowledge and skills of management have a critical role for reaching sustainable development (Esquer-Peralta et al., 2008; Malindretos, 2010).

The conceptual framework for guiding the assessment process is very important, since indicators emerge more naturally, and can be adjusted to the needs of a given locale or set of decision-makers. More specifically, the proposed here a collaborative action R&D framework (CAR&D) is based on 'constructive/collaborating action' methodology.

This study is addressed mainly to small size farmers and the framework proposed is oriented to implementation issues and process, according to literature and experience; any management solutions or developed tools are very challenging for practitioners in performing implementation of the sustainability concept (Bagheri and Hjorth, 2007).

Main points in interchange are the following:

- Sufficient understanding going up to the frontiers of the knowledge (Kuhn, 1970) and zero start concerning the fundamentals and the new environment, in view of the historical challenge of adjustment to it.
- Complete removing of past partial approach that leads to biased conclusions and adoption of multi-disciplinary R&D methodology to achieve effective synthesizing and increasing capabilities of creating value adding at supply chain level (synergy effects, economies of scale, resources preservation, participating innovation, etc.).
- Clearing-up of strategic priorities re-ordering towards long time-horizon from short-term priorities in the past.
- Critical role of information flow and control, towards equal chances between SMEs and big enterprises, avoiding 'asymmetric information', through an effective information network between the partners in the supply chain, for knowledge and information sharing.
- High-tech possibilities and choice of proper modern technology and techniques. For example, e-practices, which 'bring the world one click away' or environmental technologies, taking advantage of the local renewable energy resources.
- Pointing out the role of the institutional flexibility for making feasible the collective utilization climate differentiation (e.g. Mediterranean area) and production of qualitative farm products. Adding enhancement of regional production and brand identity, against phenomenon of foreign concerns in exploiting products sourcing.
- Use of all the available know-how and the experience acquired from both academics and practitioners, for avoiding the pitfalls of conventional practices against sustainable competitive advantage. Awareness and human resource development through customised seminars, organised by local authorities in cooperation with Universities.
- Specification of assessment tools and indicators for attaining continuous follow up and identification of realistic solutions. Such indicators should derive from deep knowledge of SMEs development constraints in rural areas.

## 6. Conclusions and future research

The research conducted in this paper has been engaged with the need for deeper understanding the concept, necessity and the ways to achieve sustainable development within a new, irreversible and ever changing economic, social, physical and technological environment. The literature review of SCM and SSCM has shown various constrains and difficulties for performing implementation, more particularly for SMEs; most noticeable have been the lack of 'economies of scale', 'collective capabilities' and 'synergy effects', towards an 'holistic value chain strategy', as a source of value creation and competitive advantage.

The entailed complicated issues have attracted increasing attention of academics and practitioners making them mainstream. In general, specific intervention measures are often applied nowadays for environment protection towards greener environment, for instance, through reduction of $CO_2$, transformation of wastes into energy, etc. Although such initiatives are considered as 'good practices in the right direction', they are based on conventional past research methodologies, practices and interests. Hence, they must be incorporated in the interdisciplinary value creation approach towards meeting the complicated SSCM

requirements of sustainability and taking into account both obvious and hidden interrelations and conflicts. In this direction, the proposed operational R&D framework can further support significantly the decision making and the process concerning the continuous effort for SD. The exploitation of synergies throughout the building-up of a value chain is critical for the sustainability goals of SMEs in the agricultural sector. New 'strategic thinking' can initiate collective innovation, leaving aside attitudes and practices dominated in the past. The on-going assessment is expected to be embedded by alignment of the 'triple line approach' of sustainability with the so-called 'three Ds' triangular analysis (Decentralization-Democracy-Development) (Yongmei, 2009).

Further on, this paper highlighted the issue of assessing sustainability, focusing on the 'Bellagio Principles' methodology, adopted for identifying the sustainability progress, prospects and future policy and research suggestions. For the purpose of better understanding of such methodology contribution, an empirical research was conducted concerning the case of UAC, a farm cooperative scheme of the Messenia region, Greece. Main strength of the UAC has been the exceptionally mild climate of the geographic area of Messinia in the east Mediterranean basin, in producing high quality health and flavour farm products. In the weaknesses list, lack of experience, difficulties to diffuse a new vision and awareness for active broad participation of fragmented small size local farmers, use of modern marketing methods mainly for exports and finally, the issue of institutional flexibility at local and central public administration. A collective restatement of the design and building-up an integrated sustainability plan of the UAC from the start seems necessary, since experience has shown that unbalanced planning based solely on technology may end to bad records in implementation performance. Useful know-how can be granted by collaboration with universities, specialised in the agricultural chain and sustainability, giving special emphasis in the implementation phase and the continuous re-assessment and follow-up process of SD. These, together with the local and central state authorities can support the implementation of the proposed integrated R&D re-approaching framework in a pilot project concerning the UAC initiative.

Although the empirical research conducted is based on a single case in a Greek region, this can be used as paradigm for similar assessments and may have broader importance for regional SMEs. It is worth noting that the relevant research and policy recommendations by OECD and other international economic organizations attribute some importance to the issue of 'equal chances' and 'terms of competition' among the factors of competitiveness. More specifically, significant part in the overarching aim of the EU Competitiveness and Innovation Framework Programme (CIP) (2007 – 2013) consists of encouraging the competitiveness of European enterprises, especially SMEs, for meeting the Lisbon goals (Centre for Strategy & Evaluation Services, 2011).

Future research needs to shed light at first to the sustainability issue regarding the identification of realistic practices towards sustainability in the agricultural sector, and more particularly focusing upon the chains that start from regional rural areas and SMEs. In this direction, the participation of farmers and expertise of professionals and practitioners is necessary, for sharing responsible experiences in this rapidly extended domain of knowledge. Besides, the specification of indicators for the continuous evaluation of the progress of implementing sustainable solutions win the supply chain would contribute significantly in the monitoring process towards the sustainability goal.

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# MODELS OF THE DETERMINANTS OF ENTREPRENEURIAL BEHAVIOUR: A LITERATURE REVIEW

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**Abstract**
*Entrepreneurship has become a growing trend with growing importance within the global marketplace, seen as providing a satisfying and rewarding working life at the level of the individual, and as contributing to prosperity and economic growth at a national level. Thus, answering the questions of why people demonstrate entrepreneurial behaviour and what factors affect their decision to become entrepreneurs has been and still remains a topic of intense research interest. Towards identifying the factors that shape the entrepreneurial decision several explanatory models of entrepreneurship determinants have been developed. The aim of this study was to provide a review of extant literature related to models of the determinants of entrepreneurial intention and behaviour. The models reviewed were of three types: traits models, situational models and intention-based models of entrepreneurship.*

***Keywords:*** *Entrepreneurial behaviour, models, traits, situation, intention*

***JEL classification: L26***

## Introduction

Understanding entrepreneurship is considered important, because, evidently, economic development is strongly influenced by entrepreneurial activities (Stam, Bosma, Van Witteloostuijn, De Jong, Bogaert, Edwards, & Jaspers, 2012). Thus, explaining and predicting the choice of an entrepreneurial career has been and still remains an important research issue (Pruett, Shinnar, Toney, Llopis, & Fox, 2009). Towards identifying the factors that shape the entrepreneurial decision several explanatory models of entrepreneurship determinants have been developed (Kennedy, Drennan, Renfrow, & Watson, 2003).

As the theoretical development of the entrepreneurship concept changed trajectories early in the 20th century, methodologies used to study the entrepreneurial activities have been also changing along the years (Liñán & Chen, 2006; Solymossy, 1998), while numerous personal and environment-based determinants of entrepreneurial activities, such as personality traits, attitudes toward entrepreneurship, or social environment have been proposed and extensively discussed in the literature (Guerrero, Rialp, & Urbano, 2008; Liñán & Chen 2009; Raposo, Ferreira, Paço, & Rodrigues, 2008; Schwarz, Almer-Jarz, & Wdowiak, 2006, as cited in Do Paço,.Ferreira, Raposo, Rodrigues, & Dinis, 2011).

## Traits models

Entrepreneurship has been historically conceptualized and studied as a phenomenon at an individual level (Ribeiro-Soriano & Urbano, 2009). As Gartner (1989, p.47) points out, much research in the entrepreneurship field has focused on the person of the entrepreneur, asking the question: "Why do certain individuals start firms when others, under similar conditions, do not?". Gartner further notes that asking *why* has led us to answering with

*who*:" Why did X start a venture? Because X has a certain inner quality or qualities". This led to an overwhelming perception that the entrepreneur is importantly different from the non-entrepreneur (Gan, 2010). Towards distinguish entrepreneurs from non-entrepreneurs traits and demographic variables differentiating entrepreneurs from non-entrepreneurs were initially looked for.

Personality traits are defined as *"enduring patterns of perceiving, relating to, and thinking about the environment and oneself that are exhibited in a wide range of social and personal contexts"* (APA, 2000, p. 686). The rationale behind the explanatory models of entrepreneurship determinants attempting to predict entrepreneurial activities from personality traits relied on the assumption that individuals who have similar personality characteristics to a typical entrepreneur would behave entrepreneurially (Izquierdo & Buelens, 2008). Later on, other studies have pointed to the importance of demographic characteristics of the person such as age, gender, origin, religion, level of studies, labour experience, and so on (Reynolds, Storey, & Westhead, 1994; Robinson, Stimpson, Huefner, & Hunt, 1991; Storey, 1994, as cited in Liñán, 2004).

Both lines of analysis have allowed the identification of significant relationships among certain traits or demographic characteristics of the individual, and the fulfilment of entrepreneurial behaviors (Liñán & Chen, 2006). Personality characteristics that have been suggested in the literature as being good predictors of the entrepreneurial behaviour are the need of self-achievement, the creativity and initiative, the innovativeness, the proactiveness, the propensity of risk, the self-confidence and the locus of control, the independence and autonomy, the motivation, energy and commitment, the persistence, the values and the attitudes, the personal objectives, the Big Five personality traits (neuroticism, extraversion, conscientiousness, openness and agreeableness), the assertiveness, the self-efficacy, and the self-esteem (Brandstätter, 1997; Caliendo, Fossen, & Kritikos, 2011; Gorman, 1997; Kourilsky, 1980; Liñán & Chen, 2006; Raposo et al., 2008; Rauch & Frese, 2007; Robinson et al., 1991; Wood, 2009). Yet, three personality constructs have emerged as 'classic' characteristics associated with the entrepreneurial personality: internal locus of control, high need for achievement, and a moderate risk-taking propensity (Korunka, Frank, Lueger, & Mugler, 2003, as cited in Reimers-Hild, King, Foster, Fritz, Waller, & Wheeler, 2005).

However, the extant literature has shown that models predicting entrepreneurial activities only from individual (for example, demographic characteristics or personality traits) variables have small explanatory power and even smaller predictive validity (Izquierdo & Buelens, 2008; Krueger, Reilly, & Carsrud, 2000). Thus, the role of personality traits in the entrepreneurial decision is discussed controversially in entrepreneurship research and many researchers raised serious doubts as to whether personality plays any role in the start-up phase and for business success (Rauch & Frese, 2007). Gartner (1985) argued that new venture creation is a complex phenomenon: entrepreneurs and their firms vary widely, and that it is not enough for researchers to seek out and focus on some concept of the "average" entrepreneur and the "typical" venture creation. In a similar vein, Blanchflower and Oswald (1998, p.51) concluded that *"psychology apparently does not play a key role"*, while Aldrich (1999) claimed that research on personality traits has reached an apparent empirical dead end.

Despite these critics and inconclusive research findings, other researchers believe that personality variables, traditionally studied by psychologists and incorporated only more recently by economists, are a potential source to explain the development of self-employed entrepreneurs (Caliendo et al., 2011); and that personality research plays a critical role in the investigation of the entrepreneurial personality (Reimers-Hild et al., 2005). Rauch and Frese (2007), in their meta-analysis on the relationship between business owners' personality traits, business creation, and success, argue that the person should be put back into entrepreneurship research. Their results indicate that traits matched to the task of running a business produced higher effect sizes with business creation than traits that were not matched to the task of running an enterprise. Moreover, traits matched to the task produced higher correlations with success. On the basis of their findings, Rauch and Frese (2007) proposed to study specific traits, such as achievement motive rather than broad categories of traits, such as the Big Five to predict entrepreneurial behaviour. They also suggested to ask the question whether the trait

is matched to the task or not. Rauch and Frese (2007) concluded that the traits matched to entrepreneurship which significantly correlated with entrepreneurial behavior (business creation, business success) were need for achievement, generalized self-efficacy, innovativeness, stress tolerance, need for autonomy, and proactive personality.

**Situational models: Incorporating individual and environmental factors**

The existing literature reveals that personality alone has limited explanatory power in predicting entrepreneurial activities. Noticing that individuals do not exist and do not act in isolation, as atomized decision-makers who operate as autonomous entities but they also take environmental conditions into account by their decision-making processes, many researchers viewed environment as an explanation why the relationship between personal-related factors and entrepreneurial intent and activity is not always deterministic in nature (Aldrich & Zimmer, 1986; Lüthje & Fanke, 2003; Schwarz, et al., 2006). Thus, studies on the entrepreneurship started to focus on environmental conditions as determinants of people's aspiration to start a company (Schwarz et al., 2006). Researchers argued that the interaction between individuals' characteristics and situational conditions would predict entrepreneurial behavior better than any one of these factors alone, and they suggested to integrate the social context into models that explore personality characteristics (Magnusson & Endler, 1977; Schwarz et al., 2006).

In 1980 Van de Ven (1980, p. 86) urged entrepreneurship researchers to follow leadership researchers in terms of concepts studied and models employed, by writing: *"Researchers wedded to the conception of entrepreneurship for studying the creation of organizations can learn much from the history of research on leadership. Like the studies of entrepreneurship, this research began by investigating the traits and personality characteristics of leaders. However, no empirical evidence was found to support the expectation that there are a finite number of characteristics or traits of leaders and that these traits differentiate successful from unsuccessful leaders. More recently, research into leadership has apparently made some progress by focusing on the behavior of leaders (that is, on what they do instead of what they are) and by determining what situational factors or conditions moderate the effects of their behavior and performance."*

In a similar vein, Gartner (1985, p. 698), in his seminal paper, presented a framework for describing the creation of a new venture across four dimensions: (a) individual(s)-the person(s) involved in starting a new organization; (b) organization-the kind of firm that is started; (c) environment-the situation surrounding and influencing the new organization; and (d) new venture process-the actions undertaken by the individual(s) to start the venture. This behavioral approach views the creation of an organization as a contextual event, the outcome of many influences (Gartner, 1989, p. 57).

Following Van de Ven (1980) and Gartner (1989), many researchers included situational factors in the traits approach conceptualizing entrepreneurship as a contextual phenomenon, affected by the economic, political, social, and cultural environment in which it occurs, and linking cultural and situational factors to the body of literature that emphasizes a psychological-based explanation for entrepreneurship (Pruett et al., 2009; Schwarz et al., 2006). Busenitz, West, Shepherd, Nelson, Gaylen, and Zacharakis (2003), in their review of entrepreneurship research, concluded that researchers should focus on the exploration of the nexus of opportunities, enterprising individuals, and the wider environment. Examples of situational factors that have received significant attention in the literature on business start-ups are time constraints, task difficulty, the influence of other people through social pressure (Lee & Wong, 2004); unemployment and family commitments (Kennedy et al., 2003; Lawrence & Hamilton, 1997); and exposure to personal entrepreneurial role models (Feldman, Koberg, & Dean, 1991; Pruett et al., 2009; Raijman, 2001; Zhao, Seibert, & Hills, 2005).

Shapero and Sokol (1982, as cited in Lorz, 2011) proposed a model which assumes that inertia guides human behaviour until some event 'displaces' that inertia and unblocks previously undesired behaviours. With this perspective, the situational variables are seen as life path changes. Shapero and Sokol (1982) classified these life path changes into three

categories: negative displacements or push factors (such as forcefully emigrated, fired, insulted, angered, bored, reaching middle age, divorced or widowed), being between things (such as graduating from high school, university, finishing military duty or being released from jail), and positive pulls from the partner, mentor, investor or customers.

The push/pull classification of situational factors in the external environment used by Shapero and Sokol (1982) was also adopted by other researchers (Cooper & Dunkelberg, 1986; Feeser & Dugan, 1989). Push factors are negative factors which drive individuals towards entrepreneurship due to negative circumstances. Some examples of push factors are dissatisfaction by previous work experiences, protection from unemployment, low income position, difficulty in finding a job, and dependence nature of a salaried job. The Global Entrepreneurship Monitor (GEM) refers to this group as 'necessity' entrepreneurs as they pushed into starting up a business not so much out of choice but out of necessity (Gray, Foster, & Howard, 2006; Orhan, 2005).

In contrast, pull factors are positive factors which attract individuals into entrepreneurship because of the potential for the business concept and the prospective future value for the individual (Orhan, 2005). Some examples of pull factors are spotting opportunities from past experiences, having a family relative bequeath a business to them, self-fulfilment, demonstration of personal capabilities, desire for wealth, desire for independence, social status and power, and social mission (Akpor-Robaro, 2012; Gray et al., 2006; Orhan, 2005; Solymossy, 1997). The 'pull' entrepreneurs who have sensed an opportunity that needed to be exploited and marshalled all their efforts to create new business, are referred to by the Global Entrepreneurship Monitor as 'opportunity' entrepreneurs (Gray et al., 2006).

Brush (1990, as cited in Orhan, 2005), notes that there is rarely a clear-cut situation of necessity or choice, and most entrepreneurs are influenced by a combination of both push and pull components. However, some analysts of the 'pull' and 'push' factors dichotomy have observed that the 'push' entrepreneurs are less successful than the 'pull' entrepreneurs (Akpor-Robaro, 2012).

Another model that brings together the characteristics that would define a 'quality entrepreneur' and the environmental factors that would influence these characteristics was proposed by Guzmán and Santos (2001). Their model views entrepreneurship as a multidimensional concept where the influence of sociological, institutional, political and personal factors are essential in the behavior of entrepreneurs and in their relationship with economic growth and development (Audretsch, 2002; Reynolds, Hay, & Camp, 1999; Verheul, Wennekers, Audretch, & Thurik, 2003, as cited in Santos-Cumplido & Liñán, 2007). In the model, developed to configure the quality of entrepreneurs and the factors that determine it from a theoretical point of view, Guzmán and Santos (2001) selected four main components: *the necessary, although not sufficient, condition to be an entrepreneur*, that is, the preference for working as self-employed; *the qualitative exponents of the energizer sub-function*, where the psychological process is developed and booster actions are undertaken; *the factors of the personal environment of the entrepreneur*, which are those that create the attitudes and abilities and, therefore, influence the psychological processes undertaken by the entrepreneur; and *the factors of the global environment of the entrepreneur which* will also impact on the factors of the personal environment and the energizer sub-function, creating opportunities and sourcing information for the entrepreneurs. This model is illustrated in Figure 1.

Guzmán and Santos (2001) included in their model two exponents of the quality of entrepreneurs: the *entrepreneurial motivation* and the *energizer behaviours* (the ambition or capacity to grow; the innovation capacity; the spirit of collaboration; and the proactiviness or leadership). These entrepreneurial qualities would be influenced by two types of environmental factors: factors of the entrepreneur's personal environment, such as education, professional experience, and family; and factors of the entrepreneur's global environment, composed of social, cultural, political, institutional and productive aspects that have an impact on the whole society in which entrepreneurs live. Contrary to the factors of the entrepreneur' s personal environment, those factors belonging to the global environment affect all

entrepreneurs, regardless of their education, experience or family support (Guzmán & Santos, 2001). At the same time, while the factors of the personal environment provide abilities and attitudes, the factors of the global environment provide opportunities and information (Guzmán & Santos, 2001; Santos-Cumplido & Liñán, 2007).

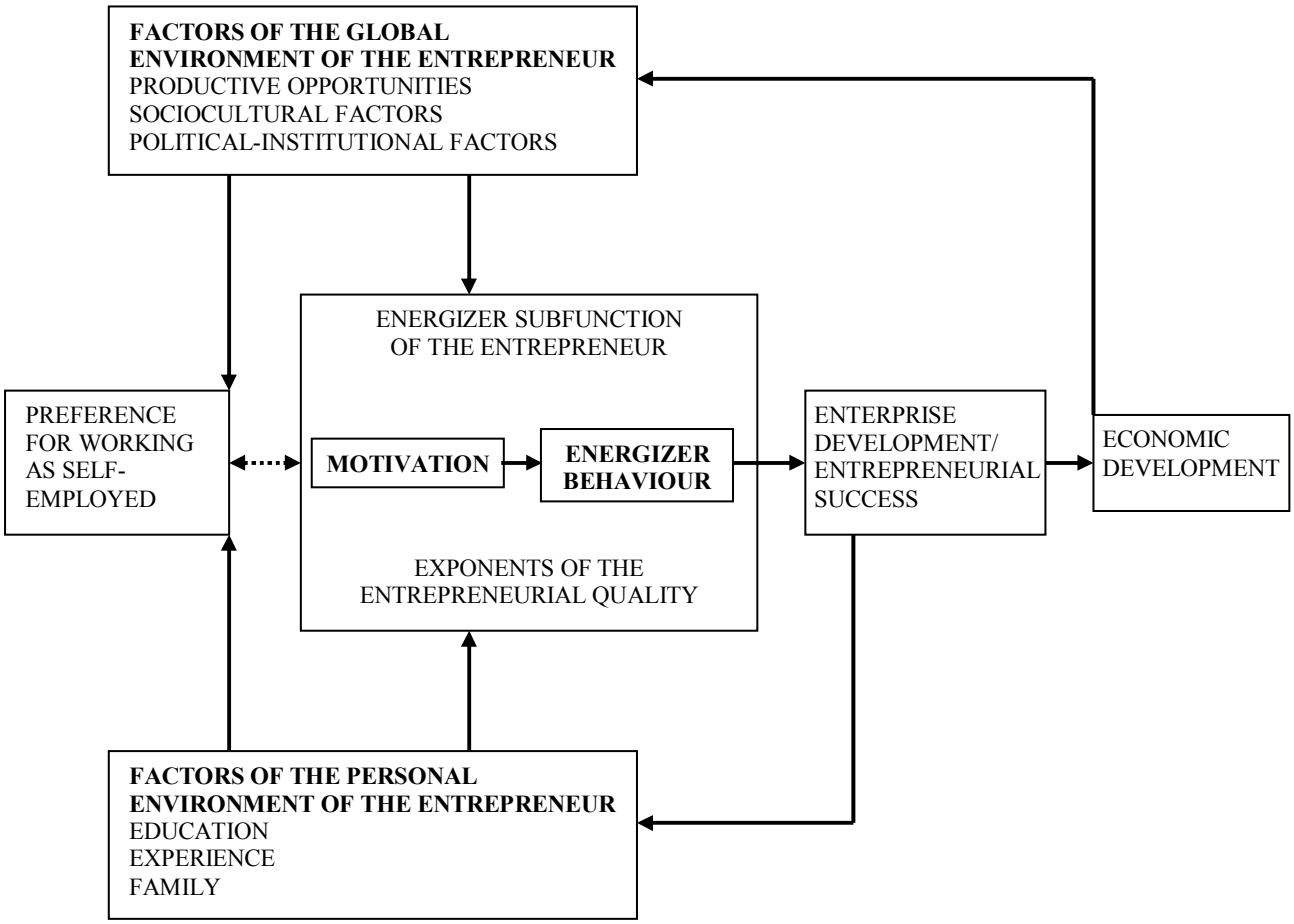


**Figure 1.** ***Entrepreneurial quality configuration model. Source: Guzmán and Santos (2001)***

**Intention-based models: From traits to attitudes**

The extant literature has shown that models of the determinants of entrepreneurial behaviour, focusing on how psychological traits, demographic, and situational factors distinguish entrepreneurial individuals from non-entrepreneurial individuals, were disappointing with respect to both explanatory power and predictive validity (Hindle, Klyver, & Jennings, 2009; Krueger et al., 2000). The failure of situational and personality measures to significantly predict entrepreneurial activity suggested another approach (Krueger et al., 2000) and, as a reaction, different entrepreneurial intention models developed (Hindle et al., 2009; Krueger et al., 2000).

The entrepreneurial intention approach emerged in the 1980s drawing heavily on Bandura's (1977) social learning theory also called social cognitive theory (Hindle et al., 2009). Social cognitive theory posits that individual behaviour is part of an inseparable triadic structure in which behaviour, personal factors and environmental factors constantly influence each other, reciprocally determining each other (Carillo, 2010). Social cognitive theory postulates also that an individual's behaviour is primarily learned through his or her observation of others as well as through interaction with his or her environment (Dimopoulou, 2012).

Bird (1992: 11) defined intention as "a state of mind directing a person's attention, experience and behavior towards a specific object or method of behaving".. According to

Boyd and Vozikis (1994: 64) an entrepreneurial intention is "the state of mind that directs and guides the actions of the entrepreneur toward the development and implementation of the business concept". Along a similar line, Fini, Grimaldi, Marzocchi, and Sobrero (2012) suggest to keep in mind that entrepreneurial intention reflects a state of mind directing a person's attention and action toward the enactment of entrepreneurial behaviour. In an attempt to clarify the construct of intention –in particular entrepreneurial intention– Thompson (2009: 676).suggested that "individual entrepreneurial intent is perhaps most appropriately and practically defined as a self-acknowledged conviction by a person that they intend to set up a new business venture and consciously plan to do so at some point in the future".

The basic rationale behind the intention models is that most behaviours of social relevance are under volitional control and are thus predictable from intention (Ajzen & Fishbein, 1980; p.41). This view is supported by existing research which reveals that intentions are the best single predictor of such volitional behaviors (Ajzen, 1991; Bagozzi, Baumgartner & Yi, 1989; Sutton, 1998, as cited in Fini et al., 2012). For Ajzen (2002a), intention is assumed to be the immediate antecedent of behavior. Meta-analyses show that intention toward a behavior would be a strong predictor of that behavior (Armitage & Conner, 2001; Sutton, 1998). Souitaris, Zerbinati, and Al-Laham (2007) indicate that intention proved to be the best predictor of planned behaviour, particularly when that behaviour is rare, hard to observe, or involves unpredictable time lags.

Many scholars argue that the decision to become an entrepreneur may be plausibly considered as voluntary and conscious, and that setting up a business involves careful planning and a thinking process which is highly intentional (Autio, Keeley, Klofsten, Parker, & Hay, 2001; Bird, 1988; Krueger et al., 2000). Thus, entrepreneurship has been seen as a good example of planned intentional behaviour and therefore applicable for intention models (Autio et al., 2001; Bird, 1988; Davidsson, 1995; Fayolle, 2006; Krueger et al., 2000; Shapero & Sokol, 1982). In this sense, entrepreneurial intentions would be the first step in the evolving and, sometimes, long-term process of venture creation, and a previous and determinant element towards performing entrepreneurial behaviours (Fayolle & Gailly, 2004; Kolvereid, 1996; Lee & Wong, 2004, as cited in Liñán & Chen, 2006).

According to Bird (1988: 442) "entrepreneurs' intentions guide their goal setting, communications, commitment, organization, and other kinds of work". In a similar vein, Krueger et al. (2000: 412) argue that intentions are " the single best predictor of any planned behavior, including entrepreneurship". For Thompson (2009: 670) "entrepreneurial intent is substantially more than merely a proxy for entrepreneurship –it is a legitimate and useful construct in its own right that can be used as not just a dependent, but as an independent and a control variable".

Deeply connected to intentional and volitional behavior are beliefs and attitudes (Elfving, 2008). Fishbein and Ajzen (1975: 6) define an attitude as "learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object". For Souitaris et al. (2007: 570), "attitude towards self-employment is the difference between perceptions of personal desirability in becoming self-employed and organisationally employed". According to Fini et al. (2012: 390) "attitude toward behavior, refers to the degree to which a person has a favorable or unfavorable appraisal of the behavior under scrutiny".

The overall tenet of the intention models is that intention is the immediate antecedent of behaviour, while in turn intention is determined by attitudes, and attitudes are affected by exogenous influences (such as traits, demographics, and situational variables) (Ajzen, 1991; Krueger et al., 2000; Shapero & Sokol, 1982). A more favourable attitude would increase the intention to carry out the intended behaviour (Fini et al., 2012; Liñán, 2004). Without a positive attitude towards a behavior one is not likely to intend to engage in the behavior. (Elfving, 2008).

As such, intentions toward behavior are absolutely critical to understanding other antecedents and serve as important mediating variables between the act of starting a business venture and potential exogenous influences which affect attitudes and indirectly intentions

and behaviour (Krueger et al., 2000; Shapero & Sokol, 1982). Intentions and their underlying attitudes are perception-based, which should mean they are learned, and accordingly, they will vary across individuals and across situations (Krueger et al., 2000). Researchers note that, like individuals who do not exist in isolation, attitudes do not similarly exist in isolation (Robinson et al., 1991). Thus, as attitudes are relative less stable than personality traits, they can change according to time and situation in virtue of individual's interaction with the environment (Liñán, 2004; Robinson et al., 1991). In this manner, the attitude approach would be preferable to the trait or the demographic approaches (Robinson et al., 1991; Krueger et al., 2000, as cited in Liñán, 2004).

Kim and Hunter (1993) conducted a series of meta-analyses, integrating the findings of 92 attitudes-behavioral intentions correlations and 47 behaviors-behavioral intentions correlations, and found that attitudes explain over 50% of the variance in intentions and intentions account for over 30% of the variance in behavior. Krueger et al. (2000) note that, explaining 30% of the variance in behavior compares favorably to the 10% typically explained directly by trait measures or attitudes. A similar conclusion was reached by a meta-analysis of meta-analyses done by Sheeran (2002) who found that intentions account for 28% of the variance in behavior, on average, in prospective studies.

A variety of intention models have been proposed and tested by entrepreneurship researchers. However, the two models of intentions that have received predominate attention, are Ajzen's Theory of Planned Behavior and Shapero's Model of the Entrepreneurial Event.

***The Ajzen Model of Planned Behaviour***

The Theory of Planned Behaviour (TPB) is rooted in the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975), and Ajzen and Fishbein (1980) which was grounded in various theories of attitude such as learning theories, expectancy-value theories, consistency theories, and attribution theory. Based on a literature review examining the theories used in the context of entrepreneurial intention, Lorz (2011) concluded that Ajzen's theory of planned behaviour is the most often used theory.

The TRA, illustrated in Figure 2, consists of three major constructs: behavioural intention, subjective norm, and attitudes. The constructs of intention and attitudes have been extensively discussed previously. Subjective norm refers to perceived social pressure to perform a specific behaviour originating from significant others such as friends, family, peers, networks or mentors; it is the person's perception of the extent to which 'reference people' would approve of the decision to manifest the behaviour, or not (Ajzen, 2001; Elfving, 2008; Friedkin, 2010; Lorz, 2011). As is evident in Figure 2, TRA implies that the immediate antecedent of a specific voluntary deliberative behavior is a person's intention to engage in the behaviour, while intention follows from the person's attitudes and subjective norm. Thus, attitudes and subjective norm are the immediate antecedents of a behavioural intention. Consequently, if a person evaluates the suggested behavior as positive (attitude), and if he or she thinks his or her significant others want him or her to perform the behavior (subjective norm), this results in a higher intention (motivation) and he or she is more likely to do so.

In terms of the standard notation for the theory s, this functional form is expressed as follows:

$$B \leftarrow I = w_{PA} A_B + w_{SN} SN$$

In the above equation, the behaviour ($B$) is a function of the intention ($I$), which in turn is a function of the person's attitude toward the behaviour ($A_B$) and the person's subjective norm ($SN$). The coefficients $w_{PA}$ and $w_{SN}$ are relative weights. Furthermore, a person's attitude toward the behavior is impacted by his or her beliefs that the behavior will lead to particular outcomes and by his or her evaluations of those outcomes (behavioural beliefs), while a person's subjective norm is determined by his or her perceptions of the attitudes of others and by his or her motivation to comply with the attitudes of these referents (normative beliefs) (Ajzen, 2002b; Friedkin, 2010).

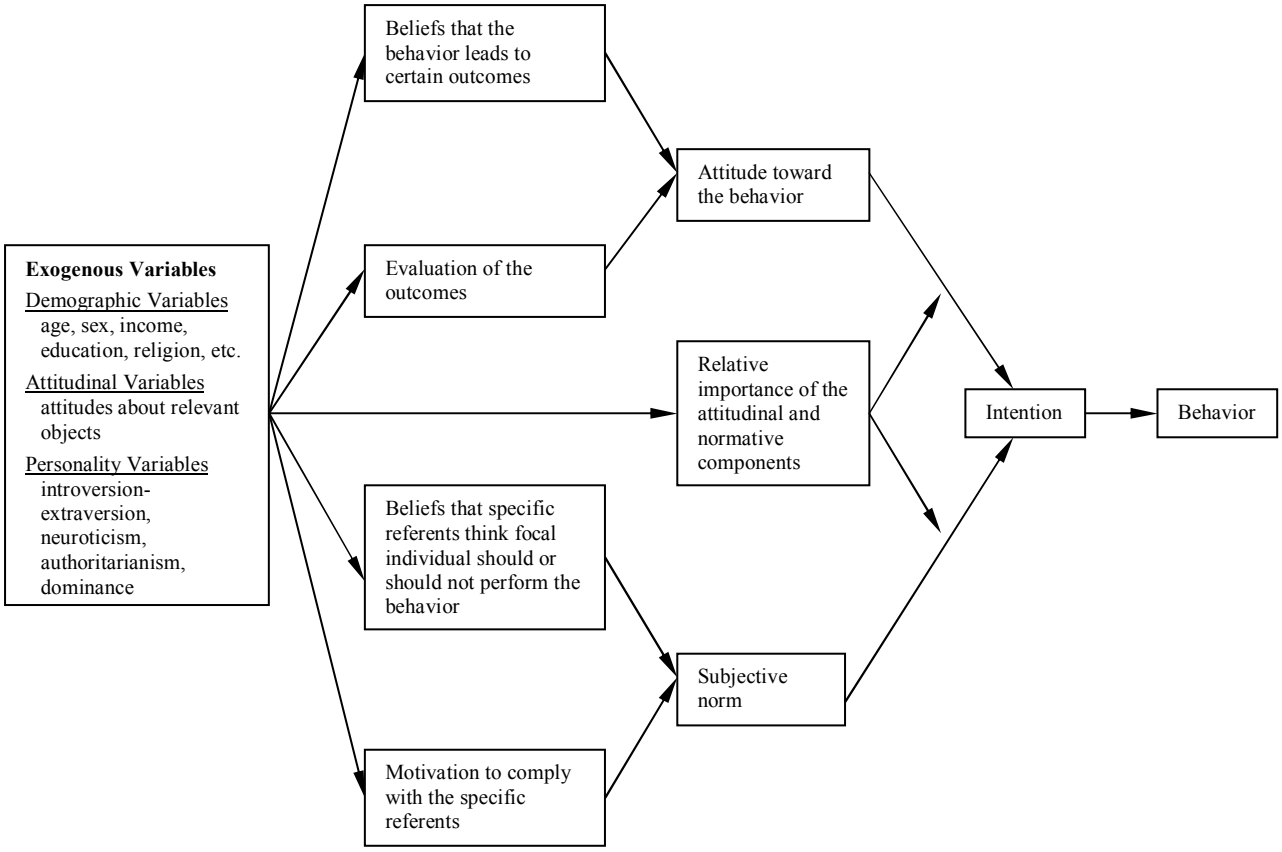


**Figure 2.** ***The theory of reasoned action. Source: Noran (2010)***

Belief strength and outcome evaluation can serve to compute a behavioural belief composite that is assumed to determine the attitude toward the behavior ($A_B$) in accordance with an expectancy-value model, as shown symbolically in the following equation (Ajzen, 2002b):

$$A_B = \sum_{k=1}^{K} b_k e_k$$

Belief strength ($b_k$) is multiplied by outcome evaluation ($e_k$), and the resulting products are summed over all accessible behavioral outcomes. (Friedkin, 2010).

In a similar manner, an overall normative belief composite is obtained in accordance with an expectancy-value model, as shown in the following equation:

$$SN = \sum_{j=1}^{n} b_j m_j$$

where here $b_j$ is the person's belief that referent *j* thinks that he or she should or should not adopt or discard the behavior and $m_j$ is a person's motivation to comply with referent *j* (Friedkin, 2010). Combining the three equations above yields:

$$B \leftarrow I = w_{PA} A_B + w_{SN} SN = w_1 \sum_{k=1}^{K} b_k e_k + w_2 \sum_{j=1}^{n} b_j m_j$$

Although the theory of reasoned action was highly functional in some areas, some researchers (e.g. Bagozzi, 1992; Bagozzi & Dholakia, 1999; Bagozzi & Warshaw, 1990) claimed that it is unsuitable for some types of behaviour. In order to expand the applicability of the model and respond to the critique Ajzen (1991) developed further the TRA and proposed the Theory of Planned Behaviour (TPB) by adding an additional construct, Perceived Behavioural Control (PBC) (Ajzen, 1985). Figure 3 presents a schematic diagram of the theory. As a general rule, TPB suggests that the more favorable the attitude and subjective norm, and the greater the perceived control, the stronger should be the person's intention to perform the behavior in question. Finally, given a sufficient degree of actual control over the behavior, people are expected to carry out their intentions when the opportunity arises (Ajzen, 2002b).

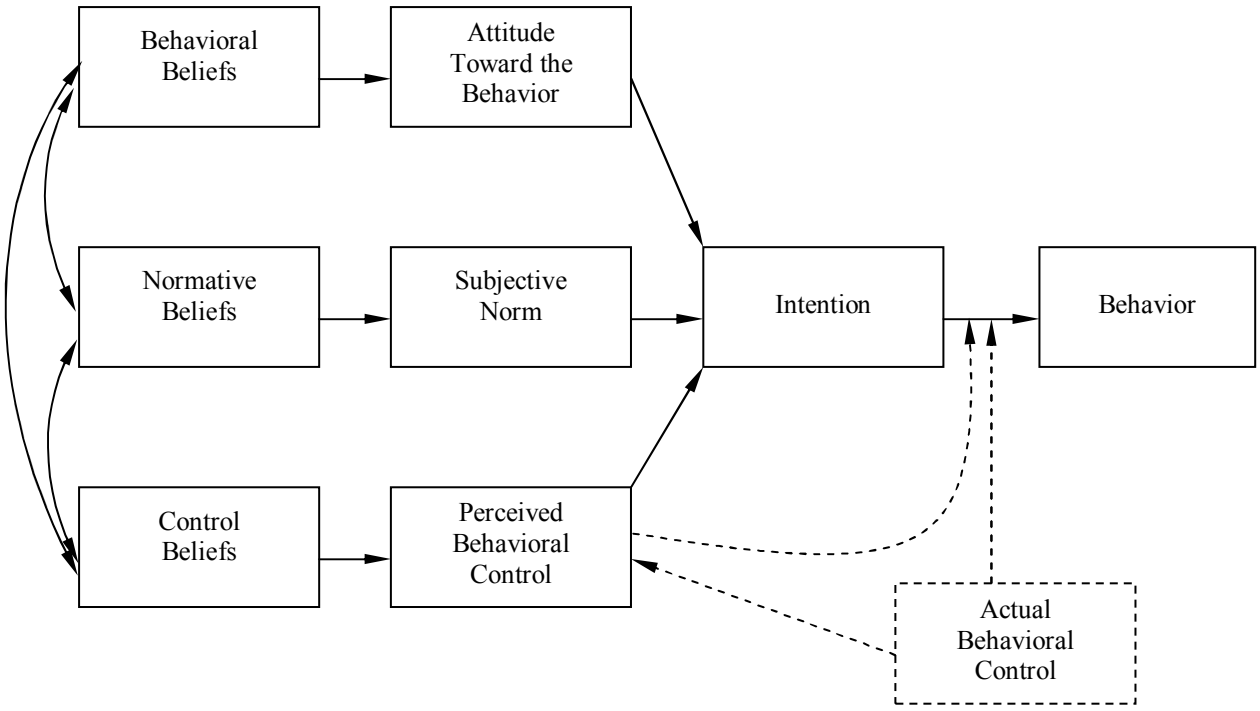


**Figure 3.** ***The theory of planned behavior. Source: Ajzen (2002b)***

PBC is a person's belief about how easy or how difficult it will be to perform a behaviour (Ajzen, 1985). It is, therefore, a concept quite similar to Bandura's (1986) view of perceived self-efficacy, though some authors consider it to be wider (Fayolle & Gailly, 2004, as cited in Liñán (2004). A person's PBC is determined by his or her beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs) (Ajzen, 2002b). In accordance with an expectancy-value formulation, a control belief composite can be obtained by multiplying belief strength and power, and summing the resulting products over all accessible control factors, as shown in the following equation (Ajzen, 2002a):

$$PBC = \sum_{i=1}^{m} c_i p_i$$

Elfving (2008) notes that the items of questionnaires tapping perceived behavioral control tend to load around two factors although researchers have not yet reached consensus as to what precisely these factors include, with some researchers arguing that they reflect

internal versus external control and others suggesting that one factor represents self-efficacy and the other control beliefs.

Ajzen and Fishbein (2005) combined the theory of reasoned action and the theory of planned behavior in a model in which the behavioral, normative and controllable beliefs are a function of a wide range of background factors such as personal, cultural and situational factors. This model is illustrated in Figure 4. It is noteworthy that the relative contribution of attitudes, subjective norm and perception of control in the prediction of intentions varies as a function of contextual factors (Elfving, 2008).

The TPB has significantly influenced entrepreneurial intention research as the entrepreneurial intention studies have been dominated by variations of this theory (Elfving, 2008).

***The Shapero Model Entrepreneurial Event***

Another well recognized model is the Shapero's Entrepreneurial Event model (SEE) (Shapero, 1975; Shapero & Sokol, 1982) that is conceptually similar to Ajzen's theory of planned behaviour (Sánchez, 2012). However, in contrast to the theory of planned behavior, which was developed to explain planned behavior in general, Shapero and Sokol (1982) used planned behaviour theory in an entrepreneurial context and their model was developed in order to explain entrepreneurial behavior specifically. The SEE model is illustrated in Figure 5.

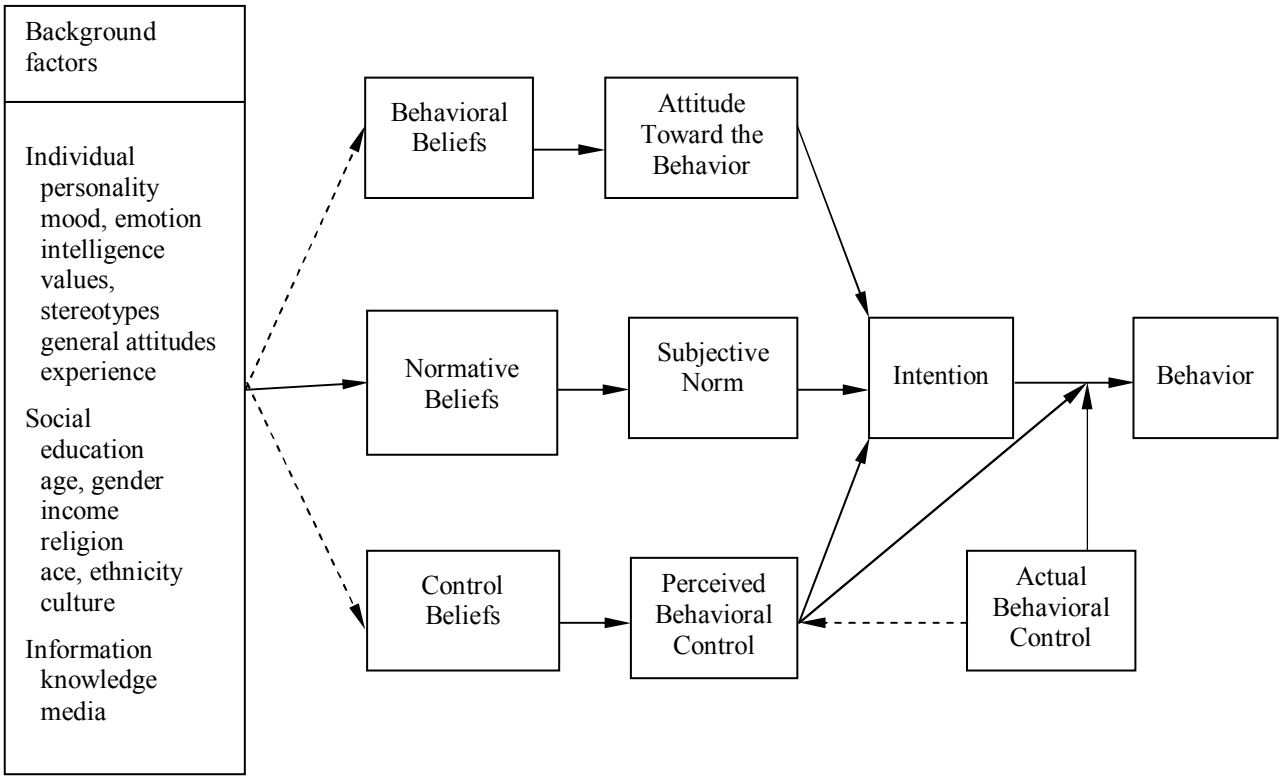


**Figure 4.** ***The theory of reasoned action and planned behavior. Source: Ajzen & Fishbein (2005)***

The aim of the model was to provide an explanation for the processes that lead to the moment when people decide to really exploit an entrepreneurial opportunity, the so-called by Shapero entrepreneurial event (Kollmann & Kuckertz, 2006). As such SEE is a process model. The greatest reason for an entrepreneurial activity is an event that precipitates a change in the person's life and career path and breaks the routine.

Shapero's unique conceptual contribution to the explanation of the determinants of entrepreneurial intention is the notion of the 'triggering event'. Shapero asserts that most individuals are bound to given life paths by inertia until a major life change or 'trigger event' disrupts the binding inertia and 'displaces' the person from the position in which he or she is established (Shapero & Sokol, 1982). Although disruption tends to be a negative factor (e.g., the loss of one's job, a midlife crisis), it also may be positive where individuals are attracted to entrepreneurship by entrepreneurial training, an innovation or an opportunity to take the risk after a financial situation becomes more secure (Stewart, Watson, Carland, & Carland, 1999).

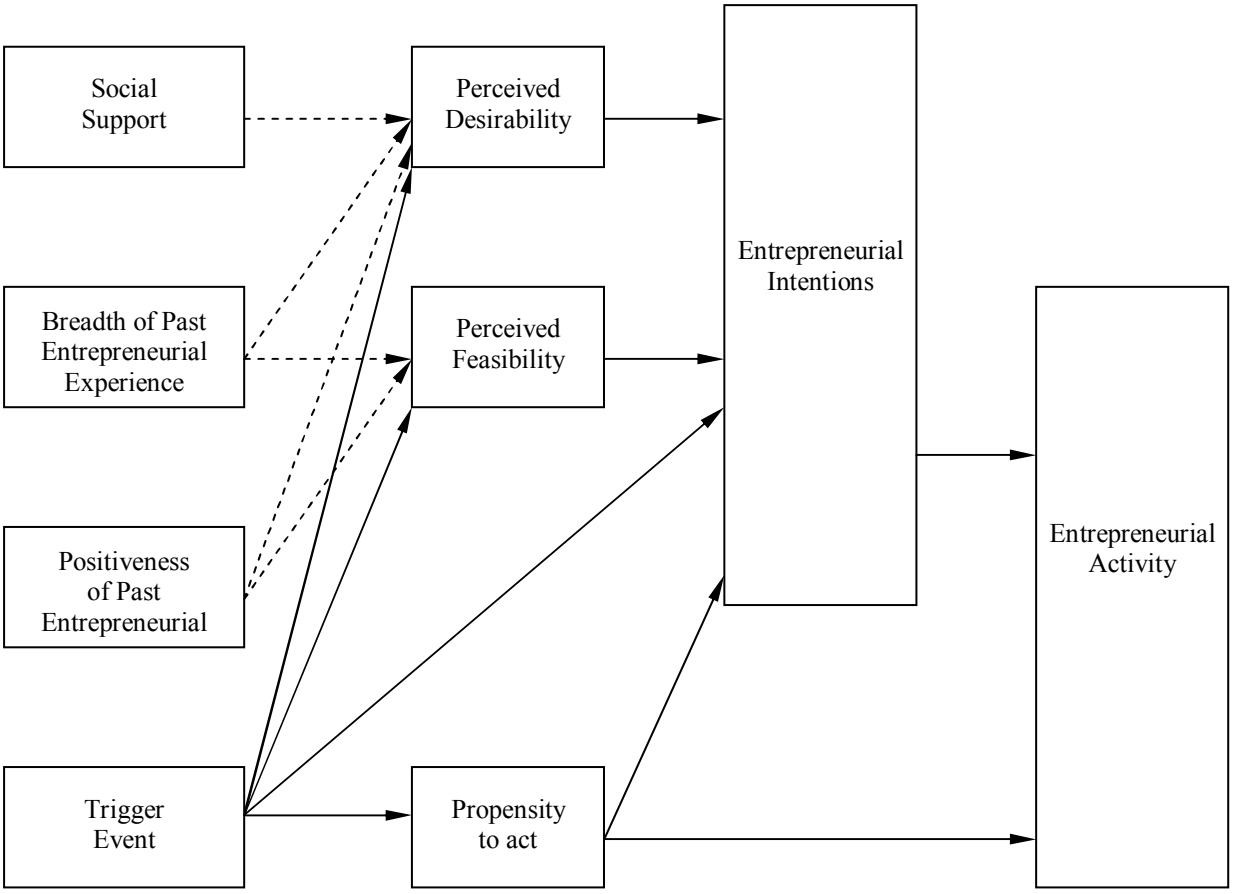


**Figure 5.** ***Shapero model of entrepreneurial event. Source: Meeks (2004)***

Representing the theory of entrepreneurial event, Shapero argued that entrepreneurial intentions have three main determinants: the perception of the desirability; the perception of feasibility; and the propensity to act (Shapero, 1982; Shapero & Sokol, 1982). Furthermore, Shapero suggested that the breadth and positiveness of past experiences influence perceptions of desirability and feasibility. Perceived desirability is also impacted by cultural and social factors through their influence on the individual's value system, while a trigger event may initiate entrepreneurial action.

Perceived desirability is defined as the extent to which a person finds a given behaviour (to become an entrepreneur) attractive. As people are particularly influenced by role models in their social environment, comprised of family and friends, and intentions are influenced by the perception that the entrepreneurial behaviour is not only personally desirable but also socially desirable, the perceived desirability of entrepreneurial behaviour is expected to be directly affected by cultural and social factors (Gasse & Tremblay, 2011).

Perceived feasibility is the degree to which the person considers himself or herself personally able to carry out that behaviour (performing entrepreneurial tasks) (Krueger & Carsrud, 1993). Feasibility depends on the perceived availability of the resources needed to create a business, on previous experience and on one's general sense of self-confidence in his or her skills and abilities to successfully execute tasks. Perceived feasibility is similar to Bandura's self-efficacy, which is often used as a proxy for perceived feasibility (Krueger et al., 2000) and has repeatedly been identified as the critical antecedent variable to one's feasibility perceptions (Kuehn, 2008).

Propensity to act is a person's ability and readiness to act on his or her decision (Krueger, 1993). Shapero and Sokol (1982) suggested using internal locus of control as a measure of the propensity to act. However, there is no agreement as to how to best assess propensity to act, as other researchers have conceptualized propensity to act as learned optimism (Krueger et al., 2000) or risk-taking propensity and tolerance of ambiguity (Kuehn, 2008). The variable itself, however, is argued to be a complex one, having both indirect and direct impact on intentions; that is, acting directly on intentions, mediating through desirability and feasibility variables and as a moderating influence on these variables on intentions (Kuehn, 2008). The propensity to act is what differentiates the Shapero entrepreneurial events model from the theory of planned behavior model (Mhango, 2006).

***The Krueger Entrepreneurial Intention Model***

While Shapero and Sokol (1982) did not propose their model as an intentions based model, it was quickly seen as precisely that by many and has since been so utilized in entrepreneurship literature (Kuehn, 2008). However, there is only one model, developed by Krueger and his associates (see for example Krueger, 1993; Krueger & Brazeal, 1994; Krueger et al. 2000) and called the Entrepreneurial Intention Model (EIM), which has been empirically tested to such an extent that it can be viewed as reliable and useful (Elfving, 2008). This model is illustrated in Figure 6. The EIM assumes that perceived feasibility and perceived desirability mediate the influence of perceived social norms and perceived self-efficacy on intent (Krueger & Brazeal, 1994), although social norms have not always a significant impact (Krueger et al., 2000).

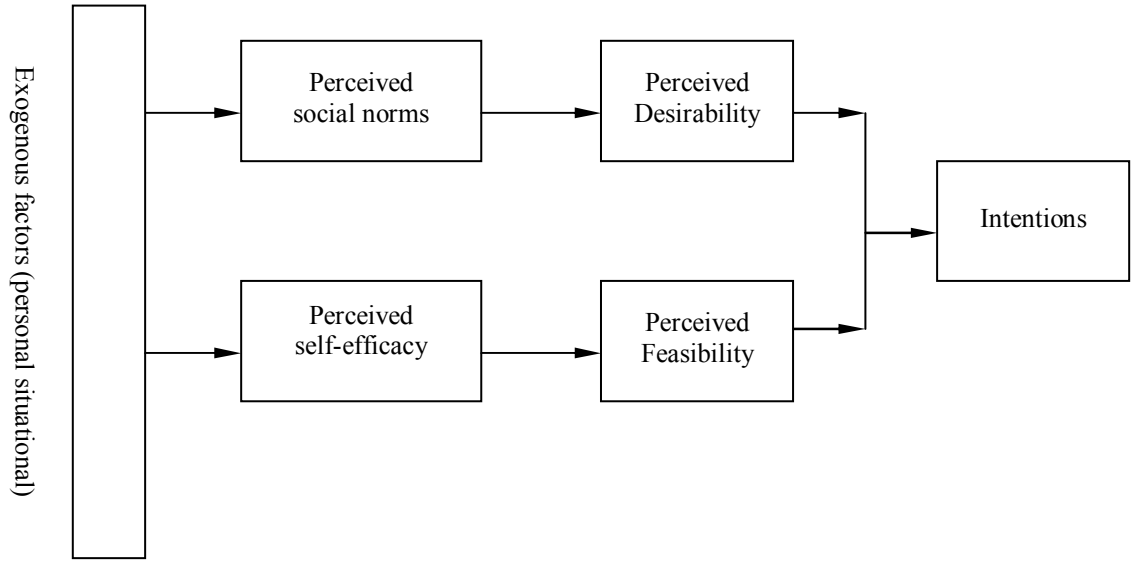


**Figure 6.** ***Krueger entrepreneurial intentions model. Source: Meeks (2004)***

Krueger and Brazeal (1994) modified the EIM by including the concepts of credibility and entrepreneurial potential. The basic tenet of the Model of Entrepreneurial Potential and Intention, which is illustrated in Figure 7, is that the decision to become an

entrepreneur depends on the 'credibility' of the best opportunity available to the decision maker from her or his enacted set of alternative behaviors plus some 'propensity to act' (without which the decision maker may not take any significant action) (Krueger & Brazeal, 1994: 93). Credibility requires that the behavior be seen as both desirable and feasible. The entrepreneurial event requires a preexisting preparedness to accept that opportunity (Krueger & Brazeal, 1994: 91), that is 'potential' (credibility and propensity to act), followed by a precipitating negative or positive event that displaces the decision maker from his or hers career path.

**Conclusion**

The present literature review revealed that intention-based models of entrepreneurship have moderate to high predictive power in explaining the entrepreneurial behaviour. Both of the two main intention-based models reviewed in this study, the theory of planned behaviour and the theory of entrepreneurial event, as well as their variants, offer researchers a valuable tool for understanding the process of organizational emergence.

However, studies have shown that, although these models are conceptually different, they have similar explanatory power, whereas each one of them provides important information related to entrepreneurial activity. Thus, combining the constructs with the highest unique explanatory power in each of the existing models into a single model would yield a model with increased predictive power.

In conclusion, more sophisticated models are required in order to better understand entrepreneurial behaviors and these models need to be tested in different entrepreneurial settings.

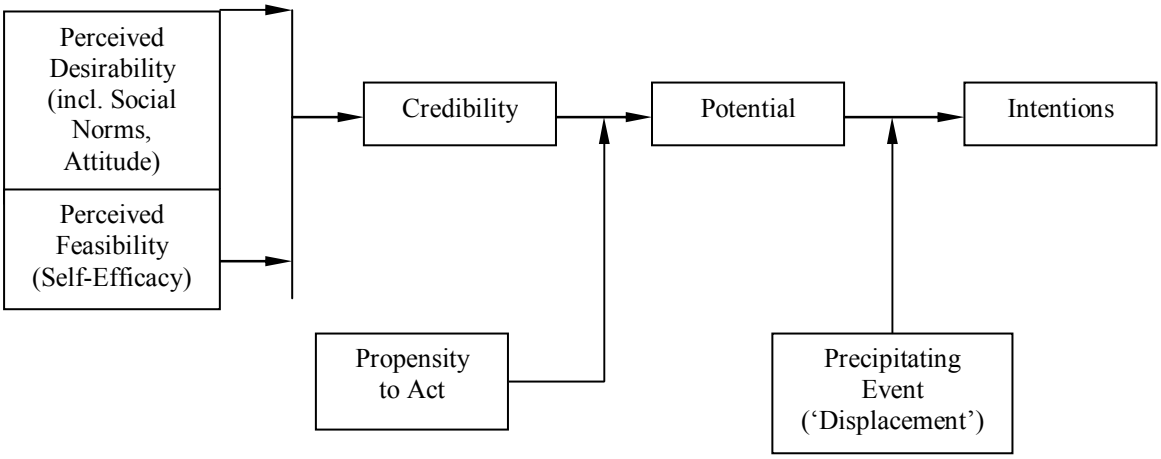


**Figure 7.** ***Model of entrepreneurial potential. Source: Krueger & Brazeal (1994)***

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# Announcements, Conferences, News

# 10th Conference of ERSA-Greek Section Economic Crises and Policies for Development and Cohesion 1-2 June 2012, Thessaloniki, Greece[17]

The 10th conference of the European Regional Science Association-Greek Section took place in Thessaloniki in 1-2 of June 2012. The conference's title was "Economic crises and policies for development and cohesion" and it was co-organized by the department of Planning and Development Engineering, Aristotle University of Thessaloniki and the department of Economics Science, University of Macedonia. Over 150 academics participated with papers and keynote speeches, which gave the opportunity to debate upon several topics. The agenda of the conference was focused on the role of spatial planning and development policies in the management of the current economic crisis. Furthermore, the themes of the conference attracted papers on:

- Growth concepts and cohesion policy,
- Sustainable development,
- Governance and local development,
- Impacts of crisis and economic restructuring,
- Migration policies,
- Transfer infrastructure,
- Spatial inequalities,
- Real estate practices,
- Innovation and development,
- Strategic planning,
- Tourism policies,
- Urban development and quality of life.

At the end of the second day the overall picture was that the conference proved to be very successful, as the discussions were much lively and the papers presented provided interesting insights and up-to-date information. The success of the conference seemed to reinforce the importance of having a section of ERSA in Greece, as it could play an important role in associating and networking all those who work, research and study regional science in Greece.

[17] **Conference overview by Dr. Vasilis Avdikos, Department of Regional Economic Development, University of Central Greece**

# Regional Studies Association, European Conference 2012, Networked regions and cities in times of fragmentation: Developing smart, Sustainable and inclusive places 13-16 May, 2012- Delft, The Netherlands[18]

The theme of the Regional Studies Association European Conference, organized in partnership with the OTB Research Institute- Delft University of Technology, was "Networked regions and cities in times of fragmentation: Developing smart, sustainable and inclusive places". Over 300 people from many different countries attended the four days of the conference, which provided a timely opportunity for participants to come together and reflect on the various strengths, weaknesses, challenges and opportunities of networked cities and regions within these different contexts of fragmentation. The conference had some illustrious speakers, like UvA professor Maarten Hajer, Sir Peter Hall, Catherine Ross (Georgia Tech), the Polish economist Danuta Hubner (ex Director of the DG Regio) and many others. The thematic strands of the conference were the following:

A. EU Regional policy and practice
B. Climate change, energy and sustainability
C. Migration, housing and labour markets
D. Social and environmental justice and inclusive places
E. Rural and peripheral challenges
F. Territorial cohesion and cooperation
G. City-regions, networks and urban systems
H. Spatial analysis and regional economies
I. Borders, border regions and cross-border learning
J. Industries, entrepreneurship, and regional competitiveness
K. Innovation and knowledge economies
L. Creativity, identities and branding
M. Territorial governance: planning policy and practice
N. Infrastructure and development
O. Local and regional economic development

[18] **Conference overview by Dr. Vasilis Avdikos, Department of Regional Economic Development, University of Central Greece**

# Academic Profiles

## Associate Professor Daniel Felsenstein

**Department of Geography, Hebrew University of Jerusalem, Mount Scopus, Jerusalem.**

Daniel Felsenstein is an associate professor in the Department of Geography, Director of the Institute of Urban and Regional Studies and Academic Director of the Center for Computational Geography.

His main areas of interest are in economic geography, regional science and spatial econometrics. He specializes in local and regional economic development and urban/regional impact analyses. His current research focuses on explaining the dynamics of inter-regional income disparities, developing and testing a 'job-chains' model for evaluating local economic development initiatives, and the development and application of land-use simulation models. This and related work has appeared in five authored or co-edited books and nearly 60 articles in international peer-reviewed journals. In terms of public and professional service, Felsenstein is chairman of the Israeli Regional Science Association, member of the editorial board of *Geografiska Annaler B*, serves on the European Regional Science Association Council and the IGU Commission on the Dynamics of Economic Spaces and is a member of the Israeli National Council of Land Appraisers and Surveyors

In addition, his current research are:

- 2010-2013 European Union, 7th Framework, Program on Global Change, Human Mobility and Sustainable Urban Development; SECOA-Solutions for Environmental Contrasts in Coastal Areas (with Eran Razin and Itai Fishendler)
- 2011-2014 European Union, 7th Framework, Security Program, DESURBS- Designing Safer Urban Spaces; (with Noam Shoval)
- 2011-2013 European Union, 7th Framework, Program on Strengthening the European Neighborhood Policy,SEARCH - Sharing Knowledge Assets Across Inter-Regionally Cohesive Neighbors (with Michael Beenstock and Guy Harpaz)
- 2012-2014, The Maurice Falk Institute for Economic Research in Israel, 'Valuing Accessibility: The Case of the Trans-Israel Highway', (with Michael Beenstock)

**By Vasiliki Vamvaka, University of Central Greece**

## Research Professor Dr. José G. Vargas-Hernández

**Marketing and International Business**
**University Center for Economic and Managerial Sciences, University of Guadalajara Jalñisco Mexico**
**Member of the National System of Researchers of México**

His most recent working papers are:

- Pablo Adrián Magaña Sánchez & José G. Vargas Hernández & Mario de Jesús Naranjo González & Felipe de Jesús Sandoval Araiza, 2010. "Los factores de competitividad de las MIPYMES agroindustriales del limón mexicano en Colima, México," Ensayos de EconomÃa 008791, UNIVERSIDAD NACIONAL DE COLOMBIA SEDE MEDELLIN.
- José Vargas-Hernández, 2010. "Las maquiladores en Centroamérica. (Axe II, Symposium 6)," Post-Print halshs-00503171, HAL.
- José Guadalupe Vargas Hernández, 2006. "La transferencia de la gobernabilidad del Estado Nación a la gobernabilidad económica global corporativa," Post-Print halshs-00103434, HAL

His most recent articles are:

- Jose G. Vargas-Hernandez, 2012. "Strategic mergers and acquisitions of Mexican emerging multinationals," Journal of Applied Management and Investments, Department of Management and Finance, Odessa National Academy of Food Technologies, vol. 1(1), pages 30-37.
- Cristina Martinez□Fernandez & Chung Tong Wu & Laura K. Schatz & Nobuhisa Taira & José G. Vargas□Hernández, 2012. "The Shrinking Mining City: Urban Dynamics and Contested Territory," International Journal of Urban and Regional Research, Wiley Blackwell, vol. 36(2), pages 245-260, 03.
- José G. Vargas Hernández, 2011. "Desarrollo Ambiental Y Económico Para La Sustentabilidad Organizacional: El Caso De Microempresas En San Sebastián Del Sur," Tecsistecatl, Grupo Eumed.net (Universidad de Málaga), issue 11, December.
- José G. VARGAS-HERNÁNDEZ & Arturo GARCÍASANTILLÁN, 2011. "Management in the Innovation Project," Journal of Knowledge Management, Economics and Information Technology, ScientificPapers.org, vol. 1(7), pages 24, December.

**By Vasiliki Vamvaka, University of Central Greece**

# Book Reviews


## European Socio Economic Integration: Challenges, Opportunities and Lessons Learned

**Elias G. Carayannis, George M. Korres**

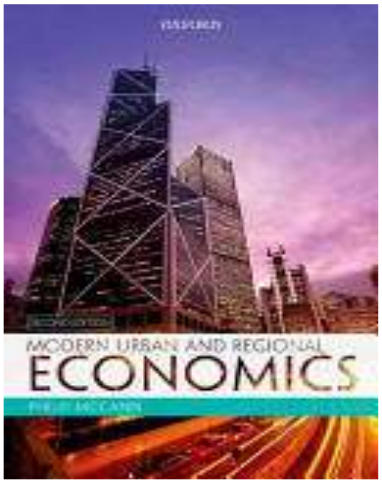
**Springer, 2013**
**ISBN-10: 1461452 538 | ISBN-13: 978-1461452539**

The book is intended to provide a basic understanding of the current issues in and the problems of economic integration and it examines many aspects and consequences of this integration that are obscure or as yet unexplored. After addressing general issues in the field of economic integration, the discussion turns to empirical and theoretical aspects of monetary union, social policy reform and social union, public finance and technology policy. In particular, with its wide range of topics, methodologies and perspectives, the book offers stimulating and wide-ranging analyses that will be of interest to students, economic theorists, empirical social scientists, policy makers and the informed general reader.

The volume comprises from two main parts. The book consists of nine main chapters. Part 1 is devoted to economic integration, macroeconomic issues, the problems and the process of economic integration. The chapters in this part contain theoretical and empirical analyses of economic integration, the European Union and the integration process. Part 2 investigates the social policy and integration process and deals with institutional matters and the policies of integration, the challenges for an integrated Europe, with emphasis on social policy, the welfare state and political reforms.

The book argues that national or regional economic development depends mainly on technical change, social and human capital and knowledge creation and diffusion. The book is intended to provide a basic understanding of the current issues and the problems of knowledge economy, technical change, and innovation activities; the book also examines many aspects and consequences of regional integration that are obscure or yet to be explored. In particular, with its wide range of topics, methodologies and perspectives, the book offers stimulating and wide-ranging analyses that will be of interest to students, economic theorists, policy makers, as well as the informed general reader.

**By Dr. Christos D. Genitsaropoulos, University of Central Greece**




## Modern Urban and Regional Economics

## Philip McCann

## Oxford University Press, 2013 (2nd Edition)

**ISBN: 0199582009,9780199582006**

Modern Urban and Regional Economics, Second Edition, explains the spatial economic foundations of the behavior of urban and regional economies, highlighting the differences between the two types of economy. By employing an explicitly spatial approach, author Philip McCann is able to discuss both urban and regional economics within a single integrated framework. He presents clear, model-based explanations from first principles and also provides extensive graphic illustrations of the theories discussed.

Covering classical approaches along with the latest models, this unique text helps students gain a thorough understanding of both basic analytical techniques and the most state-of-the-art thinking in the field. Technical appendices to each chapter allow students to further investigate the main principles and theories discussed in the text.

**By Dr. Christos D. Genitsaropoulos, University of Central Greece**

# THE REGIONAL SCIENCE INQUIRY JOURNAL (RSI J)
# Instructions to Authors

## Review process

Each suitable article is blind-reviewed by two members of the editorial review board. A recommendation is then made by the Editor-in-Chief. The final decision is made by the Editor-in-Chief. If a revision is recommended, the revised paper is sent for a final approval to one of the Editors.



### Style and Format of the Paper

In order for a paper to be submitted to the Regional Science Inquiry Journal (RSIJ) for publication, the following should be taken into consideration:

1. All submitted articles should report original work, previously unpublished and not under consideration for publication elsewhere and they are subject to both review and editing.
2. Articles should be in good technical English with a length normally between 6,500-8,000 words, while all other texts should not exceed 2,500 words, apart from the references, tables and illustrations.
3. The first page of the manuscripts should contain the article title, the name and the affiliation of the authors with sufficient contact details (the corresponding author should be properly identified here).
4. Articles should have a set of Keywords (up to 7) and an Abstract (under 250 words, without references), followed by the Introduction, Methodology and Data, Results, Discussion, Conclusions and References.
5. Manuscripts should be submitted in one single electronic file, an MS Word file, to the registered electronic address of the editors. It is also possible, for review purposes only, to submit the manuscript as a PDF file (or other similar format). The books for review are sent in two copies to the seat of the Journal.
6. Manuscripts should be typewritten with margins 2.5 cm x 2.5cm on A4 size paper. Margins should be consistent on all pages.
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9. The text should be set in Times New Roman, size 11pt, normal, in a single column. Texts that do not comply with the specified formation will be returned to the authors for proper adjustment.
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