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THE MACROECONOMIC IMPACT OF STRUCTURAL REFORMS IN THE ENERGY SECTOR

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BOX 3: THE MACROECONOMIC IMPACT OF STRUCTURAL REFORMS IN THE ENERGY SECTOR[1]

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, the Maltese authorities have enacted a number of reforms aimed at diversifying the island's 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. Second, in a bid to reduce the carbon footprint of domestic energy generation, authorities entered into an agreement with Shanghai Electric power Co. Ltd to convert Delimara 3 power station from one operating on heavy fuel oil to gas.[2]

This Box seeks to discuss the medium-to-long run macroeconomic impact of these energy reforms. Results are estimated using MEDSEA, a newly developed general equilibrium model for the Maltese economy.[3] This model is simulated using information derived from a recent international study that estimated the reduction in Enemalta's marginal costs of production as a result of these reforms.[4]

Existing studies

A Central Bank of Malta study conducted in 2014 used the Bank's traditional econometric model to estimate the macroeconomic effect of a 25% reduction in utility tariffs enacted in 2014.[5] Results show that the overall impact of these reductions would reach a peak of 0.65% of GDP by 2020, with most of this improvement being driven by the reduction in commercial tariffs that is assumed to directly affect export prices. 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. Moreover, this study does not take into consideration the major investments that are being undertaken to improve the efficiency of Maltese energy production.

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1 Prepared by Noel Rapa. The author is a Senior Research Economist within the Economics and Research Department at the Central Bank of Malta. The views expressed in this Box are the author's own and do not necessarily represent the views of the Bank. The Box builds on the results presented in Rapa, N. (2017). "The macroeconomic effects of efficiency gains in electricity production in Malta", Policy Note, Central Bank of Malta.

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 Box.

3 Rapa, N. (2016). "MEDSEA: A small open economy DSGE model for Malta", Working Paper 05/2016, Central Bank of Malta.

4 Ries, J., Gaudard, L., & F. Romerio. (2016). "Interconnecting an isolated electricity system to the European market: The case of Malta", *Utilities Policy*, 40, pp. 1-14.

5 Grech, A. G. (2014). "An estimate of the possible impact of lower electricity and water tariffs on the Maltese economy", Working Paper 01/2014, Central Bank of Malta.

Another study by the Ministry for Finance takes into consideration the higher government investment carried out to undertake these reforms.[6] However, similar to the earlier study by the Central Bank of Malta, this study does not take into consideration the extent to which these reforms will translate into lower marginal costs for Enemalta and consequently, into lower utility tariffs for its customers. 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.

Quantifying efficiency gains in electricity production

In a recently published study, three authors from the London School of Economics estimated the extent to which these reforms in the energy market will 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 use the least efficient generator so as to meet energy demand.[7] The marginal cost of producing an extra MWh of electricity is therefore 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.

This Box takes into consideration three energy 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 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 conversion.[8] To take into consideration that effects on marginal costs are non-linear in the prevailing oil price level, this Box will take into consideration three oil price levels, a baseline (BOPS), a low price (LOPS) and a high price (HOPS) scenario.[9,10]

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,

6 Ministry for Finance (2016). *Malta National Reform Programme*, pp. 13-14.

7 This implies that the marginal cost of electricity production depends on the level of electricity demand.

8 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 in the case of EPS 2015NG, on natural gas prices.

9 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.

10 Note that these price scenarios are based 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.

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 vs baseline		-25.0	-32.1		6.3	-12.5		-39.0	-46.3

Source: Ries et al. (2016).

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 prices.[11] 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.

Quantifying the macroeconomic impact of these reforms

To estimate how changes in the marginal costs of electricity generation translate into changes in economy-wide average marginal costs, the 2010 input-output tables are used to estimate the share of the value of electricity inputs arising directly and indirectly in total intermediate domestic production.[12] In 2010, this share stood at around 5.8%. MEDSEA is then simulated using a technology shock that is calibrated so as to change economy-wide marginal costs by the estimated amount. 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.

Two sets of results are reported: 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. 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%.[13] An increase in long-run productivity brings about an increase in long-run 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

[11] The sensitivity of Maltese economic activity to international oil prices is confirmed by simulation results using STREAM - (Grech, O., & Rapa, N. (2016), "STREAM: A Structural Macro-Econometric Model of the Maltese Economy", Working Paper 01/2016, Central Bank of Malta. Under baseline oil prices, a 20% increase in international oil prices results in a fall of 0.74% in economic activity.

[12] 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.

[13] All results presented in this study 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).

Table 2
LONG-RUN MACROECONOMIC EFFECTS OF ELECTRICITY GENERATION REFORMS
% deviation from baseline

	Baseline Oil Prices		Low Oil Prices		High Oil Prices	
	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[(1)]	-0.26	-0.34	0.07	-0.13	-0.41	-0.48

[(1)] Percentage deviation from baseline.

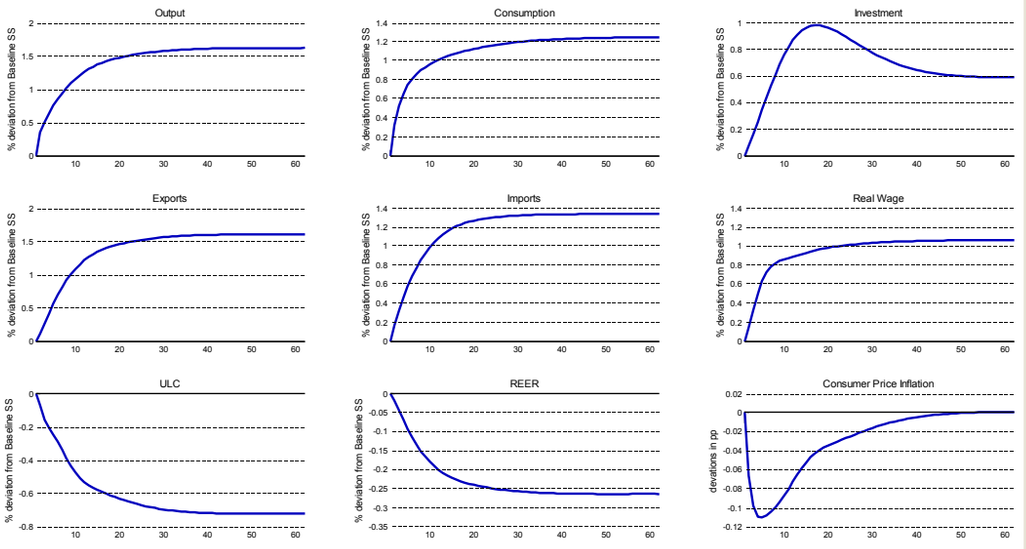
Source: Author's calculations.

costs. Moreover, efficiency gains in both domestic and foreign oriented sectors lead to lower price pressures and a depreciation of the real effective exchange rate, which translates in improvements in the country's price competitiveness. 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, plans to fire a number of generators through natural gas have positive macroeconomic effects in all three oil price scenarios considered. This proposed 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.

Transition dynamics enable the tracking of the transmission mechanism of this shock throughout the economy. Chart 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 ten 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 lead to somewhat higher demand for domestically produced goods at the expense of imported production. Real wages increase quickly,

Chart 1
TRANSITION DYNAMICS – BASELINE PRICES, EPS 2015



Source: Author's calculations.

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.

As expected, the effects on economic activity under baseline oil prices and under EPS 2015 are stronger than those reported in a previous Central Bank of Malta study, which excluded the effects of the positive economic rents accruing to Enemalta after the energy reforms.[14] The results pertaining to overall GDP under the same scenario are however in line with those published by the Ministry for Finance, both in terms of their magnitude and transition dynamics.

The results discussed above do not take into consideration the positive demand side effects stemming from the public and private investment needed to undertake these reforms. To estimate these effects a version of MEDSEA, which has been extended to include a detailed fiscal block,[15] was simulated using data on the actual investment undertaken to carry out all energy reforms. When including these demand side effects, the rise in overall output is expected to be faster and more pronounced, especially in the short run. The effects on output stemming from the investment shocks are expected to be much lower in the medium-to-long run, especially as all capital projects related to the energy reforms are completed. Indeed by 2025, output is expected to rise between 2% and 2.5% when compared to steady state, or around 0.5% higher than the results reported in Table 2.

[14] Both Grech (2014) and the Ministry for 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).

[15] Rapa, N. (2017). "Estimates of Fiscal Multipliers using MEDSEA", Working Paper 04/2017, Central Bank of Malta.