The Natural Gas Sector in Post-Revolution Egypt

***Khalid Siddig*[1] *and Harald Grethe*[2]**

Abstract

This paper assesses the economic implications of a situation in which Egypt increases the price of its gas exports to Israel and equalizes it to the world price. This is motivated by the Egyptian revolution that toppled a government, which was offering Israel preferential prices. It is also in line with the public discontent about that, which was reflected in several attacks on the pipelines that transfer the gas. Moreover, the paper also assesses the impacts of terminating the agreement in light of the April 2012 announcement of the Egyptian Natural Gas Holding Company of the termination of its contract to ship gas to Israel. Prices deviations from the average world prices are simulated in GTAP model and an updated version of GTAP database that reflects the actual natural gas production, trade shares and cost structures in both countries. Results reveal that the Egyptian economy will enjoy welfare benefits relative to preferential price variations from the world prices. However, the overall gas production in Egypt would decrease due to subsidy removal and domestic supply increase after shrinking exports. The gains would mainly be driven by increases in the exports price indices that despite the reductions in export volumes, generate higher export revenues for the economy. The GDP would also improve geared by the increasing returns to production factors in sectors other than gas and mainly in the electricity; chemical, rubber and plastic products; and service sectors.

Keywords: *Natural gas, Egyptian revolution, Israel, GTAP model.*

JEL Classification: *C6, D1, D3, D6, E6, F1, Q4.*

[1] Department of Agricultural Economics, Khartoum University. Zip code 13314, Po. Box 32, Khartoum North, Sudan. Phone Number: (+249)185318431. Email: khalidhasiddig@yahoo.com.

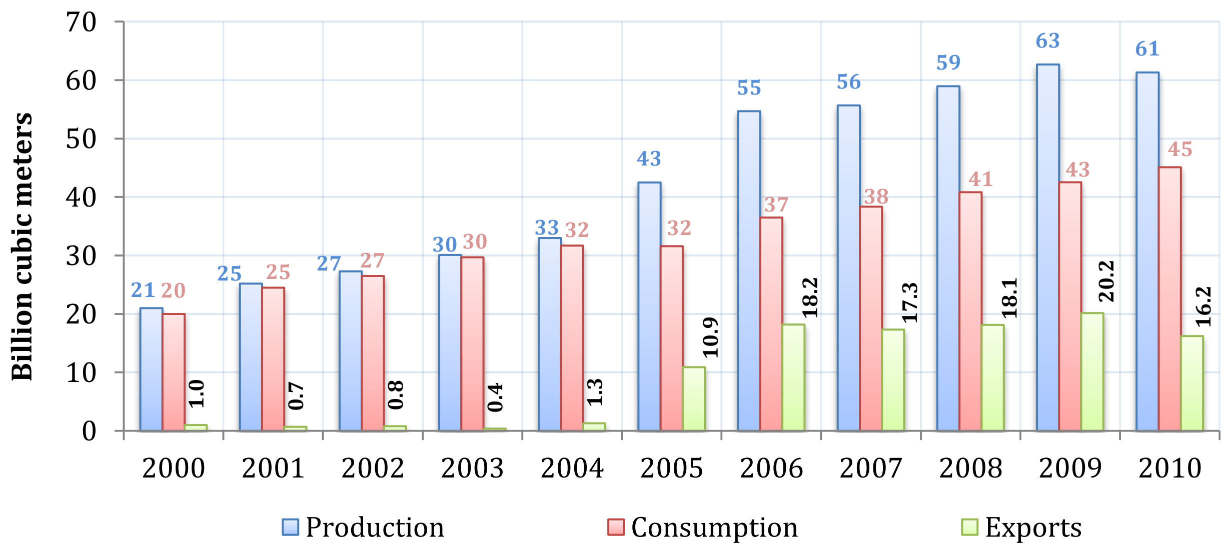
[2] Agricultural and Food Policy Group, University of Hohenheim, Stuttgart 70593, Germany. Phone Number: (+49) 711 459-22631. Email: grethe@uni-hohenheim.de.

Contents

1 Introduction

The production of natural gas in Egypt has been on the rise, while the production of oil has been on a declining path since the mid-1990s (BP, 2011). Egypt is developing rapidly its large gas reserves, which represents 15% of the total proved gas reserves in Africa in 2010. Gas production was approximating 61 billion tons in 2010, almost triple of what was produced ten years earlier (Figure 1). Until 2003, domestic consumption moved in tandem with production, leaving a very narrow room for exports. However, five major gas projects, which were developed between 2003 and 2004 (IMF, 2005) have raised annual gas production to the current level of more than 60 billion cubic meters (bcm). Therefore, Egypt evolved as a significant net exporter of gas in 2004 and was among the top 15 exporters of gas in the world in 2010 (BP, 2011).

Figure 1: Natural gas production, consumption and exports in Egypt (bcm: 2000 – 2010)



Source: BP (2011).

The importance of the natural gas sector in the Egyptian economy has been growing during the last decade. As shown in Table (1), it contributed 8% to total GDP at factor cost and nearly 56% to the value added to the mining sector on average over the period 2007 to 2010 (CAPMAS, 2011). The BMI (2009) forecasts suggest that gas exports would potentially reach 37bcm by 2013; the total production will reach about 87bcm; and the domestic consumption reach 50bcm.

On the consumption side of the economy, the total natural gas demand in Egypt has grown rapidly because the thermal power plants, which account for 65% of Egypt's total gas consumption, have switched from oil to gas (PMI, 2009). However, despite this rapid increase in the domestic consumption, exports of gas remain a major Egyptian priority (African Economic Outlook, 2011).

Table 1: The contribution of natural gas to the Egyptian Economy (2007 – 2010)

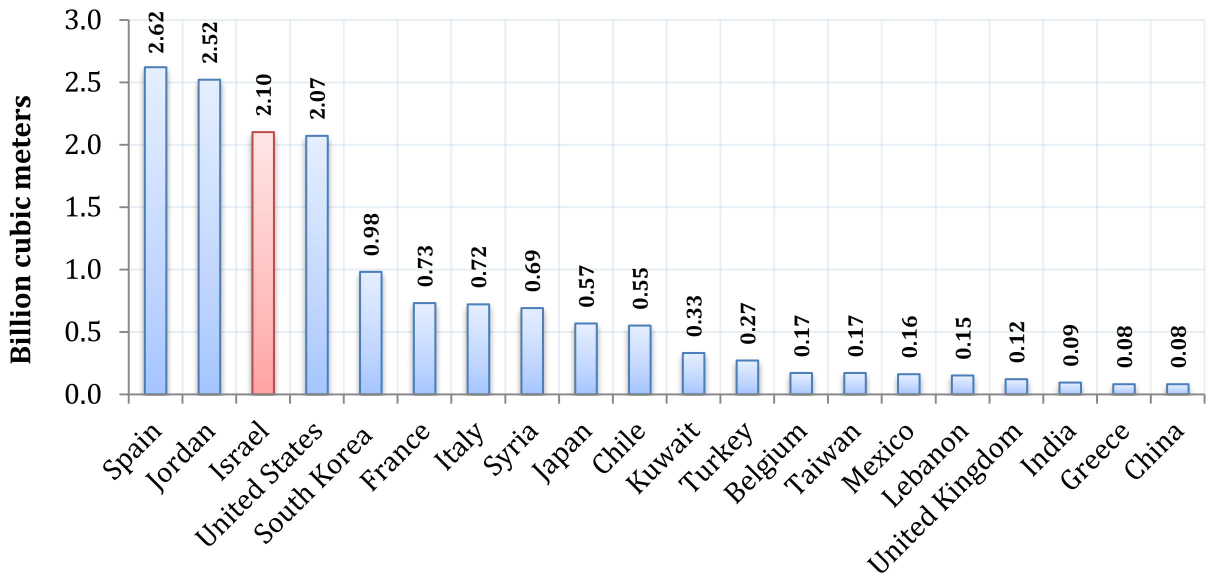
	Gas (million L.E.)[3]	% Mining sector	% GDP
2007-2008	59061.00	55.00	7.76
2008-2009	63072.00	55.46	7.92
2009-2010	64221.00	55.98	7.67
Average (2008 -2010)		55.48	7.78

Source: CAPMAS (2011).

The top four destinations of Egyptian gas exports in 2010 as shown in Figure (2) were Spain, Jordan, Israel, and USA, which received 17.3%, 16.6%, 13.8%, and 13.6%, respectively, and they all together accounted for 61.4% of total Egyptian gas export volume in 2010 (BP, 2011).

[3] Egyptian pound.

Figure 2: Destinations of Egypt's natural gas exports in 2010[4]



Source: BP (2011)

Exports of gas to Jordan via an undersea pipeline started in 2003 as first phase of the Arab Gas Pipeline project feeds a power station in Aqaba, which was followed by extensions of the pipeline to Lebanon and Syria. The first annual shipment of gas exports to Jordan was at the value of US$ 60 million in 2003/04 (IMF, 2005). A 30-year agreement envisages export volumes rising from the 2003 of about level of 1.1 bcm per year (bcmy) to 2.3 bcmy by 2010/11. In May 2004, another agreement for selling gas to Israel via an off-shore pipeline was approved. According to the agreement, the Israeli state-owned Israel Electric Corporation would buy 1.2 bcmy of Egyptian gas from July 2006, rising to 1.7 bcmy one year later under a 15-year contract, with an option to extend the agreement for a further five years (IMF, 2005).

The agreement has effectively started in 2008, and since then Egypt is supplying Israel with about 40% of its domestically consumed natural gas**.** The gas is delivered through a pipeline that connects the Arab Gas Pipeline with Israel. Although this pipeline is not officially a part of the Arab Gas Pipeline project that connects Egypt to Jordan, Lebanon, and Syria, it branches off from the same pipeline in Egypt (Shaffer, 2011).

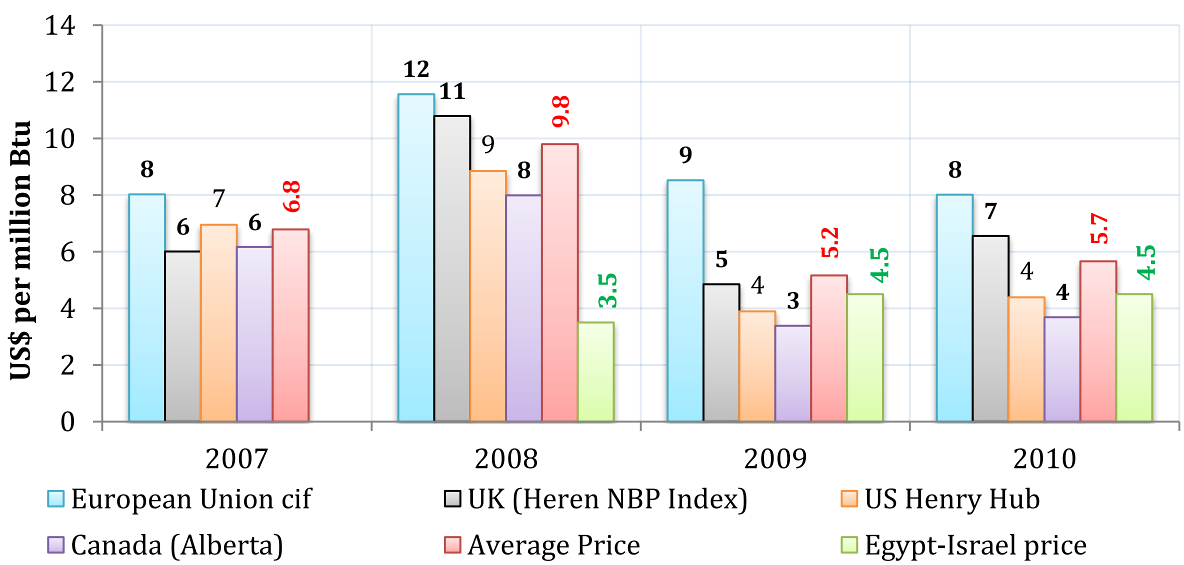
[4] Notes: Flows are on a contractual basis and may not correspond to physical gas flows in all cases.

There is public discontent against the sales of the gas to Israel in Egypt particularly after the January 2011 revolution as Israel pays below market prices for the natural gas it imports from Egypt (Ratner, 2011). Accordingly, there have been ten attacks on the pipeline since the eruption of the revolution, causing Israel's gas supply to be temporarily cut off (Afify and Fahim, 2011; Elyan, 2011). On the other side, Israel is poised to become a natural gas producer and perhaps even a natural gas exporter provided the discoveries of major offshore natural gas reserves in 2009 and 2010 that were confirmed in the Mediterranean Sea near Israel (Ratner, 2011).

There is no detailed information available on the level of the preferential price paid by Israel and their differences from the world price of natural gas. However, according to Khadduri (2011), the initially agreed upon price was 3 to 3.5 dollars per million British thermal units (Btu). Khadduri (2011) also reports that, in August, 2009 the Israel Electric Corporation (the primary consumer of the exported gas) approved an adjusted price of 4 to 4.5 dollars per million Btu.

In order to quantify the difference between this price and world price and to identify the gap between them, the price data of the BP (2011) are used. The BP (2011) prices data include four different prices; namely, (1) European Union cif, (2) UK Heren NBP Index, (3) US Henry Hub and (4) Canada (Alberta). Figure (3) compares the four prices, average price, and the price paid by Israel during the period (2007- 2010), with the latter being those reported by Khadduri (2011).

Figure 3: Different international gas prices compared to those paid by Israel (2007 – 2010)



Sources: BP (2011) and Khadduri (2011).

Table (2) shows the average prices in comparison to their absolute and percentage differences from the prices paid by Israel during the period (2007- 2010). Khadduri (2011) shows two different ranges of prices for the pre and post-2009 periods, namely (3-3.5 and 4-4.5) however, for simplicity those shown in Table (2) and Figure (3) are only the highest within each range, i.e. US$ 3.5 per million Btu and US$ 4.5 per million Btu for the two periods, respectively.

Table 2: The world prices of gas against those paid by Israel price (2007 – 2010)

Prices (US$ per million Btu)	2007	2008	2009	2010
Average Price	6.79	9.80	5.16	5.66
Egypt-Israel price	-	3.50	4.50	4.50
Difference (Israel – average)	-	-6.30	-0.66	-1.16
% difference((Israel – average)/Israel *100)	-	-179.95	-14.72	-25.80

Sources: BP (2011); Khadduri (2011); and Authors' calculations.

The highest difference in gas prices between the average world price and those paid by Israel is that of 2008, where the average world price was almost triple that paid by Israel, while in 2009 and 2010, Israel was paying 15% and 26% below the average price for its imported gas from Egypt.

2 Objectives

Based on the background of the previous section, this paper is trying to investigate the implications that possible scenarios related to gas exports from Egypt to Israel might have on the Egyptian economy. Based on the current developments we tend analyze the following scenarios:

1) Egypt decides to increase the preferential export price of gas to Israel and (almost) equalizes it to that paid by Jordan and other importers, which is likely to happen as far as the related legal issues are cleared.
2) Egypt's gas exports to Israel cease completely and are redirected to other destinations. This may happen due to two very different reasons:

   (a) Egypt decides to opt from exporting gas to Israel at the end of the current contracts. This scenario is likely to happen as very recent development that is being conveyed by several news agencies states that "the head of the Egyptian Natural Gas Holding Company has said it has terminated its contract to ship gas to Israel because of violations of contractual obligations". In a statement by Aljazeera (2012), he mentioned also that "the Sunday's decision[5] was not political. This has nothing to do with anything outside of the commercial relations; Israel has not paid for its gas in four months". The later statement was denied by the Israeli foreign ministry spokesman according to Aljazeera (2012); or

(b) Israel operationalizes its new discoveries, reaches self-sufficiency in gas and hence displaces imports from Egypt.

However, within the context of this paper we will remain under the assumption that scenario (2) is due to option (a) because option (b) has more to do with changes within the Israeli economy and this paper focusses on the problems from an Egyptian economy prospective.

3 Methodology

As shown in the objectives, the intended exercise is of a mixed nature with several dimensions. First, it has a microeconomic dimension as it evolves from one sector in the economy that influences other sectors such as the energy and electricity generation sector. Second, it is important at the macroeconomy level through its significant contribution to national GDP and external trade[6]. Third, the major issue of the paper has a multilateral trade dimension because in addition to Egypt, Israel and other countries are involved, with Israel being the focus of this study as an Egyptian trade partner and the rest of the world's regions being potential destinations for the diverting gas from the Israel. Finally, the paper topic also includes a political economy dimension, which despite its importance and influence over other dimensions, our analysis does not focus on it.

The decision about a suitable analytical method was therefore, made on the bases of capturing as much as possible in terms of these dimensions, while considering the data requirements associated with each and their availability. The global Computable General Equilibrium (CGE) model (Hertel, 1997) of the Global Trade Analysis Project (GTAP) is one of the most popular models for analyzing the impact of trade policy that has multilateral

[5] Sunday, April 22, 2012.

[6] Refer to the first section for further details on the contribution of the natutural gas to the Egyptian GDP.

partners and involves various sectors within their economies.[7] This model together with its database is found plausible for the intended exercise of this paper.

There are various advantages of employing the GTAP model in this study. Firstly, it is a multi-regional model of world production and trade; hence, it can take into account the overall trade implications of changes in natural gas prices and traded quantities between Egypt and Israel, while considering any possible diversion to other partners as reflected in the model settings. Secondly, it comes with a comprehensive global database that provides detailed information on 57 sectors and 129 regions covering all traded commodities and flexible possibilities of regional and sectoral aggregation. All the countries and commodities related to our exercise of this paper are included in the most recent release of GTAP database, namely, version 8 (Aquiar et al., 2012). Thus, trade implications for various sectors and regions of interest can be assessed.

Moreover, the representation of the trading sectors in the model allows the simulation of a situation where trade flows across certain regions can be reduced or eliminated. This advantage is particularly relevant to our second scenario.[8] Thirdly, it allows for the assessment and decomposition of the welfare effects of various trade agreements and scenarios such as the one we intend to pursue in this paper. Finally, GTAP model and its global database have been widely used to study the likely effects of different trade agreements and other trade policy issues, it is readily available to the public and, the results reported in this study can be easily replicated.

3.1 Model Description and Setup

The GTAP modeling framework consists of a comparative static CGE model and a global database. The CGE model is based on the neoclassical theories and commonly applied assumptions of constant returns to scale in production, perfect competition among markets, product differentiation by economy of origin (i.e., the Armington assumption), and profit and utility maximizing behavior of firms and households, respectively. The model is solved in GEMPACK software with a user friendly setting known as RunGTAP. [9]

---

[7] Find more details in Hertel (1997). A graphical presentation of the GTAP model with particular emphasis on the accounting relationships is given by Brockmeier (2001). A more rigorous approach is presented by Hertel and Tsigas (1997).

[8] Elaborated description of the regions and sector and their aggregation follows in section 3.2.

[9] For more details about Gempack and its related software packages, see Harrison & Pearson (1996).

3.1.1 Final demand

There is a single representative household for each region in the model called the regional household. It accrues its income from factor payments and tax revenues net of subsidies and spends it on private household expenditure, government expenditure, and savings applying a Cobb-Douglas per capita utility function.

The private household maximizes its utility subject to its expenditure constraint, which is modeled as Constant Difference of Elasticity (CDE). It spends the generated income on consumption of both domestic and imported commodities based on a Constant Elasticity of Substitution (CES) aggregate of domestic and imported goods. The imported goods are sourced to different regions according to CES function as well. Taxes paid by the private household are commodity taxes for domestically produced and imported goods and the income tax net of subsidies (Siddig, 2011). The government expenditure follows similar modeling structure as private household with the difference being the prevalence of a Cobb-Douglas sub-utility function to model the behavior of government expenditure (Hertel, 1997).

3.1.2 Production

Producers accrue their income from selling consumption goods to consumers and intermediate inputs to other producers domestically and/or across borders. They spend this income on selling intermediate inputs, paying for factors, and paying taxes, and hence, satisfy the zero profit assumption of the model. Every industry is assumed to produce a single output, Constant Returns to Scale (CRS) prevail in all markets, and the production technology is Leontief.

Producers maximize profits by choosing two broad categories of inputs including factors (value added) and intermediate inputs. Value added composite is a CES function of labour, capital, land and natural resources, while the intermediate composite is a Leontief function of inputs, which are sourced either to the domestic market or imports based on CES function. Furthermore, the imported intermediate inputs are also sourced to all regions according to CES function (Brockmeier, 2001).

3.1.3 Saving and investment

The model closes by assuming that, that the demand for investment in a particular region is savings driven and each region's savings contributes to a global pool of savings called global savings in which the global savings are homogenously allocated. The dispatching of these savings among regions in response to investment demand is then based on the changes in its rates of return in each region. Accordingly, the Walras' Law can be satisfied if (a) all markets in the model are in equilibrium; (b) all firms earn zero profits; and (c) all households are within their budget constraint. The satisfaction of these conditions equalizes global investment and global savings, which is known as Walras' Law (Hertel and Tsigas (1997).

3.1.4 International trade

Imports are distinguished by their origin in GTAP model through the employment of the Armington assumption in the trading sector, which explains intra-industry trade of similar products. Accordingly, GTAP database and model separates imported commodities from their domestically produced counterparts. Both imported and domestic goods are combined in an additional nest in the production tree, with the elasticity of substitution in this input nest being equal across all uses. Accordingly, firms decide first on the sourcing of their imports and, based on the resulting composite import price, they then determine the optimal mix of imported and domestic goods. There are separate conditional demand equations for domestic and imported intermediate inputs in the model (Brockmeier, 2001).

Final demanders (government and private households) buy domestically produced and imported commodities and pay commodity taxes on imports to the regional household. Again imported and domestically produced commodities are combined in a composite nest for final demanders with the elasticity of substitution between imported and domestically produced goods in this composite nest of the utility tree being equal across uses.

Tax revenues and subsidy expenditures in the context of trade are computed in a similar way as domestic policy instruments used in the domestic market. However, they are introduced as a buffer between world and market prices. Therefore, imports tax exists if the market price is higher than the world price; hence, the power of the ad valorem tax is greater than one, while imports subsidy exists if the market price is lower than the world price; hence, the power of the ad valorem tax is smaller than one.

In the export side, exports tax exists if the market price lies below the world price, hence, the power of the ad valorem tax is smaller than one, while exports subsidy exists if the market price lies above the world price; hence, the power of the ad valorem tax is greater than one.

3.2 GTAP Database and Adjustments

This paper makes use of the most recent global database, which is GTAP database version 8. This version of the database has several features those makes GTAP model and database particularly suitable for this study, these are (1) Dual reference years: 2004 and 2007; (2) Additional regional disaggregation as it comprises 129 regions and 57 sectors; (3) Newly added 15 regions including Israel and other countries in middle east such as Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates. In addition, they are updated/improved 16 regions and new macro-economic data, trade data, protection data, time-series bilateral trade, new export subsidies data and CO2 emissions dataset integrated into core data base (Aquiar et al., 2012).

The newly developed Israeli Input/output Table (IOT), makes pursuing the exercise of this paper possible within GTAP framework and will definitely further provide motivations to apply the model and the database on issues related to Israel (Siddig et al, 2011). The dual reference year feature of this version of the GTAP database is considered an important feature, because it updates the information contained in the countries' IOTs to more recent year, namely 2007. The contributed Israeli IOT (Siddig et al, 2011) for instance, has the year 2004 as a base, but having the 2007 update is particularly important in the context of this paper as it better reflect a closer size and influence of the natural gas sector in the Israeli and Egyptian economies. Therefore, the application of GTAP database version 8 within this study is based on the 2007 candidate of the data.

3.2.1 Database Aggregation

The 129 regions and 57 sectors of version 8 are aggregated for simplicity to 45 regions and 40 sectors, however, this aggregation has also taken care of many important aspects in connection to the natural gas sector and the related issues addressed in the study. The following aspects are relied on to select the 45 regions: (1) the importance on the country in the total production of natural gas at the global level, (2) the share of the country in the global bilateral gas trade, (3) the focus countries of the study, namely Egypt and Israel, and (4) the regions that are partnering the focus countries e.g. other importers of the Egyptian gas besides Israel as well as other exporters (existing and potential) of gas to Israel besides Egypt. In addition, some related countries in the region with connection to the gas sector are also included such as Qatar Iran and Saudi Arabia.

For the sectoral (commodity) aggregation the following factors are also used to reduce the standard GTAP 57 sectors 40: (1) the top 15 domestically sold commodities in Egypt, (2) the top 15 imported commodities in Egypt, (3) the top 15 exported commodities in Egypt, and (4) the top 15 intermediately demanders of gas at the global level. Some of the commodities are overlapping across the four categories; therefore, 38 commodities are being selected according to this procedure. In addition, "vegetable and fruits" and "sugar and sugar cane" are removed from the grain crops to avoid the heterogeneity among the components of the grain crops, leading the considered number of commodities to be 40 commodities. Appendix (1) provides the complete list of the commodities and their corresponding shares according to the described four criteria.

3.2.2 Database Adjustments

Exports of gas from Egypt to Israel started effectively in 2008. This implies that both candidates of GTAP database do not reflect the real quantities and values exported to Israel. Therefore, we started our exercise by reviewing the structure of gas sector in Egypt and Israel including production, trade and cost structure. We relied on the comprehensive information provided by BP (2011) report that includes time series data on the approved reserves, production, consumption, trade and prices of gas. It also provides detailed information focusing on the year 2010 that breaks the gas movement down across partners at the global level. Other information is also collected from official sources in Egypt and Israel such as CAPMAS (2011) and ICBS (2011).

By reviewing GTAP database in light of the real data available on the gas sectors in Egypt and Israel and their bilateral and multilateral linkages, some adjustments are found to be crucial prior to introducing the intended simulations in GTAP model and database.

These adjustments are performed in a series of simulations starting from the original GTAP database version 8, candidate 2007 (Aquiar et al. 2012). A new version is created with 45 regions and 40 sectors[10], in which the pre-simulations are introduced. The entire process is shown in Figure (4) including the related variables and their changes across the series of simulations. The required adjustments as well as their related simulations and outcomes are also summarized as follows:

(1) According to BP (2011), 40% of the domestically consumed gas in Israel in 2010 (2.1 bcm) is imported and sourced only to Egypt. This implies that the share of

[10] Refer to the previous sub-section for details on the rationale of sector and region aggregation.

Egypt in the total Israeli imports of gas is 100%. This percentage however, is only 3.0E-10% in GTAP database.

To update this share, we simulated an augmentation of the Egyptian imports of gas into Israel by 61.5%, which led to increasing the share of Egypt in the Israeli imports of gas from 3.0E-10% to 99.7% (Figure 4). The importance of this step at the beginning of our adjustments evolves from the functional representation of trade in GTAP model where Armington assumption prevail, therefore, small trade shares would remain small unless they are updated in indirect way as followed here. This approach is invented and applied within GTAP framework by Kuiper and van Tongeren (2006) following an intensively debated issue within CGE literature.[11] Kuiper and van Tongeren (2006) applied a gravity equation to estimate trade shares that would prevail after a lowering of trade barriers. Afterward they used the estimated trade shares to calculate imports augmenting shifters for the Armington functions.

In the current study, our trade shares are calculated from real world data on the gas movement, which are provided by the BP (2011) for several years, however, the details applied in the paper are only for 2010.

(2) The imported gas in Israel in 2010 represents 40% of the domestic consumption of gas. In quantity terms it is 2.1 bcm and this is equivalent to US$ 431.14 million (Appendix 2); however, in the database this value is US$ 0.51 million and represents only 2.9% of the total domestic consumption.

To update this value, similar approach was followed but on the top of the results obtained from the first simulation i.e. a new version is created based on the output of the first version.[12] Afterwards, the shock was introduced, which augments as well the domestic use of gas in Israel by its major users, so that the increasing imports do not reduce the amount produced domestically. Moreover, a component to remove Israel's exports to itself is also incorporated in the same simulation. The outcome of this simulation is also shown in the top-right box (output of step 2) of Figure (4). It was hard to achieve the US$ 431 million target through this shock alone and the maximum increase in the imports from Egypt augmenting shifter was 4%, however, it increase

[11] Refer to Kuiper and van Tongeren (2006) for extended literature review and further details.

[12] 61.5% increase in the ams parameter was the maximum achievable shock from the GTAP base data.

Israel imports to US$ 89 million and the share of imports in the total use in Israel from 2.9% to 34%.

(3) In the Egyptian side, the production of gas was 55.7, 59.0, 62.7, and 61.3 bcm in 2007, 2008, 2009, and 2010, respectively (BP, 2011). These are equivalent to US$ 13.7, 21.0, 11.7, and 12.6 billion, respectively. [13] However, the 2007 candidate of GTAP database shows only a value of US$ 9.3 billion. Therefore, GTAP database need to be adjusted to correctly reflect the production of gas in Egypt before moving forward to its exports to Israel.

(4) On the exports side, Figure (1) shows that, 26.5% of the total domestic production of gas in Egypt is exported in 2010. Out of this share, 2.10 bcm is exported to Israel, which account for 13.8% of the total Egyptian exports of gas in the same year. GTAP database however, shows only 0.001% instead; hence, this needs adjustment as well.

After the second phase of adjustment, one comprehensive simulation is introduced based on the updated data of the previous simulation to bring the database to its required baseline. This series of shocks are repeated several times in order to assure its ability to meet as much as possible of the targets and to make major variables as close as possible to their values in 2010 for both the Egyptian and Israeli gas sectors. The major components of the simulation are summarized in the following, while their outcomes against the targets are shown in the bottom-right box (output of step 3) of Figure (4):

(a) Augmenting: (1) factors use by the gas sector in Egypt, (2) factors use by the gas sector in Israel, (3) intermediate use of gas commodity in Israel, and (4) intermediate use of gas commodity in Egypt;

(b) Reallocating the Egyptian exports across the different destinations based on the shares calculated based on BP (2011) data on natural gas movement; and

(c) Eliminating: (1) Israel's exports to itself, and (2) Egypt's exports to non-recipient countries according to the BP (2011).

[13] Details on the quantity (bcm) conversion into values in US$ billion are provided in Appendix (2).

Figure 4: Data adjustments to generate a base for simulations

GTAP Base (Aquiar et al. 2012)
Version: *Ngasbase* (45 regions, 40 sectors)

Variable	*Current*	*Target*
Israel imports US$ million	0.51	431
Israel share in Egypt's exports	0.001%	13.8%
Israel imports/use %	0.0%	40%
Israel output US$ million	16.8	646
Israel share of gas in the cost structure of electricity	0.19%	10.6%
Egypt share in Israel's import	7.1%	100%
Egypt output US$ million	9300.2	12591
Egypt export US$ million	3381.5	3337
Egypt export/output %	36.4%	26.5%

1 Augmenting Egyptian imports of gas in Israel by 61.5%

Updated GTAP data based on Ngasbase
Version: *Ngasbas1* (45 regions, 40 sectors)

Variable	*Current*	*Target*
Israel imports US$ million	0.74	431
Israel share in Egypt's exports	0.02%	13.8%
Israel imports/use %	0.04%	40%
Israel output US$ million	16.5	646
Israel share of gas in the cost structure of electricity	0.19%	10.6%
Egypt share in Israel's import	99.7%	100%
Egypt output US$ million	9300.3	12591
Egypt export US$ million	3381.7	3337
Egypt export/output %	36.4%	26.5%

2 Augmenting Egyptian imports of gas into Israel by 4% and Augmenting the intermediate use of Gas in Israel by its major users

Updated GTAP data based on Ngasbas1
Version: *Ngasbas2* (45 regions, 40 sectors)

Variable	*Current*	*Target*
Israel imports US$ million	89.1	431
Israel share in Egypt's exports	2.6%	13.8%
Israel imports/use %	33.8%	40%
Israel output US$ million	174.5	646
Israel share of gas in the cost structure of electricity	4.37%	10.6%
Egypt share in Israel's import	99.7%	100%
Egypt output US$ million	9325.7	12591
Egypt export US$ million	3397.4	3337
Egypt export/output %	36.4%	26.5%

3

- Augmenting: (1) factors use in Gas sector in Egypt, (2) factors use in Gas sector in Israel, (3) intermediate use of Gas in Israel, (4) intermediate use of Gas in Egypt
- Reallocating the Egyptian exports,
- Eliminating: (1) Israel's exports to itself, and (2) Egypt's exports to non-recipient countries.

Updated GTAP data based on Ngasbas2
Version: *Gasbase* (45 regions, 40 sectors)

Variable	*Current*	*Target*
Israel imports US$ million	442.2	431
Israel share in Egypt's exports	13.1%	13.8%
Israel imports/use %	39.7%	40%
Israel output US$ million	670.7	646
Israel share of gas in the cost structure of electricity	9.85%	10.6%
Egypt share in Israel's import	99.9%	100%
Egypt output US$ million	12555.4	12591
Egypt export US$ million	3368.0	3337
Egypt export/output %	26.8%	26.5%

4 Adjusting the export taxes and subsidies by applying Atertax pre-simulation. It adds a subsidy to gas exports from Egypt to Israel

Updated GTAP data based on Gasbase (Altertax)
Version: *GasB08P* (45 regions, 40 sectors)

Variable	*Current*	*Target*
Israel imports US$ million	442.2	431
Israel share in Egypt's exports	13.1%	13.8%
Israel imports/use %	39.7%	40%
Israel output US$ million	670.7	646
Israel share of gas in the cost structure of electricity	9.85%	10.6%
Egypt share in Israel's import	99.9%	100%
Egypt output US$ million	12633.1	12591
Egypt export US$ million	3368.3	3337
Egypt export/output %	26.7%	26.5%

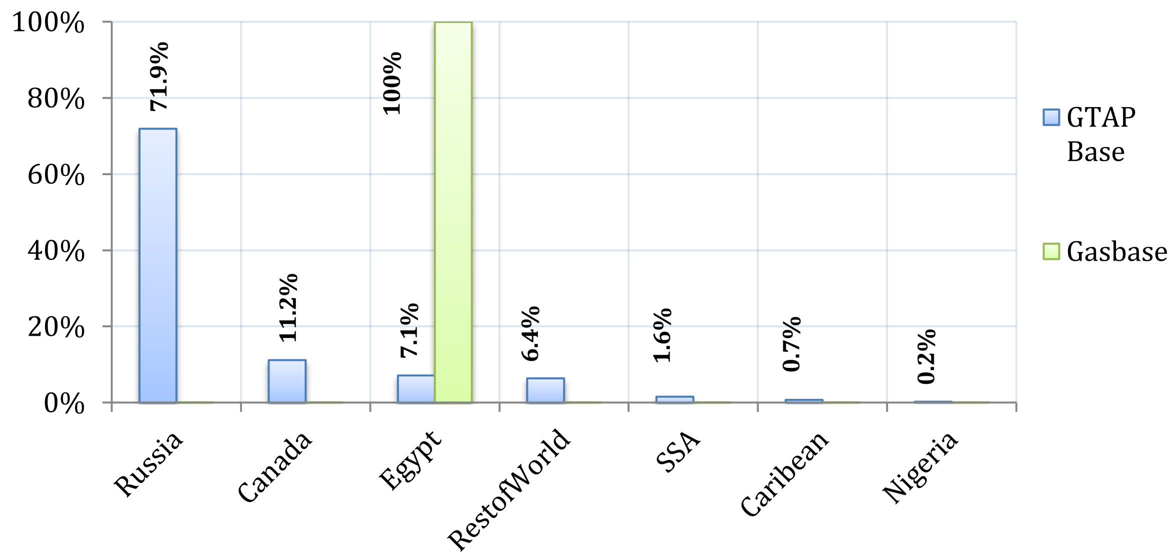
5 Simulating an icrease in the export price of gas from Egypt to Israel by 8.5%, which is equivalent to subsidy removal

Updated GTAP data based on Gasbase (pfob8.5%)
Version: *GasB08P* (45 regions, 40 sectors)

Variable	*Simulated*	*Base*
Israel imports US$ million	295.8	442.2
Israel share in Egypt's exports	8.6%	13.1%
Israel imports/use %	30.2%	39.7%
Israel output US$ million	683.8	670.7
Israel share of gas in the cost structure of electricity	10.42%	10.6%
Egypt share in Israel's import	99.7%	99.9%
Egypt output US$ million	12609.3	12633.1
Egypt export US$ million	3418.2	3368.3
Egypt export/output %	27.1%	26.7%

Figure (5) shows a comparison between the share Egypt has in the total Israeli imports in GTAP database and the updated database (Gasbase), while Figure (6) compares the shares the different destinations of Egypt's exports of gas have in GTAP database and the updated database in comparison to those of BP (2011) for the year 2010.

Figure 5: Shares of Israel's sources of gas imports in GTAP base and updated base (Gasbase)

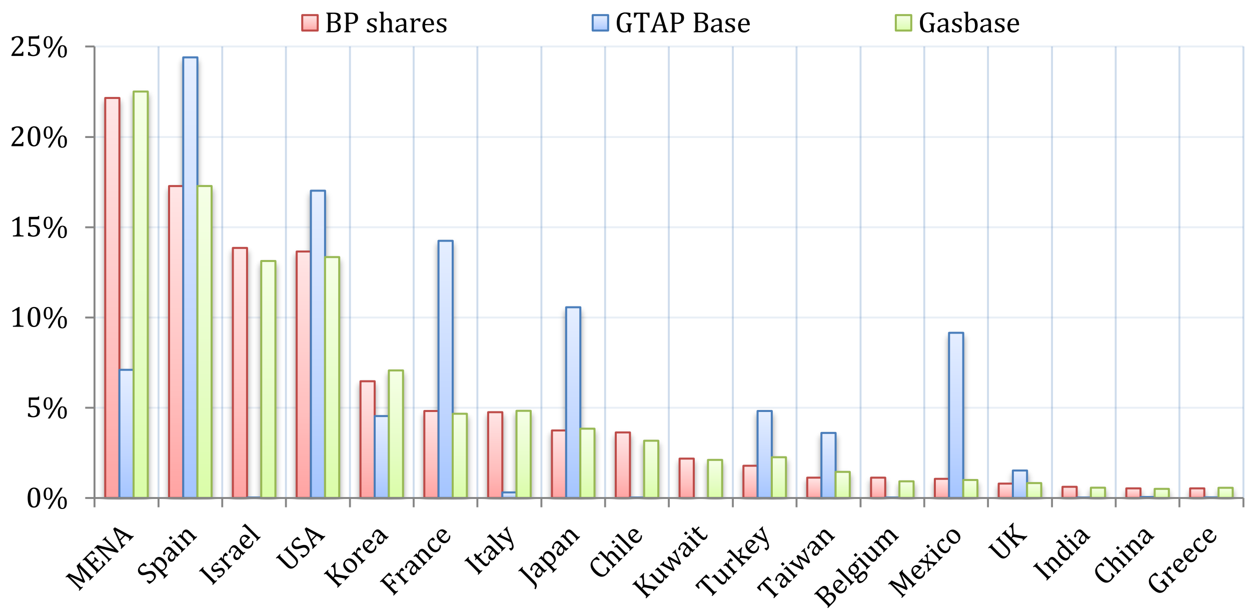


Sources: Aquiar et al. (2012); Authors.

Figure (5) clearly show that 72% of the Israeli imports of gas were sourced to Russia with the Egyptian share being only 7% in the original GTAP database. However, the pre-simulations results confirm their adjustment to the desired state that is compatible with the shares that are calculated based on BP (2011) natural gas movement data. Figure (6), focusses on the shares of each destination of Egypt's export of gas and shows how closer the updated shares to those of the BP (2011) are.

Steps 4 and 5 in Figure (4) are reserved for the simulation setup and are further described in the following section.

Figure 6: Shares of the destinations of Egypt gas exports (GTAP base and updated base)



Sources: Aquiar et al. (2012); BP (2011); Authors.

3.3 Simulations Setup

To simulate our designated scenarios in GTAP model, the relevant variable for scenario (1) is the FOB world price of gas supplied from Egypt to Israel, which is an endogenous variable. Therefore, it should be swapped by an exogenous variable that has similar dimensions and influence, so that we can simulate various price levels. The suitable swappable variable is the destination specific change in subsidy on export of gas from Egypt to Israel. Hence, the price change would in effect become equivalent to subsidy change, which requires the level of this particular subsidy to be equivalent to the intended price change in the baseline data. Accordingly, we started each of our price change sub-scenarios according to Table (2) by generating a new baseline data through a pre-simulation adjustment applying Malcolm (1998) approach. Afterward, the simulation is setup by increasing the level of price that is translated in subsidy removal.[14]

[14] See steps 4 and 5 in Figure (4) for details on the related data adjustment. Step 4 of Figure (5) prepares the baseline for the scenario considering 2009 prices of gas (Scenario 1-09).

Two sub-simulations following FOB world price changes are experimented based on the three price differences of Table (2). We selected the 2008 price with the highest price difference from the world price and 2009 price with the lowest price difference. The 2010 price falls in between and for simplicity, no separate experiment is included for that in this paper. However, the third scenario builds on that of 2010.

On the other hand, scenario (2) assumes the complete elimination of exports of gas from Egypt to Israel as previously described and justified by the existence of either situation (a) or (b) separately or a mixture of both, with the former being likely to happen in the short run, while the latter is possible in the long run and maybe sometime in between.[15]

To accommodate scenario (2) within GTAP modeling framework, the suitable variable for that is export sales of gas from Egypt to Israel, which is also an endogenous variable that need to be swapped in order to possibly simulate it to change. Again this variable is swapped with the destination specific change in subsidy on export of gas from Egypt to Israel for both consistency and relevance reasons.

Based on the previous technical description of the simulation setup, the experiments simulated and discussed in this paper could be presented as follows:

(1) *Scena1-08: increasing the FOB price of gas exported from Egypt to Israel to equalize it with the average world price in 2008.*
(2) *Scena1-09: increasing the FOB price of gas exported from Egypt to Israel to equalize it with the average world price in 2009.*
(3) *Scenario2: eliminating the exports of gas from Egypt to Israel, considering the 2010 export prices of gas.*

4 Results and Discussion

In this section, the results obtained from the three scenarios are shown and discussed. The approach we follow here is to show the results of the three scenarios together and try to draw the story line comparing the magnitude of their impact on the different components of the economy. Throughout the section we will refer to the scenarios based on their short names as (1) Scena1-08 standing for increasing the FOB price of gas exported from Egypt to Israel to equalize it with the average world price in 2008; (2) Scena1-09 for increasing

[15] Refer to section (2) for details on situations a and b.

the FOB price of gas exported from Egypt to Israel to equalize it with the average world price in 2009; and (3) Scenario2 for eliminating the exports of gas from Egypt to Israel, considering the 2010 export prices of gas.

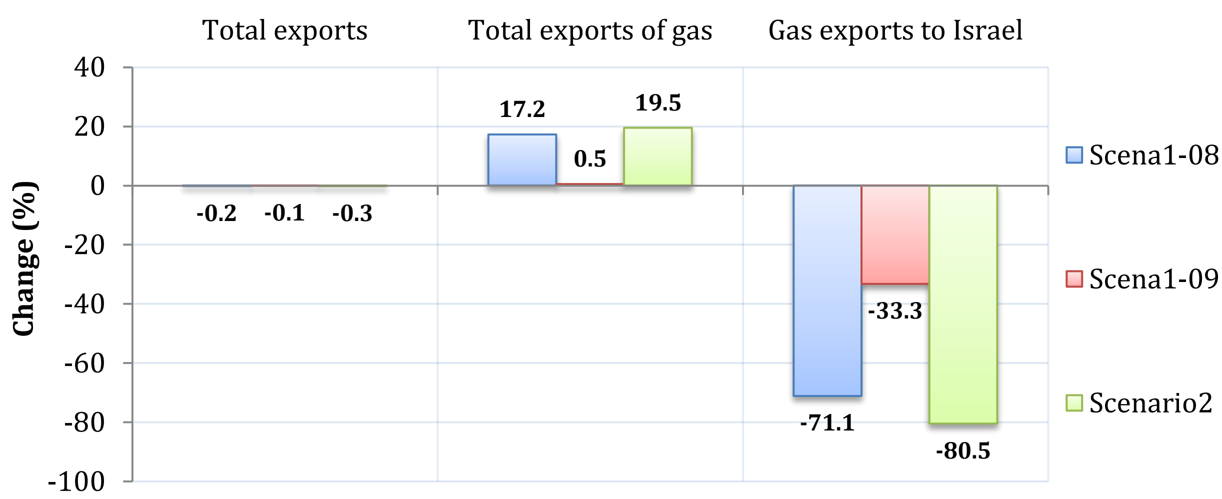
Results would also be discussed in an order that follows the sources of change, i.e. the impact on exports and trade will be first, followed by production, GDP and its components, and will be closed by discussing the welfare implications of the different simulations.

4.1 The impacts on Egypt's external sector

Exports are the directly influenced component in the Egyptian economy by our simulations and the contribution they have to the Egyptian GDP (exports of goods and services) accounted for 33%, 25% and 21% in 2008, 2009, and 2010, respectively (World Bank, 2012).

The impact of our three simulations as shown in Figure (7) will reduce gas exports to Israel, which translates in very small reductions in the total value of Egypt's exports despite the increase in the total exports of gas. What is important in these results is that the huge declines in the exports of gas to Israel do not cause reductions in the total exports of gas; however, Figure (7) shows increases in total exports of gas reaching nearly 20% under Senario2, 17% under Scena1-08 and 1% under Scena1-09. At the same time, the exported gas quantities did not increase, however the results reports volume changes (dvol) of -122, -11 and -138 reductions due to Sena1-08, Sena1-09 and Senario2, respectively. These increases in value terms are mainly due to the reallocation of exported gas towards other countries (regions) that pays more as reflected by the increases in the price index of merchandise exports from Egypt by 0.48%, 0.12% and 0.55% due to Sena1-08, Sena1-08, and Senario2, respectively (Figure 8).

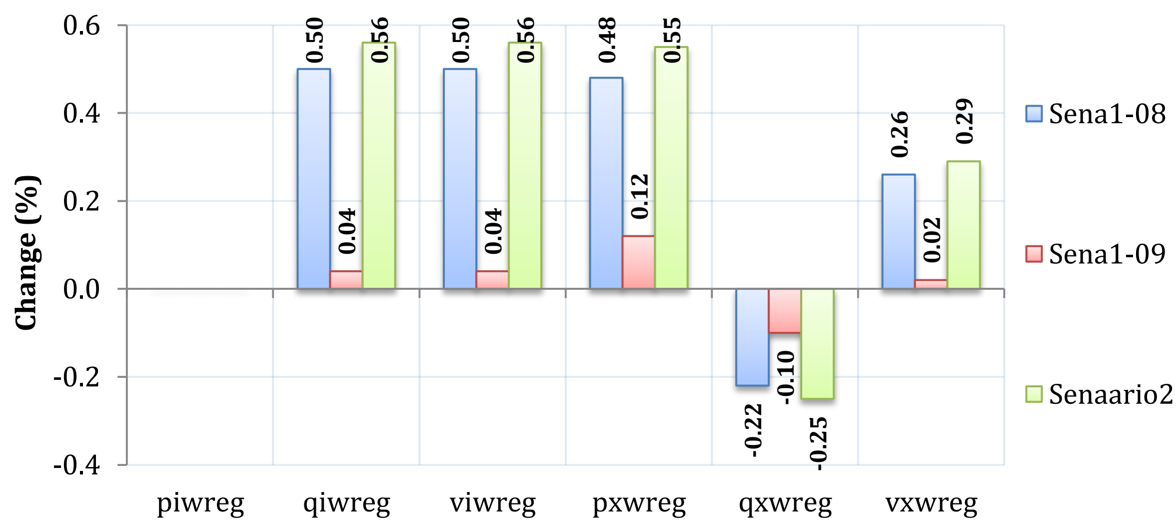
Figure 7: Impacts of the gas scenarios on Egypt's exports



Source: Model results.

At the macro-level, the impacts of the three simulations on the overall Egyptian trade balance are US$ -143 million, US$ -12 million, US$ -162 million, respectively. These can be explained by the development of the total merchandise exports (quantity – qxwreg and price index – pxwreg), the total merchandise imports (quantity – qiwreg and price index – piwreg), and their respective values (vxwreg and viwreg) as shown in Figure (8).

Figure 8: Impacts on Egypt's merchandise trade (%)



Source: Model results.

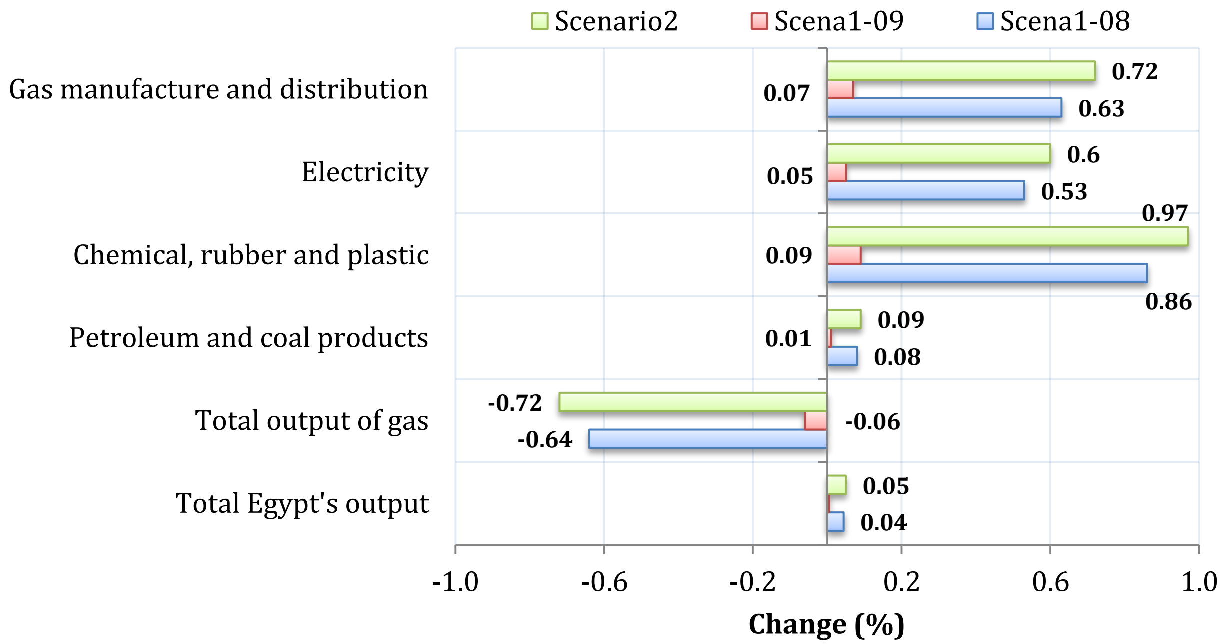
The three scenarios didn't change merchandize import price indices, but increases are shown in the overall imports, however in the exports side, despite the decreases in volumes, values have shown increases of 0.26%, 0.02%, and 0.29% due to Sena1-08, Sena1-08, and Senario2, respectively, which contributes to making the resulting deficit in the trade balance smaller.

At the commodity level, most of the commodities witness decreases in their exports except three commodities. These are gas, which would increase by 20% due to Scenario2, Gas manufacture and distribution increasing by 5%, and Chemical, rubber, and plastic products, which would increase by 1.2% due to the same Scenario2.

4.2 The impacts on domestic production

Figure (9) show the impact of the three gas scenarios on the output of gas, the overall Egyptian output of commodities, and the output of the major users of gas in Egypt. The three gas scenarios decrease the output of gas with Scenario2 causing the strongest effect, followed by Sena1-08, while Sena1-09 causes the minimal impact. The overall reduction in the output of gas is due to the nature of the three simulations as subsidy-removers because the price differences between Israel and other destinations are introduced in the model and database as subsidies, which would anyhow reduce the producers' motivation in the gas sector. Another cause of the decrease in output is the supply effect. The total exported gas as shown in the previous subsection decreases after the three gas scenarios in volume terms, which increases the domestic supply of gas and hence leads the supply price to fall by 1.3%, 0.1% and 1.5% due to Sena1-08, Sena1-08, and Senario2, respectively.

Figure 9: Impact of the gas scenarios on domestic production



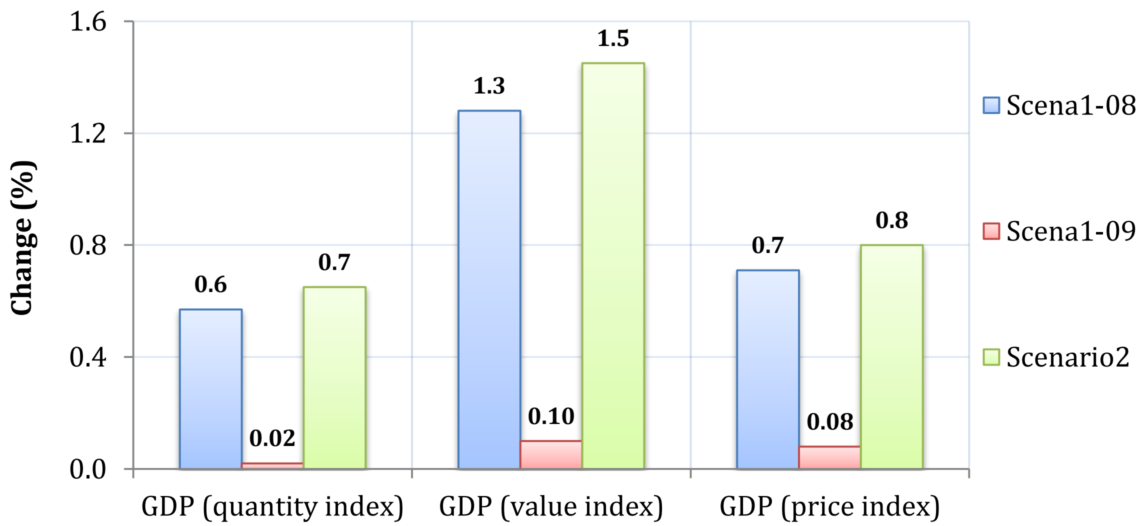
Source: Model results.

As the reductions in gas output due to the three gas scenarios are clear now, let us elaborate on the causes of the slight increases in the overall output in Egypt as shown in Figure (9). The reallocation of the productive resources among sector has led to different changes in the sectoral output. However, in relation to the domestically cheaper gas due to the simulated scenarios, the major users of gas witness increases in their output, which together with other sectors weight out the sectors with declining outputs. The major users of gas as intermediate input in Egypt are Petroleum and coal products (uses 20% of the intermediate gas demand), Chemical, rubber and plastic products (12%), Electricity (54%) and Gas manufacture and distribution (3%). The four sectors together consume 89% of the intermediately used gas in the Egyptian economy. Therefore, their output witnesses relatively high increases and together with other related sectors, they led to the overall output increases shown in Figure (9) due to the three simulated scenarios.

4.3 The impacts on GDP

Figure (10) shows the percentage changes in the Gross Domestic Product (GDP) indices due to our three gas scenarios, where all are increasing. The GDP value formula in the model is represented as the values of the different GDP components from the expenditure side including final consumption, exports, and investment less import each multiplied by its percentage changes in quantities and prices terms. Therefore, the GDP value as shown in Figure (10) is in effect the result of adding up the percentage changes in price and quantity indices.

Figure 10: Impacts on the Egyptian GDP (%)



Source: Model results.

By breaking down the GDP to its component from expenditure side and for simplicity considering only the results of Senario2, we note that government consumption witnesses the highest increase (1.6%), followed by private consumption (1.5%), investment demand (1.1%), and exports by (0.3%), while imports would also increase 0.6%. The latter two components explain the US$ -162 million overall deficit in the Egyptian trade balance caused by the same Scenario2.

Exploring the impact of the same scenario from the sources side of the GDP, which comprises (a) net factor income, (b) net tax revenue, and (c) value of depreciation reveals increases by 0.8%, 8.6%, and 0.6% in each, respectively. This explains the previous increases in the consumption side of the GDP and particularly in the government consumption as its net taxes revenue will increase as a result of the removal of subsidies on the exports of gas to Israel. Net tax income represents 8.8% of the GDP in the base, and this share will increase to 9.4% after stopping gas exports to Israel according to Scenario2.[16] By further digging in the factor income components that sources 81% of the GDP, results of Scenario2 show decreases in the use of natural resources by 5.2%, capital by 0.3% and labour by 0.1% in the gas sector. However, uses of primary factors would increase in 36 other sectors led by Mining and Extraction; Chemical, rubber, and plastic products; Public Administration, Defense, Health and Education; and Gas manufacture and distribution, where the highest percentage changes in the total factor income are recorded. However, in value terms, the highest income generated from factor use is witnessed in the sector ordered as (1) Public Administration, Defense, Health and Education; (2) Other Services; (3) Trade; (4) Construction; and (5) Communications due to their larger size in the overall economy relative to the other sectors.

4.4 The impacts on Welfare

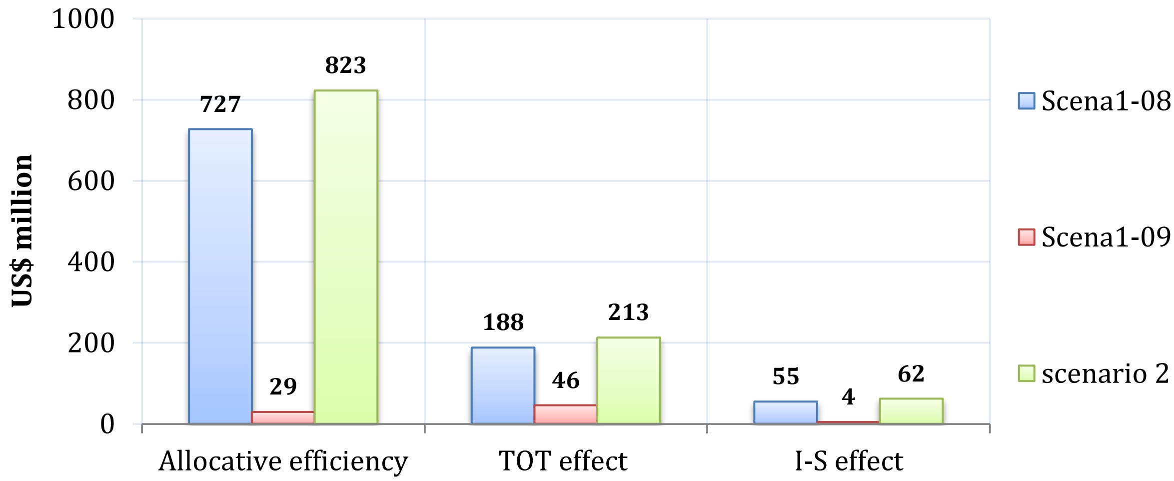
The welfare impact of our three scenarios is measured using the money metric Equivalent Variation (EV). The EV measures the welfare impact of a policy change in monetary terms and it is defined as the amount of income that would have to be given to (or taken away from) the economy before the policy change to leave the economy as well off as the economy would be after the policy change (Andriamananjara et al., 2003). If the EV for a policy simulation is a positive number, it implies that the policy change would improve economic welfare. The EV of a policy change consists of two components: allocative efficiency and terms-of-trade. Allocative efficiency contributions arise when the allocation of productive resources changes relative to pre-existing policies; terms-of-trade contributions arise from changes in the prices received from an economy's exports relative to the prices paid for its imports. [17]

Sena1-08, Sena1-09, and Senario2 are found to generate overall welfare gains to Egypt of US$ 970 million, US$ 79 million and US$ 1098 million. By decomposing the welfare effect as depicted by the EV in the model and shown in Figure (11), it is clear that the sources of gains are mainly of the reallocation of resources towards productive sectors, increases in the export prices relative to those of imports, and slightly from the investment and savings.

[16] Appendix (3) provides details on the base and updated values as well as different changes and shares on the GDP values from the expenditure and source sides.

[17] It is assumed in GTAP model that, each region has large enough market power to be able to affect world price by changing its policies.

Figure 11: Welfare impact as depicted by the EV components



Source: Model results.

The allocative efficiency is explained by the factors income generation through moving factors across sectors as described in the previous section. That was only reallocating out of the gas sector toward other productive sector accompanied by increases in the capital that generated from an increased government and final demands. The latter are obvious from the growth of many services sectors such as Public Administration, Defense, Health and Education; Other Services; Trade and Communications.

5 Conclusions

In this paper, attempts have been made to address the politically sensitive issue of the Egyptian gas exports to Israel. This issue became more debated after the Egyptian revolution that toppled a government that was presumably offering Israel preferential prices for its imports of the Egyptian natural gas as reflected in the current agreement on that, which has started gas shipment to Israel in 2008. The public discontent about that was reflected in several attacks on the pipelines that transfer the gas to Israel since January 2011. Moreover, a very recent development was the decision of the Egyptian Natural Gas Holding Company of the termination of its contract to ship gas to Israel because of violations of contractual obligations.

The paper however, focuses only on the economic part of this multi-dimensional and complex story. It tries to investigate the sensitivity of the Egyptian economy at large to changes in the price that Israel pays for its imports of gas from Egypt, and whether or not increasing the these prices to the level paid by other partners would improve the welfare and generate economic gains that could weight out the associated political instability and contractual disapprobation.

As prices are found to vary differently since the beginning of this agreement, three different year prices are considered, namely 2008, 2009, and 2010 in comparison to the average world prices. The prices variation from the average world prices are simulated in GTAP model scenarios that convert them in subsidy equivalent. The simulation scenarios are introduced to an updated version of GTAP database that became as compatible as possible to other related data sources that focuses on the natural gas production, trade shares and cost structures in both countries.

Results reveal that the Egyptian economy will reap as substantial welfare benefits as larger as the prices differences in the agreement from world prices. This however, results in a reduction in the overall gas production in Egypt due to subsidy removal and increasing supply in the domestic market due to the reductions in exports. The gains would mainly be driven by the increase in the exports price indices that despite the reductions in export volumes, generate higher export revenues for the economy.

The GDP would also improve geared by the increasing returns to production factors in sectors other than gas and mainly in the electricity; chemical, rubber and plastic products; and some major service sectors. This would basically increase income and hence final demands that boosts the overall GDP despite slight increases in imports with the latter generating slight deficits in the country's trade balance.

Similar outcome could also accrue to the Egyptian economy if exports of gas to Israel are completely stopped. As far as the price paid by Israel is below the world price, Egypt would anyhow benefit from the reallocation of its gas to other destinations. This is particularly possible as other destinations are already importing the Egyptian gas; hence no further infrastructure development would be required such as pipelines construction that might make the reallocation difficult or costly.

6 References

Afify, Heba and Fahim, Kareem (2011): Gunmen Attack Sinai Gas Pipeline. The New York Times. Published: July 30, 2011. Accessed on January11, 2012.http://www.nytimes.com/2011/07/31/world/middleeast/31egypt.html?_r=2.

African Economic Outlook (2011). African Economic Outlook Special theme: Africa and its emerging partners. http://www.africaneconomicoutlook.org/en/countries/north-africa/egypt/. Accessed on July 30, 2011.

Aguiar, Angel; McDougall, Robert and Badri Narayanan G., Editors (2012). Global Trade, Assistance, and Production: The GTAP 8 Data Base, Center for Global Trade Analysis, Purdue University.

Aljazeera (2012): Egypt terminates gas deal with Israel. Aljazeera International website. http://www.aljazeera.com/news/middleeast/2012/04/2012422191152438212.htm . Last Modified: 23 Apr 2012 08:14. Accessed on April 23, 2012.

Andriamananjara, Soamiely; Ferrantino, Michael and Marinos Tsigas (2003): Alternative Approaches in Estimating the Economic Effects of Non-Tariff Measures: Results from Newly Quantified Measures. Office of Economics Working Paper, U.S. International Trade Commission. No. 2003-12-C.

Brokmeier, Martina (2001): “A Graphical Exposition of the GTAP Model.” GTAP Technical Paper No. 8.

BP (2011): British Petroleum Statistical Review of World Energy. June 2011. bp.com/statisticalreview. Accessed on January 2, 2012.

BMI (2009). Business Monitor International. Egypt Oil and Gas Report 2010. Part of BMI’s Industry Survey & Forecasts Series. ISSN 1748-3948. Published by Business Monitor International Ltd.

CAPMAS (2011): Central Agency for Mobilization and Statistics, Egypt in Figures. http://www.capmas.gov.eg/pdf/egypt10/indst10/51.pdf. Accessed in January 2, 2012.

Elyan, Tamim (2011): Blast hits Egypt's gas pipeline to Jordan and Israel. Reuters Reporter (CAIRO | Sun Dec 18, 2011 5:13am EST). http://www.reuters.com/article/2011/12/18/us-egypt-explosion-idUSTRE7BH07N20111218. Accessed on January 11, 2012.

Harrison, W and Pearson, K. (1996): Computing Solutions for Large General Equilibrium Models Using GEMPACK. Computational Economics, Springer, vol. 9(2), pages 83-127.

Hertel, Thomas (1997): Global Trade Analysis: Modeling and Applications. (Editor), Cambridge University Press.

Hertel, Thomas and Marinos Tsigas (1997): Structure of the GTAP Model, chapter 2 in Global Trade Analysis: Modeling and Applications, T. Hertel, editor, Cambridge Univ. Press, January 1997.

Hofstrand, Don (2007): Energy Measurements and Conversions. http://ecotec-systems.com/Resources/FUEL_CONVERSION_WORK_SHEET.pdf. Accessed on April 16, 2012.

ICBS (2011): The Israeli Central Bureau of Statistics. Energy Balance of Israel. http://www1.cbs.gov.il/energy/new_energy/new_enr_nach_eng_new_huz.html. Accessed on December 29, 2011.

IMF (2005): Arab Republic of Egypt: Selected Issues. International Monitory Fund (IMF) Country Report No. 05/179, June 2005.

Kuiper, Marijke and van Tongeren, Frank (2006): Using Gravity to Move Armington: An Empirical Approach to the Small Initial Trade Share Problem in General Equilibrium Models. 9th Annual GTAP conference, Addis Ababa, Ethiopia.

Malcolm, Gerard (1998): Adjusting Tax Rates in the GTAP Data Base. GTAP Technical Papers No. 12. http://docs.lib.purdue.edu/gtaptp/15. Accessed on April 16, 2012.

NATGAS (2012): Natural Gas Units and Online Calculator. http://www.natgas.info/html/natgasunitscalculator.html. Accessed on April 16, 2012.

Ratner, Michael (2011): Israel's Offshore Natural Gas Discoveries Enhance Its Economic and Energy Outlook. Congressional Research Service. 7-5700, R41618. http://www.fas.org/sgp/crs/mideast/R41618.pdf. Accessed on January 2, 2012.

Shaffer, Brenda (2011): Israel: new natural gas producer in the Mediterranean. Energy Policy, 39 (2011) 5379–5387.

Siddig, Khalid, Flaig, Dorothee, Luckman, Jonas and Grethe, Halrald (2011b). Technical Documentation of the 2004 Input-Output Table for Israel. GTAP 8 Database Documentation. https://www.gtap.agecon.purdue.edu/databases/IO/table_display.asp?IO_ID=439.

Siddig, Khalid (2011): From Bilateral Trade to Multilateral Pressure: A Scenario of European Union Relations with Sudan. Middle East Development Journal, Vol. 3, No. 1 (2011), pp. 55–73.

World Bank (2012): World Development Indicators & Global Development Finance. http://databank.worldbank.org/Data/Views/Reports/TableView.aspx?IsShared=true&IsPopular=country. Accessed on April 29, 2012.

7 Appendix

Appendix 1 : Criteria considered in the aggregation of commodities

Top 15 exported commodities in Egypt	Share
Transport nec	19.9%
Gas	9.0%
Petroleum, coal products	8.5%
Chemical, rubber, plastic prods	6.2%
Wearing apparel	3.8%
Ferrous metals	3.6%
Metals nec	3.6%
Business services nec	3.6%
Textiles	3.4%
Air transport	3.4%
Communication	2.8%
Oil	2.7%
PubAdmin/Defense/Health/Education	2.6%
Machinery and equipment nec	2.5%
Recreation and other services	2.5%

Top 15 imported commodities in Egypt	Share
Machinery and equipment nec	15.2%
Chemical, rubber, plastic prods	11.9%
Motor vehicles and parts	6.0%
Business services nec	5.1%
Ferrous metals	4.9%
Petroleum, coal products	4.4%
Wheat	4.2%
Textiles	3.8%
Electronic equipment	3.5%
Wood products	2.7%
PubAdmin/Defense/Health/Education	2.7%
Transport equipment nec	2.6%
Oil	2.2%
Paper products, publishing	2.2%
Vegetable oils and fats	2.0%

Top 15 domestically sold com. in Egypt	Share
PubAdmin/Defense/Health/Education	9.1%
Construction	8.2%
Trade	6.0%
Petroleum, coal products	5.7%
Transport nec	5.5%
Oil	4.5%
Food products nec	4.1%
Wearing apparel	3.9%
Textiles	3.8%
Gas	3.6%
Communication	3.2%
Business services nec	3.2%
Electricity	3.1%
Chemical, rubber, plastic prods	2.7%
Vegetables, fruit, nuts	2.6%

Top 15 intermediately demanders of gas Globally (sectors)	Share
Electricity	33.0%
Petroleum, coal products	25.8%
Chemical, rubber, plastic prods	14.2%
Gas manufacture, distribution	5.4%
Oil	5.2%
Transport nec	4.6%
Gas	4.4%
Ferrous metals	1.4%
Minerals nec	1.0%
Mineral products nec	1.0%
Trade	1.0%
Business services nec	0.7%
PubAdmin/Defense/Health/Education	0.5%
Paper products, publishing	0.3%
Communication	0.3%

Appendix 2 : Converting gas production data (bcm) into values (US$ million)

The gas data that is provided by BP (2011) are in volume terms (bcm). This needs to be converted to values in US$, so that they can be comparable. To do so, BP (2011) prices data for the same years are used.

Another problem in this conversion is that, the gas prices are always calculated as US$ per million Btu, with the latter standing for British thermal units. This is because gas is not generally sold per unit of volume, but rather per unit of energy that can be produced by burning the gas. Therefore, the bcm volumes need to be converted into Btu, and afterwards calculate the resulting Btu price.

To do so we rely on (NATGAS, 2012) online converter, however, the converter is again based on the American system, hence volumes should be only in cubic feet, and therefore, we converted our volumes from bcm to bcf using the following equation: 1 cubic foot = 1,027 Btu (Hofstrand,2007). The detailed calculations are shown in Table

Table 3: The conversion of volume gas to value equivalent (2007 - 2010)

	2007	2008	2009	2010	Conversion factor
Billion cubic meters	55.69	58.97	62.69	61.33	
Billion cubic feet	1966.67	2082.51	2213.88	2165.85	*35.314667[18]
Billion Btu	2019774.0	2138733.6	2273651.1	2224326.4	*1027
	Based on US Henry Hub prices				
Price: US $ per million Btu	6.95	8.85	3.89	4.39	
Price: US $ per billion Btu	6950.00	8849.17	3893.33	4388.85	/1000
Price: US $ per Btu	0.000007	0.000009	0.000004	0.000004	/1000000000
value US$ billion	14.04	18.93	8.85	9.76	
value US$ million	14037.43	18926.01	8852.08	9762.23	/1000
	Based on average prices[19]				
Price: US $ per million Btu	6.79	9.80	5.16	5.66	
Price: US $ per Btu	0.000007	0.000010	0.000005	0.000006	
value US$ billion	13.71	20.96	11.74	12.59	
value US$ million	13708.71	20955.86	11736.99	12591.47	

[18] Conversion factor: 1 cubic meter = 35.314667 cubic feet

[19] This average is alculated considering: (1) European Union cif, (2)UK Heren NBP Index, (3) US Henry Hub, and (4) Canada (Alberta).

Appendix 3: Detailed impacts of Scenario2 on Egypt's GDP

	GDP from the expenditure side					
	Base Senario2	Updated Senario2	Change	% change	Share Base	Share updated
Consumption	95705.91	97168.90	1462.98	1.53%	75.27%	75.32%
Investment	27015.44	27317.66	302.23	1.12%	21.25%	21.18%
Government	14974.75	15215.20	240.45	1.61%	11.78%	11.79%
Exports	38716.73	38830.87	114.14	0.29%	30.45%	30.10%
Imports	-49255.65	-49532.02	-276.36	0.56%	-38.74%	-38.40%
Total	127157.18	129000.61	1843.43	1.45%	100.00%	100.00%
	GDP from the sources side					
	Base Senario2	Updated Senario2	Change	% change	Share Base	Share updated
Net factor income	103771.2	104576.8	805.62	0.78%	81.61%	81.07%
Net taxes	11182.69	12149.13	966.43	8.64%	8.79%	9.42%
Depreciation	12203.28	12274.67	71.39	0.59%	9.60%	9.52%
Total	127157.2	129000.6	1843.44	1.45%	100.00%	100.00%