No more gas from Egypt? Modeling offshore discoveries and import uncertainty of natural gas in Israel

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Abstract

Israel depends on natural gas imports from Egypt for about 40% of its domestic needs with the remaining from domestic production. Gas supplies from Egypt have been erratic since their initiation: disruptions have increased since the 2011 revolution in Egypt and have also been ignited by public discontent. Despite these developments, Israeli policy makers have viewed the gas deal with Egypt as a positive factor in preserving peace with Egypt and have had no better alternatives than relying upon Egyptian gas. This has changed, however, after recent discoveries of three major offshore fields that are expected to satisfy domestic demand for an indefinite period and to provide gas for exports. We use an extended global CGE modeling framework that incorporates multiple households and endowment ownership to investigate the effects of reduced gas imports from Egypt by shocking the price as well as the evolvement of domestic gas production as an alternative. In case of reduced gas imports from Egypt, the Israeli economy would retract by 0.2% mainly due to changes in energy intensive sectors and rich Jewish households would be negatively affected the

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most. In case of increasing domestic gas production, the economy would grow by 0.3% and rich Jewish households would be positively affected the most due to their high share of capital income.

Keywords: natural gas, energy policy, Egypt, Israel, MyGTAP.

JEL Classification: C6, D1, D6, F1, Q4.

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1 Introduction

In 2009, major offshore natural gas deposits were discovered in Israel. Historically, Israel is an energy-poor state relying on imported fossil fuels to meet its energy needs and an energy island that is disconnected from energy infrastructure in the region, with the exception of gas from Egypt (Shaffer, 2011). Since 2008, Egypt has supplied Israel with 40% of its domestically consumed natural gas. The gas is delivered through a pipeline that branches off in Egypt from the Arab gas pipeline connecting Egypt, Jordan, Lebanon, and Syria.

Natural gas entered Israel's energy mix for the first time in 2004, with a domestic field (Yam Tethys) supplying its production to the market. The consumption of natural gas expanded in 2008, when the Eastern Mediterranean Gas and Oil (EMG) Company began importing natural gas from Egypt to Israel. The EMG supplied 2.5 Billion Cubic Meters (BCM) of natural gas to consumers in Israel in 2010, which was nearly 50% of the 5.3 BCM consumed in Israel, while the rest was supplied by domestic fields (Shaffer, 2011).

There is no detailed information available on the level of the preferential price paid by Israel and its difference from the world price of natural gas. However, according to Khadduri (2011), the initially agreed upon price was US$ 3 to US$ 3.5 per million British thermal units (Btu). Khadduri (2011) also reports that in August 2009, the Israel Electric Corporation (the primary consumer of gas exports from Egypt) approved an adjusted price of US$ 4 to US$ 4.5 per million Btu. In comparison, the international gas price is between US$ 5.7 and US$ 9.5 US$ per million Btu (Siddig and Grethe, 2012).

Approximately 425 BCM of natural gas was discovered in 2009 and 2010 close to Israel's Mediterranean coastline in three fields: Tamar, Dalit, and Leviathan. According to IsraelStrategist (2011), the Tamar field was the largest natural gas discovery in the world in 2009 and is expected to meet Israel's gas needs for up to 30 years. The Leviathan field was discovered in December 2010 and represents the largest natural gas discovery in the world since 2000. This field is predicted to satisfy Israel's domestic gas needs indefinitely and could be used for export. The start of gas production from these fields is expected in 2013 and 2016, respectively (Ratner, 2011; Shaffer, 2013).

With these newly discovered fields of natural gas, Israel could get into a situation where it displaces its gas imports from Egypt. According to Ratner (2011), there are several reasons why this would reap benefits for both countries provided that three options are possible: first, because Israel pays below market prices for natural gas imports from Egypt, there is public discontent in Egypt against the sale of gas to Israel, particularly after the January revolution (Ratner, 2011). As a consequence, the gas pipelines used for transporting Egyptian gas to Israel have been attacked more than ten times since the Egyptian revolution in January 2011, causing Israel's gas supply to be temporarily cut off (Afify and Fahim, 2011; Elyan, 2011). Sustaining natural gas exports to Israel seems doubtful in post-revolution Egypt. Therefore, ending exports to Israel would have political advantages in Egypt and would also help secure a more reliable source of gas for Israel. Second, as an alternative of relying only on domestic natural gas, there may also be the option of changing the agreement between Israel and Egypt so that there is an increase in the price paid by Israel for Egyptian gas. This could improve Egypt's trade balance (Ratner, 2011) and would be supported by the argument that despite the negative factors associated with its continuation , Israeli policy makers view the gas deal with Egypt as a positive factor in preserving peace with Egypt (Shaffer, 2013).

Third, Israel may decide to continue importing the cheaper Egyptian gas and to use additional domestic production for exports to destinations, such as Europe or even countries in the Middle East, such as Jordan. This would improve Israel's energy security and generate economic benefits.

2 Objectives and research questions

This paper uses global applied general equilibrium models that link the Israeli economy with the rest of the world to investigate the economic implications of different scenarios related to the production and trade of natural gas on the Israeli economy. The following research questions are addressed with respect to their macroeconomic and welfare dimensions:

- What are the macroeconomic implications of increasing the price of Egyptian gas exports to Israel and to equalize it to the price of gas paid by other countries in the region, such as Jordan?
- The recent discoveries of the three major fields of gas in Israel (Tamar, Dalit and Leviathan) are expected to begin production in 2012-2013, 2013-2016, and 2016-2018, respectively (Ratner, 2011). What are the implications on the Israeli economy at large and on the livelihoods of different household groups?
- How would the combined effect of domestic fields entering the market and Egypt equalizing its export price to that paid by other countries in the region affect the Israeli economy?

3 Methodology

To achieve the previously stated objectives we use two applied general equilibrium models that link the Israeli and Egyptian economies to world trade and the production of natural gas. To benefit from the advantages of incorporating disaggregated household income, expenditure, transfers, and ownership of endowments we apply the newly developed MyGTAP Model (Walmsley and Minor, 2012). Moreover, because we are also interested in analyzing welfare changes in Israel associated with the different policy experiments considered in this study, we apply the GTAP model (Hertel, 1997).

3.1 Overview of the models

The GTAP CGE model relies on neoclassical theory and is based on the assumptions of constant returns to scale in production, perfect competition among firms, and product differentiation by the economy of origin (i.e., the Armington assumption). It has a single representative household for each region which is called the regional household. The regional household collects income from returns to endowment commodities and tax revenues net of subsidies. The income is distributed to private household expenditure, government expenditure, and savings applying a Cobb-Douglas per capita sub-utility function (Hertel, 1997). Private household utility maximization is modeled as a Constant Difference of Elasticity (CDE) demand system, while domestic and imported commodities are aggregated using a Constant Elasticity of Substitution (CES) function, and imported goods are sourced from different regions according to a CES function.

Production is based on an aggregation of value added and intermediate inputs according to CES technology with value added being a CES composite of primary production factors, while the intermediate composite is a Leontief function of inputs (Brockmeier, 2001). The model closes by assuming that the demand for investment in a particular region is driven by savings and that each region's savings contribute to a global pool of homogenous savings. The allocation of these savings among regions in response to investment demand is based on the relative rates of return to capital among regions.

MyGTAP model is an extension of the GTAP model that modifies the original single regional household to allow for multiple households and an improved government specification. It also includes inter-regional transfers, such as remittances and foreign capital incomes (Walmsley and Minor, 2012; Minor and Walmsley, 2012). The government account of MyGTAP collects its income from taxes and foreign aid and spends this income on consumption expenditure, transfers to households, foreign aid (out), and subsidies. The difference between government income and expenditure is either a deficit or savings (Figure 1).

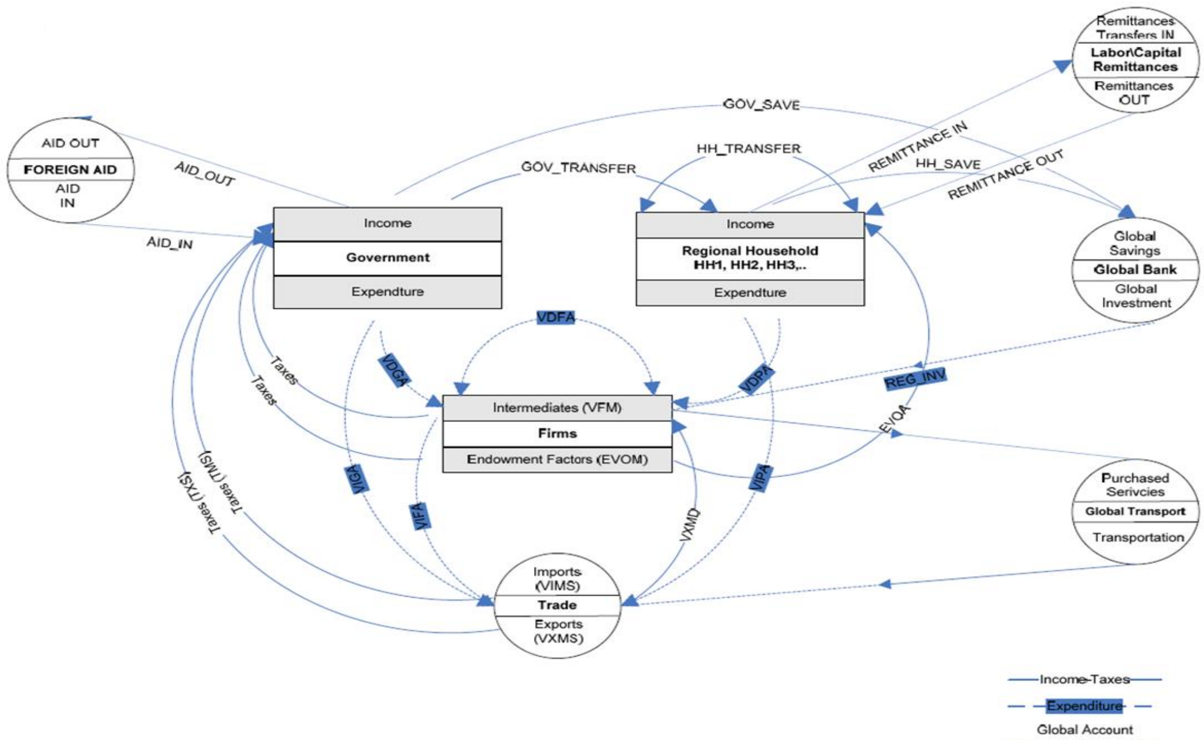

Figure 1: Income and expenditure flows in MyGTAP model.

Source: Walmsley and Minor (2012).

Private households collect their income from returns to production factors including foreign remittances and capital, transfers from the government, and transfers from other households. Income is spent on consumption expenditure, transfers, remittances (out), and savings (Figure 1).

3.2 Data adjustments and aggregation

This study uses an adjusted version of the GTAP database prepared by Siddig and Grethe (2012) and depicts recent changes in gas trade between Egypt and Israel.

Standard GTAP regions and commodities are aggregated to 45 and 40, respectively. The structure of the gas sectors in Egypt and Israel are adjusted to reflect their state in 2010 based on different sources of data including BP (2011), ICBS (2011), and CAPMAS (2011), among others.[2]

For the purpose of this study, the 40x45 aggregation of Siddig and Grethe (2012) is further aggregated to 16 commodities and 24 regions. The mapping between the 16x24 aggregation and that of the GTAP 8 data base is shown in Appendix 1 and Appendix 2, respectively. The most relevant sectors besides gas, such as crude oil, refined oil, gas manufacturing and distribution, and electricity, are represented separately. Agriculture is represented by three major aggregates, namely, 'agricultural crops', 'meat and livestock', and 'forestry and fishing'. Another three major aggregates are reserved for services, four major aggregates for industries, and the rest of mining is aggregated into one sector. As shown in Appendix 2, regional aggregation separates Israel and Egypt while it aggregates other countries of the Middle East and North Africa (MENA) together. In addition, the major players in gas trade, such as the USA and Russia, as well as other major importers of Egyptian gas, such as Italy and Belgium, are included as single regions.

After the setup of the final aggregation of the database, a pre-simulation is applied to generate a new database following the "Altertax" approach of Malcolm (1998).[3] Altertax is applied to introduce the difference between the average world price of gas (US$ 6.8/million Btu; BP, 2012) and the preferential price that Israel pays for its imports of gas from Egypt in 2011 (US$ 4.5/million Btu; Khadduri, 2012; Siddig and Grethe, 2012; Adiri, 2013). The updated database represents the base for our simulations, to which any changes are compared.

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[2] For details on the procedure applied to update the data as well as the data sources, refer to Siddig and Grethe (2012).

[3] The Malcolm (1998) approach runs a simulation where tax rates are shocked to their desired value and the updated post-simulation database is used for subsequent policy experiments. A special closure and special parameter file are applied to ensure that the rate-changing simulation leaves other cost and sales shares as little changed as possible. This closure fixes regional trade balances, whilst the parameter settings amount to Cobb-Douglas everywhere, which keeps budget shares fixed.

According to Adiri (2013), it would be expensive for Israel to import natural gas from sources other than Egypt in the short run. This is because of two main factors. First, Israel lacks importing infrastructure, such as pipelines. Second, any contract for importing liquefied natural gas is expensive for Israel because the contract would be a short-term (about two years) because domestic production of the new fields is expected soon. This implies that any imported gas other than that from Egypt would be significantly more expensive, even after the investment in a LNG import terminal in the winter of 2012/13 (Adiri, 2013). Accordingly, we brought these circumstances to our models by limiting the substitutability of natural gas imports among regions.[4]

3.3 Data extension for MyGTAP model

The application of MyGTAP model implies several modifications of the GTAP data base since the regional household is divided into multiple households based on Minor and Walmsley (2012). The additional data we use is the latest available Israeli Social Accounting Matrix (SAM) for the year 2004 (Siddig et al., 2011). The SAM provides detailed information on ten different household groups classified into Jewish and Non-Jewish households with each of these groups being classified into five income quintiles. This feature allows for assessing the distributional implications of the three policy scenarios.

Additionally, the model allows for the assignment of endowment ownership to household groups. This is done based on the Israeli 2004 SAM which is comprised of 38 different endowment commodities that are classified according to: (1) Jewish, non-Jewish, and foreigners, (2) occupation and skills, (3) gender, and (4) foreign labor, namely, Palestinians and Non-Palestinians which are also classified into legal and illegal foreign labor (Siddig et al., 2011).

[4] This is introduced by reducing the Armington Elasticity of substitution between imports of different regions (ESBM) from 34.4 (standard value, Hertel et al., 2007) to 4.00 and that of substitution between the domestic and imported gas (ESBD) from 17.2 (standard value) to 3.00.

4 Simulation scenarios

Three scenarios are simulated in this study representing the research questions raised in Section 2 of this paper. Each of the three scenarios is run twice: once in the standard GTAP model and again in the MyGTAP model. This makes the findings of the study more comprehensive since the two models are complementary. In all simulations, medium-term closure rules are applied. The microeconomic part of the closure assumes that the total supply of production factors is fixed while factors are fully mobile between sectors and factor prices adjust to maintain full employment. The macroeconomic closure assumes that the current account is allowed to adjust, changes in the current account drive domestic investment, and a reallocation of investment across regions affects production and trade by affecting final demand (Hertel, 1997). The specific scenarios are the following:

Scenario 1: increasing the price paid by Israel for its imports of gas from Egypt and equalizing it to that paid by other importers, such as Jordan. This involves an import price increase by 33.6% and is technically implemented by removing the designated subsidy that was introduced in the Altertax pre-simulation. In other words, it removes the preferential price offered to Israel by Egypt. Therefore, this scenario will be referred to throughout the paper as "NoPrfPrice".

Scenario 2: increasing domestic gas production in Israel by 100%, which is a conservative projection for the next two years based on Ratner (2011) and Nobel Energy (2010). This simulation is introduced by augmenting the technology parameter of the production factors in the gas sector[5] based on the fact that the reserves are natural resources and would be exploited by contracts with foreign companies, including Nobel Energy (Ratner, 2011). Therefore, this scenario will be referred to throughout the paper as "DomFldsPrd".

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[5] The composition of gas purchases of primary factors in the base data is as follows: natural resources (86%), capital (5%), and labor (9%).

Scenario 3: combining Scenario1 and Scenario2 into one to assess impacts from the increase in prices of imported gas from Egypt at the time that domestic fields would be in production. This scenario will be referred to throughout the paper as "NoPrf-DmFlds".

5 Results

This section begins discussing the effects on prices of gas and the sectors that intensively use gas, such as electricity and refined oil sectors. Subsequently, output and consumption impacts as well as macroeconomic impacts and welfare effects are analyzed.

5.1 Intermediate demand and prices

Natural gas in Israel is neither consumed by private households nor by the government, but only as an intermediate input. The electricity sector uses 73% of total supply (30% domestic and 43% imported), the refined oil sector 26% (19% domestic and 7% imported), and the remaining 0.8% (0.7% domestic and 0.1% imported) is used by the gas manufacturing and distribution (GasManDisn) sector (Narayanan et al., 2012; Siddig et al., 2012). This implies that the intermediate demand price is the most relevant price to assess. Moreover, it is to be noted that electricity, refined oil, and GasManDisn rely on imported gas for 56%, 24%, and 12%, respectively, of their total gas demand (Narayanan et al., 2012; Siddig et al., 2012).

Percentage changes in the intermediate demand price of gas in Israel are shown in Figure 2. The impact of the NoPrfPrice scenario, which removes the preferential imported gas price, on the composite price of intermediate gas demand by the three sectors is found to depend on the ability of each sector to replace imported gas by domestically produced gas. Therefore, percentage changes in prices are highest for electricity (48%), followed by refined oil (47%), and GasManDisn (46%).

The impact of the three scenarios on the price of gas used by the three commodities within the same category (i.e., imported or domestically produced gas) is always the same. For example, NoPrfPrice increases the price of domestic gas used by the three commodities by 45.8% and increases the price of imported gas by 50.3%.

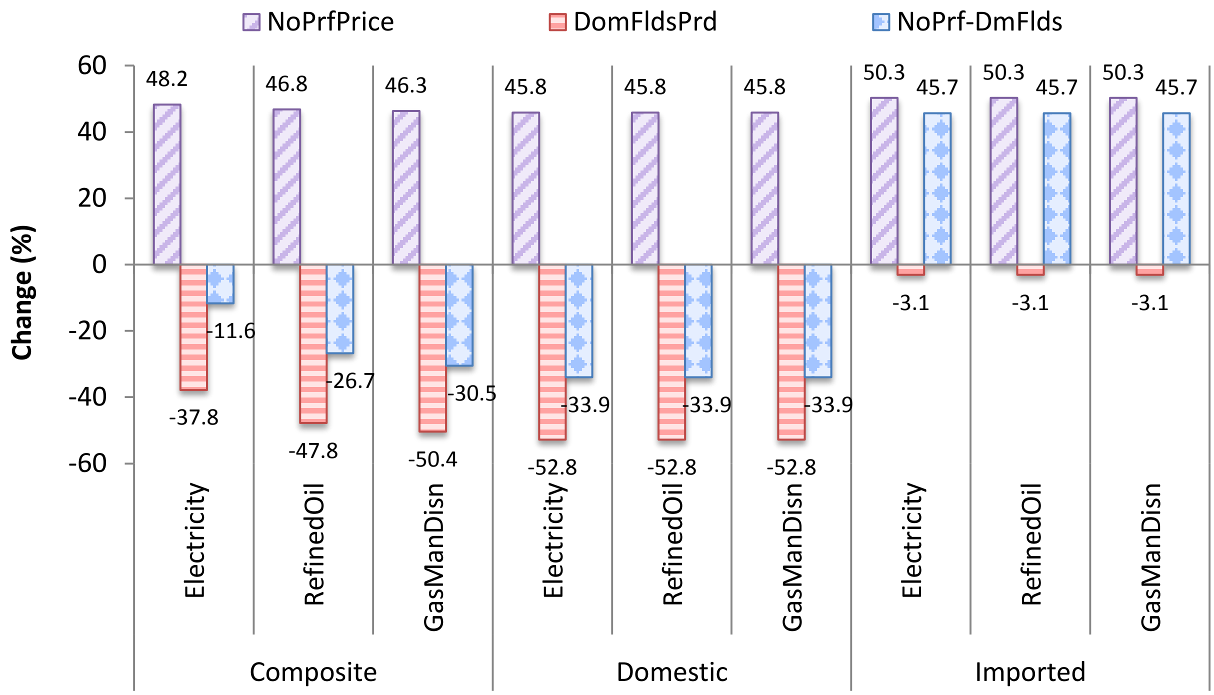

Figure 2: Changes in the intermediate demand price of gas in Israel (%)

Under the DomFldsPrd scenario, the intermediate demand price of gas decreases substantially since domestic production of gas doubles, increasing the total domestic supply of gas by 1.33%.[6] On the other hand, the combined scenario "NoPrf-DmFlds" shows changes in prices that are lower than those under NoPrfPrice, but are higher than those under DomFldsPrd since the removal of the preferential price works in the opposite direction with respect to the intermediate demand price compared to the increase in the domestic supply.

The observed changes in intermediate demand prices of gas influence the demand for gas by the three major activities that use gas. As shown in Figure 3, composite demand for gas declines under NoPrfPrice by 2.3% in the electricity and the GasManDisn sectors and by 2.7% in the refined oil sector. In the other two scenarios, composite intermediate demand slightly increases due to the falling gas price, which is a result of

[6] Restrictive intermediate input structure is imposed in the model by reducing the elasticity value (Armington CES for imported/domestic allocation).

the increase in the demand for domestically produced gas outweighing the decline in the demand for imported gas.

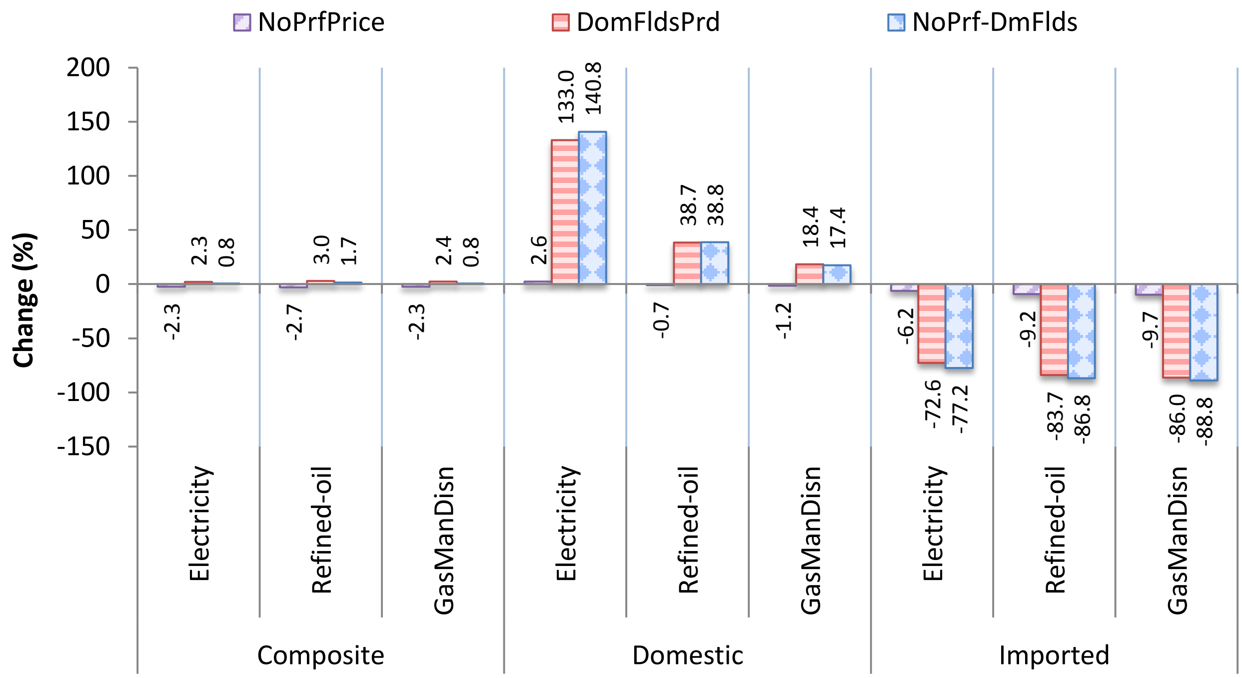

Figure 3: Changes in the quantity of intermediate demand for gas in Israel (%)

Changes in intermediate demand by the three sectors coincide with the initial shares of domestically produced and imported gas in total intermediate gas demand. This can be seen by the change in the intermediate demand for domestically produced gas, which is highest in electricity, followed by refined oil and GasManDisn, while the opposite is true for the demand of imported gas by the three sectors (Figure 3).

5.2 Domestic production

Under all three scenarios, domestic gas production increases. This is due to: increasing restrictions on imported gas under the first scenario; directly doubling resources used in the production of domestic gas under the second; and the merging of these two policies under the third. The domestic output of gas would increase by 1%, 97%, and 11% due to NoPrfPrice, DomFldsPrd, and NoPrf-DmFlds, respectively. Major domestic users of gas, which are electricity, refined oil, and GasManDisn, reduce their production under the first scenario since they are negatively affected by higher gas prices, whereas they benefit under the second and the third scenarios from lower gas prices and increased output (Figure 4).

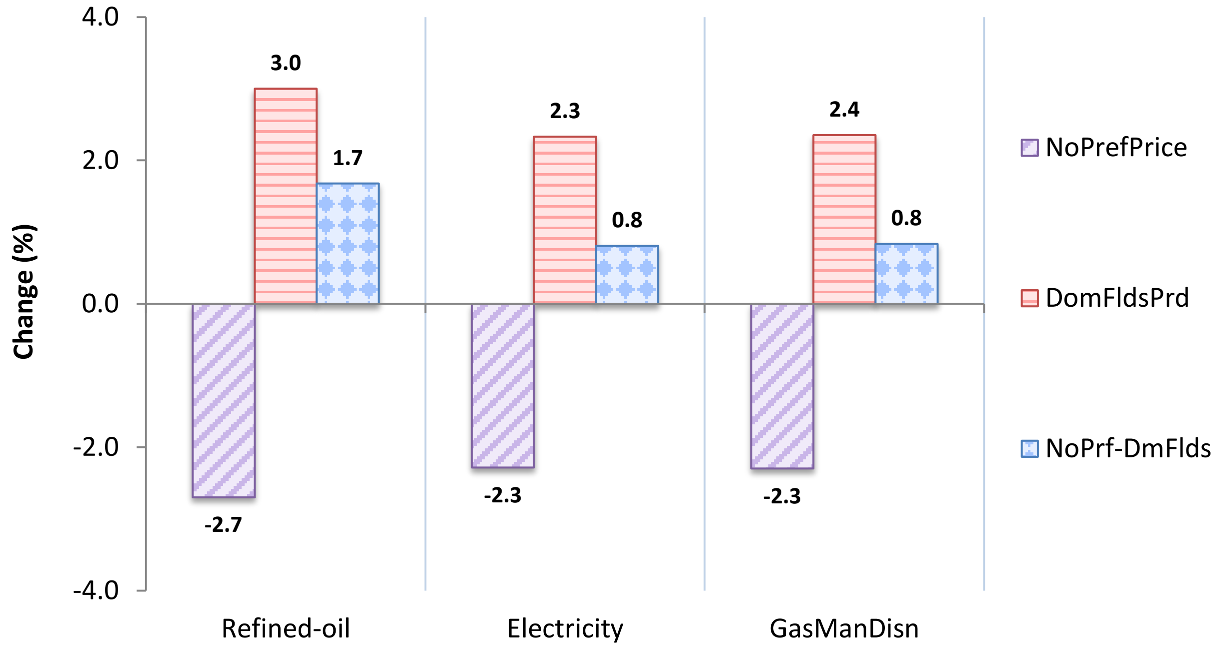

Figure 4: Changes in the domestic production of major gas users in Israel, in quantity (%)

Changes in output from the three gas consumers in Israel are found to directly reflect changes in the demand of intermediate uses of gas. This is explained by the elasticity on intermediate input substitution of the models (ESBT) being zero.

5.3 Macroeconomic indicators

From the expenditure side, the Israeli Gross Domestic Product (GDP) in the model base is composed as follows: 56% is devoted to private consumption, 20% to investment, 25% to government consumption, 41% to total exports and 42% to total imports.[7] From the sources side, the Israeli GDP is composed of income to production factors (53%), net tax revenue (38%), and depreciation (9%).

[7] Total imports represent a negative value, which makes the shares total equaling 100%.

Changes in GDP and its components from the expenditure and source sides are shown in Figure 5. The GDP declines by 0.19% under NoPrfPrice, while it increases by 0.29% and 0.27% under DomFldsPrd and NoPrf-DmFlds, respectively. These changes can be explained by corresponding changes in different GDP components. The overall change from the expenditure side is mainly from the 0.20% decline in private consumption which alone contributes 56% to GDP in the base data. Similarly, positive changes in GDP are mainly due to increases in private consumption by 0.31% and 0.28% under DomFldsPrd and NoPrf-DmFlds, respectively. The huge changes in investments under the three scenarios correspond mainly to the respective changes in the gas-related sectors, namely, electricity, refined oil, and GasManDisn.

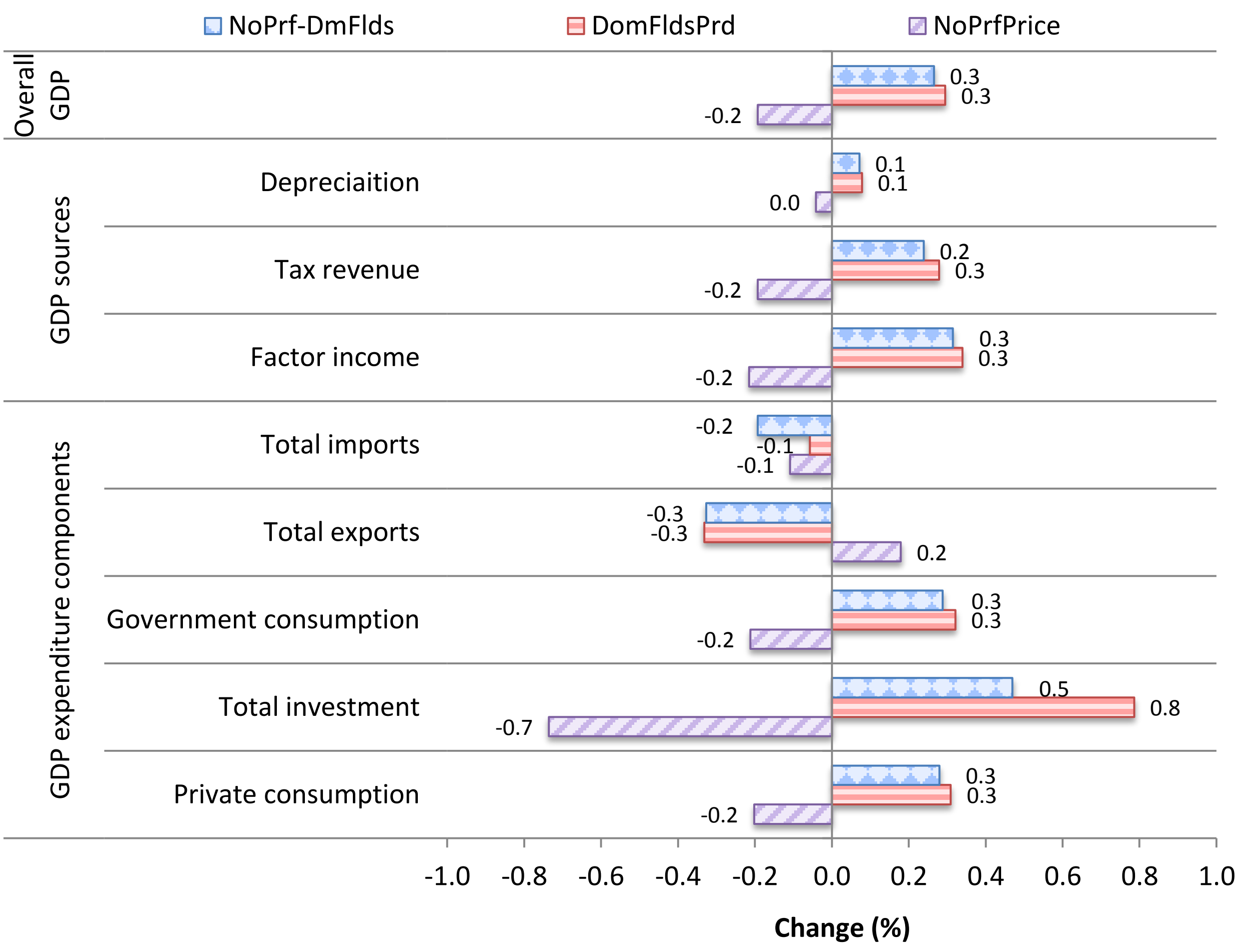

Figure 5: Changes in Israeli Gross Domestic Product (%)

The source side of the GDP, on the other hand, shows a decline in the income to production factors (GDP at factor cost), which accounts for 53% of GDP and thus strongly impacts the overall decline in GDP by 0.19% under the NoPrfPrice scenario. Similarly, the government budget declines if unsubsidized gas from Egypt is imported. The decline in net tax revenue by 0.19% also contributes to the overall retraction in GDP. In contrast, under the other two scenarios increasing factor income, net tax revenue, and depreciation lead to an increase in overall GDP.

The overall trade balance increases under NoPrfPrice (US$ million 201) and declines under DomFldsPrd (US$ million 192) and NoPrf-DmFlds (US$ million 92) as shown in Figure 6. Israel has to export more in quantity terms under NoPrfPrice in order to provide enough foreign currency for more expensive imports of gas. In this scenario, the price index of merchandise imports in Israel increases by 0.30%, while that of exports declines by 0.02%. This leads the volume of merchandise imports in Israel to decline by 0.41% and that of exports to increase by 0.20% and thus creates a positive change in the trade balance. Despite saving US$ million 336 and US$ million 308 from reduced imports of gas from Egypt under DomFldsPrd and NoPrf-DmFlds, respectively, imports of other commodities, such as heavy manufacturing and other services, tend to increase, leading to the respective declines in the overall balance of trade.

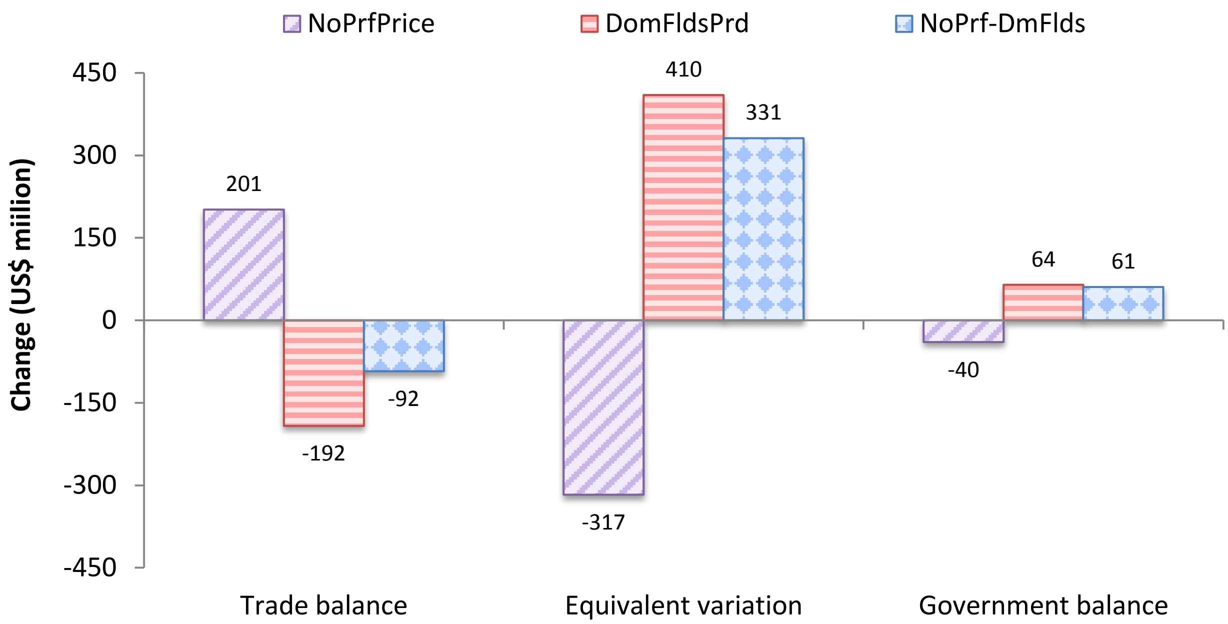

Figure 6: Changes in trade balance, equivalent variation, and government balance (US$ million)

Changes in the government balance shown in Figure 6 correspond to what is paid for imported gas from Egypt, which means that Israel would be paying a higher price should Egypt no longer supply gas at the preferential price. A negative change in government balance is recorded under NoPrfPrice following the overall slowdown of the economy, while it is positive under the other two scenarios.

The overall welfare change as represented by the change in the Equivalent Variation (EV)[8] shows a decline of US$ million 317, which is mainly driven by the negative terms of trade effect under NoPrfPrice (Figure 6). Positive welfare changes of US$ million 410 and US$ million 331 are recorded under DomFldsPrd and NoPrf-DmFlds, respectively,

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[8] The money metric Equivalent Variation (EV) measures the welfare impact of a policy change in monetary terms and is defined as the amount of income that would have to be given to (or taken away from) the economy before the policy change, so that the economy is as well off as the economy would have been after the policy change (Andriamananjara et al., 2003). If the EV for a policy simulation is positive, it implies that the policy change would improve economic welfare.

which are driven by the increase of domestic gas production being implemented as a technical change effect.[9]

5.4 Gas and energy trade

Changes in gas trade under the three scenarios are triggered by changes in the price of imported gas from Egypt. The price of imported gas would increase by 50.4% in NoPrfPrice, decrease by 3.1% in DomFldsPrd, and increase by 45.7% in NoPrf-DmFlds. These changes translate into changes in the composite market price of gas, which increases by 45.5% in NoPrfPrice and decreases by 53.7% and 35.3% in DomFldsPrd and NoPrf-DmFlds, respectively (Figure 7). The decreases in the market price of gas in DomFldsPrd and NoPrf-DmFlds are driven by the increasing domestic output of gas.

As a result, gas imports would decrease in all three scenarios because of the increasing price of imported gas in NoPrfPrice and increasing domestic gas production in DomFldsPrd and NoPrf-DmFlds (Figure 7). The highest decline in the amount of imported gas is recorded in NoPrf-DmFlds because it is comprised of two components that stimulate the replacement of imported gas by domestically produced gas. In other words, it increases both the price of imported gas and domestic production.

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[9] Additional details on the welfare decomposition are provided in Section 5.5.

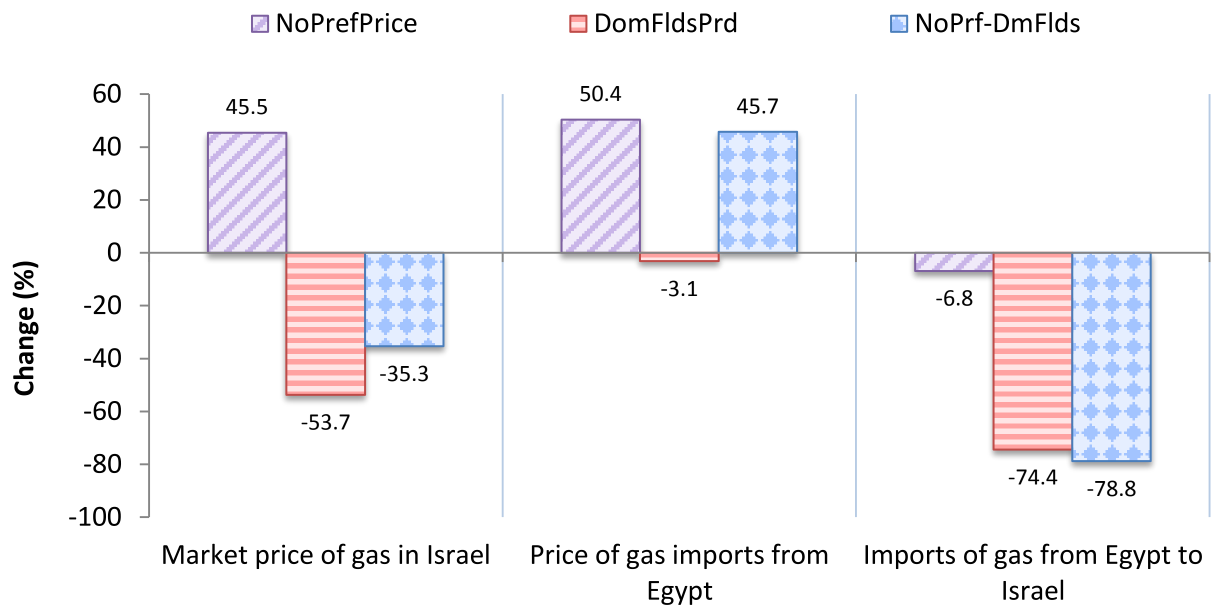

Figure 7: Changes in gas prices and imports in Israel (%)

Changes in the amount and price of imported gas in Israel also have implications for the trade of other energy commodities in the electricity fuel mix, particularly refined oil due to its considerable use of gas.[10] Gas represents 26.9% of the total intermediate use of the refined oil sector, of which 23.7% is imported (according to base data). Results show that percentage changes in the imports of refined oil in Israel are 1.09%, -0.27%, and 0.23% in NoPrfPrice, DomFldsPrd and NoPrf-DmFlds, respectively. This indicates that refined oil imports would compensate the shrinking domestic output of refined oil in NoPrfPrice. In DomFldsPrd, a decreasing gas price reduces the production cost of refined oil, increases its output, and decreases its imports, while NoPrf-DmFlds slightly increases refined oil imports due to the combined effect.

5.5 Welfare and household income

Overall welfare changes as measured by the EV and shown in Section 5.3 show that the Israeli economy would experience a welfare loss of US$ million 317 in NoPrfPrice and

[10] According to Shaffer (2011) and Ratner (2011), Israel's primary energy consumption is composed of oil (49.7%), coal (34.9%), gas (10.6%), and others (4.8%). The Israeli electricity fuel mix is coal (63%), gas (26%), oil (11%), and others (Ratner, 2011).

gains of US$ million 410 and US$ million 332 in DomFldsPrd and NoPrf-DmFlds, respectively. These changes are decomposed in Figure 8 into their major components, namely, the allocative efficiency, technical change, terms of trade, and investment and savings (changes in the price of investment goods).

Allocative efficiency contributions arise when the allocation of productive resources changes due to the applied shock, while terms-of-trade contributions arise from changes in prices received from an economy's exports relative to prices paid for its imports.[11]

Considering the price scenario (NoPrfPrice), Figure 8 shows that the welfare loss is mainly associated with the negative terms of trade effect since the price index of imports increases by 0.30% under this scenario, while that of exports decreases very slightly by 0.002%. The change in allocative efficiency also contributes to the welfare loss in this scenario and mainly occurs in the refined oil, electricity, utility-construction, and heavy-manufacturing sectors.

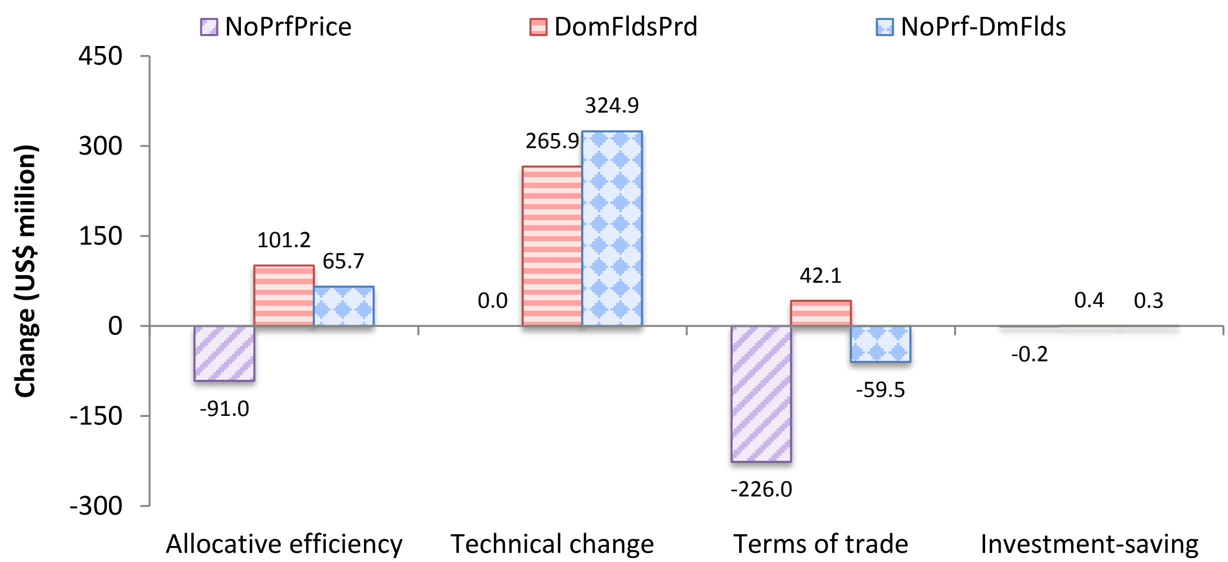

Figure 8: Decomposition of welfare changes in Israel (US$ million)

[11] It is assumed in the GTAP model that each region has enough market power to be able to affect international trade prices by changing its imports or exports.

For DomFldsPrd and NoPrf-DmFlds, the major driver of the welfare gain is the additional production of domestic gas, which is implemented as the increased productivity of primary factors, namely natural resources, capital, and labor. These welfare changes are reflected in income changes of different household groups as depicted in Figure 9. Changes in household expenditure (not reported) are almost equal to those in income, with both declining to different degrees under NoPrfPrice and increasing under DomFldsPrd and NoPrf-DmFlds, as depicted in Figure 9.

Differences in income changes among households are driven by differences in income composition and changes in the different income components. For factor income, it is important to note that changes in the market price index of primary factors in Israel are -0.17%, 0.29%, and 0.28% due to NoPrfPrice, DomFldsPrd, and NoPrf-DmFlds, respectively.

Rich Jewish households witness the strongest reduction in income due to the increase in the import price of gas. This is because these households are owners of resources (especially capital) used by enterprises involved in the energy sector, particularly gas, refined oil, and heavy manufacturing, which retract under this scenario. The declining returns to exports in this scenario also contribute to losses for large exporting enterprises which are mainly owned by rich Jewish households. These retractions in household income decrease as we move down toward Jewish households in the first income quintile, for which capital income constitutes only a small share in their total income.

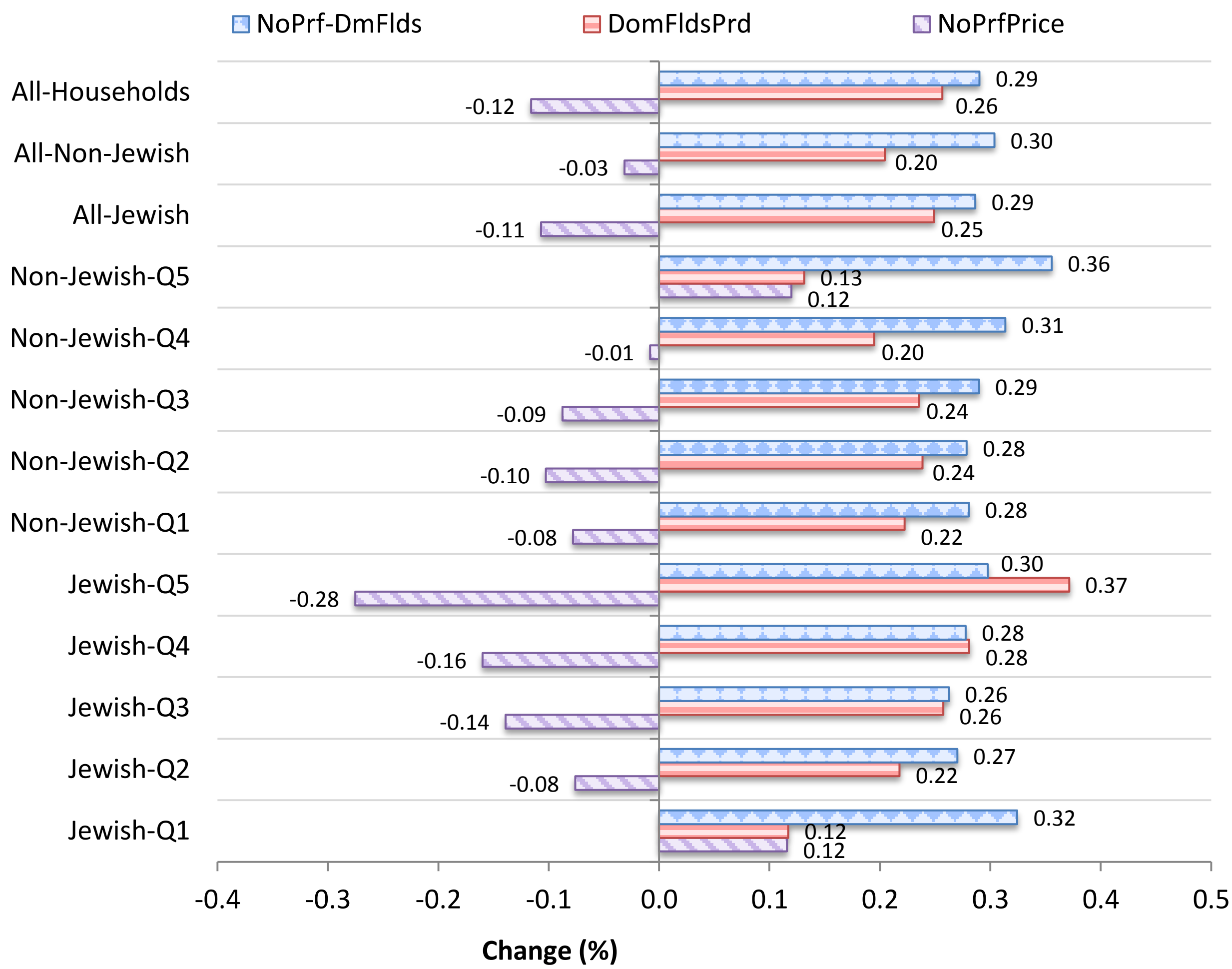

Figure 9: Changes in income of households net of depreciation (%)

Returns to endowments, which are a major source of household income, decrease for all Jewish households except for those in the first income quintile. Generally, reductions are larger for richer households: 0.15%, 0.23%, 0.27%, and 0.51% for Jewish-Q2, Jewish-Q3, Jewish-Q4 and Jewish-Q5, respectively. This is because richer households source a larger share of their income from returns to capital.

Figure 9 also show households in Jewish-Q1 and Non-Jewish-Q5 as outliers since their income increases under the NoPrfPrice scenario. This is justified for Jewish-Q1 by the following: (1) 53% of its income coming from government transfers that are fixed in our model closure; and (2) income from endowments are mainly composed of returns to male industrial skilled workers (17% of the entire household income) as well as male sales and service workers (13% of the entire household income) and female clerical workers (11% of the entire household income). These labor categories are employed strongly by the sectors that witness a production increase under this scenario, such as heavy and light manufacturing.[12] Similarly for Non-Jewish-Q5 households, 25% of their endowment returns stem from Non-Jewish male academic professionals that are not employed by the energy-related sectors, while 22% of their endowment returns stem from Non-Jewish male industrial skilled workers.[13]

The impact of the other two scenarios (DomFldsPrd and NoPrf-DmFlds) on household income is positive and mainly driven by returns to household endowments. This impact is shown to be higher for the NoPrf-DmFlds scenario since it combines the price impact with technical progress, which both increase returns to endowments. Therefore, an increase in income for all household categories would be highest in this scenario, with the exception of the Jewish-Q5 households for which the impact of the component of "gas price increase" is higher relative to other household categories, as shown previously under the NoPrfPrice scenario.

6 Summary and conclusions

Israel currently relies on imports from Egypt for 40% of its domestically consumed natural gas. Imported gas from Egypt is at a relatively lower price compared to other Egyptian gas destinations because of an agreement between Egypt and the EMG. The price issue creates public discontent in Egypt against the sales of gas to Israel, particularly after the 2011 revolution. This discontent is reflected in the repeated attacks on gas pipelines that transport Egyptian gas to Israel.

[12] For example, 20% and 11% of the returns to Jewish male industrial skilled workers accrue from heavy manufacturing and light manufacturing, respectively. The output of the two sectors under the NoPrfPrice scenario increases by 0.74% and 0.29%, respectively.

[13] For example, 5% and 8% of the returns to Non-Jewish male industrial skilled workers stem from heavy manufacturing and light manufacturing, respectively. The output of the two sectors increases by 0.74% and 0.29%, respectively. At the same time, 81% and 23% of the returns to Non-Jewish male industrial skilled workers and Non-Jewish male academic professionals, respectively, stem from the other services sector, for which output increases by 0.025% under the NoPrfPrice scenario.

The domestic discoveries of the natural gas fields of Tamar, Dalit, and Leviathan, which are planned to come into production between 2013 and 2016, will transform Israel to be self-sufficient in natural gas and probably begin its export of natural gas to other countries. This opens the option of replacing Israeli gas imports from Egypt by domestic supply. Alternatively, Israel may decide to continue importing cheap Egyptian gas and exporting its own additional production to destinations, such as Europe or countries in the Middle East, such as Jordan.

In this paper, we investigate the economic implications these options may have for the Israeli economy. We apply the newly developed MyGTAP model of Walmsley and Minor (2012) as well as the standard GTAP model of Hertel (1997) together with the most updated global GTAP database (Version 8.1) that includes the recently developed Israeli Input Output Table (IOT) (Siddig et al., 2012) and a SAM (Siddig et al., 2011). First, we run a scenario that equalizes the price of imported gas from Egypt to Israel to that of the average world market price. Second, we preserve the status quo in terms of the import price, but double domestic production to represent the expected output of the newly discovered gas fields in the short run. Third, we combine scenarios 1 and 2.

Under the first scenario (NoPrfPrice), the price of imported natural gas in Israel – which is mainly used as an intermediate input by the electricity, the refined oil, and the gas manufacturing and distribution sectors – increases by more than 50%, leading to a decrease in the total demand for imported gas by more than 80% and thus a retraction of production in these gas-dependent sectors. At the macro level, this results in a reduction in total investment, final consumption, and total imports, while total exports slightly increase, resulting in a net decline in GDP by 0.19%. Welfare of Israeli private households, which is measured by equivalent variations, declines by US$ million 317 and the government balance decreases by US$ million 40. Nonetheless, retracting imports and increasing exports generate US$ million 201 savings in the balance of trade.

At the household level, rich Jewish households whose income is mainly generated from capital are most severely affected. At the same time, the income of the lowest tier of Non-Jewish households would also decline since these households are affected by the overall retraction of several sectors that reduces returns to labor.

Under the other two scenarios (DomFldsPrd and NoPrf-DmFlds), income of all household categories improves, which is mainly driven by returns to household endowments. The impact of the combined scenario (NoPrf-DmFlds) on household income is shown to be higher than the production scenario (DomFldsPrd) since it combines the import price effect with the domestic discoveries, where both components increase domestic production and hence returns to household endowments. At the macro level, however, the pure domestic production scenario generates the highest increase in GDP, resulting from increases in investment and final consumption. Although the production and combined scenarios increase overall welfare and the government balance, they generate deficits in the trade balance of US$ million 192 and US$ million 92, respectively.

These findings imply that the continuation of the gas importation agreement between Egypt and Israel is the best option for the Israeli economy and its households. This holds true even if its domestic gas fields come into production. Given the fact that Israel has no option to import gas from other countries due to its lack of infrastructure, the infeasibility of developing such infrastructure, and the infeasibility of importing liquefied natural gas based on a short-term contract from other origins, preserving the agreement with Egypt remains the best choice. This coincides with the dominant argument among Israeli policymakers that the gas agreement with Egypt contributes to preserving the peace treaty of Camp David. Nevertheless, the Egyptian policymakers may yield to popular discontent over the policy, in which case this study provided evidence that should imports from Egypt cease, the Israeli economy would not be greatly negatively affected because of its recent discovery of natural gas.

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8 Appendices

Appendix 1: Sectoral mapping of the 57 GTAP8 sectors to 16 sectors

No.	New code	Sector description	No.	Old code	Sectors description
1	AgrCrops	Cereals, Vegetables, Fruits, Oilseeds, and Sugar	1	pdr	Paddy rice
			2	wht	Wheat
			3	gro	Cereal grains nec
			4	v_f	Vegetables, fruit, nuts
			5	osd	Oil seeds
			6	c_b	Sugar cane, sugar beet
			7	pfb	Plant-based fibers
			8	ocr	Crops nec
2	MeatLstk	Livestock, Meat, and Other animal products	9	ctl	Cattle,sheep,goats,horses
			10	oap	Animal products nec
			11	rmk	Raw milk
			12	wol	Wool, silk-worm cocoons
			19	cmt	Meat: cattle,sheep,goats,horse
			20	omt	Meat products nec
3	ForsFishing	Forestry and Fishing	13	frs	Forestry
			14	fsh	Fishing
4	Gas	Natural Gas	17	gas	Gas
5	Crudeoil	Crude Oil	16	oil	Oil
6	Foodindustr	Food industries and other food products	21	vol	Vegetable oils and fats
			22	mil	Dairy products
			23	pcr	Processed rice
			24	sgr	Sugar
			25	ofd	Food products nec
			26	b_t	Beverages and tobacco products
7	LightMnfc	Textile, Wearing apparel, Paper, Leather, wood and other manufactured goods	27	tex	Textiles
			28	wap	Wearing apparel
			29	lea	Leather products
			30	lum	Wood products
			31	ppp	Paper products, publishing
			42	omf	Manufactures nec
8	HeavyMnfc	Motor vehicles, parts and equipment	38	mvh	Motor vehicles and parts
			39	otn	Transport equipment nec
			40	ele	Electronic equipment
			41	ome	Machinery and equipment nec
9	RefinedOil	Refined Petroleum products	32	p_c	Petroleum, coal products
10	ChmRubPlas	Chemical, rubber and plastic products	33	crp	Chemical, rubber, plastic
11	OthMinMnrals	Other Mining and Mineral nec	15	coa	Coal
			18	omn	Minerals nec
			34	nmm	Mineral products nec
			35	i_s	Ferrous metals
			36	nfm	Metals nec
			37	fmp	Metal products
12	UtilConstrcn	Construction and water	45	wtr	Water
			46	cns	Construction
13	Electricity	Electricity	43	ely	Electricity
14	GasManDisn	Gas manufacture, distribution	44	gdt	Gas manufacture, distribution
15	TransComcn	Transports and communications	48	otp	Transport nec

			49	wtp	Sea transport
			50	atp	Air transport
			51	cmn	Communication
16	OthServices	Most of the Services	47	trd	Trade
			52	ofi	Financial services nec
			53	isr	Insurance
			54	obs	Business services nec
			55	ros	Recreation and other services
			56	osg	PubAdmin/Defence/Health/Educat
			57	dwe	Dwellings

Appendix 2: Regional mapping of the 129 GTAP8 regions to 24 regions

No.	New code	Region description	No.	Old code	Regions description
1	Japan	Japan	6	jpn	Japan
2	Korea	Korea	7	kor	Korea
3	China	China	4	chn	China
4	RAsia	Rest of Asia	5	hkg	Hong Kong
			8	mng	Mongolia
			9	twn	Taiwan
			10	xea	Rest of East Asia
			11	khm	Cambodia
			12	idn	Indonesia
			13	lao	Lao People's Democratic Republic
			14	mys	Malaysia
			15	phl	Philippines
			16	sgp	Singapore
			17	tha	Thailand
			18	vnm	Viet Nam
			19	xse	Rest of Southeast Asia
			20	bgd	Bangladesh
			22	npl	Nepal
			23	pak	Pakistan
			24	lka	Sri Lanka
			25	xsa	Rest of South Asia
5	India	India	21	ind	India
6	USA	United States of America	27	usa	United States of America
7	RAmerica	Rest of America	26	can	Canada
			28	mex	Mexico
			29	xna	Rest of North America
			30	arg	Argentina
			31	bol	Bolivia
			33	chl	Chile
			34	col	Colombia
			35	ecu	Ecuador
			36	pry	Paraguay
			37	per	Peru
			38	ury	Uruguay
			39	ven	Venezuela
			40	xsm	Rest of South America
			41	cri	Costa Rica
			42	gtm	Guatemala
			43	hnd	Honduras
			44	nic	Nicaragua
			45	pan	Panama
			46	slv	El Salvador

No.	New code	Region description	No.	Old code	Regions description
			47	xca	Rest of Central America
			32	bra	Brazil
8	Belgium	Belgium	50	bel	Belgium
9	France	France	56	fra	France
10	Germany	Germany	57	deu	Germany
11	Italy	Italy	61	ita	Italy
12	Netherlands	Netherlands	66	nld	Netherlands
13	Spain	Spain	71	esp	Spain
14	UK	United Kingdom	73	gbr	United Kingdom
15	REurope	European Union 25	49	aut	Austria
			51	cyp	Cyprus
			52	cze	Czech Republic
			53	dnk	Denmark
			54	est	Estonia
			55	fin	Finland
			58	grc	Greece
			59	hun	Hungary
			60	irl	Ireland
			62	lva	Latvia
			63	ltu	Lithuania
			64	lux	Luxembourg
			65	mlt	Malta
			67	pol	Poland
			68	prt	Portugal
			69	svk	Slovakia
			70	svn	Slovenia
			72	swe	Sweden
			74	che	Switzerland
			75	nor	Norway
			76	xef	Rest of EFTA
			77	alb	Albania
			78	bgr	Bulgaria
			79	blr	Belarus
			80	hrv	Croatia
			81	rou	Romania
			84	xee	Rest of Eastern Europe
			85	xer	Rest of Europe
16	Egypt	Egypt	102	egy	Egypt
17	RMENA	Rest of MENA	92	bhr	Bahrain
			93	irn	Iran Islamic Republic of
			95	kwt	Kuwait
			96	omn	Oman
			97	qat	Qatar
			98	sau	Saudi Arabia
			100	are	United Arab Emirates
			101	xws	Rest of Western Asia
			103	mar	Morocco
			104	tun	Tunisia
			105	xnf	Rest of North Africa
18	Nigeria	Nigeria	109	nga	Nigeria
19	RAfrica	Rest of Africa	106	cmr	Cameroon
			107	civ	Cote d'Ivoire
			108	gha	Ghana
			110	sen	Senegal
			111	xwf	Rest of Western Africa
			112	xcf	Central Africa

No.	New code	Region description	No.	Old code	Regions description
			113	xac	South Central Africa
			114	eth	Ethiopia
			115	ken	Kenya
			116	mdg	Madagascar
			117	mwi	Malawi
			118	mus	Mauritius
			119	moz	Mozambique
			120	tza	Tanzania
			121	uga	Uganda
			122	zmb	Zambia
			123	zwe	Zimbabwe
			124	xec	Rest of Eastern Africa
			125	bwa	Botswana
			126	nam	Namibia
			127	zaf	South Africa
			128	xsc	Rest of South African Customs
20	Russia	Russian Federation	82	rus	Russian Federation
21	Ukraine	Ukraine	83	ukr	Ukraine
22	Israel	Israel	94	isr	Israel
23	Turkey	Turkey	99	tur	Turkey
24	RestofWorld	Rest of World	1	aus	Australia
			2	nzl	New Zealand
			3	xoc	Rest of Oceania
			48	xcb	Caribbean
			86	kaz	Kazakhstan
			87	kgz	Kyrgyztan
			88	xsu	Rest of Former Soviet Union
			89	arm	Armenia
			90	aze	Azerbaijan
			91	geo	Georgia
			129	xtw	Rest of the World