ΙΔΡΥΜΑ ΟΙΚΟΝΟΜΙΚΩΝ & ΒΙΟΜΗΧΑΝΙΚΩΝ ΕΡΕΥΝΩΝ
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ECONOMIC IMPACT FROM THE CONSTRUCTION AND OPERATION OF THE TRANS ADRIATIC PIPELINE ON GREEK TERRITORY

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Study team:

Svetoslav Danchev

Nikos Paratsiokas

Aggelos Tsakanikas

Foundation for Economic and Industrial Research (IOBE)
11, Tsami Karatasou Str, 117 42 Athens,
Tel. (+30210 9211200-10), Fax:(+30210 9233977)
http://www.iobe.gr

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HIGHLIGHTS

- **The Trans Adriatic Pipeline constitutes a foreign direct investment with considerable benefits at difficult times for the Greek economy.**
- **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 in total.**
- **TAP is expected to generate between 4,300 - 4,800 jobs per year on average for almost five and a half decades (~8,000 – 10,000 during the construction phase).**
- **The impact of the project is concentrated at regions that are hurt strongest by the unprecedented depression.**
  - **Almost 3/5 of the investment's total impact on output in the Greek economy occurs in Northern Greece (Macedonia and Thrace).**
- **In East Macedonia - Thrace, TAP would lead to an increase of GVA by about €65 million per year during the construction period and about €85 million on average per year during its five decades of operation.**
  - **In employment terms, on average 600 people will be employed each year in the region as a result of TAP for more than five decades.**
  - **More than 1,800 employees during the construction phase.**
- **TAP would generate about €80 million GVA in Central Macedonia during the construction phase and almost €90 million during the operation phase.**
  - **Approximately 1,200 people will be employed in the region.**
  - **More than 2,200 employees during the construction phase.**
- **In Western Macedonia, TAP would generate €30 million of value added during the construction phase and about €40 million during operation.**
  - **On average, the employment in the region will be boosted every year by about 500 jobs.**
  - **Almost 800 additional jobs during construction.**
- **The materialisation of the long-term benefits to their full extent requires a more proactive entrepreneurship, non-distortive legislation and supportive socio-political climate.**

EXECUTIVE SUMMARY

The Trans Adriatic Pipeline (TAP) is a project that competes to transport gas originating in the Caspian region through Greece and Albania to the Italian market. Currently, TAP is the only route left that crosses Greek territory among those competing to transport gas from the second phase of the development of the Shah Deniz field in Azerbaijan.

Large-scale foreign investments, such as TAP, contribute directly to the economy through direct payments (taxes etc.), employment during construction & operation and voluntary contributions. In addition, the economy benefits indirectly through the employment, procurement of goods and services and other output that occurs along the supply chain. Moreover, the additional income that accrues to workers employed by TAP and across the wider supply chain translates into consumer purchases, resulting in further rounds of economic activity. Meanwhile, export advantage could also accrue to companies, who have enhanced their expertise as a result of their involvement with TAP, which can be used in other similar projects abroad or have reduced their production cost by gaining access to natural gas.

The purpose of the study is to quantify the impacts of TAP on the Greek economy. The study investigates the direct and the broader effects on output, gross value added and jobs across all the sectors of the Greek economy from the construction and operation of TAP. The scope of the study includes a breakdown of the benefits at regional level and in particular for each of the regions in Northern Greece that host sections of TAP (East Macedonia and Thrace, Central Macedonia, West Macedonia). It covers both the 3-year construction phase and the 50-year operations phase.

Methodology

For the purposes of this study we developed a Multi-Regional Input-Output Model with a long-term projection, using well-established methods and techniques. In particular, we broke down the national input-output table down to regional level, applying the Cross-Industry Location Quotient (CILQ) method with employment data. In order to capture the interregional dependencies, we used the Leontief-Strout Gravity Model (LSGM). For the extension of the input-output analysis over the lifespan of the pipeline, we projected the input-output tables using Eurostat's Euro method. The projection utilised assumptions on the future structure of the Greek economy that reflect the expected trends in technology and trade.

Impact of TAP on the Greek economy

The construction and operation of TAP over a 50 year economic life is expected to generate total output between €33 - 36 billion in the Greek economy. The variation comes from uncertainty, regarding the source of supply of the pipes for the project. There are Greek companies that have gained sufficient expertise to be capable of supplying pipes for similar projects internationally. Nevertheless, whether they would win the contract for TAP would depend on the outcome of the trade negotiations between the company and its potential suppliers.

In terms of gross value added, the impact from the investment is estimated at €18 billion in the case of domestic pipe production (Figure 1) and €17 billion under the imported pipes scenario. Out of this estimate, more than €5 billion correspond to value added generated through the operation of the project itself (i.e. taxes, depreciation expenses, net operating surplus, etc.). With respect to employment, TAP is expected to generate between 235 and 260 thousand job-years across the Greek economy. In annual terms, this corresponds to 4,300 to 4,800 jobs to Greek residents per year on average for almost five and a half decades (~8,000 – 10,000 during the construction phase).

Figure 1: Impact on value added and employment in Greece, domestic pipes scenario, 2015-2068

Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

The results are comparable with those generated by other studies. A study conducted in 2011 by IENE estimated that TAP's construction would generate €371 million GVA p.a. in Greece (IENE, 2011), compared with €402 million in the domestic pipe scenario and €315 million in the imported pipe scenario of our study. Similarly, IENE's study estimated that 9,054 people will be employed for TAP's construction, compared with 9,992 in our estimations for the domestic pipe scenario and 7,909 for the imported pipes scenario. Moreover, given that our study includes the section of the pipeline between Komotini and Kipi that was only recently added to the project, our impact estimates can be seen as conservative, for the construction phase at least.

In addition, our estimates on employment are quite close to those produced using Ministry of Finance's instructions for NSRF candidates (Υπουργείο Οικονομίας και Οικονομικών, 2009). The direct effect on employment during construction (excluding employment along the value chain and wider employment effects), estimated using these instructions, amounts to 10,688 job-years, which is fairly close to our estimate of 10,983 job-years.

Impact of TAP on the economy of Northern Greece

The Trans Adriatic Pipeline is routed to pass through the administrative regions of East Macedonia-Thrace, Central Macedonia and West Macedonia, which often are colloquially grouped as Northern Greece[1]. The construction of TAP is expected to generate a total of €20 billion of output over the lifespan of the project in this group of administrative regions (Figure 2). This represents almost 3/5 of the investment's total impact on the Greek economy, with the remaining 2/5 of the impact occurring in the remaining Greek regions that would supply Northern Greece with the required goods and services.

It should be noted that the domestic and imported pipes scenaria yield similar results for the regions of Northern Greece. This is due to the fact that key Greek pipe suppliers are situated outside these regions (i.e. in Central Greece and Peloponnese).

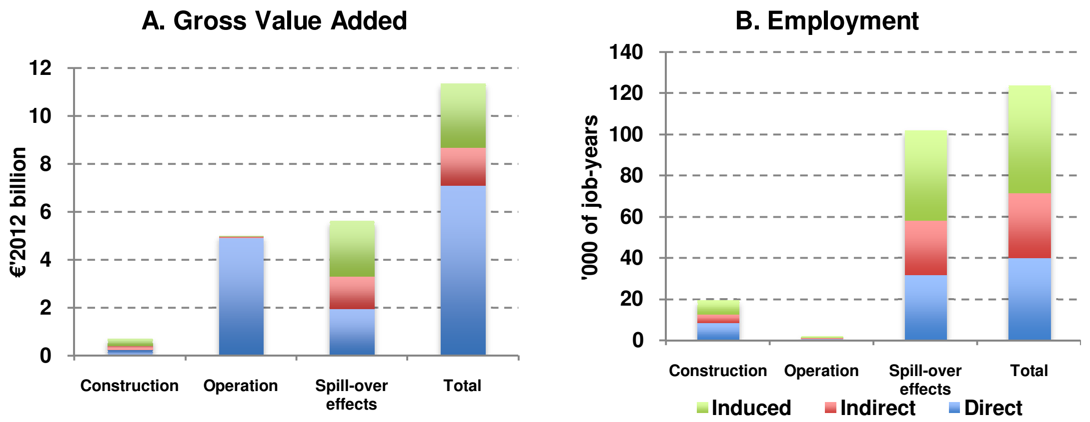
In terms of gross value added, the impact is estimated at €11.4 billion (Figure 2), with almost half of this (€5 billion) resulting directly from the operation of the pipeline. On an annual basis, the investment would generate €180 million on average during the construction phase and €210 million during the pipeline's operation.

In addition, the investment is expected to support more than 120 thousand job-years during the entire period. This implies that on average more than 2,200 people would

[1] Not to be confused with EU NUTS 1 region of Voreia Ellada (lit. Northern Greece), which also includes the region of Thessaly.

be employed in Northern Greece each year over more than five decades as a result of TAP.

Figure 2: Impact on Value Added and Employment in Northern Greece, 2015-2068

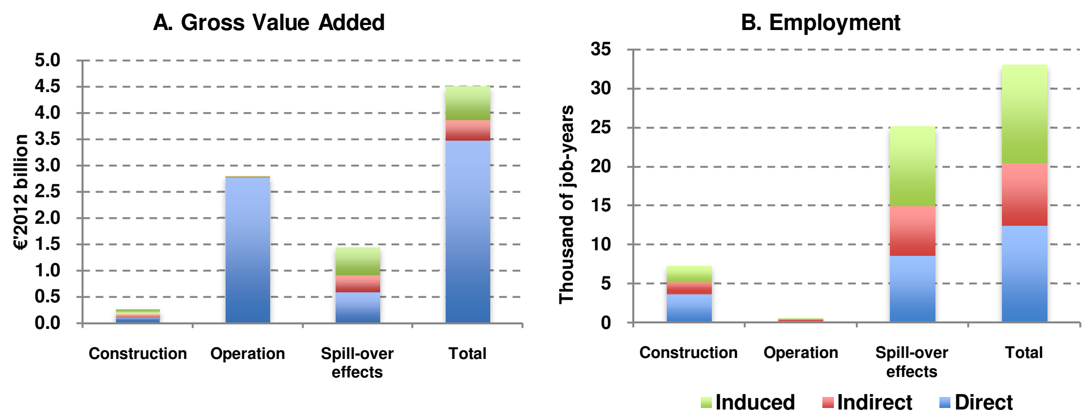


Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

Impact of TAP on the economy of East Macedonia – Thrace

In East Macedonia-Thrace, TAP is estimated to boost the total value of production by about €7 billion. This corresponds to about a third of the overall impact on Greek territory. It should be noted that the impact in the region is boosted significantly by the fact that it would host a compressing station near Komotini.

Figure 3: Impact on Value Added and Employment in East Macedonia – Thrace, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In terms of gross value added the total impact over the life-time of the project is estimated at €4.5 billion, of which almost €2.8 billion (or more than 60%) comes directly from the operation of the project (Figure 3). Annually, TAP would lead to an increase of GVA by about €65 million during the construction period and about €85 million during operation.

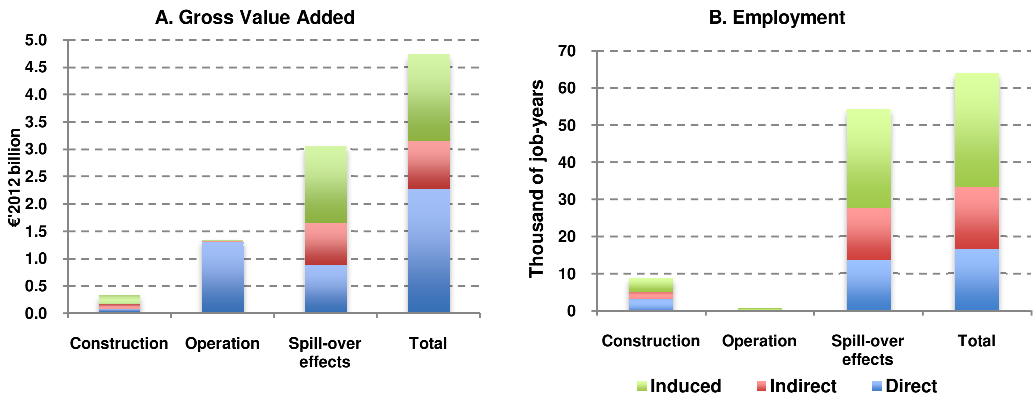
In employment terms, more than 33 thousand job-years will be created in the region over the entire lifetime of the investment, which is almost a quarter of the investment's total impact on employment. This implies that on average 600 people will be employed each year in the region as a result of TAP for more than five decades (more than 1,800 during the construction phase).

Impact of TAP on the economy of Central Macedonia

In Central Macedonia the construction of TAP is expected to expand output, through the entire life of the investment, by more than €9 billion, almost half of the investment's total impact in Northern Greece (Figure 4). Unlike, however, East Macedonia-Thrace and Western Macedonia most of the impact would come from export effects on suppliers due to stronger activity in the region in the Machinery and Equipment sector.

In terms of Gross Value Added this translates to more than €4.7 billion of which almost 30% (or €1.4 billion) comes from TAP's operation itself. These estimates imply that on an annual basis TAP would generate more than €80 million GVA in the region during the construction phase and almost €90 million during the operation phase.

Figure 4: Impact on Value Added and Employment in Central Macedonia, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

The pipeline project will boost employment in the region by 65 thousand job-years, representing almost half of the investment's total impact on employment in Northern

Greece. On average each year, approximately 1,200 people will be employed in the region (more than 2,200 during the construction phase).

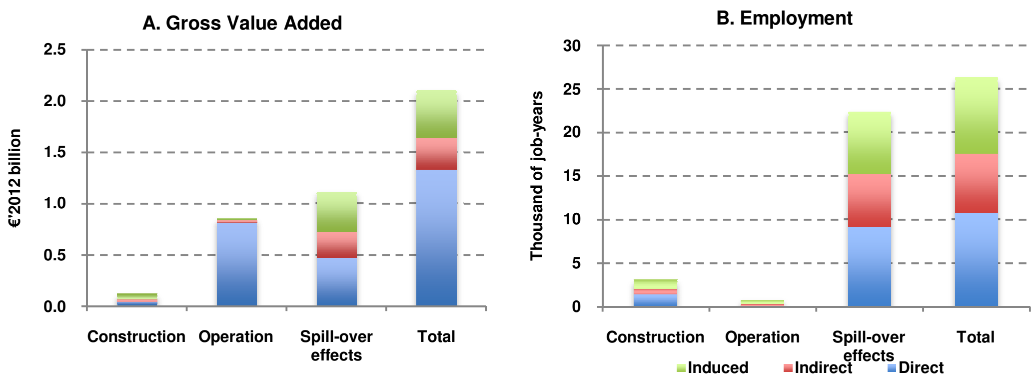
Impact of TAP on the economy of West Macedonia

In Western Macedonia the construction of TAP is expected to generate more than €4 billion of output, representing almost 1/5 of the investment's total impact in Northern Greece. More than 1.1 billion euro of the total output would come from the eventual introduction of natural gas to the fuel mix in the region.

It should be noted, however, that further actions, such as an establishment of a gas distribution company, construction of a low pressure grid, negotiations of a gas supply contract with gas producers, etc. are also required to enable the penetration of natural gas in the region's economy.

Further economic benefits for the region could be expected in the future, in case an additional compressor station is constructed near the border with Albania in order to double the capacity of the pipeline as more gas becomes available upstream.

Figure 5: Impact on Value Added and Employment in West Macedonia, 2015-2058



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

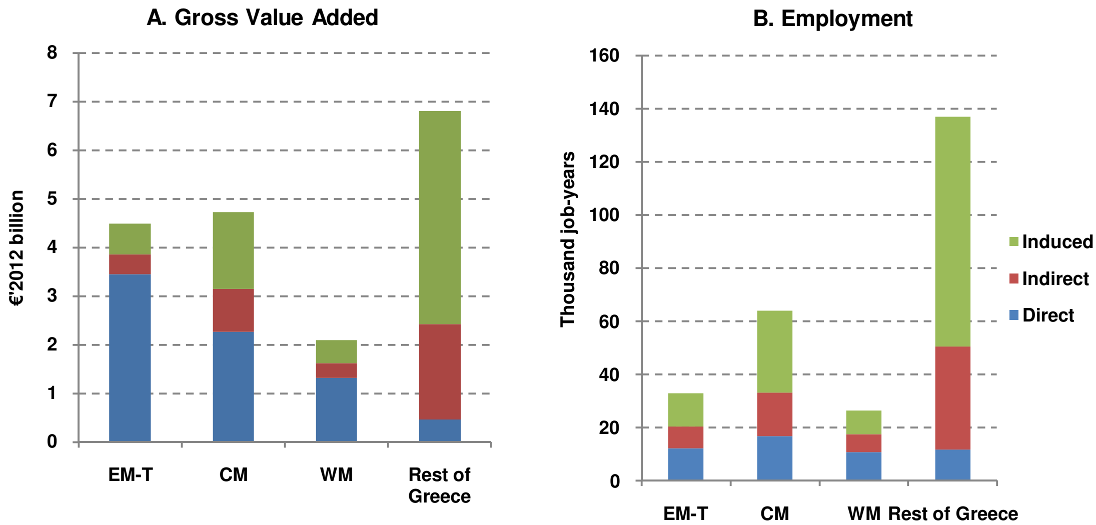
In terms of gross value added, the impact for the local economy exceeds €2 billion with about 40% of it coming directly from the operation of the pipeline (Figure 5). On an annual basis, the investment is expected to generate more than €30 million of value added during the construction phase and €40 million during operation.

In addition, the investment creates significant economic benefits in terms of employment in the region with the estimated impact exceeding 26,000 job-years through the entire life of the project, most of which (85%) resulting from spill-over effects. On average, the employment in the region will be boosted every year by about 500 jobs as a result of TAP (almost 800 jobs during construction).

Summary

The Trans Adriatic Pipeline constitutes a foreign direct investment with considerable benefits at difficult times for the Greek economy. Its impact is concentrated at, but not limited to, regions that are hurt strongest by the unprecedented depression the country has been experiencing in the past 5 years.

Figure 6: Impact per region, domestic pipes scenario, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

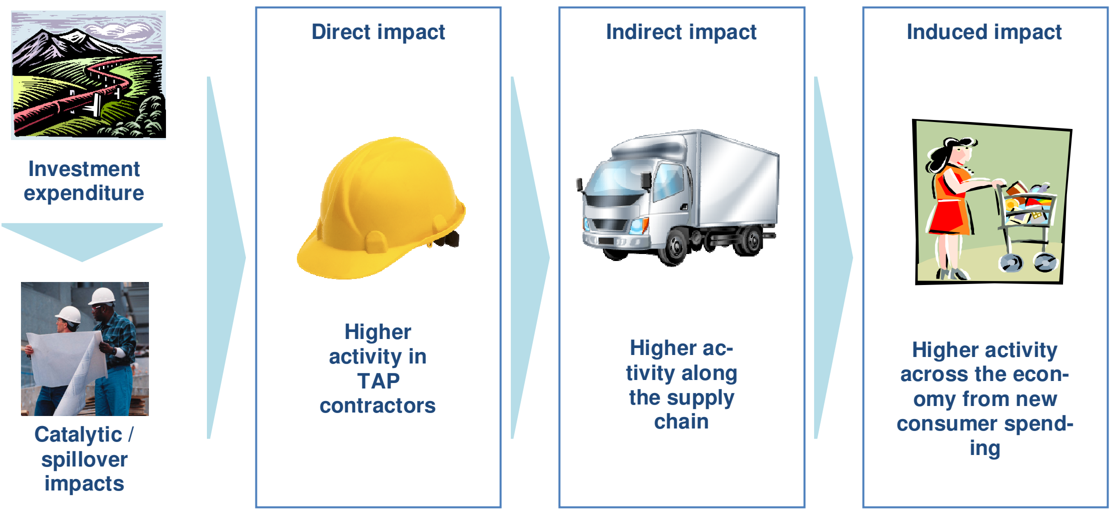
Meanwhile, the project can have significant benefits over the long-term as well. Part of them comes directly from the operation of the project, yet some of them are conditional on the capability of the Greek manufacturing sector to capitalise on its experience with the project. The materialisation of the long-term benefits to their full extent thus requires a more proactive and export-oriented entrepreneurship, a legislation that does not distort the market incentives and socio-political climate that supports the viable and socially responsible business activity.

1 SCOPE OF STUDY

The Trans Adriatic Pipeline (TAP) is a project that competes to transport gas originating in the Caspian region through Greece and Albania to the Italian market. On Greek territory, it is routed to start near the Turkish-Greek border and cross the northern Greek regions of Thrace and Macedonia to reach the Albanian border near North-East of Kastoria. Currently, TAP is the only route left that crosses Greek territory among those competing to transport gas from the second phase of the development of the Shah Deniz field in Azerbaijan.

Large-scale foreign investments, such as TAP, contribute directly to the economy through direct payments (taxes etc.), employment during construction & operation and voluntary contributions. In addition, the economy benefits indirectly through the employment, procurement of goods and services and other output that occurs along the supply chain of TAP-related purchases (Figure 1.1). Moreover, the additional income that accrues to workers employed by TAP and across the wider supply chain translates into consumer purchases, resulting in further rounds of economic activity. Furthermore, the enhanced availability of gas reduces the production costs and boosts competitiveness, leading to potential increase of exports. Meanwhile, export advantage could also accrue to companies, who have enhanced their expertise as a result of their involvement with TAP, which can be used in other similar projects abroad.

Figure 1.1: Types of impact



The purpose of the study is to quantify the impacts of TAP on the Greek economy. The study investigates the direct and the broader effects on output, gross value added and jobs across all the sectors of the Greek economy from the construction and operation of TAP. The scope of the study includes a breakdown of the benefits at regional level and in particular for each of the regions in Northern Greece that host sections of TAP (East Macedonia and Thrace, Central Macedonia, West Macedonia). It covers both the 3-year construction phase and the 50-year operations phase.

2 METHODOLOGY OVERVIEW

The building block of all sectoral impact assessment studies is the input-output model, pioneered by the Russian-American economist Wassily Leontief in the 1930s. Leontief restated general equilibrium economic analysis in such a way so as to make its computation feasible and applicable in practical issues, for which he was awarded the Nobel Memorial Prize in Economic Sciences in 1973. The input-output methodology forms an essential building block of the complex multisector computable general equilibrium models that have been developed since then and has remained a very popular tool for performing impact assessment studies.

The Input-Output model takes explicitly into account that in order to produce anything ("output") a producer has to pay for "inputs" (e.g. labour, capital, products and services). In order to illustrate better the intuition of the model, let us take for example an investment of €100 million spent on a compression station in Greece.

Table 2.1: Purchases for a €100 million investment in a compression station (illustrative example)

Product / Service	Domestic supply	Imports	Total
Machinery and equipment	17	63	**80**
Construction	3,5	1,5	**5**
Land transport	5,0	0,0	**5**
Architectural and engineering	2,9	0,1	**3**
Administrative services	2,9	0,1	**3**
Accommodation and food	2,8	0,2	**3**
Legal, accounting & consulting	0,9	0,1	**1**
Total	**35**	**65**	**100**

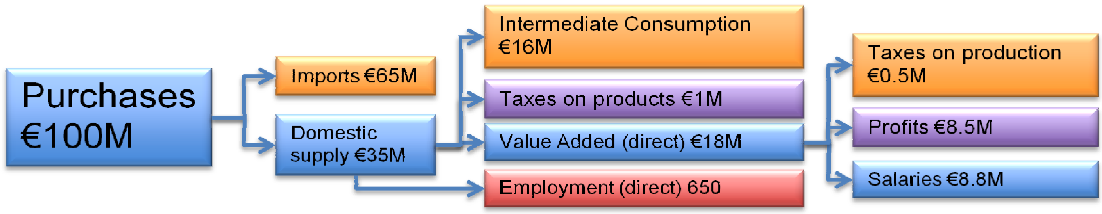
Source: IOBE assumptions

In order to build a compression station for that amount, it would be reasonable to assume that the entrepreneur would need to purchase machinery and equipment (€80M), hire a construction company (€5M), pay for land transport (€5M) and for a number of other goods and services. Given the existing structure of the Greek economy, we could expect that out of the €80 million spent on Equipment, €63 million would be paid for goods coming from abroad, while €17 million would be procured from Greek manufacturers (Table 2.1).

Similarly for the remaining goods and services that would be procured for the station, a part of the supply would be produced on Greek territory and the remaining will be imported from abroad, with the extent of local content depending on the competitiveness of the local producers and the outcome of the trade negotiations between the project and its suppliers. Overall, we can expect the investment in this illustrative example to generate a direct impact on imports to the amount of €65 million and on domestic output by €35 million.

Given the coefficients in the input-output table for Greece, in order to produce these €35 million of output, the Greek companies involved in the procurement of the compressing station would pay €17 million for goods and services themselves as inputs in their production processes. Out of this, €1 million would go to the State Treasury in the form of taxes, while the remaining amount (€16 million) would be collected as revenue by the producers / importers of the inputs. The remaining €18 million would represent the value added that will be generated in the Greek economy as a direct impact from the construction of the compressing station.

Figure 2.1: Direct impact of an investment on value added (illustration)



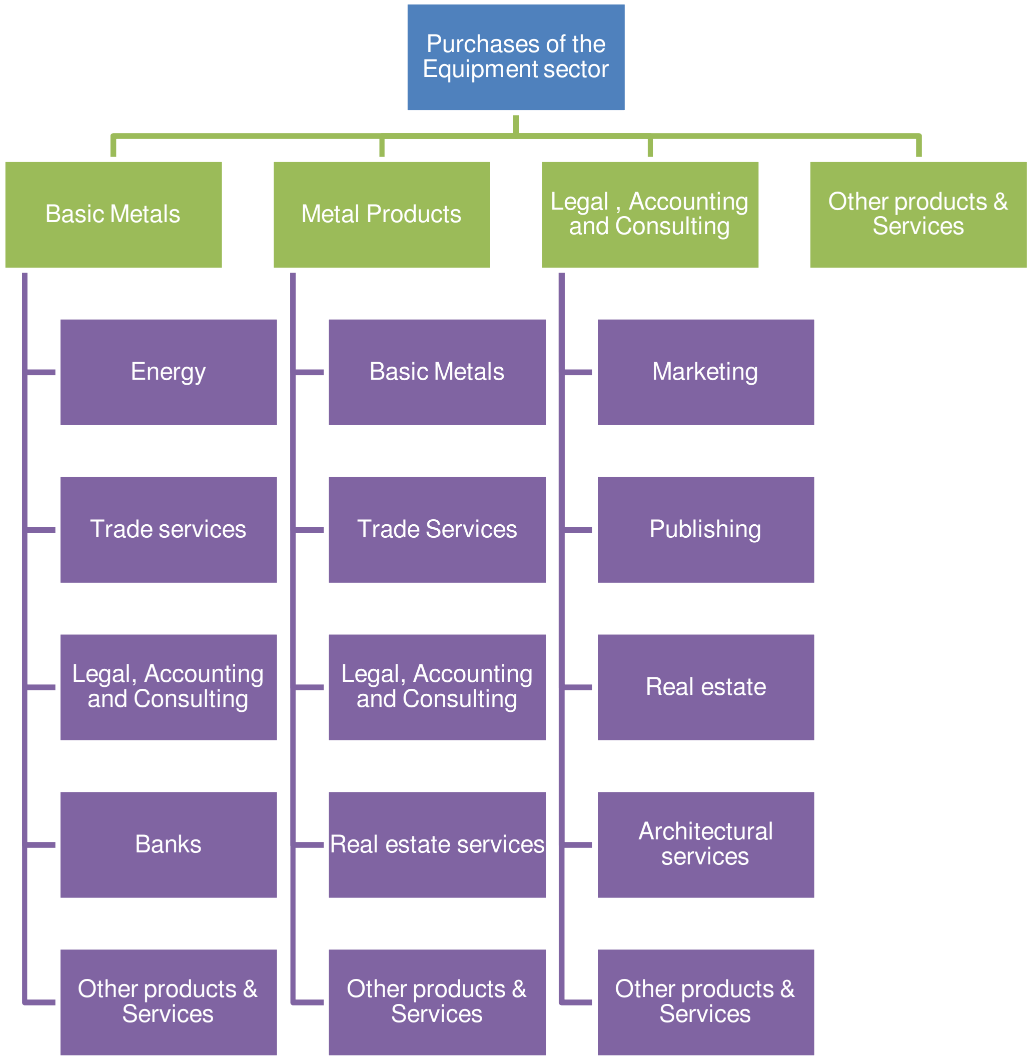
Source: IOBE assumptions, Eurostat IO tables for Greece (http://goo.gl/c9pT7)

In turn, the value added can be further broken down to its constituent elements (Figure 2.1). About half a million of the impact on value added would represent taxes that the companies would pay for their ongoing production (e.g. for securing licenses, etc.). The remaining would be split almost equally between salaries to the employees and gross profit (e.g. dividends to the shareholders and depreciation and amortisation expenses to compensate for the wear and tear of the companies' assets).

Meanwhile, in order to produce the additional €35 million of output, about 650 job-years should be created. This implies that if a project lasts for a year, 650 people would be employed in order to produce these goods. If alternatively, the project lasts for 3 years, 650 job-years would imply that almost 220 people would be employed over the project's lifespan.

In turn, the procurement of €16M to the compression station suppliers itself would generate (indirect) value added and employment. Each of the sectors involved in the procurement of products and services for the construction of the compressing station would need to purchase goods and services in order to produce the required output.

Figure 2.2: Indirect impact of an investment (illustration)



Source: Eurostat IO tables for Greece (http://goo.gl/c9pT7)

For example, the companies supplying the equipment would need to buy basic metals, metal products and other goods, while they would also need legal, accounting, consulting and other services (Figure 2.2). In turn, the companies supplying the metallic plates to the equipment companies would need iron, steel and other products and services. The basic metals producers would require energy and various services. In short, a demand shock that comes from a new investment causes a chain reaction across the economy that leads to an acceleration of economic activity, generating in turn additional imports, domestic output, employment, value added, wage income, profits, etc. The impact and effects coming from this process are termed “indirect” in the Input-Output literature.

But the overall impact of an investment does not stop here. The increased economic activity, as we saw, would generate value added, part of which would end up in the household budgets in the form of additional wage income. Some of it would be transformed into wealth through savings, still most of it would be spent on consumer goods, such as housing, eating out, food products, health services, energy, etc.

This triggers one more round of effects on economic activity to satisfy the increased demand for consumer goods, which in itself has a multiplicative effect, as the production of consumer goods requires inputs. The output, value added, employment, wages, etc. generated along the mesh of supply chains that come from this process are termed “induced effects/impact” in Input-Output terms.

The mechanics of the estimation of the model are explained in detail in the appendix, but it is important to note that to estimate these effects in practice involves a number of simplifications. These assumptions limit the applicability of the static input-output model, yet are essential in order to make it suitable for applied analysis.

As this study involves an estimation of an impact at regional level for a significant time span, the static input-output model is not suitable without significant extension effort. For the purposes of this study we developed a Multi-Regional Input-Output Model with a long-term projection, using well-established methods and techniques.

Figure 2.3: Basic data sources

Input-output tables	• Source: Eurostat IO Tables Database (http://goo.gl/c9pT7) • Reference year: 2010 • Coverage: 62 economic branches (NACE rev.2) • Date of publication: 13/01/2012
Regional employment	• Source: Eurostat Structural Business Statistics (http://goo.gl/6H2qP) • Reference year: 2009 • Coverage: Regions (NUTS 2) and economic branches (NACE rev.2) • Date of publication: 13/06/2012
Capital and operating expenditure	• Source: IOBE assumptions • Validated by TAP's representatives in the project team
Macroeconomic projections	• Source: IOBE Macroeconomic Analysis and Policy Unit • Comparable with EC, IMF and OECD projections
Distance between regions	• Source: Google Maps (http://goo.gl/maps/DMp1C) • Optimum road route between region borders

In particular, we broke down the national input-output table down to regional level, applying the Cross-Industry Location Quotient (CILQ) method with employment data (Figure 2.3). In order to capture the interregional dependencies, we used the Leontief-Strout Gravity Model (LSGM). For the extension of the input-output analysis over the lifespan of the pipeline, we projected the table using Eurostat's Euro method. The projection utilised assumptions on the future structure of the Greek economy that reflect the expected trends in technology and trade.

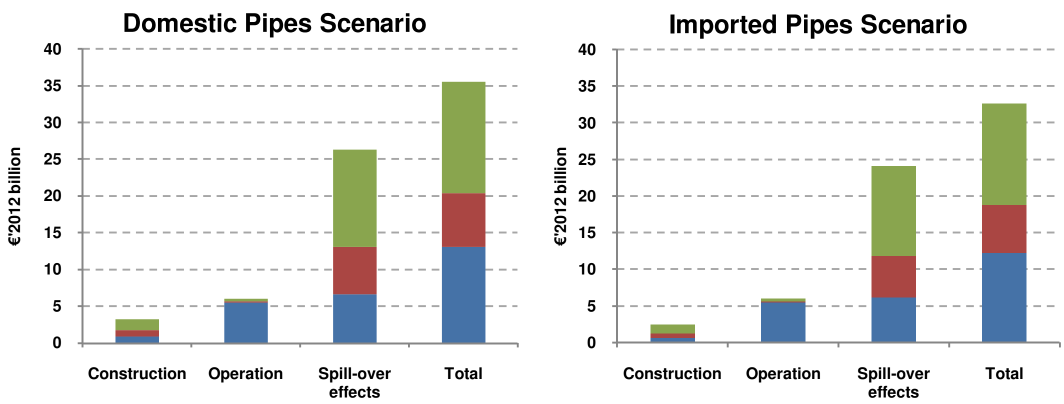
3 ECONOMIC IMPACT

The construction and operation of TAP over a 50 year economic life is expected to generate total output between €33 - 36 billion in the Greek economy (Figure 3.1). The variation comes from uncertainty, regarding the source of supply of the pipes for the project. There are Greek companies that have gained sufficient expertise to be capable of supplying pipes for similar projects internationally. Nevertheless, whether they would win the contract for TAP would depend on the outcome of the trade negotiations between the company and its potential suppliers.

In case Greek manufacturing firms supply the pipes, additional economic benefits are to be expected, both directly for the fabricated metal products sector and indirectly for the sectors supplying equipment, material and services for the construction of the pipes, but also across the economy as induced impact from the spending of the additional household income.

In either case, more than 70% of the overall impact on output over the lifetime of the project comes from spill-over effects. This corresponds mostly to potential benefit that the companies participating in the project would be able to utilise by capitalising on the experience they would gain in the project.

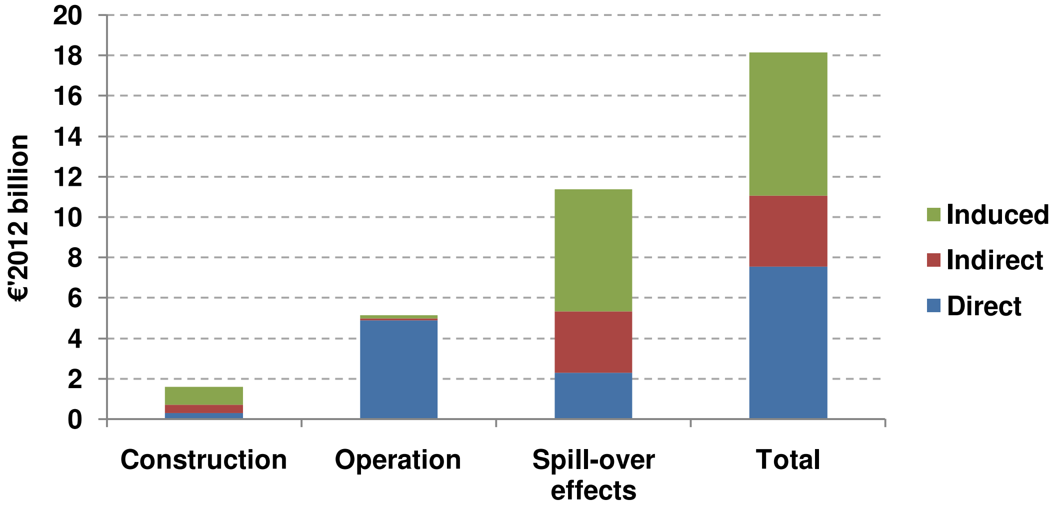
Figure 3.1: Impact on Output (local pipes versus imported pipes scenario)



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In terms of gross value added, the impact from the investment is estimated at €18 billion in the case of domestic pipe production (Figure 3.2) and €17 billion under the imported pipes scenario. Out of this estimate, more than €5 billion correspond to value added generated through the operation of the project itself.

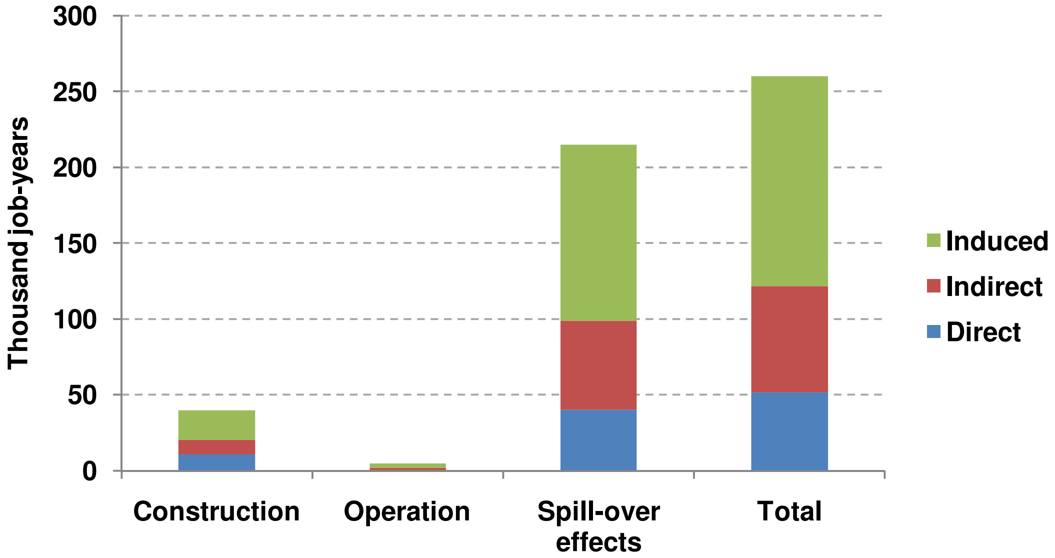
Figure 3.2: Impact on Value Added for Greece in the domestic pipes scenario, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

Given the fact that pipelines are capital intensive businesses with comparatively little expenses for procuring supplies, most of the revenue generated by their operation corresponds to value added, in the form of taxes, duties and levies paid to the host government, depreciation expenses to cover the wear and tear of the fixed assets and net profit. Given also the relatively low number of people that would be employed directly for the project after the completion of its construction, the indirect and induced impact on value added from the operation of the pipeline itself would be much smaller than the direct impact.

Figure 3.3: Impact on Employment in Greece, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

With respect to employment, TAP is expected to generate between 235 and 260 thousand job-years across the economy. In annual terms, this corresponds to 4,300 to 4,800 jobs per year on average for almost five and a half decades. The operation of the project itself would have a relatively small impact on employment, as already mentioned. Therefore, the jobs during the operation phase would mostly come from spill-over effects (Figure 3.3).

Table 3.1: Impact on the economy of Greece, annual average

Scenario	Impact	2015-18	2019-28	2029-38	2039-48	2049-58	2059-68
Output (€M'2012)							
Domestic pipes	Direct	228	189	215	240	267	302
	Indirect	198	70	104	131	158	196
	Induced	390	150	212	265	326	405
	Total	816	409	530	635	751	902
Imported pipes	Direct	177	181	205	229	256	289
	Indirect	153	61	92	117	142	179
	Induced	300	136	195	246	304	379
	Total	630	378	492	592	702	847
Value Added (€M'2012)							
Domestic pipes	Direct	79	126	135	143	153	165
	Indirect	106	36	49	62	75	90
	Induced	217	73	98	121	148	181
	Total	402	235	282	327	376	436
Imported pipes	Direct	70	125	134	142	152	164
	Indirect	77	31	43	55	67	82
	Induced	167	67	90	112	138	169
	Total	315	223	267	310	357	415
Employment (No.)							
Domestic pipes	Direct	2.746	1.004	924	819	716	630
	Indirect	2.440	783	976	1.117	1.324	1.809
	Induced	4.806	1.609	1.985	2.260	2.663	3.422
	Total	9.992	3.396	3.885	4.197	4.703	5.861
Imported pipes	Direct	2.401	947	860	749	636	542
	Indirect	1.804	680	864	1.005	1.202	1.664
	Induced	3.704	1.459	1.824	2.094	2.478	3.209
	Total	7.909	3.086	3.547	3.848	4.316	5.415

Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

The annual impact on jobs is more pronounced during the construction phase (Table 3.1), when we could expect almost 10,000 jobs per year under the domestic pipes scenario (almost 8,000 if the pipes will be imported from abroad).

In contrast, the wake effect from the investment shock is stronger in GVA terms. The impact on value added during the first 15 years of operation is lower compared with the construction phase, yet the difference is relatively small due to the strong direct impact on value added (but not on employment) from the operation of TAP itself. Overtime, as the spill-over effects compound, the annual value added may even exceed the level it reached during the construction phase.

The results are comparable with those generated by other studies. A study conducted in 2011 by IENE estimated that TAP's construction would generate €371 million GVA p.a. in Greece (IENE, 2011), compared with €402 million in the domestic pipe scenario and €315 million in the imported pipe scenario. Similarly, IENE's study estimated that 9,054 people will be employed for TAP's construction, compared with 9,992 in our estimations for the domestic pipe scenario and 7,909 for the imported pipes scenario. Moreover, given that our study includes the section of the pipeline between Komotini and Kipi that was only recently added to the project, our impact estimates, for the construction phase at least, can be seen as conservative.

In addition, our estimates on employment are quite close to those produced using Ministry of Finance's instructions for NSRF candidates (Υπουργείο Οικονομίας και Οικονομικών, 2009). According to the instructions, direct employment in terms of job-years can be estimated from the total investment amount by assuming that a certain share of it corresponds to labour expenses, which is than divided by an indicative wage. The instructions do not specify what personnel cost coefficient should be used for pipelines, yet if we use the coefficient for a somewhat similar type of work (30% for laying railway networks) and divide the result by the indicated wage (€27,170 per person per year), we would get that the direct effect on employment during construction amounts to 10,688 job-years, which is fairly close to our estimate of 10,983 job-years direct impact on employment.

3.1 Impact on Northern Greece (Macedonia and Thrace)

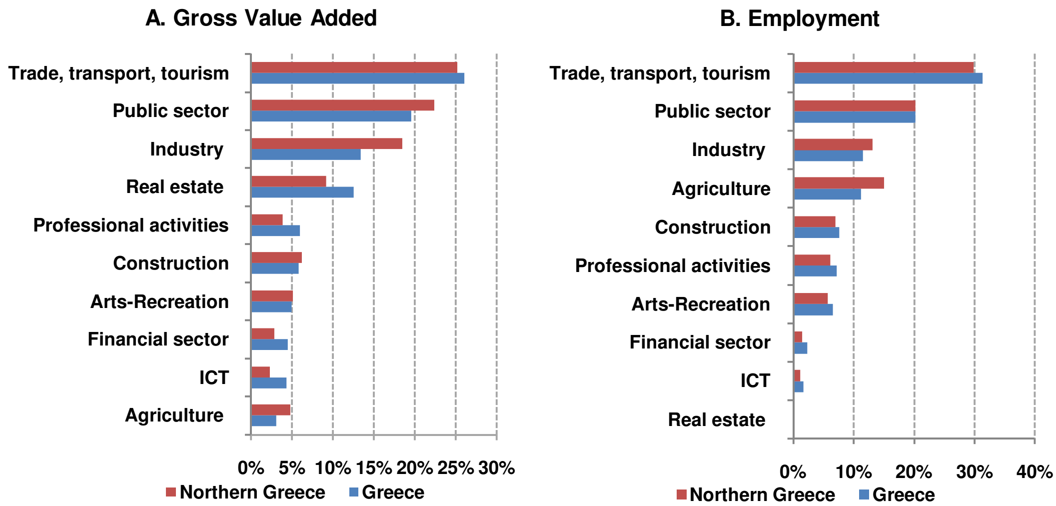
The Trans Adriatic Pipeline is routed to pass through the administrative regions of East Macedonia-Thrace, Central Macedonia and Western Macedonia, which often are colloquially grouped as Northern Greece[2]. These regions occupy an area of 42,755 km^2 with a population of 2.85 million inhabitants (25 per cent of Greece).

[2] Not to be confused with EU NUTS 1 region of Voreia Ellada (lit. Northern Greece), which also includes the region of Thessaly.

This group of regions has a Gross Value Added of €41.9 billion,[3] representing 20 per cent of the country's total output. As in the Greek economy overall, services dominate, with Trade-Transport-Tourism and activities that are predominantly part of the General Government (Public Administration, Defence, Education, Human Health and Social Work Activities) generating nearly half of the region's gross value-added (GVA).

Still, the share of contribution of the tertiary sector in the economy is 70 per cent, which is lower by 8 per cent compared to the national average. Agriculture's contribution to the economy of Northern Greece is above 5 per percent (€2.9 billion), which is almost double than the contribution of the primary sector in Greece overall (6%). Similarly the industrial sectors have a stronger presence, as their share is higher by five per cent compared to Greece overall.

Figure 3.4: Share of NACE chapters in GVA and employment in Northern Greece, 2009



Source: Eurostat Regional Economic Accounts (http://goo.gl/YqKjH)

According to the Labour Force Survey of the National Statistics Office for the second quarter of 2012, Northern Greece has an active workforce of 1.2 million people of which 897 thousand are employed. Unemployment in the region has increased to 26.4% in the second quarter of 2012, which is higher by almost 2 per cent compared to the national average.

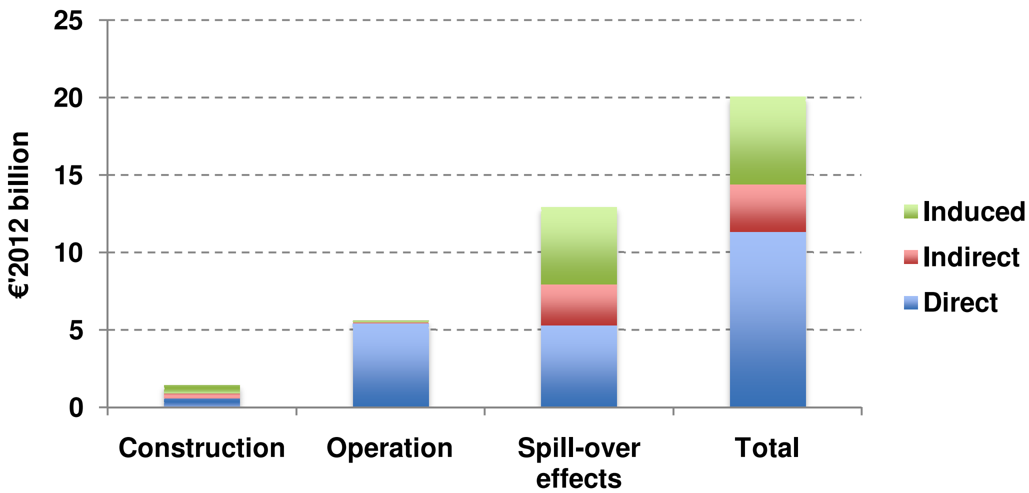
[3] The historic regional data on value added and the sectoral composition of employment in this study refers to the latest available time period (2009) and comes from Eurostat's Regional Economic Accounts database (http://goo.gl/YqKjH).

The highest concentration of jobs is observed in Trade-Transport-Tourism (29%) and the Public sector activities. The primary sector comes third, with a share that is higher by 5 per cent compared to the national average.

The construction of TAP is expected to generate a total of €20 billion of output over the lifespan of the project in Northern Greece (Figure 3.5). This represents almost 3/5 of the investment's total impact on the Greek economy, with the remaining 2/5 of the impact occurring in the remaining Greek regions that would supply Northern Greece with the required goods and services. More than half of the impact (€11 billion) corresponds to direct effects, with the induced impact amounting to almost €6 billion and the remaining €3 billion coming from indirect effects.

It should be noted that the domestic and imported pipes scenaria yield similar results. This is due to the fact that key Greek pipe suppliers are situated outside the region's borders (i.e. in Central Greece and Peloponnese).

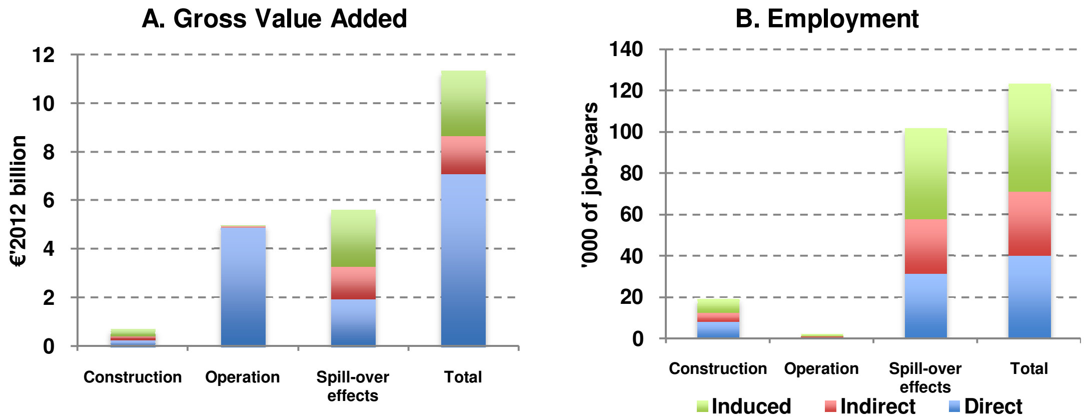
Figure 3.5: Impact on Output in Northern Greece, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In terms of gross value added, which represents the difference between total output and the cost of inputs from the other sectors, the impact is estimated at €11.4 billion (Figure 3.6), with almost a half (€5 billion) resulting directly from the operation of the pipeline. On an annual basis, the investment would generate €180 million on average during the construction phase and €210 million during the pipeline's operation.

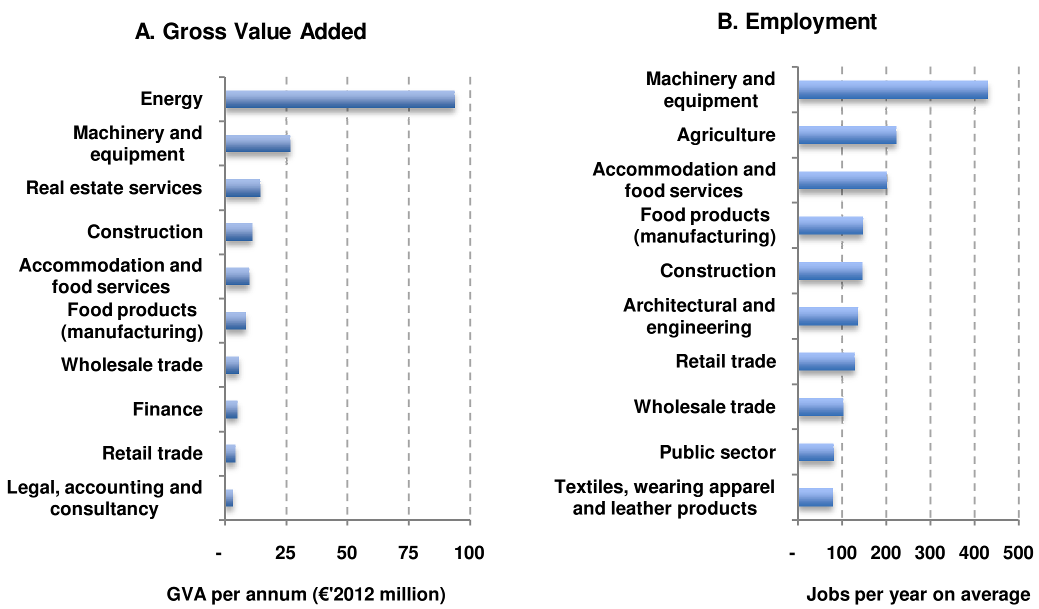
Figure 3.6: Impact on Value Added and Employment in Northern Greece, 2015-2068



Source: IOBE Input-output model; Eurostat, IO tables (http://goo.gl/c9pT7)

In addition, the investment is expected to support more than 120 thousand job-years during the entire period. This implies that on average more than 2,200 people would be employed in Northern Greece each year over more than five decades as a result of TAP.

Figure 3.7: The 10 economic branches with the highest impact in Northern Greece, average per annum



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

Almost 2/3 of the value added would be generated by Industry sectors. In particular, the Energy sector would see its value added higher by more than €90 million on average per year (45% of overall impact), which mostly represents the direct impact from TAP's operation. In employment terms, the impact is strongest in Machinery-Equipment (more than 400 jobs or 19% of the impact), followed by Agriculture and Accommodation - Food services (10% and 9% share respectively).

3.2 Impact on East Macedonia – Thrace

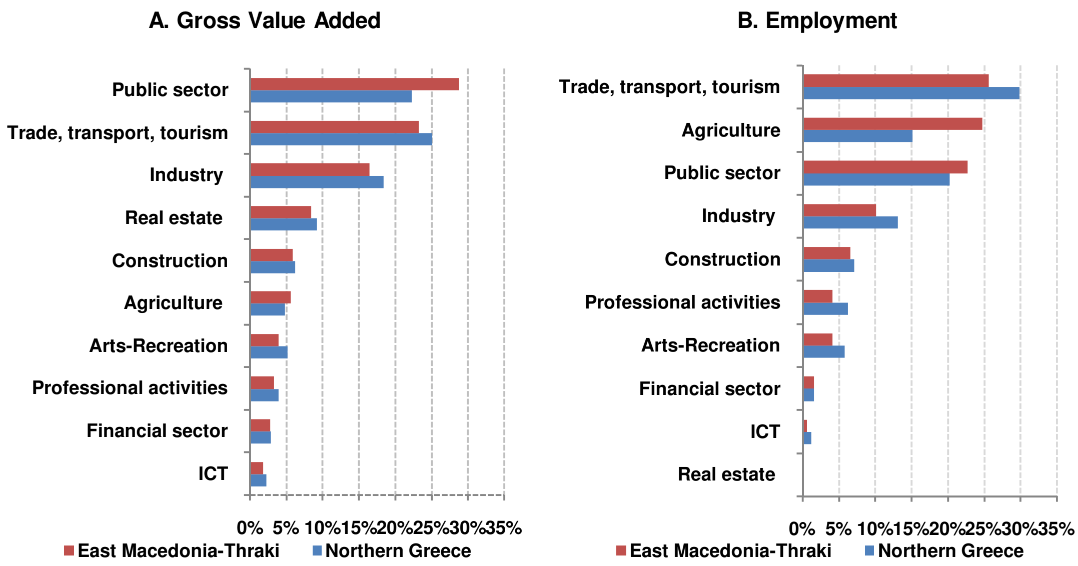
East Macedonia and Thrace is one of Greece's 13 administrative regions, occupying an area of 14,157 km^2 in the northeast of the country. It comprises of the prefectures of Evros, Rodopi, Xanthi, Kavala and Drama, including also the Aegean islands of Thassos and Samothraki. The region borders with Turkey on the east, Bulgaria on the north and the region of Central Macedonia on the east. It is the sixth largest region in terms of population with approximately 600 thousand residents, representing 5.4 per cent of the country's total population.

The region contributes approximately 4 per cent of Greece's gross value added (€8.3 billion in 2009). In terms of employment, East Macedonia –Thrace has an active workforce of 254 thousand people of which 194 thousand are employed. The unemployment rate is at 24%, almost identical to the national level, with 61.2 thousand people (5.2% of total unemployment in Greece) unemployed.

As elsewhere in Greece, Services dominate the region's economy. Compared with Northern Greece, however, the share of Public Administration services in both the region's GVA and employment is considerably higher (+6.5 and +2.5% percentage points respectively), most probably due to the need to guard the country's border with Turkey (Figure 3.8). Another sector with increased relevance for the region's economy is Agriculture, which accounts for ¼ of the region's employment, a share that is higher by 8.7 percentage points compared with Northern Greece and 13.5 p.p. with Greece overall.

In contrast, the contribution of Trade-Transport-Tourism is lower than in Northern Greece by 1.6 p.p. in GVA and by 3.7 p.p. in Employment. Industry and Real Estate Activities are also less dominant than in Northern Greece (-1.5 p.p. and -0.9 p.p. lower share in GVA respectively).

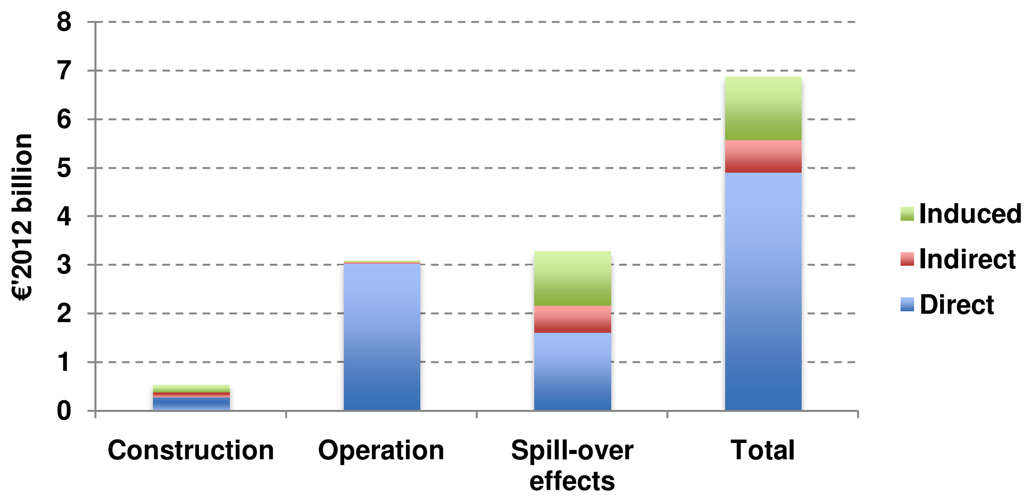
Figure 3.8: Share of NACE chapters in GVA and employment in East Macedonia – Thrace, 2009



Source: Eurostat, Regional Economic Accounts (http://goo.gl/YqKjH)

In East Macedonia-Thrace, TAP is estimated to boost the total value of production by almost €7 billion (Figure 3.9). This corresponds to about a third of the overall impact on Greek territory. It should be noted that the impact in the region is boosted significantly by the fact that it would host a compressing station near Komotini.

Figure 3.9: Impact on Output in East Macedonia – Thrace, 2015-2068

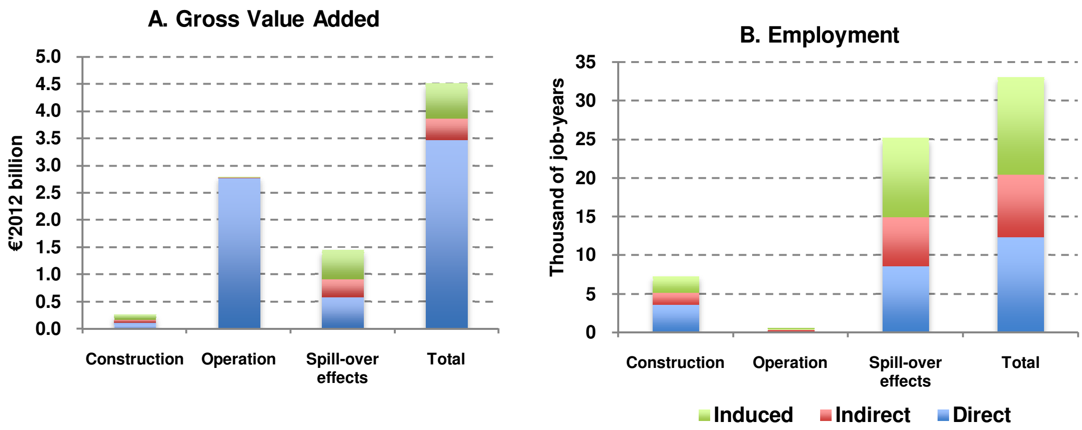


Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

The direct impact amounts to €4.9 billion. The induced effects account for €1.3 billion, almost twice as high as the indirect effect. Overall, every million of euro invested by TAP in the region results in 21 million euro of total output over the lifetime of the project.

In terms of gross value added the total impact over the life-time of the project is estimated at €4.5 billion, of which €2.8 billion (or 70%) comes directly from the operation of the project (Figure 3.10).[4] Annually, TAP would lead to an increase of GVA by about €65 million during the construction period and about €85 million during operation (Table 3.2).

Figure 3.10: Impact on Value Added and Employment in East Macedonia – Thrace, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In employment terms, more than 33 thousand job-years will be created in the region over the entire lifetime of the investment, which is almost a quarter of the investment's total impact on employment. This implies that on average 600 people will be employed each year in the region as a result of TAP for more than five decades. The direct contribution to local employment amounts to more than 12 thousand job-years, whereas about the same number of job-years is expected to be supported from consumer spending on goods and services out of the generated wage income (induced effect on employment). About 8 thousand job-years are estimated to be supported from the increase in the production of intermediate goods and services (indirect effect).

Across the sectors of economic activity, the highest impact in GVA terms would be observed in the Energy sector (more than 60% of the total impact), mostly due to the direct involvement of TAP's operation in this sector (Figure 3.11). The largest impact

[4] Under the assumption that the value added of the project's operation is split across the regions, based on their share in the project's capital expenditure.

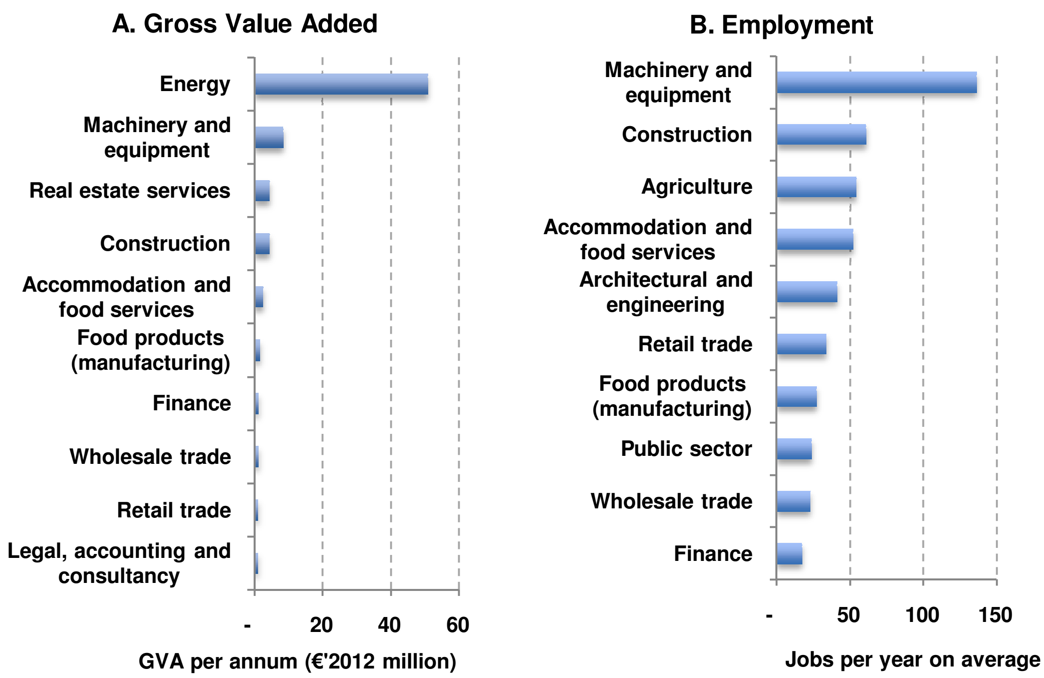
on employment is expected in Machinery-Equipment (22% of total impact), Construction and Agriculture (approximately 10% each).

Table 3.2: Impact on the economy of East Macedonia - Thrace, average per annum

Impact	2015-18	2019-28	2029-38	2039-48	2049-58	2059-68
Output (€M'12)						
Direct	67	78	85	92	99	108
Indirect	26	6	9	12	14	18
Induced	41	12	17	22	28	34
Total	**134**	**96**	**111**	**126**	**141**	**161**
Value Added (€M'12)						
Direct	27	62	65	67	70	73
Indirect	14	4	5	7	8	10
Induced	24	6	8	11	13	16
Total	**65**	**72**	**78**	**84**	**91**	**99**
Employment (No.)						
Direct	902	225	205	177	148	123
Indirect	384	85	108	125	146	187
Induced	540	143	179	204	236	285
Total	**1,826**	**453**	**491**	**506**	**530**	**594**

Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

Figure 3.11: The 10 economic branches with the highest impact in East Macedonia-Thrace, average per annum

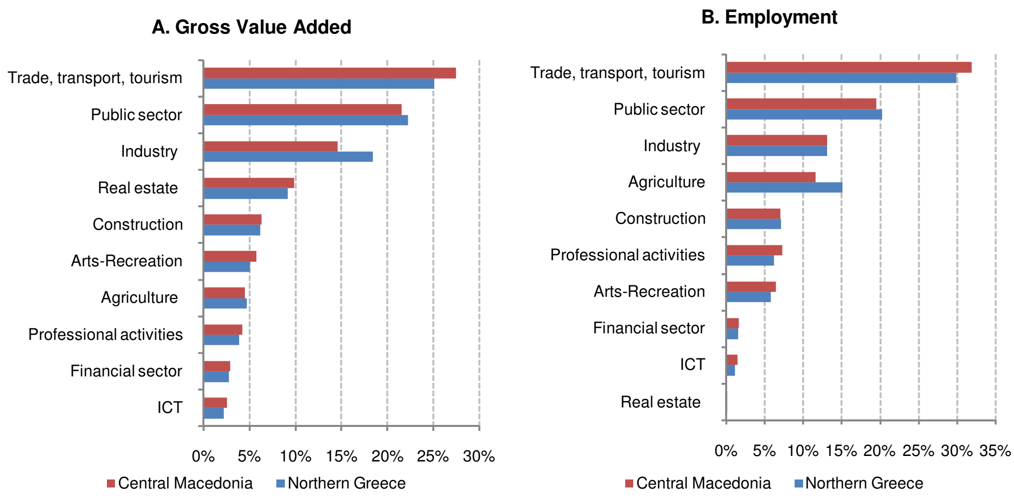


Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

3.3 Impact on Central Macedonia

Central Macedonia is the administrative region with the largest area in Greece, occupying 19,147 km^2 (14.5% share). With almost two million inhabitants (17% share) it is the second most populated region in the country. About 60% of the region's population lives in Thessaloniki, the country's second largest city and the major economic and commercial centre in Northern Greece. The region is formed by the prefectures of Imathia, Thessaloniki, Kilkis, Pella, Pieria, Serres and Chalkidiki.

Figure 3.12: Share of NACE chapters in GVA and employment in Central Macedonia, 2009



Source: Eurostat Regional Economic Accounts (http://goo.gl/YqKjH)

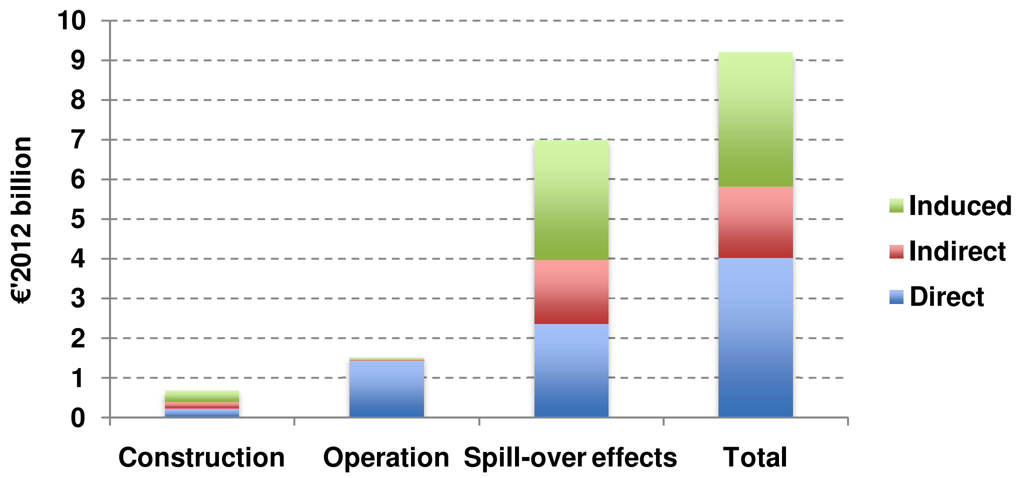
Given its largely urban character, Central Macedonia has a diversified production structure with a significant presence in all economic sectors. It contributes 14% of total Greek GVA (or €28.8 billion in 2009).

The industrial sector has been in decline over the past years, partially due to a migration of manufacturing enterprises to neighbouring countries. The sector's contribution in the region's GVA is approximately 15%, lower by 3.8 p.p. compared to Northern Greece (Figure 3.12).

In contrast, Services contribute more than 70% of total gross value added, 2 p.p. higher compared to Northern Greece. Trade-Transport-Tourism has a share of 28%, higher by 2.4 p.p. than in Northern Greece overall. This is mostly due to the fact that the Tourism sector is well-developed in the region, attracting foreign visitors mainly from neighbouring Balkan countries. Nights spent in Hotels and similar establishments in Central Macedonia (domestic residents and foreigners) account for 10% of

Greece's total, half of which take place in Chalkidiki, one of the most popular tourism destinations in the country.

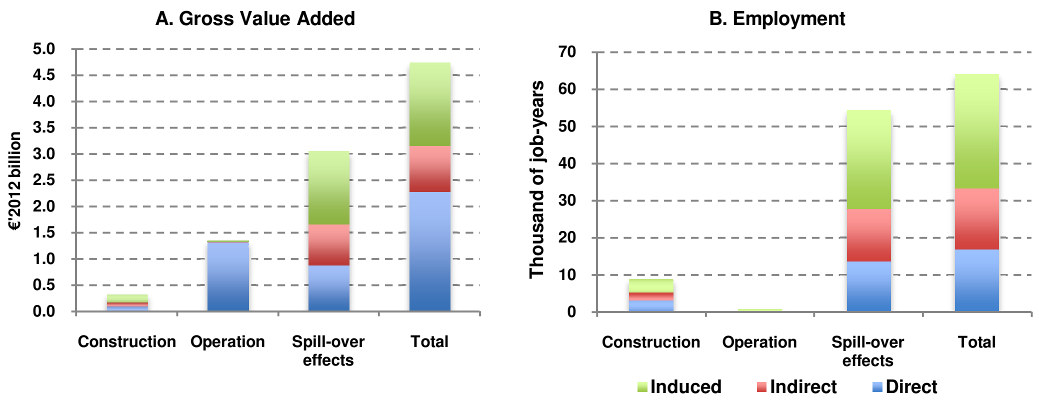
Figure 3.13: Impact on Output in Central Macedonia, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In terms of employment, the workforce is estimated at 826 thousand people, of which 619 thousand are employed. About one in three employees work in the Trade-Transport-Tourism sector, which is 2.1 p.p. higher than in Northern Greece overall. In contrast, lower employment share is observed in Agriculture (-3.5 p.p.) and Public Sector Activities (-0.7 p.p.). Despite the diversified economy, the unemployment rate in the second quarter of 2012 stood at 25.1%, the third highest among Greek regions. The unemployed people are approximately 207 thousand representing 2/3 of the jobless people in Northern Greece and 18% of Greek unemployment.

Figure 3.14: Impact on Value Added and Employment in Central Macedonia, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In Central Macedonia the construction of TAP is expected to expand output, through the entire life of the investment, by more than €9 billion, almost half of the investment's total impact in Northern Greece (Figure 3.13). Unlike, however, East Macedonia-Thrace and Western Macedonia most of the impact would come from export effects on suppliers due to stronger activity in the region in the Machinery and Equipment sector.

Table 3.3: Impact on the economy of Central Macedonia, average per annum

Impact	2015-18	2019-28	2029-38	2039-48	2049-58	2059-68
Output (€M'12)						
Direct	58	55	65	75	86	100
Indirect	41	17	25	33	40	50
Induced	72	33	47	60	75	94
Total	**170**	**104**	**137**	**167**	**200**	**243**
Value Added (€M'12)						
Direct	23	36	40	43	47	52
Indirect	20	9	12	16	19	24
Induced	40	16	22	28	34	42
Total	**83**	**61**	**74**	**87**	**101**	**118**
Employment (No.)						
Direct	778	348	320	278	234	194
Indirect	526	192	241	275	316	409
Induced	933	372	461	524	607	747
Total	2.237	911	1.022	1.077	1.157	1.350

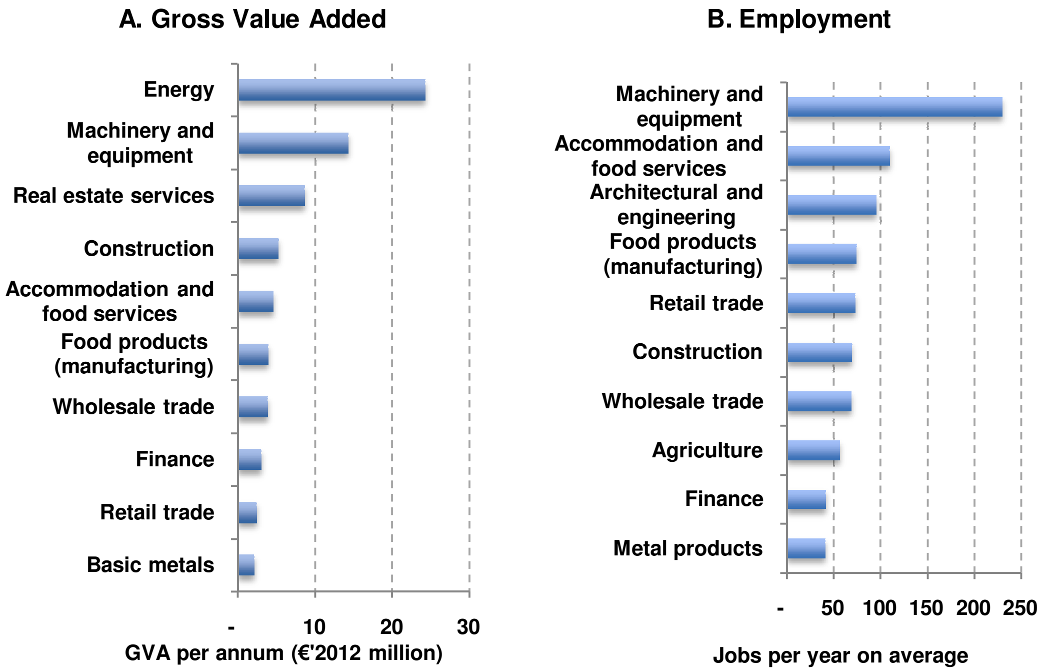
Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In terms of Gross Value Added this translates to more than €4.7 billion of which almost 30% (or €1.4 billion) comes from TAP's operation itself. The direct effect represents almost a half of the total impact on GVA (about €2.3 billion), whereas the effect on the region's economy from boosted intermediate demand along the project's supply chain is estimated at more than €870 million. The income effect from salaries and wages resulting in consumer spending is estimated at €1.6 billion. These estimates imply that on an annual basis TAP would generate more than €80 million GVA in the region during the construction phase and almost €90 million during the operation phase.

Across the sectors of economic activity, the impact on GVA in the region is more evenly distributed compared with the other two regions in Northern Greece (Figure 3.15). The highest impact in terms of value added in the local economy would be observed in the Energy sector (28%), followed by Machinery-Equipment (16%) and Real estate services (10%).

The pipeline project will boost employment in the region by 65 thousand job-years, representing almost half of the investment's total impact on employment in Northern Greece. On average each year, approximately 1,200 people will be employed in the region.

Figure 3.15: The 10 economic branches with the highest impact in Central Macedonia



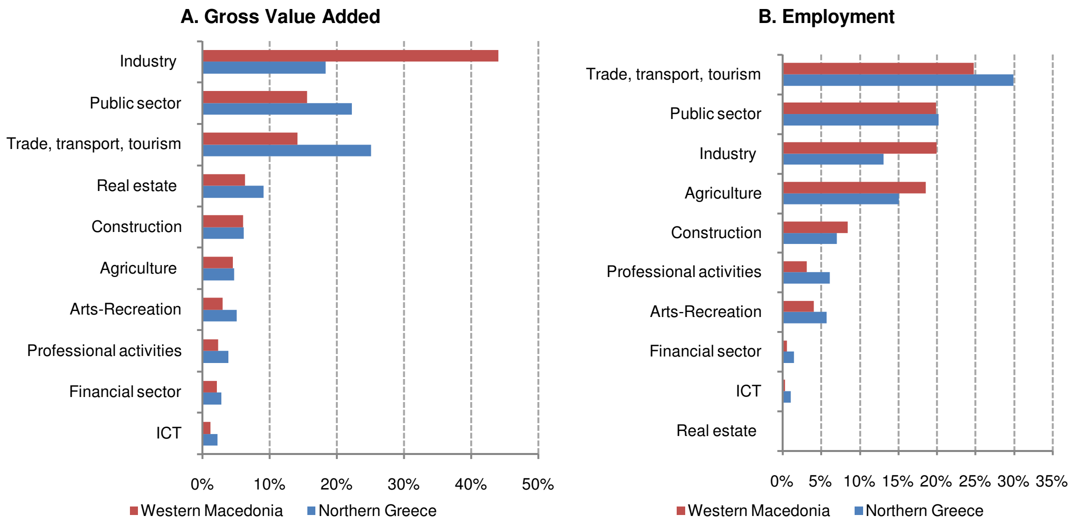
Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

The direct employment, through the entire life of the project, is estimated at 17 thousand job-years, approximately the same with the indirect contribution, whereas the induced effect would be almost twice as high (more than 30 thousand job-years). The investment will boost employment most in the Machinery-Equipment sector (19% of total impact), followed by Trade (12%), Accommodation and food services (9%) and Professional services (8%).

3.4 Impact on West Macedonia

Western Macedonia is situated in North-Western Greece and occupies an area of 9,451 km^2 (7% of Greece's total). It is the only Greek administrative region without access to sea, with almost 80% of its surface being mountainous and semimountainous. It borders with Central Macedonia from the east, Thessaly from the south and Epirus from the west, while on its north are the international borders of Greece with Albania and FYROM. Western Macedonia is formed by the regions of Grevena, Kastoria, Kozani and Florina with 292.5 thousand inhabitants, the third least populated region of Greece.

Figure 3.16: Share of NACE chapters in GVA and Employment in West Macedonia



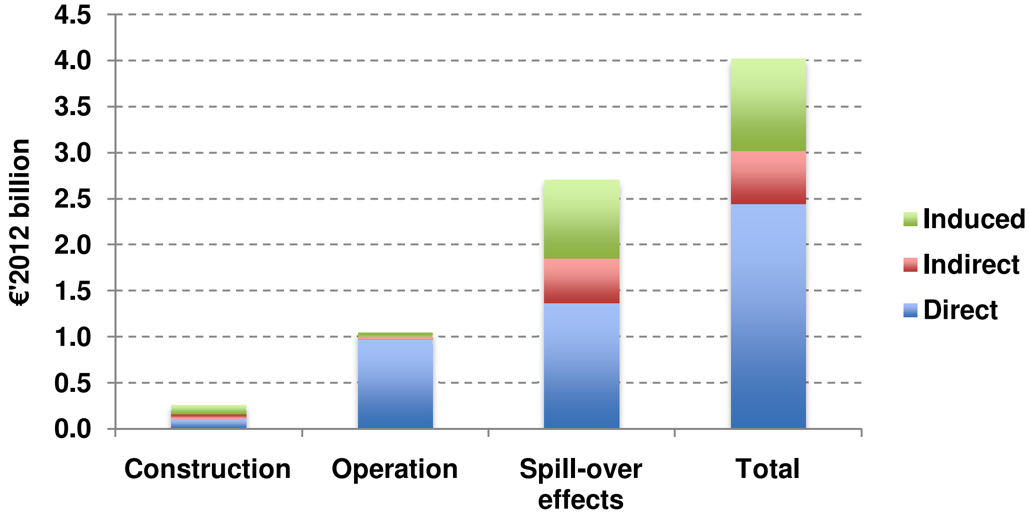
Source: Eurostat Regional Economic Accounts (http://goo.gl/YqKjH)

With a Gross Value Added of €4.9 billion in 2009 (2.4% of Greece's total), Western Macedonia is placed on the 10th position among the 13 Greek administrative regions. The economy is dominated by the industry sector with a gross value added of €2.2 billion in 2009, representing 44% of the value added generated in the region when the respective share in Northern Greece is approximately 18%.

This is mainly due to the concentration of electricity generation and lignite mining activities in the region. The power generating capacity of the stations around Ptolemaida, Kozani and Amyntaio exceeds 65% of Greece's total. Fur manufacture is also a prominent sector in the region (and in Kastoria, in particular) with almost the entire production exported to Russia and the CIS countries.

Furthermore, the agriculture sector has an important role in the economy with a GVA share similar to that of Northern Greece (5%) and employment share higher by 3.5 p.p. than in the wider region (+7.3 p.p. compared with Greece overall). The region produces renowned products with registered of protected designations of origin and geographical indication, such as the saffron of Kozani. In contrast, the services sector contributes a smaller share of gross value-added compared with Northern Greece overall, accounting for 45% of total gross value added (€2.2 billion in 2009).

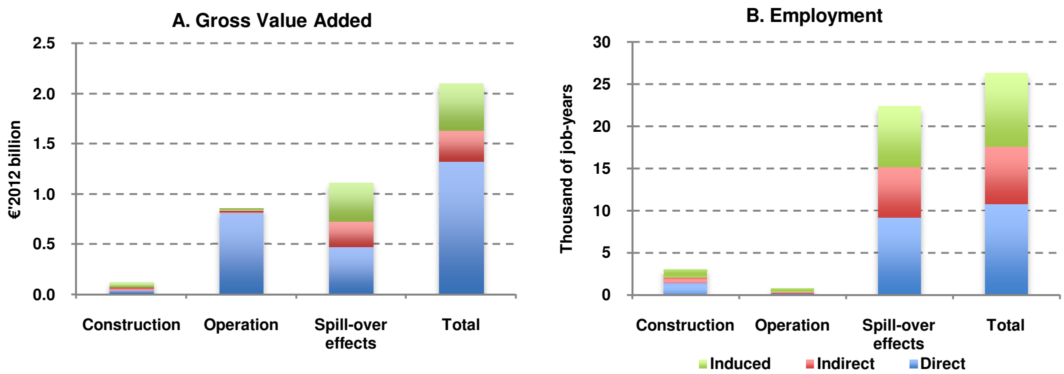
Figure 3.17: Impact on Output in West Macedonia, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

As far as the labour market is concerned, the unemployment rate in Western Macedonia is the highest of all the Greek administrative regions at 30 per cent in the second quarter of 2012, having risen by about 18 percent over the last three years as a result of the economic downturn. The workforce is estimated at 121 thousand people, of which 84 thousand are employed. The region has a relatively high proportion of jobs in Industry (20% or +7 p.p. than the average in Northern Greece), Trade-Transport-Tourism (25% but -5 p.p. on Northern Greece) and the Public Sector activities (20%, just as in the wider region).

Figure 3.18: Impact on Value Added and Employment in West Macedonia, 2015-2058



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

In Western Macedonia the construction of TAP is expected to generate more than €4 billion of output, representing 1/5 of the investment's total impact in Northern Greece (Figure 3.17). More than 1.1 billion euro of total economic output would come from the eventual introduction of natural gas to the fuel mix in the region.

It should be noted, however, that further actions, such as an establishment of a gas distribution company, construction of a low pressure grid, negotiation of a gas supply contract with gas producers, etc. are also required to enable the penetration of natural gas in the region's economy.

Table 3.4: Impact on the economy of West Macedonia, average per annum

Impact	2015-18	2019-28	2029-38	2039-48	2049-58	2059-68
Output (€M'12)						
Direct	28	38	42	46	50	56
Indirect	13	7	9	11	12	14
Induced	25	13	16	18	20	23
Total	**66**	**59**	**67**	**75**	**82**	**93**
Value Added (€M'12)						
Direct	11	23	24	26	27	29
Indirect	7	4	5	6	6	7
Induced	14	6	7	8	9	11
Total	**31**	**33**	**36**	**39**	**43**	**47**
Employment (No.)						
Direct	363	242	210	183	157	141
Indirect	147	104	113	119	129	156
Induced	272	141	145	150	159	177
Total	781	487	469	452	445	474

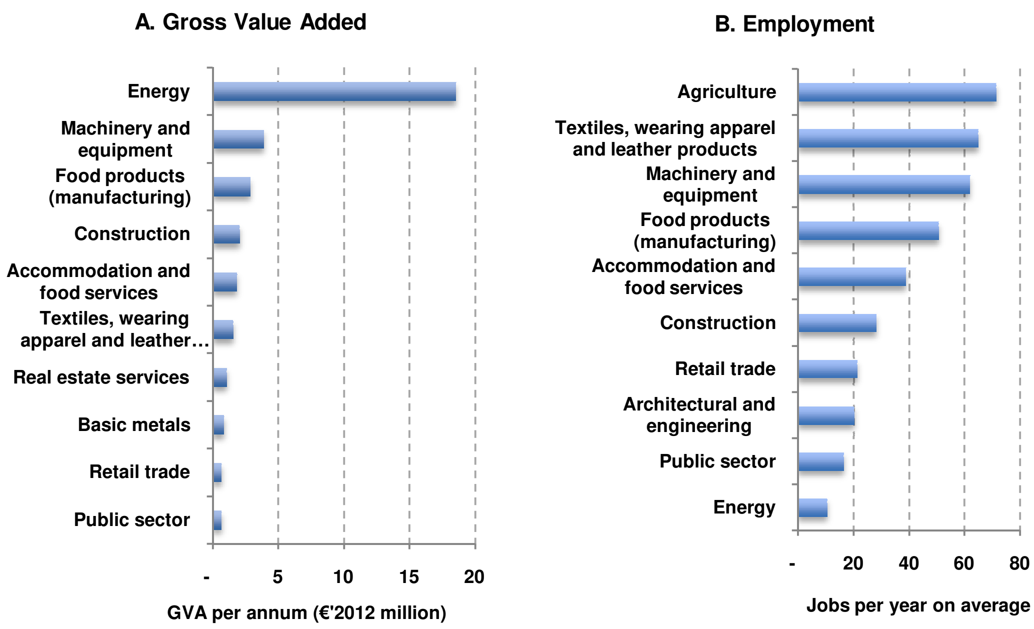
Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

Further economic benefits for the region could be expected in the future, in case an additional compressor station is constructed near the border with Albania in order to double the capacity of the pipeline as more gas becomes available upstream. The direct impact of the investment on output over the project's lifetime is estimated at €2.4 billion, whereas the indirect and induced impacts are equal to €580 million and €1.0 billion respectively.

In terms of gross value added, the impact for the local economy exceeds €2 billion with about 40% of it coming directly from the operation of the pipeline (Figure 3.18). On an annual basis, the investment is expected to generate more than €30 million of value added during the construction phase and about €40 million during operation (Table 3.4). In a breakdown with respect to the sectors of economic activity, almost half of the value added is expected to come from the Energy sector (47%), followed, at a distance, by Machinery and Equipment (10%).

In addition, the investment creates significant economic benefits in terms of employment in the region with the estimated impact exceeding 26,000 job-years through the entire life of the project, most of which (85%) resulting from spill-over effects. On average, the employment in the region will be boosted every year by about 500 jobs as a result of TAP. The largest employment boost would be observed in Agriculture (15%), Clothing-Textiles (13%) and Machinery-Equipment (13%).

Figure 3.19: The 10 economic branches with the highest impact in West Macedonia



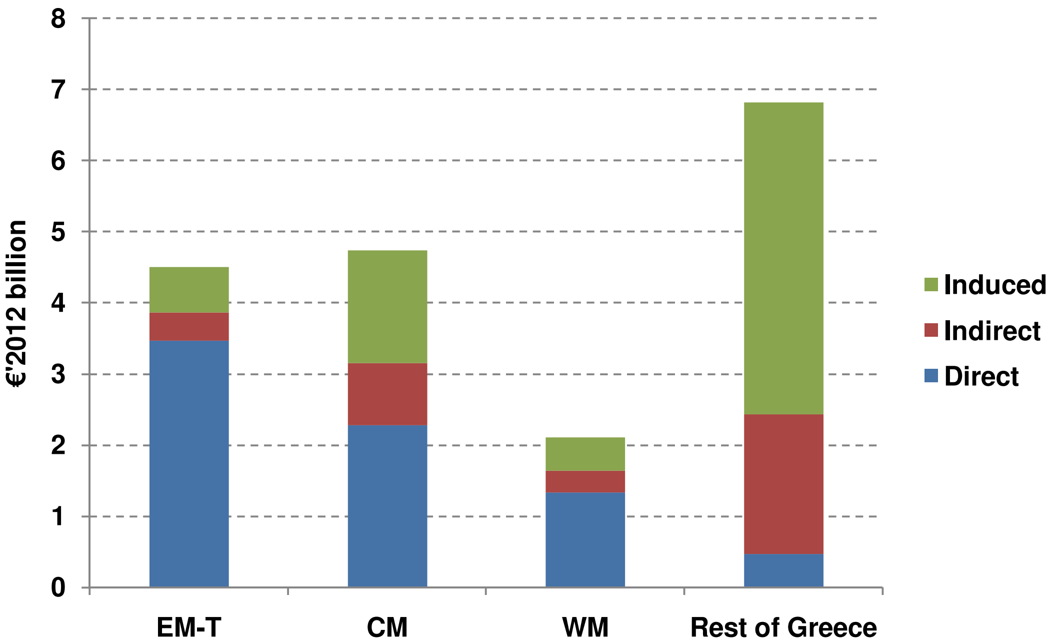
Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

4 SUMMARY

The Trans Adriatic Pipeline will have a considerable and long-lasting impact on the Greek economy. Most of this impact would occur in the regions through which the pipeline is routed to pass.

TAP would generate €310 – 340 million of Gross Value Added per annum on average over a life span of at least 54 years, which amounts to €17 – 18 billion in total over the whole period, depending on whether the pipes for the project would be supplied by domestic manufacturers or not. In employment terms, this implies that there would be about 4,300 – 4,800 more jobs on average for at least 54 years (or 235 – 260 thousand job-years in total).

Figure 4.1: Impact on Gross Value Added per region, domestic pipes scenario, 2015-2068



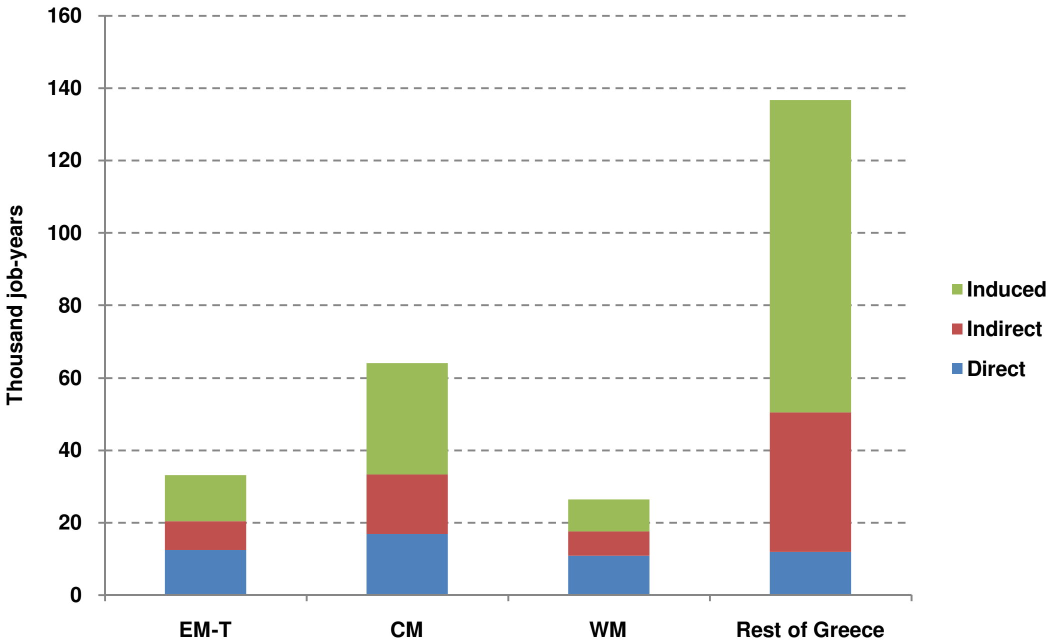
Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

Either way, about 3/5 of the impact on Gross Value Added would occur in Northern Greece. About 2/3 of the impact on GVA in Northern Greece would be generated by Industry branches. The spill-over of employment effects to the rest of Greece will be stronger, with the share of Northern Greece in the employment impact standing slightly below 50%.

This is mainly due to the fact that the direct effect from TAP's operation on employment in Northern Greece would not be that significant, unlike the significant boost to

Gross Value Added, in the form of taxes, duties, levies and other forms of pre-tax net revenue. In fact, about 44% of the estimated impact on GVA would come directly from the operation of TAP itself.

Figure 4.2: Impact on Employment per region, domestic pipes scenario, 2015-2068



Source: IOBE Input-output model; Eurostat IO tables (http://goo.gl/c9pT7)

The largest share of the impact at regional level would be observed in Central Macedonia - 26% of GVA under the domestic pipe scenario and 27% of GVA under the imported pipe scenario (Figure 4.1). Meanwhile, the region also has the highest share in the employment impact, as about one in four of the new jobs that would be created as a result of the investment in the pipeline would occur in the region (Figure 4.2),. This comes from the fact that the region's economy has a stronger presence of sectors that could serve as suppliers to the project, which boosts the spill-over effects of the project in the region.

East Macedonia – Thrace, which would host the pipeline's Greek territory compressing station, comes next at a close distance with 25%-26% of the overall GVA impact (about €4.5 billion). In employment terms, about 33 thousand job-years will be created in the region which corresponds to more than 600 jobs per year on average (more than 1,800 during the construction phase).The smallest of the three regions – West Macedonia – would absorb about 12% of the impact on Gross Value Added and about 10-11% of the impact on jobs. The impact is boosted by the potential effect of introducing natural gas to the region's manufacturing sector. The economic impact in the region could expand further, if the capacity of the pipeline is extended in the future, which would require the construction of an additional compressing station close to the Albanian border.

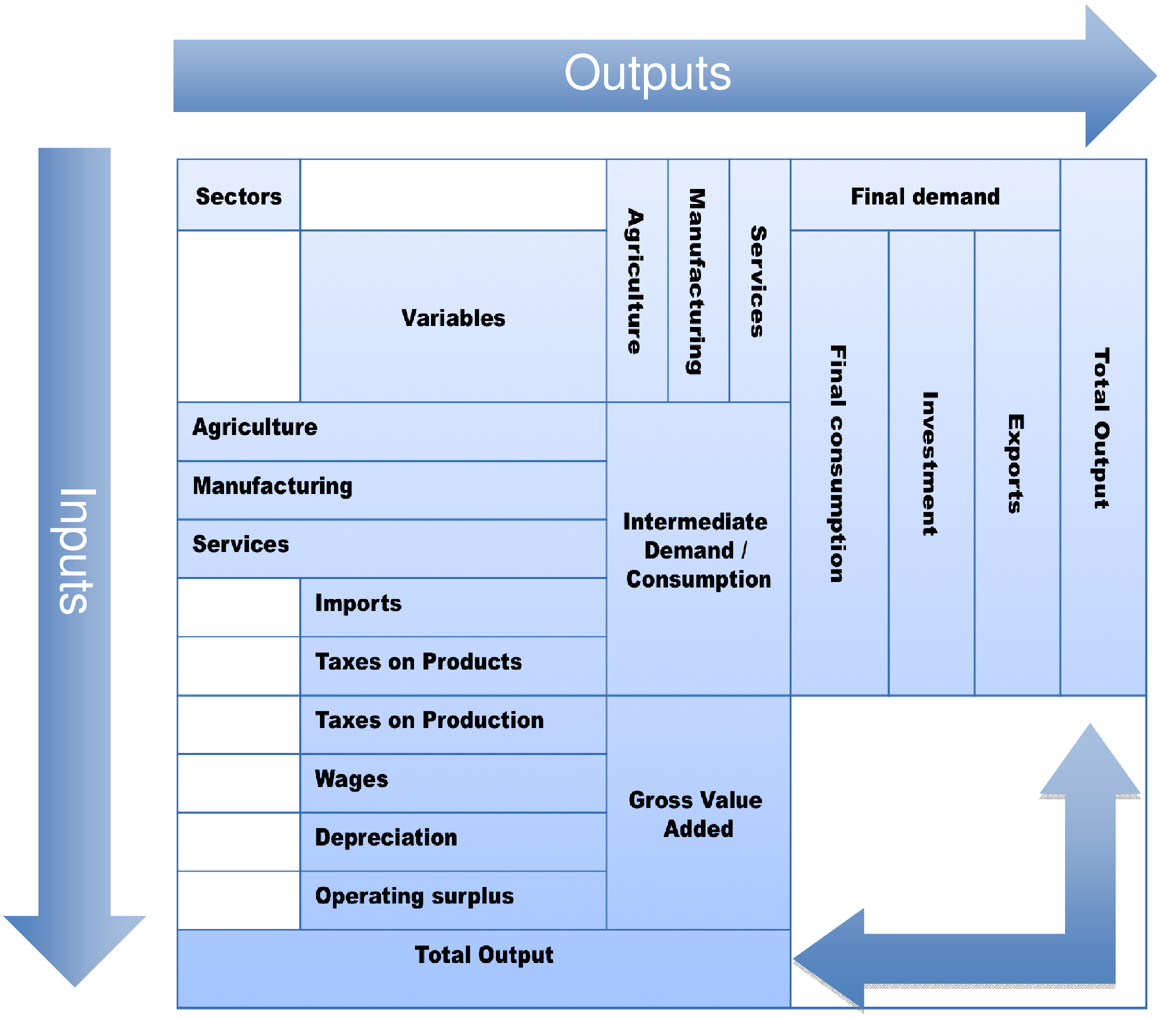
In conclusion, the Trans Adriatic Pipeline constitutes a foreign direct investment with considerable benefits at difficult times for the Greek economy. Its impact is concentrated, but not limited to regions that are hurt strongest by the unprecedented depression the country has been experiencing.

Meanwhile, the project can have significant benefits over the long-term as well. Some of these benefits come directly from the operation of the project, yet some of them are conditional on the capability of the Greek manufacturing sector to capitalise on its experience with the project. The materialisation of the long-term benefits to their full extent thus requires a more proactive and export-oriented entrepreneurship, a legislation that does not distort the market incentives and socio-political climate that supports the viable and socially responsible business activity.

5 APPENDIX: METHODOLOGY NOTES

The input-output models are primarily used to estimate the impact from a change in final demand on output, value added, GDP, employment and other variables of interest that can be thought of as varying in proportion to output. The essence of the input-output analysis is that it captures the interrelations between the sectors of the economy. The fundamental data input to this type of analysis is provided by Input-Output tables, which for Greece are published by Eurostat.

Figure 5.1: Generic Input-Output table



An input-output table can be thought of as a concatenation of three tables that depict intermediate demand/consumption between the economy's branches, final demand per sector and value added per sector respectively (Figure 5.1). The rows of the intermediate demand and the final demand sections of the table depict the destination of a branch's product across branches and final demand items (i.e. household consumption, government consumption, investment, exports, etc.). Meanwhile, the columns of the intermediate consumption and value added sections of the table represent the inputs required by each branch in order to produce its output. The inputs take the form of products from other branches of the domestic economy (with taxes on products depicted separately), imports, labour (measured as total wages), taxes on production (e.g. for licenses, etc.) and capital (measured as depreciation expenses).

The difference between the value of its output and the aforementioned inputs constitutes the sector's net operating surplus, out of which the sector's companies pay for any other non-operating expenses, set aside reserves for further investment or pay out dividends. Adding to the operating surplus the expenses for wages, depreciation and taxation on production we obtain the Gross Value Added (GVA) of a sector. If we add the GVA obtained this way and the taxes on products across all branches we obtain the economy's Gross Domestic Product (GDP). GDP can also be calculated by adding the final demand totals of the IO table - household consumption, government consumption, investment and net exports (i.e., exports less imports).

The input-output models assume that the supply of a sector is equal to the intermediate and final demand for its products and that this holds across the economy for all sectors (Equation 5.1). As such, these models belong to the general equilibrium family.

A crucial simplifying assumption that makes the input-output models computable and suitable for applied work comes from the use of the Leontief production functions (Equation 5.2). This implies that a unit of output can be produced by using fixed amounts of each input and the production process can be described by constant technical input coefficients that can be calculated from an input-output table.

Equation 5.1: Equilibrium conditions

$$\begin{aligned} x_1 &= z_{11} + z_{12} + \cdots + z_{1n} + d_1 \\ x_2 &= z_{21} + z_{22} + \cdots + z_{2n} + d_2 \\ &\vdots \\ x_n &= z_{n1} + z_{n2} + \cdots + z_{nn} + d_n \end{aligned}$$

where x_i: output of sector *i*

z_{ij}: demand by sector *j* for the products of sector *i*

d_i: final demand for the products of sector *i*

The use of Leontief production functions simplifies the general equilibrium analysis enough to make it computable, yet this practice involves a significant simplification of the production process in the real economy. In particular, the analysis involves the following assumptions:

- **Homogenous products**: This assumption is needed in order to be able to express the inputs as a linear function of output, which implies that a single technological process is available to produce the product of that sector. In practice the product classifications used in the input-output table depict product groups, each of which includes an aggregation of products, often produced using different technological processes.
- **No factor substitution**: Technology is fixed in the static one-period version, in the sense that it cannot be changed even under a large shift in the relative prices of inputs.
- **Constant returns to scale**: Production output and inputs scale up and down by the same proportion. Yet, in practice there are often economies of scale as fixed costs are spread over larger amount of output and diseconomies of scale due to adverse impact on productivity when output approaches full production capacity. In effect, the static model presupposes that supply can scale up indefinitely to accommodate shocks to final demand, without hitting upon scarcity constraints. As in practice, this is not always the case, this implies that the use of the model is not warranted for very large shocks to the economy.
- **Optimum use of inputs:** As the model estimates technical input coefficients from data on intermediate consumption of inputs for the production of goods in each sector, this presupposes that the resources are used optimally in the sense that the cost function is minimised in each sector. Otherwise, demand would be able to fluctuate without the need to change the level of an input that has not been fully used up.

Equation 5.2: Leontief production function

$$x_j = \min\left\{\frac{z_{1j}}{a_{1j}}, \frac{z_{2j}}{a_{2j}}, \cdots, \frac{z_{nj}}{a_{nj}}\right\}$$

where a_{ij}: the amount of good *i* required to produce 1 unit of good *j*

These assumptions limit the applicability of the static input-output model, yet are essential in order to make it suitable for applied analysis. The static one-period input-output model is considered not suitable for studies exceeding a five-year period. Given this rule of thumb and the difficulties of producing balanced input-output tables, Eurostat allows the EU member states to provide input-output tables once in five years. Various extensions have been developed to deal with these limitations, when the analysis spans a longer time frame.

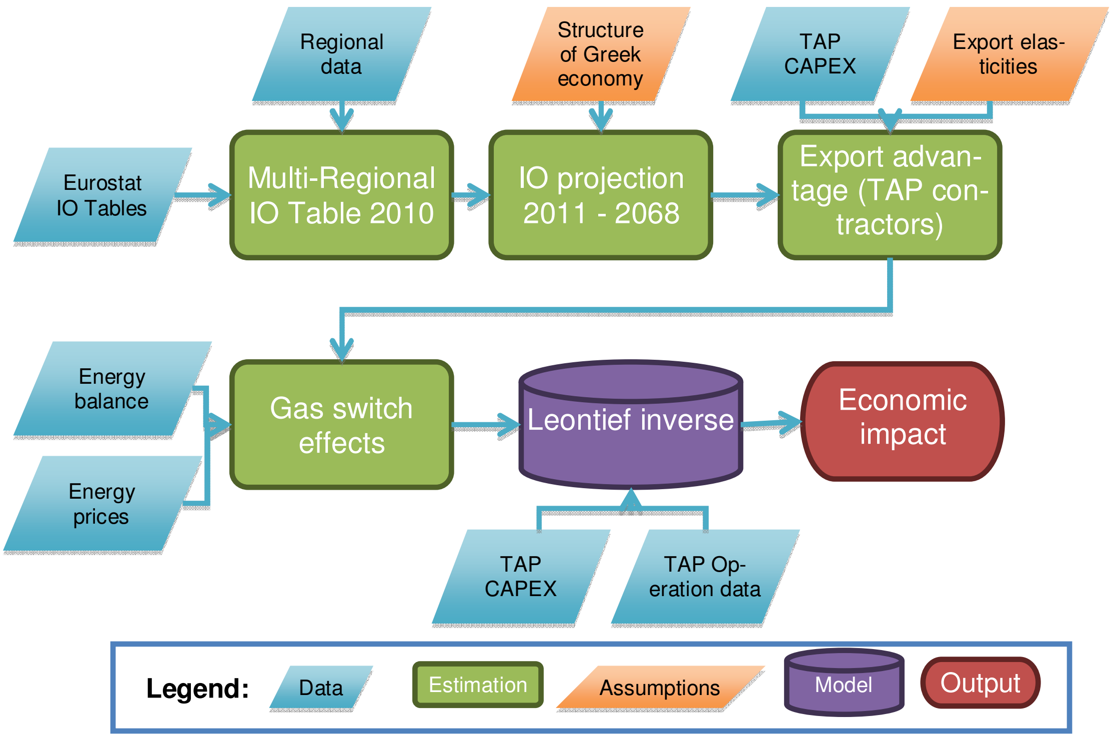
Given the homogeneity assumption, each input z_{ij} can be expressed as a linear function of output x_i. Substituting this into the equilibrium conditions and solving for output, we end up with output, as a function of final demand and the technical input coefficients, properly transformed by using matrix algebra inversion (Equation 5.3).

Equation 5.3: Leontief's inverse matrix

$$\begin{aligned} x_1 &= a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n + d_1 \\ x_2 &= a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n + d_2 \\ &\vdots \\ x_n &= a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n + d_n \end{aligned} \quad \Leftrightarrow x = Ax + d \Leftrightarrow x = (I - A)^{-1} d$$

Having output expressed in such a way allows us to examine how output, and other variables that vary with output, change as a result of changes in final demand components (e.g. a new investment project or a boost of exports).

Figure 5.2: Estimation process flow



As this study involves an estimation of impact at regional level for a significant time span, the static input-output model is not suitable without significant extension effort. We need to break the national input-output table down to the regional level, using data at a suitable level of disaggregation (Figure 5.2). For the extension of the input-output analysis over the lifespan of the pipeline, we need to project the table, using assumptions on the future structure of the Greek economy that reflect the expected trends in technology and international trade.

Further estimation is required to capture the spillover effect to the TAP suppliers and industries switching to gas due to its enhanced availability, modeled in our case as a boost of exports and an adjustment of the relevant input coefficients. Applying the demand shocks to the extended IO table would then enable us to estimate the economic impact at regional level and over time. In the remainder of this appendix we describe the base data, assumptions and estimation steps taken along this process flow.

5.1 Multi-regional IO table

For a multi-regional input-output model we need to regionalise the national table and to capture the interregional dependencies. There is a number of ways to achieve this. The most accurate results are provided by survey methods, whose execution, however, requires a considerable amount of time and resources. As a compromise between the quick yet rather approximate non-survey methods and the very expensive survey methods, various hybrid approaches have also been devised.

The use of survey and hybrid methods for this project should be ruled out due to budget constraints and data availability issues respectively. Among the non-survey approaches, the Cross-Industry Location Quotient (CILQ) method for the estimation of regional out of national input-output tables has been found to provide results closest to those obtained with hybrid or survey methods,[5] which is why we have opted to use it here.

The location quotient methods adjust the technical input coefficients in cases where a particular input is not fully available from regional sources (Equation 5.4). If, for example, there is hardly any activity in engineering services in West Macedonia, the

[5] Schaffer and Chu (1969), Chamanski and Malizia (1969) and Morrison and Smith (1974); all in Tzouvelekas (2003).

required input should come from other regions. CILQ differs from other location quotient methods by taking into account the relative sizes of the industries.

Equation 5.4: Cross-Industry Location Quotient

$$a_{ij}^{R} = \begin{cases} a_{ij}^{N} \text{ if } CILQ_{ij}^{R} \geq 1 \\ CILQ_{ij}^{R} \cdot a_{ij}^{N} \text{ if } CILQ_{ij}^{R} < 1 \end{cases}$$

$$m_{ij}^{R} = \begin{cases} 0 \text{ if } CILQ_{ij}^{R} \geq 1 \\ \left(1 - CILQ_{ij}^{R}\right) \cdot a_{ij}^{N} \text{ if } CILQ_{ij}^{R} < 1 \end{cases}$$

$$CILQ_{ij}^{R} = \frac{e_i^R / e_i^N}{e_j^R / e_j^N}$$

where e_i^R: employment of good *i* in region *R*

e_i^N: employment of good *i* at national level

a_{ij}^R: the amount of good *i* required to produce 1 unit of good *j* in region *R*

a_{ij}^N: input coefficient at national level

m_{ij}^R: the amount of good *i* required to produce 1 unit of good *j* imported in region *R*

A number of variables can be used to capture the structure of the regional economy. In our case, we opted for employment due to the availability of data at both NUTS 2 and NACE Rev 2 double-digit codes in Eurostat's Structural Business Statistics database. For the national input-output table, we used as a source the Eurostat database, which contains domestic and total input-output tables for 62 NACE Rev. 2 branches. The data refers to 2010 and was published on 13/1/2012.

With the use of CILQ we can estimate a region's input-output table, so that we can study the region's economy as we would study that of a country. This does not allow us, however, to examine the dependencies and feedback effects that exist across the regions, which can lead to underestimation of the economic impact in a region. The increase of demand for, say, pipes in West Macedonia can lead to higher activity in Central Macedonia's steel plants, which in turn may result in higher demand for electricity from West Macedonia. These effects can only be captured in multi-regional input-output models that explicitly take into account the interregional trade flows.

In order to capture the interregional dependencies, we used the Leontief-Strout Gravity Model (Leontief, 1986). Using the estimates obtained from the stand-alone regional input-output tables, we can infer the interregional flows of a product between any two regions from the product's total inflow and total outflow of the two regions of interest and the distance between them (Equation 5.5). We can also eliminate a flow, in case where we would not expect such a flow to occur in practice by setting a subsidiary condition to zero.

For the distance variable we used optimal road route metrics of Google Maps from border to border of a region, selecting coordinates that corresponded to the most likely exit/entry points to those regions (i.e. major highways). This method implies that the distance between two neighbouring regions is considered equal to zero. LSGM also involves two scaling parameters, whose value is determined endogenously by solving the system of equations in an iterative procedure.

Equation 5.5: Multi-regional dependencies estimation

For any good i (subscript supressed) :

$$x_{gh} = \frac{x_{go} x_{oh}}{x_{oo}} (c_g + k_h) d_{gh} \delta_{gh}$$

$$x_{go} \sum_{r=1}^{m} \left[x_{or} (c_g + k_r) d_{gr} \delta_{gr} \right] = (x_{go} - x_{gg}) x_{oo}$$

$$x_{oh} \sum_{r=1}^{m} \left[x_{ro} (c_r + k_h) d_{rh} \delta_{rh} \right] = (x_{oh} - x_{hh}) x_{oo}$$

where x_{gh} : flow of good i from region g to region h

x_{go} : total output of good i in region g

x_{oh} : total input of good i in region h

x_{oo} : total output of good i in all regions

d_{gh} : reciprocal distance between regions g and h

δ_{gh} : subsidiary conditions $\{0,1\}$

c_g : position of a supplier region (endogenous)

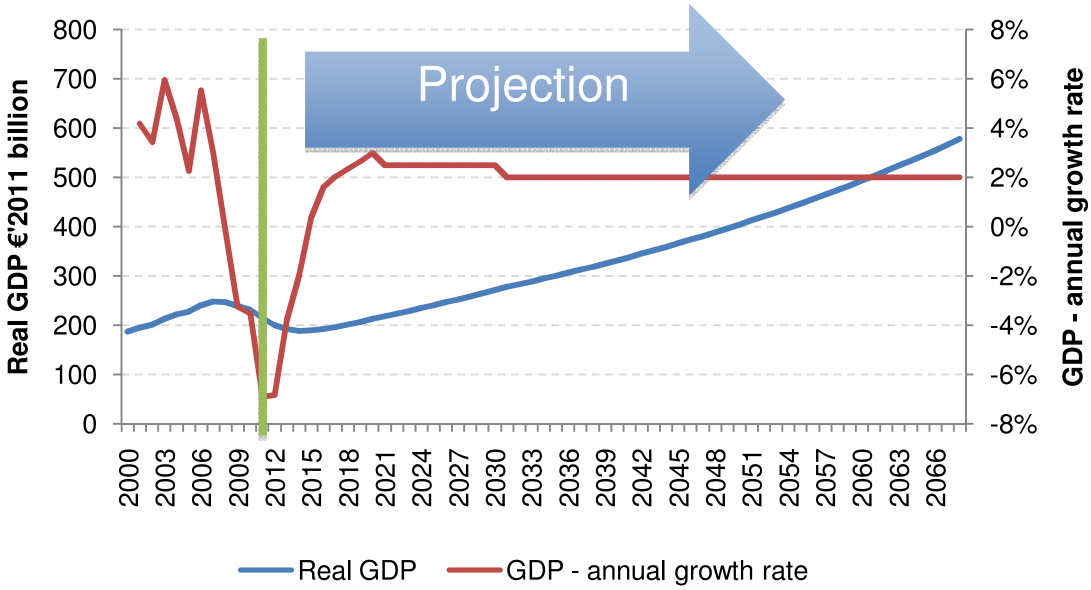
k_h : position of a supplier region (endogenous)

5.2 IO projections

It is not considered a good idea to use the static input-output model for projections that extend for a period exceeding five years from the year of data collection, as in the mean time the structure of the economy has most probably shifted significantly. New techniques become available due to technological progress, which implies that the input requirements change as well. Prices also vary and over a longer time span the industries could change their production technologies in the aftermath of a permanent shift in relative input prices.

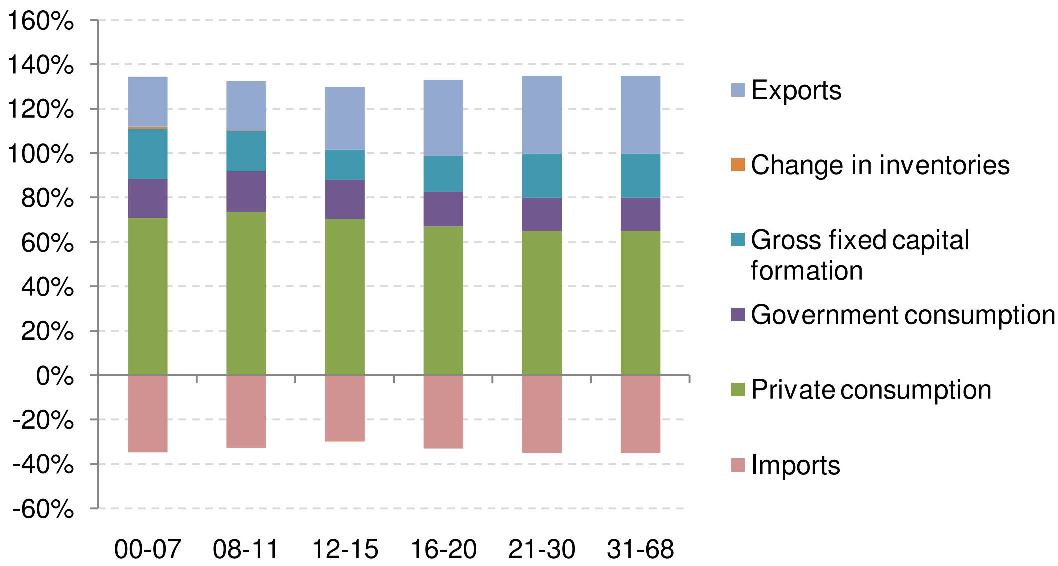
We needed to project the multi-regional input-output tables overtime, taking into account changes in adopted technologies. For this purpose, we used the EURO method, which was developed by Eurostat in order to overcome some of the weaknesses of other popular IO projection methods (e.g. RAS). Its key feature is that it works with externally derived projections on final demand, imports and value added per sector that outline the future course of the economy and in an iterative procedure generates a balanced input-output table that can be used for impact assessment purposes. The method is described in full detail in Eurostat (2008).

Figure 5.3: GDP projections



Source: IOBE Assumptions

Figure 5.4: Projection of GDP components



Source: IOBE Assumptions

For the projection of GDP, we assume that the Greek economy will shrink on average by -3.1% per year in the period from 2012 until 2015, albeit at a lower rate compared with the preceding recession period 2008-2011 (-3.5% Compounded Average Growth Rate - CAGR). In the remaining years until the end of the decade, GDP is expected to grow by 2.3% on average, accelerating to 2.5% in the following decade, but still below the rate experienced immediately before the economic crisis (4.1% CAGR in 2000-7). In the very long term, from 2031 and until the end of the projected period, we assume a growth rate of 2%.

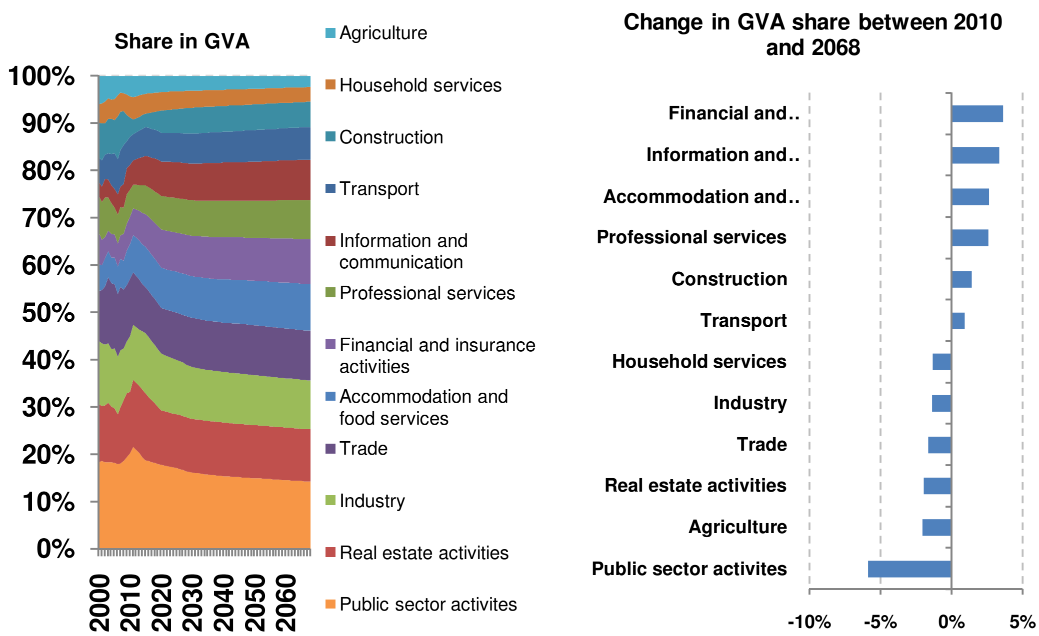
Table 5.1: Projection of GDP components

% of GDP	2000-07	2008-11	2012-15	2016-20	2021-30	2031-68
Private consumption	71%	74%	71%	67%	65%	65%
Government consumption	18%	19%	18%	15%	15%	15%
Gross fixed capital formation	22%	18%	13%	16%	20%	20%
Change in inventories	1%	0%	0%	0%	0%	0%
Exports	23%	22%	28%	34%	35%	35%
Imports	-35%	-33%	-29%	-33%	-35%	-35%

Source: IOBE Assumptions

It is not reasonable to expect that the composition of GDP will remain the same on either the supply or the demand side. The demand side composition of GDP is currently characterised with deep imbalances, as there has been persistent trade deficit that has boosted consumption (private and public) to more than 90% of GDP (Figure 5.4 and Table 5.1). Such imbalances cannot last in the long-term.

Figure 5.5: Projection of GVA per sector



Source: IOBE Assumptions

Consumption is projected to fall down to its pre-crisis level in the near term (2012-15), continue to drop, reaching 80% in the next decade (65% private and 15% public) and stabilise at that level for the remainder of the projection period. The share of imports will fall in the near term, as income will continue to contract, yet it is expected to return to its pre-crisis level in the long-term. In order to make the economy's growth path viable over the long term, exports need to increase their share well above the pre-crisis level to match the share of imports, while investment should also recover in the long run.

On the supply side, the share of Agriculture and Manufacturing is projected to continue its fall (Figure 5.5 and Table 5.2). The share of Construction is expected to return and slightly exceed its pre-crisis level in the remaining of this decade and the decade to come, falling slightly in the long term. Trade is also projected to decline, while growth will be mostly driven by Tourism, Transport and the remaining branches of services that are currently less developed in Greece, compared with other developed economies.

Table 5.2: Projection of GVA per sector

% of GVA	2000-07	2008-11	2012-15	2016-20	2021-30	2031-68
Agriculture	5%	4%	4%	4%	3%	3%
Industry	13%	11%	12%	12%	11%	11%
Construction	8%	5%	3%	4%	5%	5%
Trade	13%	12%	10%	10%	10%	10%
Transport	6%	6%	6%	6%	6%	7%
Tourism	6%	7%	8%	9%	9%	9%
ICT	4%	5%	6%	7%	8%	8%
Finance	5%	6%	6%	8%	8%	9%
Real estate activities	12%	13%	14%	13%	11%	11%
Professional services	7%	6%	6%	7%	7%	8%
Public sector activities	18%	20%	20%	18%	17%	15%
Household services	4%	4%	4%	4%	4%	3%

Source: IOBE Assumptions

5.3 Export advantage effects

Before estimating the economic impact over time and at regional level, we need to take into account the spill-over structural effects that would come to the sectors involved in TAP's construction and to the sectors that can switch to natural gas, once the fuel becomes available.

The companies involved in TAP would acquire experience, which they can use for similar projects abroad. How much gain there is from the participation to the TAP project depends, in our view, on the size of the involvement, relative to the overall size of the sector. Thus, if a sector's involvement in TAP represents a significant share of that sector's output, we would expect large advances in experience. In contrast, even if a significant expenditure from TAP is directed to a sector, if it represents only a small fraction of the sector's output due to the size of the sector, it is not reasonable to expect that the project itself would have a significant impact on that sector's experience. The involvement of a domestic sector, in turn, depends on the share that it takes from TAP's capital expenditure (CAPEX).

Equation 5.6: Gained experience of a sector, as a function of its relative involvement to TAP's CAPEX

$$Exp_i = f\left(CAPEX_{TAP}, s_i, dom_i, O_{dom,i}\right)$$

where Exp_i : gained expertise of sector i

$CAPEX_{TAP}$: capital expenditure of TAP

s_i : share of sector i in $CAPEX_{TAP}$

dom_i : share of domestic production in the supply of sector i

$O_{dom,i}$: domestic output of sector i

Gained expertise can lead to improved quality of a company's output and to reduce its cost of production. Better quality at lower cost translates into a competitiveness boost, which improves a sector's stance in the international markets. Thus, these effects would transpire empirically as an increase of exports.

Equation 5.7: Exports boost to TAP's contractors

$$\Delta \ln Ex_i = \beta \frac{CAPEX_{TAP} \cdot s_i \cdot dom_i}{O_{dom,i}}$$

where $\Delta \ln Ex_i$: % boost of exports of sector i

β : elasticity of exports wrt a demand boost (rescaling parameter)

Ideally, we would calculate the parameters of this function, with exports as an empirical proxy of experience, using econometric methods. However, no such data is readily available. Instead, for the purposes of this study we assumed that 1% increase of a sector's output due to involvement in TAP results in 1% boost of the sector's exports in the years following TAP's construction, by setting the relevant elasticity or scale coefficient equal to 1 (Equation 5.7).

Combining the above estimates, we can see that the strongest boost of exports can be expected in Machinery and Equipment, followed by Fabricated Metal Products (in the domestic pipe scenario). Third, at a considerable distance, comes Construction

(Table 5.3). This differentiation comes from both the fact that the share of international trade in Construction's output is much more limited and that the relative exposure of the other two sectors to TAP is much more significant due to their considerably smaller size.

Table 5.3: Export boost for TAP's contractors

Export effects	Total supply 2010*	Exports 2010*	Δ In Exp	Δ Exp 2010*
Machinery and equipment	955	463	5,9%	27,5
Fabricated metal products	4.645	267	4,1%	11,0
Construction	27.181	563	1,3%	7,3
Land transport	7.920	204	0,8%	1,6
Other business services	5.573	76	1,3%	1,0
Legal , accounting and consulting	6.913	298	0,3%	0,9
Architectural and engineering	5.592	114	0,8%	1,0
…				
Total / weighted average	**152,762**	**38,200**	**0.6%**	**265**

* Million €

Source: Eurostat Input-Output tables 2010 (http://goo.gl/c9pT7)

5.4 Gas switch effects

Another source of spill-over effects comes from the enhanced availability of gas along the route of the new pipeline. The introduction of a competitive fuel into a region's fuel mix extends the choice set of the companies, which potentially allows them to achieve a lower energy cost by choosing a different combination of energy products. This leads to enhanced cost competitiveness, boosting exports as a result.

For TAP in particular this effect is expected to be relatively limited in the Greek case. For some of the route over the Greek territory, such as in East Macedonia – Thrace and Central Macedonia, natural gas is already available. Thus, the possibility of such spill-over effects is expected to be limited to West Macedonia.

The introduction of gas into an electricity system also brings down the cost of electricity, as gas fuelled power plants usually replace power plants that run on oil products, which are considerably more expensive than natural gas. In TAP's case, however, such effects are not expected to be observed, as the building of gas-fired electricity generation plants in West Macedonia is not envisaged, in the near and medium term at least, due to the strong presence of lignite fuelled power plants and grid constraints in the transport of electricity from North to South Greece.

Electricity generation in Greece has taken place primarily near West Macedonia's lignite fields. Meanwhile, the population of Greece is disproportionately concentrated in South Greece and in particular in the wider Athens metropolitan area. As a result of this mismatch, there is a bottleneck in the electricity grid connecting North and South Greece.

Equation 5.8: Export boost from gas switch effects

$$\Delta \ln Ex_i = s_{ng,i} \beta_i \ln \frac{P_{ng}}{P_{el}}$$

where $\Delta \ln Ex_i$: % boost of exports in sector i

β_i : price elasticity of foreign demand in sector i

P_{el} : Price of electricit y for industries

P_{ng} : Price of natural gas for industries

$s_{ng,i}$: Share of natural gas in the final energy consumptio n of sector i

An incentive system is in place in order to make it more attractive to build new electricity capacity in the south section of the electricity system. As a result, all new CCGTs that have been introduced in the past few years, or are currently under construction, are situated in South Greece. Even if we envisage a switch in the long-run in West Macedonia from lignite generation to CCGT using gas from TAP, say due to environmental constraints, this would most probably lead to an increase of the cost of electricity. Meanwhile, some of the long-term energy strategy scenaria envisage the use of carbon capture and storage, which would preserve some lignite production in the region, precluding from a switch to natural gas there. Given the uncertain prospects of electricity generation with natural gas in the West Macedonia region, we opted from not modelling these effects here.

Table 5.4: Prices of energy products and export elasticity

Item	Unit	Value
Price of natural gas for industry, 2011	€ / MWh GCV	40.25
Price of electricity for industry, 2011	€ / MWh	90.25
Elasticity of exports to price differential		-0.447

Source: IEA (2012), Sideris and Zonzilos (2005)

We modelled the gas switch effects in potentially gas-consuming industries in West Macedonia as a boost of exports that comes from a more optimal energy fuel mix and improved cost competitiveness. The size of this effect can be assumed to depend on the share of natural gas in the sector in regions where natural gas is readily available, which takes into account the technology constraints in the choice of fuel for the production process in each sector (Equation 5.8). Meanwhile the effect can also be assumed to depend on the price differential between natural gas and other energy products. Lastly, we also need a parameter that translates the improvement of cost competitiveness to export effects.

Natural gas for industry per unit of energy was less than half as expensive as electricity in Greece in 2011, which implies that there is a potential for a significant cost reduction (Table 5.4). Using export elasticity with respect to changes in relative prices from the literature and data from the latest available energy balance, the largest boost of exports from switching to natural gas can be expected in the Iron and Steel sector (12%), followed by the Manufacturing of paper, pulp and print, Chemical and petrochemical plants and other industry sectors (Table 5.5). This data was matched with the regional production pattern of West Macedonia to obtain the anticipated boost of exports from the enhanced availability of natural gas in the region.

Table 5.5: Boost of exports from switch to natural gas

	Consumption of natural gas 2010	Total energy consumption 2010	Share of natural gas	Export boost
Iron and Steel	61	177	34%	12%
Paper, Pulp and Print	31	121	26%	9%
Chemical and Petrochemical	45	194	23%	8%
Textile and Leather	15	89	17%	6%
Machinery	3	19	16%	6%
Food and Tobacco	82	580	14%	5%
Non-Ferrous Metals	64	764	8%	3%
Non-Metallic Minerals	60	969	6%	2%
Non-specified (Industry)	11	295	4%	1%
Wood and Wood Products	1	48	2%	1%
Transport Equipment	0	26	0%	0%

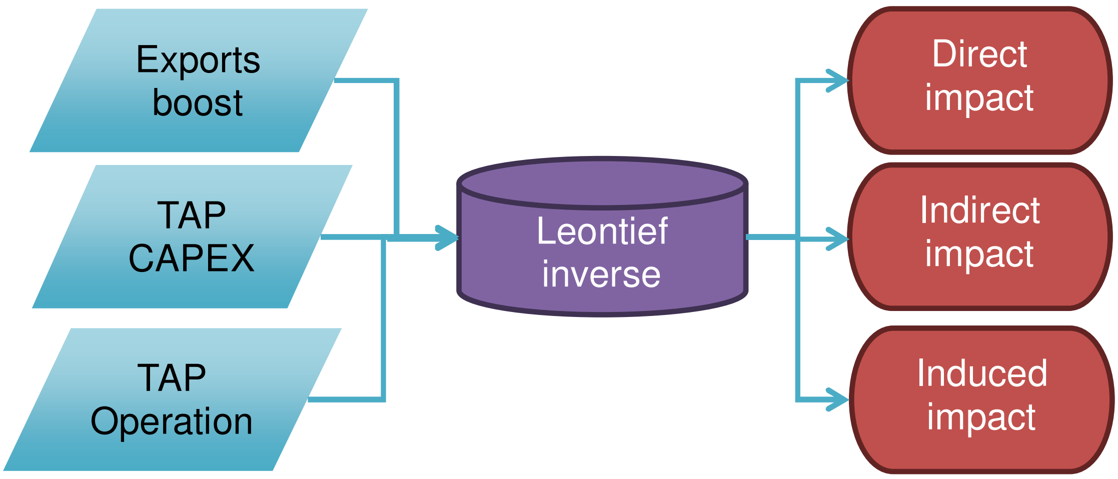
Source: Eurostat Energy Statistics (http://goo.gl/aafGR)

5.5 Economic impact assessment

Having incorporated all the above data into a Multi-Regional IO Model with long-term projection, we estimated the economic impact of TAP as a demand boost from the pipeline's construction and operation and the enhanced competitiveness that it brings into the economy (Figure 5.6).

In particular, we calculated the Leontief inverse matrix of the mutli-regional table of technical input coefficients for each year over the projection horizon and applied to it the demand shock that would come from TAP. This gave us an estimate of the impact of TAP on output of each sector for every year of the estimation (Equation 5.9) in each region. The impact on the remaining variables of interest, such as employment, value added, etc. can be estimated using the respective shares from the input-output tables for the corresponding year of estimation under a reference scenario, where the demand shocks from TAP are not present.

Figure 5.6: Estimation of economic impact



In order to perform the above estimations, we also need to break down TAP's capital expenditure and operation data per product category.[6] For the operating expenditure breakdown, we used the input coefficients of the wider sector to which TAP belongs (Electricity, gas, stream and air-conditioning), modified in order to leave out the particularities of the electricity generation process.

In particular, we set to zero the input coefficient for lignite (which is exclusively used for electricity generation and not for gas transmission) and advertising (which is primarily spent to promote retail business in gas and electricity supply). Meanwhile, we

[6] The data is not presented in the report due to issues of confidentiality.

also adjusted the input coefficient for oil products as some of the electricity generation, particularly in islands not interconnected with the national grid, is performed using light and heavy residual fuel oil. We used the coefficient from another network industry (water supply) for this particular input (0.4% of output).

Equation 5.9: Estimation of economic impact

$$x_t = (I - A_t)^{-1} d_t$$

$$y_{i,t} = \frac{y^0_{i,t}}{x^0_{i,t}} x_{i,t}$$

where $x^0_{i,t}$: output of sector i in year t under the reference case (no TAP)

$y^0_{i,t}$: employment, VA, etc. of sector i in year t under the reference case

$x_{i,t}$: output of sector i in year t under the investment scenario

$y_{i,t}$: employment, VA, etc. of sector i in year t under the investment scenario

As the latest input-output data refer to 2010, the monetary values in the report were initially estimated in 2010 prices (using constant-price projections over the study's estimation horizon). The monetary values were then converted to 2012 prices, using data on CPI inflation from the Hellenic Statistical Authority (http://goo.gl/2DmRO). In particular, according to EL.STAT. the Consumer Price Index grew by 3.3% in 2011 and by 1.5% in 2012.

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