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Assessing the Macroeconomic Effect of Gas Pipeline Projects: The Case of Trans-Adriatic Pipeline on Greece

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Abstract

This paper presents a framework for analyzing in quantitative and monetary terms the macroeconomic effects associated with the construction and operation of large energy investments, including the impact on Gross Domestic Product (GDP), employment and public revenues, by sector of economic activity. The proposed framework has been implemented for analyzing the macroeconomic implications associated with the construction and operation of the Trans-Adriatic Pipeline (TAP) project in Greece. To this end, the input–output methodological framework has been used for estimating the macroeconomic implications of the project under consideration in conjunction with the adjusted earnings gain approach for monetizing the resulting employment effects. The results of the analysis clearly show that the construction activities will create significant direct, indirect and induced benefits to the Greek economy, growing the GDP by €931 million, creating employment benefits amounted to €197 million and contributing €359 million to the treasury. Furthermore, it was estimated that ongoing operation of the pipeline could increase the national GDP at about €17 million, the employment benefits of about €4.7 million and the tax revenues of approximately €6.8 million, on an annual basis and for a period of 50 years.

JEL classification: D57, M14
Keywords: macroeconomic effects; input-output analysis; social return on investment; employment benefits; gas pipelines.

1. Introduction

In recent decades, natural gas covers a significant amount of global energy needs and gas consumption worldwide reached 3,500 billion cubic meters (bcm) in 2013 (International Energy Agency, 2014). The transportation of natural gas from production areas to consumption areas takes place mainly through pipelines and secondarily as liquefied natural gas with LNG carriers. The transport of natural gas through pipelines is the most economical and practical way for exploiting large gas reserves and simultaneously the most secure one (Hopkins, 2015). Consequently, the exploitation of gas reserves requires the construction of an extensive pipeline network, covering distances of hundreds of kilometers and linking production and consumption areas across (in many cases) transit countries.

The energy dependence of the European Union (EU) to meet its needs for oil and natural gas, which play an increased role in EU’s energy balance (Commission of the European Communities, 2008), creates significant concerns about the security of energy supply. EU’s desire to be energy independent from Russia as well as the exploitation of the natural gas-rich region of Caspian Sea, were the main reasons that lead the European policy to open the South Corridor of Natural Gas (Livanios, 2013). In June 2013, this effort led to the adoption of the Trans Adriatic Pipeline – TAP to transport gas originating in the Caspian region from the Turkish network through Greece and Albania to the Italian market.

The construction and operation of gas transmission pipelines constitute large energy investments with significant economic, environmental and social implications. Based on the experience of other countries (see indicatively CHMURA Economics & Analytics, 2014; ECONorthwest, 2012), the TAP project is expected to positively affect the transit countries, mainly in terms of economic growth, job creation, increased public revenues, etc. Conversely, since almost all the transported volumes of natural gas will channeled to energy markets in central Europe, the environmental benefits of the project in transit countries are expected to be limited.

This paper aims at developing and implementing a methodological framework for quantifying the macroeconomic implications associated with the construction and operation of the TAP project in Greece, with a view to utilize these results to assess the Social Return On Investment (SROI) in question. SROI is an outcomes-based measurement tool that helps organizations to understand and quantify the social, environmental and economic value they are creating (Lawlor et al., 2008). Developed from traditional cost-benefit analysis and social accounting, SROI is a participative approach that is able to capture in monetized form the value of a wide range of outcomes, whether these already have a financial value or not (see for example Kuckshinrichs et al. 2010; Mirasgedis et al., 2014; Williams and Parker, 2010, for implementations of the SROI framework in energy projects).

Therefore, the macroeconomic implications examined in the context of this analysis, are expressed both in physical and monetary terms, in order to be directly comparable with the required investment costs and accelerating the evaluation of the attractiveness of the project from a social perspective. The methodological framework developed, combines the input-output analysis for estimating the direct, indirect and induced effects of the project in question on GDP, employment and various categories of public revenues (see indicatively Scott et. al. 2008; Pollin et al. 2009; Markaki et al. 2013, for the implementation of input-output analysis in estimating the macroeconomic effects of energy projects) with the adjusted earnings gain approach (Bartik et al., 2012) for monetized the estimated employment impacts (for an implementation of this method in energy efficiency projects see Mirasgedis et al., 2014).

As Greece is suffering from economic recession and high unemployment rates, the macroeconomic effects associated with the construction and operation of the project in question are of particular importance and have been examined in a number of studies undertaken in the past. Specifically, the Institute of Energy for South-East Europe (2011) compared the macro-economic effects that will be generated in the Greek economy from two competitive pipeline projects, the one of which was the TAP. They used input–output analysis and it was found that during the construction phase of the project, the output and the gross added value of the Greek economy will grow by €785 million and €371 million respectively, while 9,054 new jobs will be created. In another study, Danchev et al. (2013) examined the economic impact from the construction and operation of the TAP project on Greek territory, based on a Multi-Regional Input-Output Model. The results of the analysis show that the construction and operation of TAP, over a 50 year economic life, is expected to generate €33-36 billion of output in the Greek economy (direct and broader effects), about €17-18 billion of additional gross value added, and 4,300-4,800 jobs per year on average for almost five and a half decades (~8,000 – 10,000 during the construction phase).

Oxford Economics (2014) examined the economic impact of the TAP project in Albania using an input-output analysis, as well. The results of the study showed that in total, the construction phase of the project will generate directly €157 million in GDP and support 2,900 jobs (part-time and full-time) per year (€0.7 million and 13.8 jobs per km of pipeline, respectively). Including the indirect and induced effects, the construction of the project will generate €373 million in GDP (about €1.8 million per km of pipeline) and create 9,900 jobs (47 jobs per km of pipeline) per year. The operational effects during the 50 years life of the TAP, attributed to the project comprise €743 million contribution to GDP, creation of 22,500 job-years, and €400 million direct tax revenues (€3.5 million, 110 job-years and €1.9 million per km, respectively).

Several other studies have examined the macroeconomic effects of various gas pipelines projects. CHMURA Economics & Analytics (2014) examined the macroeconomic effects associated with the Atlantic Coast Pipeline (ACP) in three states, namely West Virginia, Virginia and North Carolina. The construction activities will result in increases of output by $3.1 million and the creation of 19.6 new jobs per km of pipeline constructed (average estimates for the whole region). When the pipeline is in full operation, the project is estimated to have an annual impact in the three-state region of $79,000 per km of pipeline, which can support 0.3 new jobs/km and increase the tax revenues by $476/km of pipeline. ECONorthwest (2012) presents the economic impacts in Oregon and Washington associated with the construction of the Jordan Cove Energy Project LNG terminal facilities and the Pacific Connector Gas pipeline. In terms of GDP, Oregon and Washington would experience a total increase of $1.738 billion (i.e., $4.5 million per km of pipeline) due to the construction activities between 2014 and 2017, creating 5,135 job-years (i.e., 14 job-years per km of pipeline).

Black and Veatch (2012) examined the economic impact of $200 billion in midstream investments (natural gas, oil and natural gas liquid) from 2012 until 2035 in the USA. They found out that the midstream infrastructure investments would generate $141 billion in labor income, $218 billion in GDP of USA, $16.8 billion in state and local taxes and $30.9 billion in federal tax revenues, supporting 104,579 job positions annually. In addition, operation & maintenance (O&M) expenditures between 2012 and 2035 will add $29.7 billion in labor income, $43.1 billion in GDP, $3.3 billion in total state and local taxes and $6.0 billion in federal tax revenues, supporting 20,760 jobs annually.

The added value of this paper compared to other similar works undertaken in the past for the TAP project in Greece is related to: (i) the quantification of a wider range of macro-economic impacts, particularly those related to public budget effects; and (ii) the monetization of the employment effects, facilitating their incorporation in cost-benefit analysis. More generally, the paper provides a methodological framework for quantifying in monetary terms a great variety of macro-economic implications associated with large energy investments, thus improving the decision-making process and allowing the estimation of the social return of the investment in question and (possibly) its social acceptance. Last, it shows quantitative evidence about the macroeconomic effects associated with the development of large natural gas projects in countries with relative limited production basis.

The structure of this paper is as follows: Section 2 describes the methodological approaches used in this paper. The TAP project and the main assumptions of the analysis are presented in Section 3. In Section 4, the methodological framework developed is applied to estimate the macroeconomic implications associated with the TAP project on Greek territory. Finally, in Section 5, the main findings of the study are summarized and conclusions are drawn.

2. Methodological Framework

2.1 Overview

As already mentioned, in the present work, we have quantified and monetized the macroeconomic implications associated with the construction and operation of the TAP project on the Greek territory.

As a large-scale investment, TAP contributes directly to the economy through direct payments, taxes, creation of employment, etc. In addition, the realization of the activities associated with TAP construction and operation requires the purchase of goods and services such as construction materials and equipment, maintenance tools, supplies, and equipment and manpower essentials such as food, clothing, spares, safety equipment, etc., enhancing further the economic development at both local and national level (indirect economic effects). Furthermore, as those engaged directly or indirectly in the project activities will increase their available income for spending, additional economic effects are expected due to the increased consumption for purchasing goods and services (induced economic impacts). In the context of this paper, we have analyzed all the direct, indirect and induced macroeconomic effects associated with TAP construction and operation activities, namely:

- Contribution to GDP through changes in Gross Value Added (GVA),
- Employment effects,
- Contribution to treasury (i.e., revenues for the government attributed to the economic activities associated with the project). These include: (i) income tax raised on employee's earning; (ii) corporation tax levies of companies' profit; (iii) social security contributions from employers and employees; (iv) revenues from VAT and other taxes on products and production.

The quantification of these effects is based on input-output analysis, which is presented in Section 2.2. The multipliers that can be derived from input-output tables and used for estimating the impacts on GDP, employment and other macroeconomic parameters are presented in Section 2.3, while Section 2.4 focuses on the approaches used for estimating the various categories of public revenues due to the realization of the project in question. Finally, with a view to accelerate cost-benefit analysis, the estimated direct, indirect and induced employment effects of the project have been monetized on the basis of the adjusted earnings gain approach, which is presented in Section 2.5.

2.2 Input-Output analysis

Input-output analysis is a methodological approach, which can evaluate the effects of an investment on key socio-economic variables taking into account the inter-sectoral linkages in the economy where the investment in question is realized. Specifically, input-output tables provide a complete overview of the monetary flows representing the exchange of goods and services in an economic system for a given year, either between producers and consumers or among economic sectors. The standard representation of the input-output model in matrix notation is defined in the following Equation, which allows constructing disaggregated multipliers in order to estimate the direct, indirect and induced impacts of a project (Leontief, 1966; Oikonomidis, 2007):

$$X = (I - A)^{-1} Y \quad (1)$$

where,

X: is the vector of output of the economy in question

(all elements of the vector are expressed in €).

Y: is the vector of final demand of the economy

(all elements of the vector are expressed in €).

I: is the identity matrix.

A: is a n × n matrix of technical coefficients. A technical coefficient a_{ij} is defined as the amount of production of sector i used by sector j in order for the latter to produce one unit of output. Through these coefficients one can estimate the direct impacts from an increase in final demand for a particular commodity on the various economic sectors.

The $(I - A)^{-1}$ is the n × n matrix of input–output multipliers, or the Leontief inverse. The rows and columns of the Leontief inverse matrix are the sectors of the economy and each element b_{ij} of this matrix shows the total required increase in the production of sector i to meet an increase of one unit in the final demand of sector j. The sum of all the elements of the j column of the Leontief inverse matrix gives the output multiplier of the sector j, which shows the total change in gross output (or sales) of the entire economy created by a change in the final demand of sector j by 1 €.

There are two types of Leontief inverse matrices, each one of them provides different type of multiplier. The first named Type I, includes the relationship among various economic sectors and is used to estimate the indirect economic effects. The second one named Type II, includes additionally the effect of households' consumption (by expanding the matrix with one column, namely the households' expenditure and one row, namely the compensation of employees) and is used in combination with Type I Leontief inverse to estimate the induced effects of a policy or project.

It is also worth mentioning that the input-output analysis is based on certain assumptions/prerequisites (Trewin, 2000), namely homogeneity (i.e., each sector produces a single output, has a single input structure and there is no substitution between the products of different sectors), proportionality (i.e., the change in output of a sector will lead to proportional changes in the quantities of its intermediate and primary inputs), and no existence of externalities (i.e., the production process of each sector does not affect the production activities of any other sector). Even though these assumptions are far from being realistic given the multiplicity and variability of processes in modern economies, input–output analysis is still considered as an attractive and powerful tool that is capable of adequately capturing the inter-linkages within an economic system. Since radical changes in economic structure can be assumed to occur relatively slowly, the results derived from such models can remain robust for many years.

2.3 Estimation of macro-economic effects through input-output analysis

Input-output tables can be used to estimate several of the macro-economic effects associated with a policy or an investment. These comprise impacts on employment, GVA, wages, taxes on products and production, etc.; for some others (e.g. income and corporate taxes) additional modifications are needed which are presented in Section 2.4. To this end, the total investment in question is disaggregated to a number of distinct economic sectors, which are included in the input-output table. It is assumed that the marginal change MX_j in the activity of sector j caused by the realization of the project in question incurs an analogous change in the level of various macro-economic parameters (i.e., employment, GVA, wages, taxes on products and production) that can be approximated by the following simple formula:

$$ME_j = MX_j \cdot \frac{E_j}{X_j} \tag{2}$$

Where ME_j is the marginal change of the macroeconomic parameter E, which characterizes sector j, from the marginal change MX_j of the output (X) of sector j. Thus, the direct effects on employment, GVA, wages, taxes on products and production, etc., from TAP construction and operation result as the sum of all marginal changes estimated in all sectors of the economy affected by the project in question.

The indirect and induced effects on these macro-economic parameters can also be estimated exploiting the input-output table through appropriate multipliers. As in the case of output, there are two types of macro-economic multipliers. Specifically:

- The Type I multiplier of the macro-economic parameter E ($M_{I,E}$) calculates the increase of E in the whole economy (direct and indirect effects) due to a unit direct increase of E in sector j:

$$M_{I,E,j} = \sum_{i=1}^{n} \frac{e_i \cdot b_{ij}}{e_j} \tag{3}$$

where $M_{I,E,j}$ is the Type I multiplier for the macro-economic parameter E and sector j, e_i (or e_j) is the corresponding macroeconomic effect creating in sector i (or j) per €1 of total output per sector i (or j) and $b_{i,j}$ is the Leontief coefficient which depicts direct and indirect impacts on the demand for the output of sector i as a result of changes in the demand of sector j.

- The Type II multiplier of the macro-economic parameter E ($M_{II,E,j}$) measures the ratio of direct, indirect and induced effects on E to the direct change of E in sector j:

$$M_{II,E,j} = \sum_{i=1}^{n} \frac{e_i \cdot b'_{i,j}}{e_j} \quad (4)$$

where $b'_{i,j}$ is the Type II Leontief coefficient.

By implementing this accounting framework, the macroeconomic effects attributed to the investments under examination per sector of economic activity can be estimated for the entire lifetime of the project in question. The results will be more reliable for the first years of the analysis while uncertainties increase in the long-run as the structure of the economy changes.

A key assumption for the analysis is to what extent the necessary equipment for developing the TAP project as well as the additional expenditures due to the increased income, occurs in Greece or elsewhere abroad. In the latter case, the estimation of the associated macroeconomic impacts should be based on this part of the expenditures that are spent inside the economy in question.

2.4 Estimation of public budget effects

This Section focuses on the revenues raised for the government as a result of the direct, indirect and induced economic activities in question. The analysis takes into account seven distinct types of public revenues and the approaches used for their quantification are shortly presented below.

- *Net taxes on products*: according to European System of Accounts 95 (European Commission, 2008), taxes on products comprise VAT, import taxes, tariffs, and other taxes on products. This category of taxes is described as a separate line in the input-output table and consequently the resulting Government revenues from the investment in question can be easily calculated using the approach described in Section 2.3 and the corresponding multipliers.
- *Net taxes on production*: they comprise taxes on the ownership or use of land, taxes on pollution resulting from production activities, subsidies received by agricultural farmers, etc. Similarly to the previous category, this type of taxes is included as distinct line in the input-output table and therefore the calculations are undertaken with an analogous approach.
- *VAT revenues*: VAT is usually paid by final consumers, so in the context of this analysis VAT revenues are estimated as a percentage of the induced effects on GDP attributed to the construction and operation activities of the project in question.
- *Social security contributions of employers*: on sectoral level this information is provided by input-output tables subtracting the “wages, salaries” from “compensation of employees”. Then, the contributions attributed to the economic activities of the project in question are calculated using the approach described in Section 2.3 and the corresponding multipliers.

- *Social security contributions of employees*: in Greece the social security contributions of employees are estimated as a certain percentage of their gross salary. Consequently, in the context of this analysis, the relative contributions are calculated on the basis of the new direct, indirect and induced employment created per sector of economic activity due to the project activities in question (for details see Section 2.3), the average gross salary per economic sector and the social insurance rate paid by employees.
- *Income taxes*: their estimation is based on the official personal income tax rates implemented in Greece. The new employment created due to the project activities can be covered either by workers previously unemployed or by existing personnel through overtime working (see Section 2.5 for a more analytical discussion on this issue). For the former the income taxes collected by Exchequer are estimated taking into account the number of employees in each sector that were previously unemployed, the average gross salary per sector of economic activity (excluding the social security contributions) and the corresponding level of personal tax in each sector by applying the current progressive tax scale. For the latter, the income taxes collected are estimated on the basis of the full-time equivalent jobs that were covered by existing workers in each sector, the average gross salary per sector of economic activity (excluding the social security contributions) and the highest tax rate implemented to the average gross salary of the corresponding economic sector.
- *Corporation tax levied on companies' profits*: the realization of the economic activities in question generates profits for the companies providing those services as well as all the companies along the supply chain. In the input–output table, the profits of the companies are recorded as net operating surplus, and therefore the profits generated due to the economic activities in question can be estimated on the basis of the process described in Section 2.3 and the appropriate multipliers. Then, the resulting public revenues are calculated implementing the applicable tax rate on corporate profits.
- *Avoided cost of unemployment*: as already mentioned part of the new jobs created due to the project activities will be covered by the pool of previously unemployed workers. This will result in public budget benefits as fewer people will receive unemployment benefit and they can be calculated by multiplying the number of workers engaged in project activities and were previously unemployed, the percentage of unemployed workers that receive unemployment benefit, and the level of this unemployment benefit.

2.5 Monetization of employment benefits

The valuation of the estimated employment effects is of particular importance in order to easily incorporate this type of impacts in cost-benefit analysis. Bartik (2012) presents two feasible approaches for measuring the employment benefits, namely: (i) the *adjusted reservation wage gain approach*, which assumes that the reservation wage (i.e., the lowest wage at which the worker is indifferent between working and continuing to search for a job) measures the value of worker access to the labor market; (ii) the *adjusted earnings gain approach*, which assumes that the worker's willingness to pay for policies creating extra employment will be equal to the increased earnings minus the value of the worker' reduced leisure time, adjusted for stigma effects.

A simplified version of the adjusted earnings gain approach is used in the context of this analysis for monetizing the employment benefits associated with activities in question. In a free and competitive economy when a new job position is created there is a probability this to be covered either by a worker previously unemployed (P) or by an existing worker (1-P) through overtime working. Consequently, the resulting employment benefits (B) can be estimated through the following formula:

$$B = P \cdot (W_n - I_o - L + S) + (1 - P) \cdot (W_n - W_o) \quad (5)$$

Where W_n is the individual's, income as a result of the new job, W_o is the individual's wage from the previous working conditions, I_o is the potential income the individual had as unemployed (e.g. unemployment benefits, income from informal employment that cannot be continued), L the value of time that the person had at his or her disposal in cases that he or she was previously unemployed and S an economic measure of health and psychology effects associated with unemployment (stigma effects).

The estimation of the probability P mentioned in the above formula depends on the unemployment rate of the economy where the new position job is created and ranges between 0 and 1 (Haveman and Krutila, 1968). Specifically, if the unemployment rate in an economy is lower than 5%, which is considered as normal rate, then it is assumed that P equals to 0 and all new jobs will be covered by people already employed through overtime working. On the other hand, if the unemployment rate is high (e.g. 25%) it is assumed that the new jobs will be covered by previously unemployed persons and P equals to 1. Therefore, the value of P for levels of unemployment between these two extremes, can be calculated through interpolation or the empirical function proposed by Haveman and Krutilla (1968).

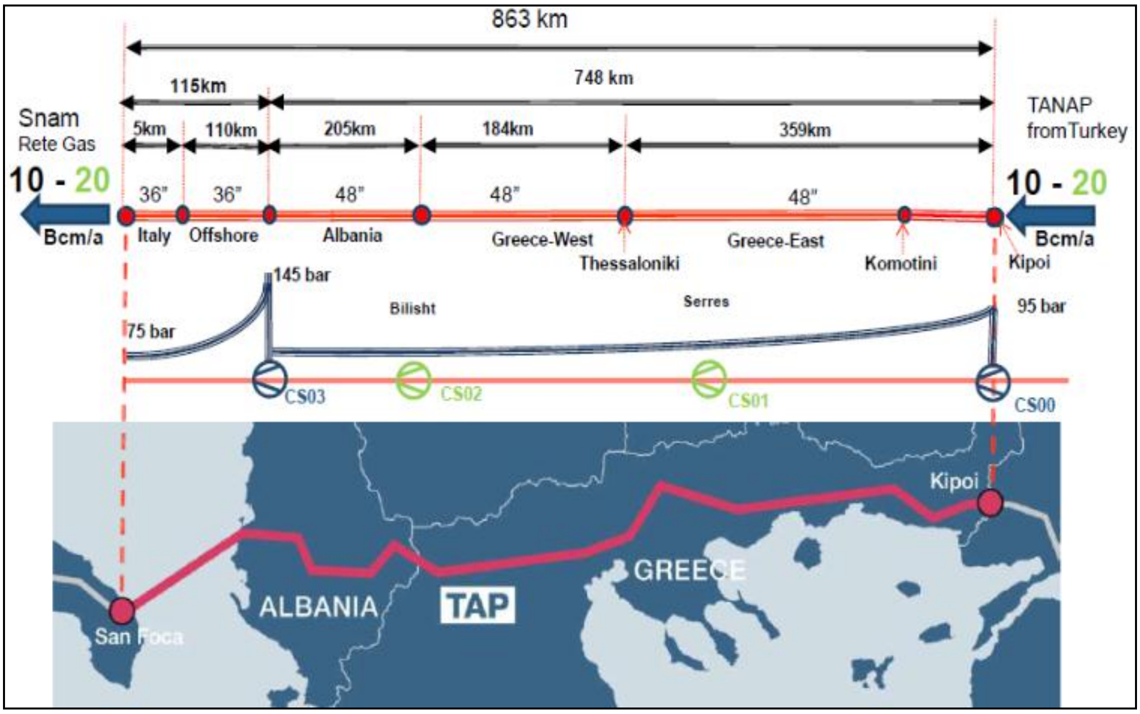
The values of fiscal parameters included in Eq. 5 (i.e., W_n, W_o, I) are estimated on the basis of statistical data and assumptions, which are analytically presented in Section 3.

The value of leisure time (L) as well as health and psychology effects associated with unemployment (S) present significant uncertainties. For a more analytical discussion about the factors influencing the economic magnitude of these parameters see Gwilliam (1997), Markandya (1998) and Fujiwara (2010). In the context of this analysis, the value of leisure time is expressed as a percentage of the gross wage (Markandya, 1998). The stigma effects associated with unemployment include a range of social phenomena, such as higher levels of mortality and morbidity, alcoholism, criminality, etc. The quantification of such effects is usually based on social surveys and statistical analyses, and the results may differ significantly among countries. So, in the context of this analysis the health and psychology effects associated with unemployment are not taken into account.

3. Case Studies, Data And Assumptions

The TAP project will cross Greece and Albania and across Adriatic Sea will be connected with the Italian gas network (**Figure 1**). It will have a total length of 863 km (543 km in Greece, 205 km in Albania, 110 km in the Adriatic Sea and 5 km in Italy) (TAP AG, 2013). The diameter of the pipeline will be 48 in. in the onshore section and 36 in. in the offshore section. The pipeline is scheduled to transfer 10 bcm per year, but there is the possibility to double annual capacity to 20 bcm by increasing the power of existing compressor station in Kipois and installing two additions compressor stations, in Serres and in the Greek-Albanian borders in Albania (TAP AG, 2013). The analysis presented in this paper concerns the full development of the project.

Figure 1: The TAP project



Source: TAP AG (2013)
Bcm/a: billion cubic meters per year; CS: compressor station.

The lifetime of the TAP project is taken equal to 50 years; however, based on the international experience of pipeline technology it is expected that the TAP project will operate for a longer period. Electromechanical equipment in compressor stations will be replaced after 25 years (TAP AG, 2013).

The project in question involves the following infrastructure on Greek territory: (i) a terrestrial underground pipeline of 543 km length and 48 in. diameter; (ii) 22 block valve stations along the pipeline; (iii) a compressor station in the Kipois region with a capacity of 75-90 MW; and (iv) a second compressor station of 100-125 MW in Serres.

The total investment cost of the TAP project in Greece will be €1.5 billion (Ministry of Foreign Affairs, 2013). It is assumed that part of the necessary equipment corresponding to investments of €400 million will be directly imported from abroad while the rest of the investment costs will be either spent domestically or imported through Greek trade companies. The analysis undertaken in the context of this analysis relies on these domestic activities, with a view to estimate the beneficial impacts on economy and employment occur within the country. The operation and maintenance cost of the project has been taken equal to 2% of the investment cost (Knoope et al., 2013). Table 1 presents the total spending required for the realization and operation/maintenance of the project in question, the part of this spending that will take place domestically and the analysis of spending per sector of economic activity. These disaggregations have been based on a literature review and empirical information drawn from other relevant projects.

Table 1: Total and domestic spending for the construction and operation of the TAP project in Greece disaggregated per sector of economic activity

Economic sector	Construction (in M€)		Operation (in M€/year)	
	Domestic investments	Total investments	Domestic investments	Total investments
Fabricated metals	183.1	244.1	0	0
Machinery & equipment	59.7	284.6	1.8	9.0
Repair & installation of machinery & equipment	0	0	5.4	6.0
Construction	546.8	648.6	5.4	6.0
Warehousing and support services for transportation	123.8	123.8	0	0
Accommodation and food services	75.0	81.6	0	0
Legal, accounting and consulting services	44.8	47.8	2.7	3.0
Administrative services	66.7	69.4	5.7	6.0
Total	1099.9	1500.0	21.0	30.0

Source: Ministry of Foreign Affairs (2013) and own assumptions

The analysis of the macroeconomic effects has been done with the most recent Input-Output table for the Greek economy, which refers to the year 2010. Furthermore, as the unemployment rate in Greece for the period 2014-2018 (the construction period of the project) is expected to decrease from 24.5% to 15.9% (Alpha Bank, 2014), the analysis was undertaken assuming an unemployment rate of 20%. Consequently, the share of newly employed workers that were previously unemployed is estimated at 87.5% on the basis of the function proposed by Haveman and Krutilla (1968).

In addition, the estimation of the increased public revenues and the employment benefits associated with the project in question were undertaken on the basis of the following data and assumptions:

- In Greece, public revenues from VAT amounting to 7.1-7.3% of GDP over the period 2010-2012 (Eurostat, 2014). In the context of this analysis, VAT revenues have been estimated as 7.2% of the induced effects on GDP.
- Taking into account the most recent data from the OECD database for Greece, which concern the year 2013, social security contributions of employees are estimated as 16% of their gross salaries in each sector of economic activity.
- Data on gross average earnings per economic sector and employee in Greece have been derived by Eurostat database. Income taxes are then estimated on the basis of the applicable tax scale on gross earnings excluding social security contributions. The

resulting net average earnings have been used for estimating the employment benefits according to the methodology described in Section 2.5. In case a new job position is covered by existing employees through overtime working, it is assumed that the worker will increase his/her income by 15%.

- Revenues from corporate taxation are estimated implementing the applicable tax rate of 26% on corporate profits in Greece.
- Based on data of Greek Manpower Employment Organization, it was assumed that about 15% of unemployed persons in Greece receive an employment reward for 12 months. The average level of these unemployment payments was €400 per month in 2013.
- The value of leisure time a person had when he or she was previously unemployed equals to 15% of the gross income (Markandya, 1998).
- The health and psychology effects associated with unemployment are not taken into account in the context of this analysis.

4. Results

The results of the analysis clearly show that the construction and operation of the TAP project in Greece will have significant macroeconomic implications. In **Figure 2**, the estimated impact per effect (i.e., direct, indirect and induced) created by the construction activities of the TAP on GDP, employment and public revenues are presented in monetary terms. Similarly, **Figure 3** presents the annual direct, indirect and induced benefits on GDP, employment and public revenues attributed to the operation of the project in question.

In total, it was estimated that construction activities will contribute €931.1 million to Greek GDP of which 44% is created directly, 38% indirectly and 18% induced. Assuming that the development of the project will last 4 years the average annual increase of GDP is expected to be €232.8 million, which corresponds to 0.13% of the country’s GDP. From 2019 onward, ongoing operation will increase national GDP by €17.1 million annually, 44% of which is attributed to direct activities while the rest 35% and 21% are due to indirect and induced effects.

Figure 2: Direct, indirect and induced macroeconomic effects attributed to the construction activities of the TAP project in Greece (in € million)

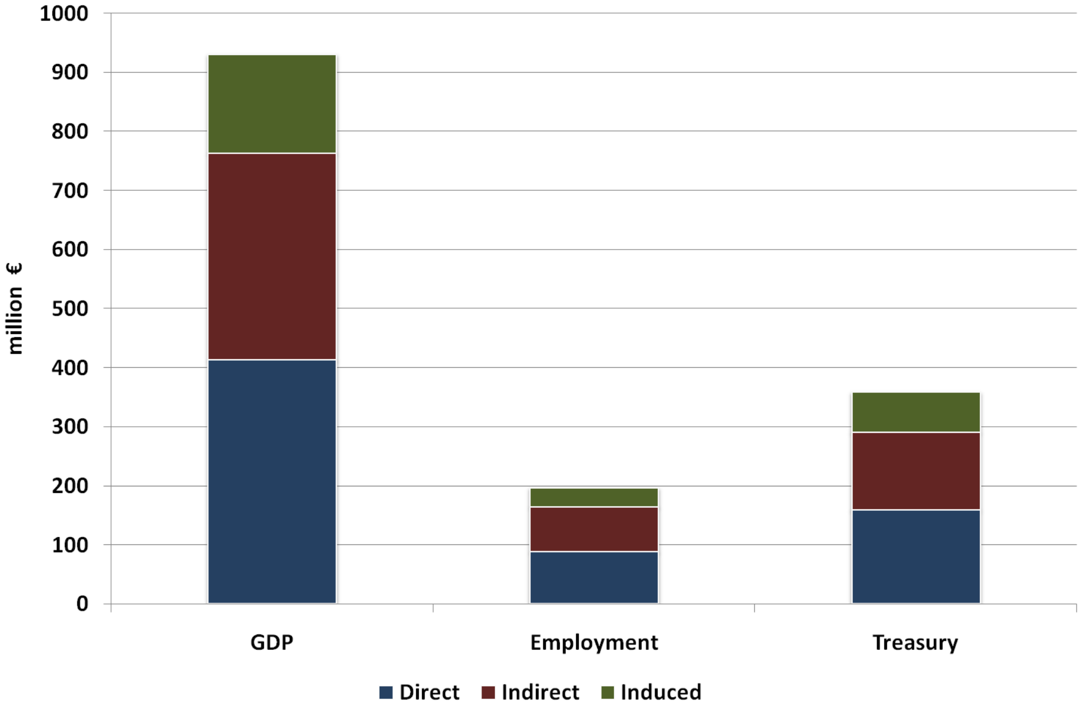
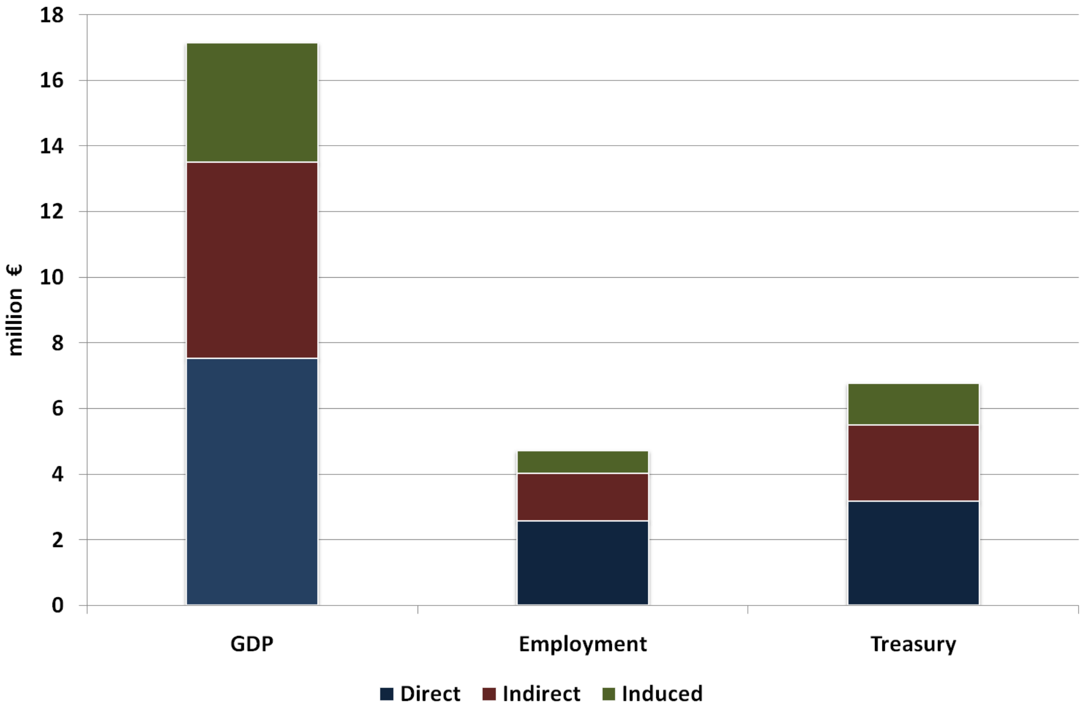


Figure 3: Direct, indirect and induced macroeconomic effects attributed to the operation phase of the TAP in Greece (in € million/year)



Furthermore, the project in question will support approximately 21,900 full time equivalent job-years or approximately 5,500 permanent jobs during the 4 years of construction, of which 49% is attributed to direct spending (Table 2). Firms supporting pipeline and related facility construction will support 7,827 cumulative job-years during the construction period (indirect employment effects), while the induced jobs concentrated in consumer service-related industries are estimated at 3,462 cumulative job-years. The annual employment caused by the operation of the project is estimated to 420 full-time equivalent jobs, of which 53% is created directly, 29% is created indirectly and 18% is induced. Economic valuation of the employment effects on the basis of the methodological framework presented in Section 2 shows that employment benefits will reach €196.8 million (€49.2 million per year) during the construction period and €4.7 million per year during the operation of the project.

Table 2: **Direct, indirect and induced employment effects associated with the construction and operation activities of the TAP project in Greece**

Employment	Construction (job-years)	Operation (job-years/year)
Direct	10,645	222
Indirect	7,827	122
Induced	3,462	75
Total	21,934	420

Furthermore, construction and operation of the pipeline in question will generate significant revenues for the Greek Exchequer. The results of the analysis show that the project will raise cumulatively €358.9 million during the construction phase and annually €6.8 million during the operation of the project. About 44% of these effects during construction activities and 47% during operation are created directly, while the rest 56% during construction and 53% during operation via indirect and induced channels. The analysis of the components (Figure 4), which contributes to the treasury effects shows that during construction the biggest percentage of the expected revenues comes from corporation tax levied on companies' profit (€115.4 million).

Revenues attributed to social security contributions from employers and employees (€73.7 million and €54.9 million correspondingly) as well as taxes on products (€57.3 million) are also quite important. On the other hand, income taxes, the avoided cost of unemployment, the VAT and the taxes on production are estimated to have lower contribution (€30.9 million, €13.7 million, €12.6 million and €0.5 million correspondingly) to the public revenues associated with construction activities. The relatively low revenues from income tax are attributed to the fact that according to the results of the analysis about 86.5% of the job-years created by the project activities are covered by previously unemployed workers and therefore a significant part of their income is not taxed or taxed at lower tax rates. Also, the VAT revenues are relatively low as for their estimation only the induced effects on GDP due to the project activities have been taken into account. Regarding to the public revenues associated with the operation of the TAP (Figure 5), again the corporation tax levied on companies' profit and the social security contributions from employers will have the highest contribution to the treasury effects (€1.6 million per year for both components).

Figure 4: Direct, indirect and induced treasury effects associated with the construction activities of the TAP project in Greece (in € million)

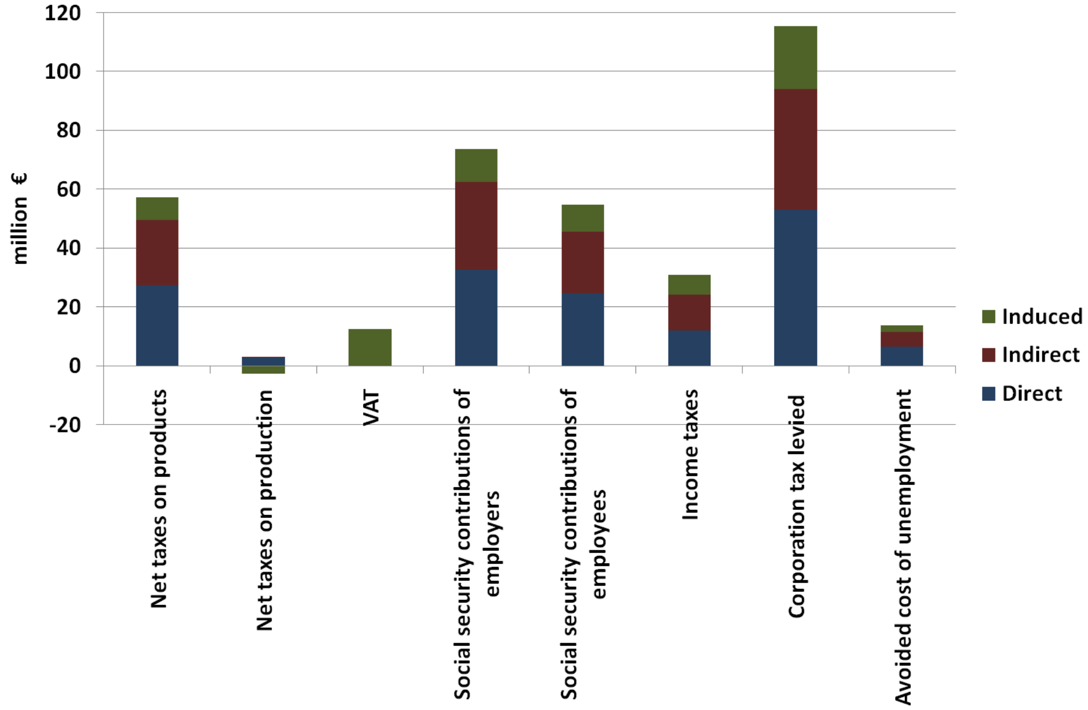
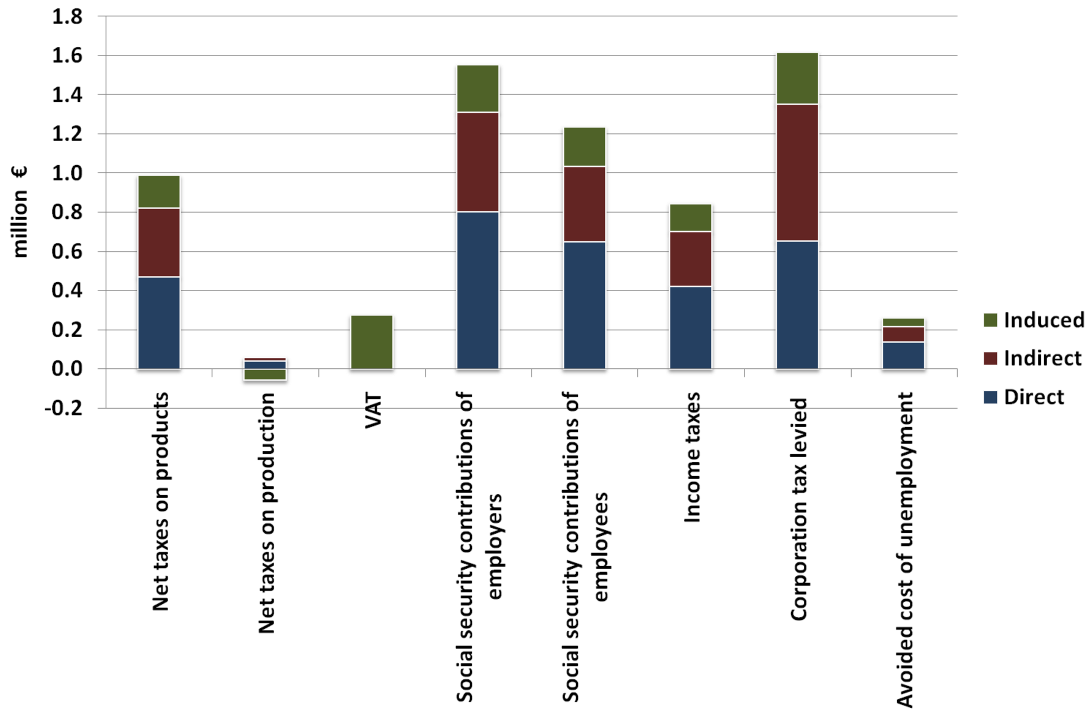


Figure 5: Direct, indirect and induced treasury effects associated with the operation activities of the TAP project in Greece (in € million/year)



Moreover, Table 3 presents a sectoral distribution of the total estimated effects on GDP, employment and public revenues due to the construction and operation of the TAP project in Greece, highlighting those economic sectors that will mainly benefit from the realization of the project. Manufacturing and construction sectors will have the highest contribution to the triggered effects during the construction of the TAP, while the main effects during the operation of the TAP will be emanated mainly by the sectors of manufacturing, construction and administrative and support service activities.

Table 3

Allocation of the direct, indirect and induced macroeconomic effects (in € million) attributed to the construction and operation activities of the TAP project in Greece (for construction activities the results are cumulative while for operation activities are annually)

	GDP		Employment		Treasury	
Sector	Construction	Operation	Construction	Operation	Construction	Operation
Agriculture, hunting, forestry and fishing	7.1	0.1	0.5	0.0	0.0	0.0
Mining and quarrying	1.3	0.0	0.6	0.0	0.7	0.0
Manufacturing	120.7	2.9	35.8	1.3	52.0	1.2
Electricity, gas, steam and air conditioning supply	9.1	0.2	1.5	0.0	4.4	0.1
Water supply; sewerage, waste management and remediation activities	4.2	0.1	1.0	0.0	1.3	0.0
Construction	334.8	3.4	68.9	0.7	128.1	1.3
Wholesale and retail trade; repair of motor vehicles and motorcycles	51.4	0.9	14.5	0.2	21.7	0.3
Transportation and storage	84.1	0.3	14.6	0.0	30.3	0.1
Accommodation and food service activities	84.9	0.5	8.2	0.0	28.5	0.2
Information and communication	23.0	0.5	3.5	0.1	8.6	0.2
Financial and insurance activities	20.3	0.4	8.1	0.2	12.1	0.2
Real estate activities	47.1	1.0	1.0	0.0	10.4	0.2
Professional, scientific and technical activities	62.8	2.3	10.2	0.4	23.4	0.8
Administrative and support service activities	55.3	4.1	20.7	1.5	25.8	1.9
Public administration and defence; compulsory social security	0.8	0.0	0.4	0.0	0.5	0.0
Education	5.7	0.1	2.6	0.1	3.2	0.1
Human health and social work activities	5.5	0.1	2.0	0.0	2.5	0.1
Arts, entertainment and recreation	5.4	0.1	0.5	0.0	2.0	0.0
Other service activities	7.7	0.2	2.4	0.1	3.3	0.1
Total	931.1	17.1	196.8	4.7	358.9	6.8

5. Conclusions

The present study explored the macroeconomic effects associated with the construction and operation of the TAP project in Greece, including the impact on GDP, employment and public revenues, by sector of economic activity, in quantitative and monetary terms. The input–output methodological framework has been used for estimating the macroeconomic implications of the project under consideration in conjunction with the adjusted earnings gain approach for monetizing the resulting employment effects.

It is interesting to compare the results of this study to similar work, already summarized in Introduction. Regarding to the construction activities, comparing values for GDP and job creation in Greece per km of pipeline developed, with those of Oxford Economics (2014) for the TAP project in Albania, CHMURA Economic & Analytics (2014) for the ACP project in the US, and ECONorthwest (2012) for the Pacific Connector Gas pipeline, one sees that the results derived are in the same order of magnitude. For example, for construction activities the corresponding job-years created per 1 km of pipeline are 47, 20 and 14, respectively, as compared with 40 for Greece. Similar agreement is found for impacts on GDP, as the TAP project in Albania will contribute €1.8 million on the Albanian GDP per km of pipeline slightly higher compared to €1.7 million/km estimated for Greece, while the relevant value in the case of the Pacific Connector Gas pipeline has been estimated at €3.3 million (a value of 1.35$/€ has been used for conversion). The estimated macroeconomic effects present larger deviations during the operation of the pipelines in question. Specifically, the operation of the TAP in Greece will create annually 0.8 job per km of pipeline, more than double the estimated employment in ACP (0.3 jobs per km of pipeline) but considerably lower compared to the TAP project in Albania (2.1 jobs per km of pipeline). Differences in the technological characteristics of the projects in question, in geomorphological characteristics of the areas that the pipelines will be developed as well as in the structure of the economies in which they take place can explain the observed deviations to a large extent.

Furthermore, the results of this study are more conservative compared with those generated by Danchev et al. (2013), which also analyzed the macroeconomic effects of the TAP project in Greece. Specifically, Danchev et al. (2013) estimated that the average annual employment during construction activities will reach 7,909 jobs, of which 2,401 direct. Our estimates show that the construction of the project in question will create annually 5,484 jobs, of which 2,661 direct. The estimated direct effects in the two studies are quite close, while the induced effects estimated in our study are considerably lower compared to those estimated by Danchev et al. (2013). Last, Energy for South-East Europe (2011) estimated that the macroeconomic effects of the TAP project in Greece will be less significant; however, these results have been derived assuming that the investment costs of the project will be considerably lower compared to those adopted in our study.

Despite the different estimates, all studies agree that the investment in question will have significant macroeconomic benefits to the Greek economy. The results of our analysis show that the construction activities will contribute to the Greek GDP by €931 million, supporting 21,900 job-years of employment and increasing the public revenues by €359 million. From 2019 onward, ongoing operation can increase annually the GDP by €17.1 million, supporting 420 jobs and generating annual tax revenue of €6.8 million. Assuming a lifetime for the project equal to 50 years, the total tax revenues are estimated at almost €700 million and the employment benefits at €430 million. If one takes into account the possibility offered by the project in question for further penetration of the natural gas into the Greek energy system, additional social benefits associated with improved environmental conditions, enhancement of energy security and diversification of energy supply sources may arise.

The accounting framework developed and implemented in the context of this study allows for a detailed quantification of the various macroeconomic effects associated with the realization of energy investments. As unemployment is one of the most significant social problems in many countries, monetization of the employment effects is of particular importance and may assist in the incorporation of these implications in social cost-benefit analysis. More generally, the economic valuation of the macroeconomic, environmental and energy security impacts associated with the implementation of energy projects, can improve decision-making processes by indicating the technologies, policies and scenarios, which maximize the social return on investment.

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