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The Macroeconomic Effects of Efficiency Gains in Electricity Production in Malta

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Policy Note

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Abstract

This note studies the impact energy market reforms might have on the Maltese economy in the medium-to-long run using a DSGE model. Contrary to previous studies, this note takes in consideration the changes in the marginal cost of electricity production of Enemalta under a number of energy production setups. Results show that the decommissioning of the Marsa power plant and the installation of an undersea interconnector results in a fall in marginal costs, and therefore an increase in long run output, under both baseline and high oil price scenarios ranging between 1.61% and 2.53%. This energy setup is however consistent with an increase in marginal costs, and therefore a fall in long run output of 0.41% in the case of a low oil price scenario. The future setup of natural gas fired turbines results in a fall in marginal costs and an increase in long run output in all oil price scenarios, ranging between 0.81% in the low oil price scenario to 3.00% in case of high oil prices.

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Executive Summary

In line with the EU Energy Roadmap 2050, Malta is required to reform its existing power generation structure and reduce its dependence on fossil fuels, reducing potential vulnerabilities in its electricity generation structure. To this end, Maltese authorities have opted to install a high voltage alternating current undersea cable that connects Malta's energy grid with Italy's. Moreover, in a bid to reduce the carbon footprint of its domestic electricity generation, the government has chosen to gradually convert its electricity generation capacity to natural gas. By affecting the marginal cost structure of Enemalta, these reforms are likely to have broad macroeconomic implications through changes in the overall marginal costs faced by economic agents. This policy note seeks to quantify these macroeconomic effects by answering three questions:

- **What previous assessments have been made on the macroeconomic impact of the reforms in the energy market?**

Grech (2014) uses STREAM (Grech and Rapa, 2016), the Central Bank of Malta macroeconomic model, to study the effect of a 25% reduction in utility tariffs enacted in 2014. This study decomposes the effects of the reduction in utility tariffs into those pertaining to residential and commercial tariffs. Results show an overall impact on GDP of 0.65%, the majority of which driven by the reductions in commercial rates. Apart from the reduction in utility tariffs, the Ministry of Finance (2016) takes in consideration the higher government investment carried out to undertake these reforms. The effect of GDP peaks at 2.93%, of which 1.78 percentage points are driven by reductions in utility tariffs. Both studies, however, do not take in consideration the extent to which the energy reforms are likely to affect Enemalta's marginal cost of producing electricity and consequently the overall marginal costs faced by economic agents.

- **What was the impact of the reforms on the marginal costs of producing electricity in Malta?**

In a recently published study, Ries et al (2016) estimate how the reforms in the energy market will likely impact Enemalta's marginal cost of electricity production. The authors use a merit order curve to find the marginal cost of generating an additional unit of electricity conditional on actual levels of electricity demand and over a number of energy setups: an isolated setup prior to the installation of the interconnector and in which both Delimara and

Marsa power plants are operative, a system linked to the Italian grid via an interconnector and in which the Marsa power station has been decommissioned and an identical system with a number of generators running on natural gas.

Results indicate that the change in marginal costs of electricity depends on both the generation setup and oil price levels. Under baseline and high oil prices the energy setup with the interconnector is consistent with a reduction in marginal costs, while under low oil prices the setup results in higher marginal costs. The future setup of natural gas fired turbines is consistent with a reduction in marginal costs across all oil price scenarios.

- **How could changes in the efficiency of energy production affect the Maltese economy?**

The changes in electricity generation marginal costs are translated into economy wide average marginal cost, assuming that the changes in marginal costs faced by Enemalta will be fully passed on to consumers. A technology shock calibrated to reduce economy-wide marginal costs is then performed in MEDSEA (Rapa, 2016).

Long run results for output under an interconnector setup ranges from a fall of 0.41% in the low oil price scenario to a rise of 2.53% in the high oil price scenario. With this energy setup and under baseline oil prices, long run output is expected to increase by 1.61%. The future natural gas setup is expected to result in an increase in long run output ranging from 0.81% in the low oil price case, to 3.00% in the high oil price case with an increase of 2.08% under baseline oil prices.

Results depend on the extent to which these efficiency gains will be passed on to Enemalta's final consumers. Since results are linear in the level of efficiency pass-through we can interpret these results as elasticity measures of the sensitivity of macroeconomic variables for a given pass-through. Thus under baseline oil prices, economic activity in the long run is expected to increase by 0.16% (in the case of the interconnector energy setup) and 0.21% (in the future gas setup) for every 10% pass-through assumed.

What previous assessments have been made on the macroeconomic impact of the reforms in the energy market?

The European Union's energy policy requires all member states to reform existing power systems and decrease their reliance on single, vertically integrated power suppliers. Malta's small size and geographic isolation implies that it does not have to comply with all EC directives; most notably those regarding the unbundling of distribution system operators, third-party access and market opening. However in line with the EU Energy Roadmap 2050, Malta is required to reduce the vulnerability of its electricity generation to fossil fuel prices and potential import disruptions. To this end Maltese authorities have enacted a number of reforms aimed at diversifying the island's exclusive fossil fuel based energy mix and increase the efficiency of its electricity production. First, authorities opted to install a high voltage alternating current undersea cable that connects Malta's energy grid with Italy's. This together with an increase in the nominal capacity of the Delimara power plants would have resulted in the possible decommissioning of the Marsa power station. Second, in a bid to reduce the carbon footprint of domestic energy generation, authorities opted to enter into an agreement with Shanghai Electric power Co. Ltd to convert Delimara 3 power station from one operating on heavy fuel oil to gas².

Studies aimed at estimating the impact of reforms in the energy sector include Grech (2014). This study uses STREAM (Grech and Rapa, 2016), the Central Bank of Malta macroeconomic model, to estimate the macroeconomic effect of the 25% reduction in utility tariffs enacted in 2014. In view of the high level of disaggregation of the model, Grech decomposes the effects of the reduction in utility tariffs into those pertaining to residential tariffs and those that follow a cut into commercial tariffs. Results show that the overall impact of these reductions would reach a peak of 0.65% of GDP. The direct effect of the fall in residential tariffs is rather subdued reaching a maximum of 0.08%. The largest impact results from the reduction in commercial tariffs that is assumed to directly affect export prices. This is estimated to boost GDP by 0.28% in the second year, 0.45% in the third year rising to a maximum 0.57% in the sixth year after the cut in utility tariffs. Due to the type of model used, this study is only able to capture part of the effects of the reforms in the Maltese energy sector. For instance, the study is unable to capture the positive effects of higher surpluses accruing to Enemalta which boost economic activity from the income side.

² The energy reforms currently underway also envisage the installation of a new combined cycle gas fired power plant, Delimara 4. To the author's knowledge, at the time of writing no information on the effect of this plant on Enemalta's marginal cost of energy production was available. Thus this part of the energy sector reform is not dealt with in this note.

Moreover, this study does not take in consideration the major investments that are being undertaken to improve the efficiency of Maltese energy production.

Contrary to Grech, the study by the Ministry of Finance (2016) takes in consideration the higher government investment carried out to undertake these reforms. However, similar to Grech, this study does not take in consideration the extent to which these reforms will translate into lower marginal costs for Enemalta and consequently into lower utility tariffs for its customer. Instead, in line with Grech, the study aims to quantify the macroeconomic effects of the reduction in utility tariffs implemented in 2014. Results show that by the sixth year, economic activity is expected to increase by 1.78% due to the reduction in utility tariffs and by a total of 2.93% when considering the government investment undertaken in the energy reforms.

What was the impact of the reforms on the marginal costs of producing electricity in Malta?

In a recently published study Ries et al (2016) estimate how the reforms in the energy market will likely impact Enemalta's marginal cost of electricity production. Enemalta's power plants contain a number of generators with different efficiency rates. As demand for electricity increases, Enemalta is required to fire the least efficient generator so as to meet energy demand³. To arrive at a figure for marginal cost, the authors use a merit order curve that ranks each generator by its marginal cost of production (in ascending order). The marginal cost of producing an extra MWh of electricity is ultimately given by the marginal cost of the last generation unit used to satisfy any level of electricity consumption. To get at an average clearing price, the authors propose an algorithm that runs through the hourly electricity consumption in Malta between 2007 and 2010 and optimally chooses which energy sources to be used. This experiment is then repeated over a number of energy setups.

For the purpose of this note we will take in consideration three setups: an isolated setup prior to the installation of the interconnector and in which both Delimara and Marsa power stations are operative (EPS 2010), a system in which the Marsa power plant has been decommissioned and where the interconnector gives access to Sicilian energy production (EPS 2015) and a system identical to EPS 2015 but in which Delimara 3 generators are converted to natural gas (EPS 2015NG). The interconnector grants Enemalta the possibility

³ Note that this implies that the marginal cost of electricity production depends on the level of electricity demand.

to either import or export electricity from or to the Italian grid. Since the Italian energy system is “mature” the Sicilian spot price is lower than the marginal cost of most of Enemalta’s existent generators. Moreover given the higher efficiency of the gas fired turbines, the cost per MWh of Delimara 3 is projected to be lower after the planned conversion⁴. To take in consideration that effects on marginal costs are non-linear in the prevailing oil price level the authors repeat these experiments with three different oil price levels, a baseline (BOPS), a low price (LOPS) and a high price (HOPS) scenario^{5,6}.

Table 1: Results for marginal cost of electricity production for different scenarios

	Baseline Oil Prices (BOPS)			Low Oil Prices (LOPS)			High Oil Prices (HOPS)		
	EPS 2010	EPS 2015	EPS 2015 NG	EPS 2010	EPS 2015	EPS 2015 NG	EPS 2010	EPS 2015	EPS 2015 NG
Marginal cost of electricity (€MWh ⁻¹)	140	105	95	80	85	70	205	125	110
% change in Marginal cost vis-à-vis baseline		-25.0	-32.1		6.3	-12.5		-39.0	-46.3

Source: Ries et al (2016)

Results in Table 1 show that the change in the marginal cost of electricity generation depends on both the generation setup and oil prices. While in both BOPS and HOPS scenarios the EPS 2015 setup is consistent with a reduction in marginal cost, under LOPS, a reduction in marginal costs will only be achievable with the future gas-fired setup. In general, the future setup of natural gas-fired turbines helps reduce marginal costs across all oil price scenarios. Apart from reducing marginal costs, the setup of the interconnector and the conversion of the existent turbines to natural gas helps reduce Malta’s sensitivity to international oil prices⁷. Indeed prior to these reforms marginal costs under HOPS are 156% higher than under LOPS. Under EPS 2015 and EPS 2015NG, the difference in marginal costs between HOPS and LOPS falls to 47% and 57% respectively.

⁴ Note that under EPS 2015, electricity can be either generated by the Delimara plants or imported through the interconnector. Under EPS 2015NG, electricity can be either generated from the Delimara plants (in which Delimara 3 plant has been converted to natural gas) or imported from the interconnector. Under both scenarios, it is assumed that the energy mix (how much electricity is produced by the local plants, and how much is imported through the interconnector) is optimally determined depending on electricity demand, on the relative efficiency levels of the different energy sources, as well as on prices for gas oil, heavy fuel oil and for the case of EPS 2015NG on natural gas prices.

⁵ Price levels in Euro per kg under BOPS: Heavy fuel oil: 0.42, Gas oil: 0.74, Natural gas: 0.42; LOPS: Heavy fuel oil: 0.24, Gas oil: 0.41, Natural gas: 0.28; HOPS: Heavy fuel oil: 0.60, Gas oil: 1.02, Natural gas: 0.56. In the last 12 months, the Brent crude oil price averaged EUR 0.46/kg.

⁶ Note that these price scenarios have been on the historical relationship that exists between natural gas and crude oil prices and thus, might not take into consideration that this relationship has weakened significantly over the last three years.

⁷ The sensitivity of Maltese economic activity to international oil prices is confirmed by simulation results using STREAM (Grech and Rapa, 2016). Under baseline oil prices, a 20% increase in international oil prices results in a fall of 0.74% in economic activity.

How could changes in the efficiency of energy production affect the Maltese economy?

To estimate how changes in the marginal costs of electricity generation translate into changes in economy-wide average marginal costs, I estimate the share of the value of electricity inputs arising directly and indirectly in total intermediate domestic production⁸. In 2010, this share stood at around 5.8%. A technology shock calibrated so as to change economy-wide marginal costs by the estimated amount is then performed. For the purpose of this exercise it was assumed that the changes in marginal costs faced by Enemalta will be fully passed on to consumers in five years. Moreover, it is assumed that economic agents are aware of the future falls in marginal costs, assuming that there is no uncertainty with regards to the pass-through of these efficiency gains to the rest of the economy.

I report two sets of results, the new long run values as well as the transition of a number of variables of interest from the initial to the new steady state. Moreover, since results are heavily dependent on the assumed pass-through (both its overall magnitude as well as its speed) I present some sensitivity analysis.

Results in table 2 show that in the baseline oil price scenario (BOPS) an energy setup with an interconnector and the decommissioning of Marsa power station (EPS 2015) raises long run output by 1.61%. An increase in long run productivity brings about an increase in long real wages leading to a positive income effect that raises long run consumption. Improvements in long run productivity outstrip those in real wages implying a reduction in Unit labour costs. Moreover, efficiency gains in both domestic and foreign oriented sectors lead to lower price pressures that lead to a depreciation of the REER leading to improved price competitiveness in the long run. This explains a long run increase in the exports level of 1.6%. Finally higher capital productivity reduces the implicit price of capital leading to higher investment in the long run.

Mirroring the results shown in Table 1, the long run gains in output following the installation of the interconnector are very sensitive to the prevailing oil price level, ranging from an output loss of around 0.4% in the case of LOPS, to a gain of around 2.5% in the case of HOPS. On the other hand, the plans to fire a number of generators through natural gas have positive macroeconomic effects in all three oil price scenarios considered. This proposed

⁸ Since the simulation exercise features a shock to domestic technology that changes marginal costs faced by local intermediate firms excluding directly imported costs, the share of electricity on overall production costs needs to be computed vis-à-vis total intermediate production excluding direct imports (as opposed to total output). This share is computed on the basis of the 2010 input output tables for Malta published by NSO in 2016.

energy setup is expected to raise economic activity by 0.81% in the case of LOPS, 2.08% in the case of BOPS and by a maximum of 3.00% under HOPS.

Table 2: Long Run Effects of Electricity Generation Reforms

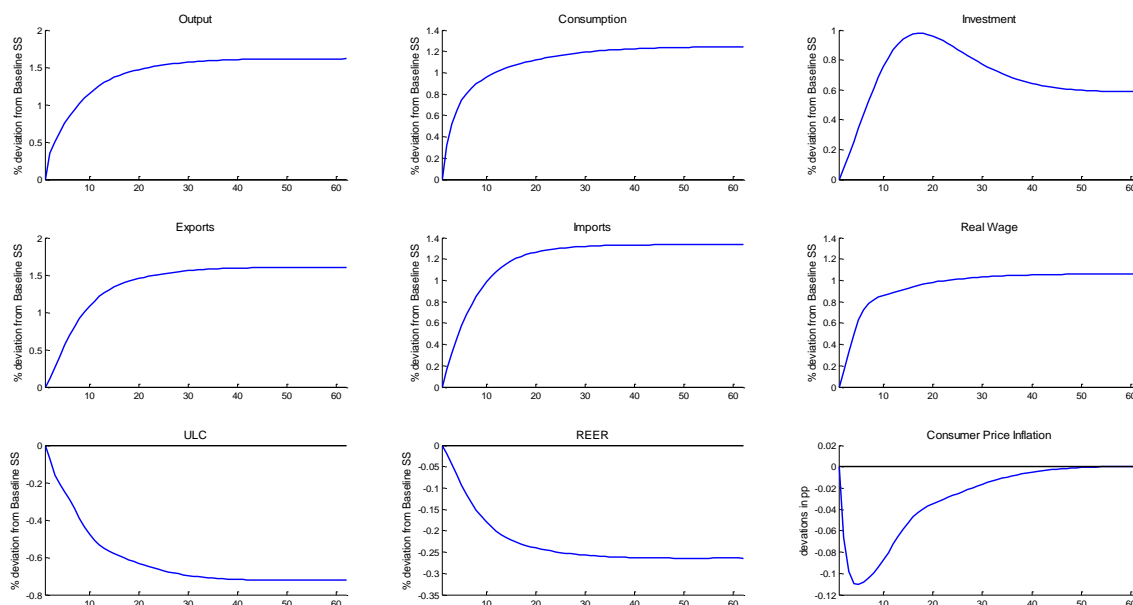
percentage deviation from baseline

	Baseline Oil Prices (BOPS)		Low Oil Prices (LOPS)		High Oil Prices (HOPS)	
	EPS 2015	EPS 2015 NG	EPS 2015	EPS 2015 NG	EPS 2015	EPS 2015 NG
Real activity						
GDP	1.61	2.08	-0.41	0.81	2.53	3.00
Consumption	1.25	1.59	-0.31	0.63	1.94	2.30
Investment	0.60	0.75	-0.16	0.30	0.90	1.11
Exports	1.60	2.06	-0.40	0.80	2.50	2.97
Imports	1.33	1.72	-0.34	0.67	2.09	2.47
Labour market						
Real Wages	1.05	1.37	-0.28	0.53	1.65	1.95
Productivity	1.80	2.32	-0.45	0.90	2.81	3.34
ULC	-0.70	-0.88	0.19	-0.33	-1.12	-1.30
Relative Prices						
REER	-0.26	-0.34	0.07	-0.13	-0.41	-0.48

Source: Author's calculations

Transition dynamics help us track the transmission mechanism of this shock throughout the economy. Figure 1 illustrates transition dynamics from the initial to the new steady state under baseline oil prices and under EPS 2015 assuming that Enemalta will pass on all the efficiency gains to its consumers over five years. The impulse responses show that the new steady state output is reached after almost 10 years, five years after the overall marginal costs in the economy have stopped falling due to lower energy prices. Following the shock, the increased level of efficiency with which factors of production are used leads to lower overall price pressures, leading to an immediate improvement in Malta's cost competitiveness. Improved economic prospects lead consumers to quickly increase consumption. Lower local production costs leads to somewhat higher demand for domestically produced goods at the expense of imported production. Real wages increase quickly, driven by higher labour productivity and lower inflation. Notwithstanding higher real rates, consumption and investment increase driven by a positive income effect and by higher capital productivity.

Figure 1: Transition Dynamics – Baseline Prices, EPS 2015



Source: Author's calculations

As expected, the effects on economic activity under baseline oil prices and under EPS 2015 are stronger than those reported in Grech (2014) which excludes the effects of the positive economic rents accruing to Enemalta after the energy reforms⁹. The results pertaining to overall GDP under the same scenario are however in line with those published by the Ministry of Finance, both in terms of their magnitude and transition dynamics.

It is important to note that the results in Table 2 are based on the assumption of a full pass-through of the efficiency gains to the rest of the economy under all electric power systems (EPS 2015 and EPS 2015NG) and under all oil price scenarios (BOPS, LOPS and HOPS). Due to the lack of information regarding the level of pass-through and its dependence on the energy setup and oil price scenarios, the results in Table 2 are re-interpreted in terms of long run elasticities of macroeconomic variables for a given pass-through level. This is aided by the fact that the macroeconomic results portrayed in this study are linear in the level of efficiency pass-through assumed¹⁰. Thus, Table 3 portrays the projected long run effects of macroeconomic variables for a 10% assumed pass-through. This implies that assuming that Enemalta will pass on 50% of the efficiency gains to its final consumers, real economic

⁹ Both Grech (2014) and the Ministry of Finance (2016) assume a fall in energy tariffs of 25%. Under a perfect pass-through assumption, this is consistent with the results under baseline oil prices with EPS 2015 which predicts a fall in marginal costs of around 25% (see Table 1).

¹⁰ Technically, MEDSEA is solved as a linear approximation around a steady state ruling out non-linearities in the level of pass-through assumed. However, since we are assuming no uncertainty surrounding the pass-through, solving the model with higher order approximations will not yield significantly different results.

activity in Malta is expected to increase by around 0.8% under baseline oil prices and EPS 2015.

Moreover, it is important to note that this study only takes in consideration macroeconomic effects emanating from improvements in the efficiency of energy production in Malta and ignores the possibility of further positive effects stemming from the public and private investment needed to undertake these reforms. Indeed, preliminary results indicate that when taking in consideration both the effects of public investment and marginal cost reductions, the energy market reforms enacted by the authorities are expected to push up economic activity by around 3% by 2020 under baseline oil prices and under the interconnector setup (EPS 2015), in line with results in Ministry of Finance (2016).

Table 3: Long Run Effects of Electricity Generation Reforms for 10% pass-through
percentage deviation from baseline

	Baseline Oil Prices (BOPS)		Low Oil Prices (LOPS)		High Oil Prices (HOPS)	
	EPS 2015	EPS 2015 NG	EPS 2015	EPS 2015 NG	EPS 2015	EPS 2015 NG
Real activity						
GDP	0.16	0.21	-0.04	0.08	0.25	0.30
Consumption	0.12	0.16	-0.03	0.06	0.19	0.23
Investment	0.06	0.08	-0.02	0.03	0.09	0.11
Exports	0.16	0.21	-0.04	0.08	0.25	0.30
Imports	0.13	0.17	-0.03	0.07	0.21	0.25
Labour market						
Real Wages	0.10	0.14	-0.03	0.05	0.16	0.19
Productivity	0.18	0.23	-0.04	0.09	0.28	0.33
ULC	-0.07	-0.09	0.02	-0.03	-0.11	-0.13
Relative Prices						
REER	-0.03	-0.03	0.01	-0.01	-0.04	-0.05

Source: Author's calculations

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