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The Effect of EU Energy and Climate Policies on the Economy of Cyprus

Elena Ketteni
Europrism Research and Department of Economics, University of Cyprus

Theofanis Mamuneas
Department of Economics, University of Cyprus

Theodoros Zachariadis
Department of Environmental Science & Technology, Cyprus University of Technology

Leonor Coutinho
Europrism Research

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Executive Summary

This report is a shortened version of deliverable D9 of the research project entitled "Economic Impacts from the Implementation of the European Union's Energy and Climate Change Legislation Package in Cyprus", which is funded by the Research Promotion Foundation of Cyprus in the framework of 'DESMI 2009-2010', a programme co-funded by the Republic of Cyprus and the European Regional Development Fund (project number ΑΕΙΦΟΡΙΑ/ΚΟΙΑΦ/0609(ΒΙΕ)/02).

The European Union's energy and climate policy package, which was legally adopted in early 2009, will have significant effects on the European economy because it will induce an increase in energy prices. In this paper we model the effect of this policy package on the economy of Cyprus, a small EU island state. We first formulate and estimate econometrically an innovative production model that embodies rational expectations and dynamic optimization, which accounts not only for efficiency gains due to investments in energy-saving technology but also for adjustment costs associated with capital replacement. Estimation results are in line with the international literature and with economic theory. We then simulate changes in factor demands and production costs up to the year 2020 for two scenarios. Production costs may grow by 4.3-9.6% over the entire economy in the year 2020 as a result of the combined effect of higher electricity prices and higher automotive fuel prices. In absolute terms, the manufacturing sector and the hotels and restaurants sector are projected to incur two thirds of the total cost increases. Per unit of output, the greatest cost increases are expected in two sectors: mining and quarrying and hotels and restaurants. Observing relative increases in production costs, we find that mining and quarrying, hotels and restaurants and non-metallic minerals are the sectors most vulnerable to these price increases. This indicates that the competitiveness of these sectors may be seriously endangered due to the increased costs associated with the implementation of energy and climate policies.

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Έλενα Κεττένη, Θεοφάνης Μαμουνέας, Θεόδωρος Ζαχαριάδης και Leonor Coutinho

ΠΕΡΙΛΗΨΗ

Το παρόν Δοκίμιο συνοψίζει εργασία που διενεργείται στο πλαίσιο του έργου με αρ. πρωτοκόλλου ΑΕΙΦΟΡΙΑ/ΚΟΙΑΦ/0609(ΒΙΕ)/02, το οποίο χρηματοδοτείται από το Ίδρυμα Προώθησης Έρευνας στο πλαίσιο της «Δέσμης Προγραμμάτων 2009-2010» που υποστηρίζεται χρηματικά από την Κυπριακή Δημοκρατία και το Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης.

Η νομοθεσία για την ενέργεια και την κλιματική αλλαγή, που υιοθετήθηκε το 2009 από την Ευρωπαϊκή Ένωση, αναμένεται να έχει επιπτώσεις στην κυπριακή οικονομία επειδή θα οδηγήσει σε αύξηση των λιανικών τιμών σε ορισμένα ενεργειακά προϊόντα και σε πιθανή επακόλουθη αύξηση των τιμών και σε άλλα αγαθά και υπηρεσίες. Για τη διερεύνηση των επιπτώσεων αυτών, αναπτύχθηκε ένα θεωρητικό μοντέλο παραγωγής της κυπριακής οικονομίας και εκτιμήθηκε οικονομετρικά με βάση δεδομένα που συυλέχθηκαν από επίσημες στατιστικές πηγές για τον σκοπό αυτό. Στη συνέχεια, προσομοιώθηκαν δύο συγκεκριμένα σενάρια μεταβολής των τιμών της ενέργειας μέχρι το 2020. Η ανάλυσή μας οδηγεί στα εξής συμπεράσματα:

1. Εξαιτίας της αύξησης των ενεργειακών τιμών (προπαντός στον ηλεκτρισμό και δευτερευόντως στα καύσιμα κίνησης), και παίρνοντας υπόψη τον περιορισμό στην κατανάλωση ενέργειας και τις αλλαγές στη ζήτηση άλλων συντελεστών παραγωγής ανά παραγωγικό τομέα, κατά το έτος 2020 το συνολικό κόστος παραγωγής της οικονομίας αναμένεται να αυξηθεί κατά 331 εκ. Ευρώ (σε τιμές του 2010).

2. Μολονότι το κόστος αυτό σε απόλυτα μεγέθη είναι σημαντικό, η αύξηση του μοναδιαίου κόστους παραγωγής προβλέπεται να είναι συγκριτικά χαμηλή (κάτω από 0,30 Ευρώ), με συνέπεια οι επιπτώσεις στην ανταγωνιστικότητα της οικονομίας να είναι περιορισμένες. Επίσης, δεν αναμένεται να επηρεασθούν αισθητά οι επενδύσεις και η απασχόληση στην ευρύτερη οικονομία.

3. Το ανωτέρω κόστος είναι συγκρίσιμο με (και συχνά χαμηλότερο από) το κόστος που προκαλείται στην κυπριακή οικονομία από τη διακύμανση των διεθνών τιμών της ενέργειας για λόγους ανεξάρτητους της όποιας ενεργειακής και περιβαλλοντικής πολιτικής.

1. INTRODUCTION

The European Union's energy and climate package, which was adopted in early 2009, involves several legally binding measures that aim at reducing greenhouse gas (GHG) emissions in the EU by the year 2020. In short, the package envisages a reduction of carbon dioxide (CO2) emissions of energy intensive industries by 21% in 2020 compared to 2005, to be realized through participation of these industries in the EU Emissions Trading System (EU ETS) with most of the emission permits purchased in auctions; a further substantial decrease of GHG emissions from all other sectors not included in the EU ETS, e.g. the residential sector and transportation; and a considerable increase in the share of renewables in each country's energy mix, with an additional mandate for a minimum 10% share of renewable fuels in the total consumption of automotive fuels.

This group of measures will substantially affect the economies of EU countries – households, firms and the public sector. The European Commission, the EU's executive body, has conducted an economy-wide analysis of the impacts of this legislative package, which included calculations of the costs of compliance with the policy targets carried out with partial and general equilibrium models (Capros et al. 2011). According to this assessment, the compliance cost to meet both GHG reduction and renewables targets was estimated to range between 0.4% and 0.6% of the EU's GDP (depending on scenario assumptions) in year 2020. An independent assessment of the same policy package, carried out with three different computable general equilibrium (CGE) models, concluded that the costs would most likely be considerably higher than those assessed by the European Commission (Böhringer et al. 2009). At the same time, several EU governments and non-governmental organizations have expressed scepticism about these economic impact assessments, often claiming that the total cost of these measures might be significantly higher in some countries.

In the case of Cyprus, a small island state in the Eastern Mediterranean that became an EU member in the year 2004, a preliminary review of Zachariadis and Shoukri (2011) found that the most probable direct effects from the implementation of EU's energy and climate policy package are twofold. First, a considerable increase in end-user prices of electricity is expected as a result of the stronger penetration of renewable energy sources (which are still more costly than conventional power generation) and the participation of power utilities in the EU ETS with the obligation to purchase emission permits (whose cost will then be passed through to consumers). Second, a modest increase in the prices of automotive fuels is very likely because of the obligations to use an increasing fraction of renewable fuels (primarily biofuels) in transportation.

Starting from such considerations, we model the effect of the EU's energy and climate policy package on the economy of Cyprus, keeping in mind that the available national economic data do not allow developing a CGE model for the country. We first formulate and estimate econometrically a production model for Cyprus, based on the work of Bernstein et al. (2004), which embodies rational expectations and dynamic optimization in the presence of efficiency gains and adjustment costs. As will be explained in Section 3, such a model specification provides the appropriate framework to assess the effect of energy prices on sectoral production costs and input demand because it accounts for the fact that energy is closely tied with energy-using technology. Hence investments in new capital, e.g. in energy-saving technology, do not simply lead to efficiency gains; they also involve adjustment costs in the short run. In contrast to other modeling approaches, we do not distinguish between fixed and variable production factors; in our specification, whether each production factor is variable or not is tested empirically. To our knowledge, this is the first energy-related study that uses this modeling framework.

Using the above mentioned price increases as an input to our empirically estimated model, we perform simulations of changes in factors of production, production output and production costs in year 2020 as a result of these assumptions. We find that efficiency gains arise from new electricity and fuel inputs, and these gains are not offset by adjustment costs. We also find, in line with earlier literature on this topic, that labor and electricity and labor and fuels are complements, as well as capital and electricity and capital and fuels. Furthermore, we observe that an increase in the price of electricity will mostly affect demand for electricity and fuels and to a lesser extent decrease demand for labor and physical capital, while it has on average a positive effect on the demand for materials. Production costs are expected to rise modestly in all sectors of the Cyprus economy; it seems, however, that these increases due to the EU's energy and climate legislation are comparable in magnitude to fluctuations of energy prices during the last decade that have been independent of environmental policy.

The next Section summarizes the available literature on the interaction between energy, productivity and economic output. Section 3 describes the theoretical model we developed and its empirical specification. The data we collected and used are presented in Section 4. The econometric estimation results are discussed in Section 5, while Section 6 describes the policy simulations performed with the empirical model. Section 7 concludes, offers policy recommendations and outlines future research paths.

2. LITERATURE REVIEW

The impact of energy use and energy price changes on productivity and economic growth has been a controversial subject with unclear conclusions. Most of the empirical evidence examines the causality between energy and growth. A general finding of these studies is that the results are conflicting and there is no consensus on the existence or on the direction of causality between energy and economic output. Additionally, studies suggest that the relationship between energy use and aggregate GDP can be affected by other factors such as the substitution between energy and other inputs, technological change, shifts in the composition of energy inputs, shifts in the composition of output as well as environmental implications from the production and use of energy (Stern 2011).

The impact of energy prices on productivity performance has also been controversial; energy price changes have a much larger impact on productivity measures than is indicated by the energy cost shares, for the energy price increases spill over to affect real capital inputs as well (Berndt 1991). Some studies conclude that an increase in the price of electricity stimulates technical change, while others find that increases in the relative price of energy result in reduced productivity growth (Berndt and Hesse 1986). The estimation of substitution elasticities among energy and non-energy inputs has also been the subject of several studies, most of which indicate that energy and capital are complements and therefore increases in energy prices will result in lower growth. Another issue in the literature is how to account properly for input quality changes.

There is a large empirical literature on the issue on whether capital and energy are substitutes or complements and – in the latter case – on how substitutable they are. Econometric studies have come to varying conclusions. Apostolakis (1990) concluded that capital and energy act more as substitutes in the long run and more than complements in the short run. Frondel and Schmidt (2002) revisit the study of Apostolakis (1990) using additional data and find evidence of complementarity only in cases where energy cost shares are small. When materials are included as a distinct factor of production, the cost shares of capital and energy are smaller and complementarity is more likely. Similarly, Berndt and Wood (1979) found that studies which include capital, labor and energy but not materials as inputs indicate substitution, while econometric cost functions that also include materials indicate complementarity. Koetse et al. (2008) conclude that the microlevel Hicks elasticity of substitution between capital and energy is less than unity, especially in the short run. Capital and energy are likely complements in the short run and substitutes in the long run. In Atkeson and Kehoe's (1999) model energy is used in fixed proportion to capital, but different types of capital have different energy requirements. Thus, in the short run energy and capital are poor substitutes but in the long run quite a lot of substitution is possible as the capital stock turns over. They find that this model matches changes in the US macroeconomic data much better than any alternative models.

Changes in the energy/GDP ratio that are not related to changes in the relative price of energy are called changes in the autonomous energy efficiency index (AEEI). Estimates of the trend in AEEI are mixed. The direction of change has not been constant and varies across different sectors of the economy (Stern 2011). Berndt et al. (1993) use a model to estimate augmentation trends in labor, electricity, fuels, machines and structures in the US manufacturing industry from 1965 to 1987. The rates of augmentation were 11.8% and -3.4% per annum for electricity and fuels respectively. Patterns for Canada and France were entirely different.

Judson et al. (1999) estimate time effects that show rising energy consumption over time in household and other sectors but flat to declining effects in industry and construction. They suggest that technical innovations tend to introduce more energy-using appliances in households and energy-saving techniques in industry. When there is endogenous technological change, changes in prices may induce technological changes. As a result an increase in energy prices tends to accelerate the development of energy-saving technologies, while periods of falling energy prices may result in energy-using technological change. There can also be an effect on the general rate of total factor productivity (TFP) growth. Jorgenson (1984) found that technical change was biased and tended to be energy-using. If this is the case, lower energy prices tend to accelerate TFP growth and vice versa.

Recent research investigates the factors that affect the adoption of energy efficiency policies or energy efficiency technology. Differences in the adoption of energy efficiency technologies across countries and states over time and among individuals might be optimal due to differences in endowments, preferences or the state of technology (Stern 2011). Fredriksson et al. (2004) find that the greater the corruptibility of policy makers the less stringent is energy policy, and that the greater the lobby group coordination costs the more stringent the energy policy. Matisoff (2008) finds that the most significant variable affecting the adoption of energy efficiency programs across US states is citizen ideology.

Strong correlations between the state of technology and the levels of other inputs can result in biased and inconsistent results of the trend in efficiency or energy augmentation indexes. Using a method to address the issue of biased estimation, Stern (2011) finds that energy efficiency improved from 1971 to 2007 in most developed countries, former communist countries, China and India, but there was no improvement in many developing countries. Globally, such technological change resulted in a 40% reduction in energy use. He finds that energy efficiency rises with increasing general TFP but it is also higher in countries with more undervalued exchange rates in purchasing parity adjusted terms. Higher fossil fuel reserves are associated with lower energy efficiency. Energy efficiency converges over time across countries with growing economies, and technological change was the most important factor mitigating the global increase in energy use and carbon emissions due to economic growth.

3. METHODOLOGY

It is evident from the above literature review that there is much scope for further research in order to explore empirically the role of energy on economic growth and productivity. Country-specific and sector-specific analyses are crucial for this purpose as the effects may vary considerably across economic sectors. It is essential to employ a dynamic model so as to understand how changes in energy prices affect investment behavior, employment; productivity and energy use (see e.g. Pindyck and Rotemberg 1983, Morrison 1993). Ideally, for reasons to be explained in the following paragraphs, a dynamic factor demand model should retain the generality of its functional form, but it should also embody rational expectations and dynamic optimization in the presence of efficiency gains and adjustment costs.

A model that takes into account indirect effects permits energy price increases to have a much larger impact on productivity measures than is indicated by the energy cost shares, as energy price increases spill over to affect real capital as well. When energy price shocks occur, utilization rates of the various surviving vintages of capital adapt, and this also affects the flow of services per unit of capital. Such changes are unlikely to be uncovered by traditional measures of capital input and as a result Multi Factor Productivity growth will be incorrectly measured.

If, for example, energy and capital are at least short run complements, then increased energy prices will cause the marginal product of capital – and thus capital utilization – to decline. Not only would this cause efficiency to be suppressed, it would also cause errors in standard measures of technical change. This in turn would cause diminished technical change through reduced incentives to invest in new equipment that embodies new technology. Other scale effects due to fixities not reflected in measured inputs may also cause changes in the overall efficiency of production. In addition, the composition of output and capital would likely be affected. Thus, the impact of energy price changes is difficult to identify without an appropriate modeling framework of a firm's production decisions and performance.

The assumption of instantaneous adjustment of all inputs to price changes may not be very useful under sharp and unexpected increases in the energy prices. In such cases the characteristics of short run behavior may differ from those when full adjustment to long run equilibrium is attained. Dynamic models have been developed along the basic assumption that adjustments of certain quasi-fixed inputs, such as capital, are explicitly taken into account by firms in their production decisions so that adjustment costs become an endogenous part of their firms' total optimization problem.

Based on all the above considerations we will be using a dynamic framework, which also incorporates the technical efficiency of energy inputs, as well as other inputs, along with the possibility of substitutability between all inputs under investigation. This framework is sufficiently general so as to:

- capture the effect of input prices on the demands of all inputs under consideration (therefore capturing own and cross price effects of all input prices and demands), to evaluate whether these are complements or substitutes;

- allow efficiency gains in production to arise when new inputs generate an improvement in technical efficiency that is not fully offset by cost of adjustment.

Our analysis will follow the methodology of Bernstein et al. (2004), parameterizing technical efficiency (which includes adjustment costs) directly into the production function. We begin by describing the theoretical framework for our model, and then we explain its empirical implementation.

3.1 Theoretical Model

This section develops a model incorporating the possibility that the efficiency of factor additions from physical and ICT capital accumulation, intermediate input purchases, energy inputs or labor hiring, differ from current efficiency levels.

Following Bernstein et.al (2004), technical efficiency is parameterized directly into the production function adding a dynamic dimension to the problem. One attraction of this model is the parsimonious treatment of efficiency as a single parameter for each input.

Efficiency gains in production arise when new inputs generate an improvement in technical efficiency that is not fully offset by costs of adjustment.

Specifically, consider a production function written as:

$$\mathrm{Y_t = F[(v_{1t-1} + h_1(v_{1t} - v_{1t-1}), \dots, v_{nt-1} + h_n(v_{nt} - v_{nt-1}), t]} \qquad (1)$$

where y_t is output quantity in period t, F is the production function, v_{it} is the ith input quantity in period t, and t also represents the exogenous disembodied technology index.

Parameters h_i provide for changes in technical efficiency levels related to factor additions. These parameters reflect the variations in "net" efficiency by capturing the gains from factor improvements, and the losses associated with adjustment costs. The value of these parameter are always positive ($h_i > 0$, i = 1,2, …, n).

To understand the role of these parameters, first consider $h_i = 1$. In this case the marginal product of net additions of input *i* in the current period is the same as that of existing units of the input, and the standard production function emerges. The increased technical efficiency of net additions is being just offset by costs of adjustment.

Next, suppose $h_i > 1$. In this case, the marginal product of net additions of input *i* in the current period exceeds that of existing units of the input. Accordingly, the benefits from factor improvements dominate adjustment costs incurred through incorporating new inputs into the production process.

Finally, when $0 < h_i < 1$, the marginal product of net additions of input *i* in the current period is lower than that of existing units of the input. Adjustment costs dominate the benefits associated with factor improvements, and as a result factor additions are less productive than existing inputs.

Factor accumulation is presented by:

$$\mathrm{v_{it}} = \mathrm{x_{it}} + (1 - \delta_\mathrm{i})\mathrm{v_{it-1}} \qquad (2)$$

where x_{it} is the addition to the *i*th input quantity in period *t*, and $0 \leq \delta i \leq 1$ is the *i*th input depreciation rate.

Input demands are determined from minimizing the expected present value of acquisition and hiring costs. The expected value is given by the following:

$$\sum_{s=0}^{\infty} \sum_{i=1}^{n} \mathrm{a(t, t+s) q^e_{it+s}\, x_{it+s}} \qquad (3)$$

where q^e_{it+s} is the expectation in the current period *t* of the *i*th factor acquisition or hiring price in period $t + s$ and $a(t, t + s)$ is the discount factor.

The expected value is minimized subject to the production function and the factor accumulation equations. Let $w^e_{it+s} = q^e_{t+s} - aq^e_{it+s+1}(1 - \delta_i)$ be the *i*th factor price in period *t*, but expected in period $t + s$, and $a = a(t, t + s + 1)/a(t, t + s)$ is the constant discount factor.

Bernstein et al. (2004) show that this problem is equivalent to the following problem defined by the cost function:

$$C(w_{1t,} \dots, w_{nt}, y_t, t) = \left\{ \min_{z_t} \sum_{i=1}^{n} w_{it} z_{it} : f(z_{1t}, \dots, z_{nt}, t) \gg y_t \right\} \quad (4)$$

where $w_{it} = h_i^{-1}\{w_{it} + \sum_{s=1}^{\infty} w_{it+s}^{e}[(a(1-h_i^{-1})]^{s}\}$ is the *i*th user cost in period *t*, and $z_{it} = h_i[v_{it} - (1-h_i^{-1})v_{it-1}]$ is the efficiency-adjusted *i*th input quantity. Note that because of the efficiency parameter h_i the user cost is more general than the traditional factor price. Producers take into account the effect of the efficiency change in current and all future efficiency adjusted marginal products of the inputs. To see this, assume that there is no efficiency change and set the efficiency parameters to unity. With $h_i = 1$ then $w_{it} = q_{it} - aq_{it+1}^{e}(1-\delta_i)$ which is the traditional factor price.

This equivalence enables us to define a cost function which is denoted as:

$C(w_{1t}, \dots, w_{nt}, y_t, t)$

Using Shepard's Lemma it is possible to retrieve the efficiency-adjusted factor demands according to:

$$z_i(w_{1t}, \dots, w_{nt}, y_t, t) = \frac{\partial C}{\partial w_i}, i = 1, \dots, n \quad (5)$$

The efficiency-adjusted factor demands, however, are not observable because the technical efficiency parameters are unknown. Using the definition of the efficiency-adjusted quantity, $z_{it} = h_i(v_{it} - (1-h_i^{-1})v_{it-1})$, the observable factor demands v_{it} can be obtained by

$$v_i(w_{1t}, \dots, w_{nt}, y_t, t) = h_i^{-1}\frac{\partial C(w_{1t}, \dots, w_{nt}, y_t, t)}{\partial w_{it}} + (1-h_i^{-1})v_{it-1\,,} i = 1, \dots, n \quad (6)$$

These sets of equations form the basis for the estimation model which is specified in the following Section. They depend on user costs (and thereby depreciation and technical efficiency parameters, expected acquisition and hiring prices), on output quantity and on the technology indicator. Therefore, estimation of the above method requires the specification of two elements:

1. the cost function; and
2. the price expectation-generating process for the acquisition and hiring prices.

When doing so, a system can be estimated which includes: the factor demand equations derived from the cost function chosen along with the specific price expectation generating processes (Bernstein et al. (2004) suggested it to be an AR(1) process, but other versions can be used and tested).

3.2 Empirical Specification and Estimation

This section specifies the cost function and the price expectation generating processes for the acquisition and hiring prices required to estimate the model. The cost function specified below is assumed to be the symmetric generalized McFadden functional form introduced by Diewert and Wales (1988). This functional form is attractive because it is flexible and retains its flexibility even under the imposition of concavity with respect to user costs.

$$c_t = (\sum_{i=1}^{n} \beta_i w_{it} + \frac{0.5 \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} w_{it} w_{jt}}{\sum_{i=1}^{n} b_i w_{it}} + \sum_{i=1}^{n} b_{it} t w_{it} + a_{tt} t^2 \sum_{i=1}^{n} b_i w_{it}) y_t + \sum_{i=1}^{n} a_i w_{it} a_t t \sum_{i=1}^{n} b_i w_{it} + a_{yy} y_t^2 \sum_{i=1}^{n} b_i w_{it} \qquad (7)$$

where the parameters are denoted by the $\alpha's$ and $\beta's$. The $n \times n$ matrix formed by parameters β_{ij} is symmetric, and must be negative semidefinite so that the function is concave in user costs. Coefficients $bi, i = 1, \dots, n$ are nonnegative constants that are not all zero for some reference time period τ. For the reference time period, the cost function is homogenous of degree one in user costs if $\sum_{i=1}^{n} \beta_{ij} w_{i\tau} = 0$, and $\sum_{i=1}^{n} b_i w_{i\tau} \neq 0$. The expression $\sum_{i=1}^{n} b_i w_{it}$ is an index of input prices, and the constants $bi, i = 1, \dots, n$, are set equal to the input cost shares in the reference time period.

Based on the specified cost function (7), and dividing the observable factor demands (6) by output quantity (in order to reduce any possible heteroskedasticity and make calculations with the results more tractable), *i*th investment demand per unit of output becomes:

$$\frac{v_i}{y_t} = h_i^{-1} \left\{ \beta_i + \frac{\sum_{j=1}^{n} \beta_{ij} w_{jt}}{\sum_{i=1}^{n} b_i w_{it}} - \frac{.5 b_i \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} w_{it} w_{jt}}{(\sum_{i=1}^{n} b_i w_{it})^2} + \frac{a_i}{y_t} + \frac{b_i a_t t}{y_t} + b_i a_{tt} t^2 + b_{it} t + b_i a_{yy} y_t \right\} + \left(1 - h_i^{-1}\right) \frac{v_{it-1}}{y_t}, \qquad i = 1, \dots, n \qquad (8)$$

Equation (8) allows estimation of the coefficients using observed data. Concavity is also imposed.

The next requirement for estimation involves the expectation generating processes for acquisition and hiring prices. It is assumed that price expectations follow a first order autoregressive process:

$$q_{it+1}^{e} = \varphi_i + \theta_i q_{it} + e_{it}, i = 1, \dots, n \qquad (9)$$

where φ_i and θ_i are parameters, q^e_{it+1} denotes $E_t(q_{it+1})$, e_{it} is identically and independently distributed over time, and since expectations are rational, the expected value of e_{it} is zero. This equation set (9) implies, in the current period t, that the ith expected acquisition or hiring price in period $t+s$ is

$$q^e_{it+s} = \frac{\varphi_i(1-\theta_i^s)}{(1-\theta_i)} + \theta_i^s q_{it} \qquad (10)$$

It is clear from this expression that it is necessary that $\theta_i \neq 1\ \forall i$. However no other condition needs to be imposed on either the sign or the magnitude of the parameters. Combining this equation with the input demand from the minimization of the expected value of acquisition and hiring costs, user costs become:

$$w_{it} = h_i^{-1}\left[q_{it}\frac{1-ad_i\theta_i}{1-a\mu_i\theta_i} + \frac{\varphi_i}{1-\theta_i}\left(\frac{1-ad_i}{1-a\mu_i} - \frac{1-ad_i\theta_i}{1-a\mu_i\theta_i}\right)\right], i = 1, \ldots, n \qquad (11)$$

where $\mu_i = 1 - h_i^{-1}$, $d_i = 1 - \delta_i$ and $\alpha = 1/(1+r)$, r is a constant discount rate.

With the simplification that $\varphi_i = 0$, expression (11) becomes:

$$w_{it} = \frac{1}{h_i}\left\{\frac{1 - ad_i\theta_i}{1 - a\mu_i\theta_i}\right\} q_{it}$$

Specifying the price expectations processes reveals that the user costs are unobservable because of the technical efficiency parameters h_i and the expectations parameters φ_i, θ_i. Once the concavity and user cost elements are incorporated into the demand equations for efficiency adjusted inputs, the outcome is a set of equations that are very nonlinear in coefficients. With the cost function and price expectations processes specified, the estimation model becomes equation sets:

1. The observed demand per unit of output equations (with the user costs defined) and
2. The AR(1) price expectation equations: $q_{it+1} = \theta_i q_{it} + e^q_{it+1}$

The error terms are assumed to be identically and independently distributed over time with zero expected value. Equation sets are jointly estimated by the Nonlinear Seemingly Unrelated Regression estimator, applied to the data. There are five factors of production, and thus our system consists of ten equations, five input intensity equations, and five equations relating to price expectations.

3.3 Derivation of Elasticities

The main concern of the paper is to investigate the effects of increases in end-user prices of fuel and electricity (as a result of policies to reduce GHG emissions and increase the penetration of renewable) on factor demands. When the system of factor demand equations is estimated along with the price generating processes one can obtain the elasticities of input demands. This way one can establish complementarities and substitutes between the inputs under investigation.

The elasticity of demand for efficiency adjusted input i with respect to the user cost of this input, w_{it} evaluated at year *t* is:

$$\varepsilon_{iit}^{zw} = \left[\partial Z_i(\dot{t}) / \partial w_{it} \right] \left(w_{it} / z_{it}^{*} \right), i = 1,2,\ldots,n$$

where $Z_i(\dot{t})$ is the demand function and z_{it}^{*} is the value of this function in year *t*.

The elasticity of demand for efficiency adjusted input i, with respect to the user cost of input *j*, namely w_{jt} ($j \neq i$) and evaluated in year *t* is:

$$\varepsilon_{ijt}^{zw} = \left[\partial Z_i(\dot{t}) / \partial w_{jt} \right] \left(w_{jt} / z_{it}^{*} \right), i,j = 1,2,\ldots,n; j \neq i$$

4. DATA DESCRIPTION

To estimate the model in line with the methodology described in the previous Section, one needs data for the prices and quantities of both the output and the inputs included in the cost function. We obtained relevant data from several publications of the Statistical Service of Cyprus. The data cover the period 1976 to 2008. All prices are expressed in constant Euros of year 2000.

We collected data for each major sector of the Cyprus economy: Agriculture, hunting and Forestry, Mining and Quarrying, Electricity, Gas and Water Supply, Construction, Wholesale and Retail Trade, Hotels and Restaurants, Transport and Communication and Manufacturing. We also collected more detailed data for manufacturing subsectors. A detailed description of the data can be found in Appendix 1.

5. EMPIRICAL RESULTS

5.1 Estimation Results

The equation sets mentioned in Section 3.2 are jointly estimated by the Nonlinear Seemingly Unrelated Regression estimator. As mentioned above, there are five factors of production (labor, capital, raw materials, electricity and fuels), and thus our system consists of ten equations – five input intensity equations and five equations relating to price expectations.

The results from the system estimation are presented in Table 1.

Table 1: Parameter estimates

Parameter	Estimate	St. Error	Parameter	Estimate	St. Error
β_{LL}	-0.343	0.303	β_{LT}	-0.019	0.008
β_{LK}	-0.766	0.331	β_{KT}	-0.048	0.013
β_{LF}	-0.990	6.339	β_{FT}	0.036	0.233
β_{LE}	-0.124	0.086	β_{ET}	0.009	0.005
β_{LM}	0.228	0.099	β_{MT}	-0.0006	0.005
β_{KK}	-1.708	0.181	h_L^{-1}	0.173	0.035
β_{KF}	-2.208	14.09	h_K^{-1}	0.133	0.003
β_{KE}	-0.277	0.148	h_F^{-1}	0.022	0.035
β_{KM}	0.509	0.025	h_E^{-1}	0.329	0.022
β_{FF}	-2.855	36.46	h_M^{-1}	0.883	0.025
β_{FE}	-0.355	2.293	θ_L	0.175	0.066
β_{FM}	0.659	4.205	θ_K	0.943	0.005
β_{EE}	-0.045	0.048	θ_F	0.353	0.051
β_{EM}	0.083	0.044	θ_E	0.233	0.053
β_{MM}	-0.152	0.017	θ_M	0.076	0.063
β_L	0.039	0.131			
β_K	0.982	0.356			
β_F	-1.513	9.744			
β_E	-0.248	0.140			
β_M	0.594	0.045			

Equation	St. Error	R^2
Labor	0.009	0.997
Capital	0.022	0.996
Fuel	0.025	0.927
Electricity	0.011	0.966
Materials	0.168	0.828
Log of LF	2073.78	

The estimates of the efficiency parameters suggest that technical efficiency levels increase with factor additions. Moreover, as the case of $h_i = 1$ implies that efficiency does not change, the rate of efficiency growth for the ith input can be expressed as $h_i - 1$. Significant adjustment costs would occur if efficiency parameters were below 1, implying negative rates of efficiency growth. These rates, for our data, are estimated to be 0.13% for raw materials, 2.04% for electricity, 6.52% for capital, 4.71% for labor and 46.6% for fuels.

The estimated rates of efficiency growth for raw materials are the lowest, whereas efficiency growth rates for capital accumulation and labor indicate that the new capital and labor are more efficient than their current levels. Efficiency gains arise from new electricity inputs as well. The efficiency gains from new electricity inputs are not offset by the efficiency-eroding adjustment costs.

The results here indicate that technical efficiency levels rise with new fuel inputs (used in production). From the estimation we observe that fuels have the largest rate of efficiency growth among all inputs. Therefore, the efficiency gains from fuel input improvements or new fuel inputs are not offset by the reductions in efficiency arising from their adjustment costs. The large efficiency effect of fuels relative to the other inputs implies that every year the contribution of this input in production increased not only because of net editions, but also because those net additions had a higher marginal product than fuel inputs already in use.

5.2 Short Run Elasticities

The short run elasticities are given by:

$$e_{ij} = \frac{\partial v_i}{\partial w_j}\frac{w_j}{v_i} = h_i^{-1}\left\{\frac{\partial Z_i}{\partial w_j}\frac{w_j}{v_i}\right\}$$

The resulting short run price elasticities (average over the whole sample) are summarized in Table 2. A positive elasticity implies that the two inputs are substitutes, while a negative one points to a complementary relationship.

Table 2: Elasticities (average over the sample)

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.00554	0.00657	0.00346	-0.01799	-0.00329
CAPITAL	0.00359	-0.05214	0.04615	0.03937	-0.06570
MATERIALS	0.00530	0.38057	-0.38587	-0.09183	0.53598
ELECTRICITY	-0.00033	-0.00691	0.00691	-0.01283	-0.00987
FUELS	-0.00001	-0.00124	0.00109	-0.00098	-0.00143

As expected, the own effect of each input price is negative. Therefore each input price affects its own demand negatively. The total average elasticities shown in Table 2 suggest that labor and electricity and labor and fuels are complements, while labor and materials and labor and capital are substitutes. Capital and material also appear to be substitutes, while the relationship between capital and electricity as well as capital and fuels is complementary. Materials and electricity, as well as materials and fuels appear to be substitutes. Finally, electricity and fuels are complements in the production process.

The results for the average short run elasticities by economic sector are presented in Table A in Appendix 2, along with the elasticities for the selected manufacturing subsectors. These are similar to the total averages. Again positive elasticity implies substitutes, while negative implies complements. Here, as well, the own elasticities are negative as expected.

We now turn to the cross-elasticities of electricity price with all the inputs as well as the fuel price cross-elasticities, since these are of particular interest in our analysis.

In Agriculture we observe that electricity appears to be a complement with labor, capital and fuels and a substitute for raw materials. Additionally, fuels appear to complement labor, capital and electricity and substitute raw materials. The same picture emerges for the Mining and Quarrying industry, the Hotels and Restaurants sectors and the Transport and Communication.

For sectors Electricity, Gas and Water, Construction and Total Manufacturing we observe a different picture with respect to the relationship between electricity and labor, as well as fuels and labor. These factors appear to be substitutes in these sectors, since the elasticities are now positive. The rest are the same as in the previous industries.

Finally, for the Wholesale and Retail Trade sector we find that electricity complements all inputs in the production process, while the elasticities for fuels are all positive (implying substitutability) but very small.

These results indicate that the relationship between electricity price and input demands, as well as that between fuel price and input demands, is not similar among sectors. Therefore the effect of the quantity of this input and its price should be carefully examined on a sector by sector basis.

The same can be observed in the case of other inputs. In most cases capital and materials as well as labor and materials appear to be substitutes. The relationship between labor and capital varies; in some industries they appear to complement each other while in others they seem to be substitutes.

As regards the manufacturing subsectors we observe the following:

- Electricity has a complementary relationship with labor and raw materials, while it substitutes capital and fuels.
- Fuels appear to complement only capital, while they substitute for labor, materials and electricity.
- Materials and labor appear to be complements in the production process.
- Capital and both labor and materials are substitutes.

Note that the results for the manufacturing subsectors should be interpreted with caution due to limited data availability by subsector for years prior to 1980, which made it necessary to make some generic assumptions in order to construct a consistent time series.

5.3 Long Run Elasticities

Using the estimation results, the long run elasticities can be derived on the basis of the following formula:

$$\varepsilon_{ij} = \left\{\frac{\partial Z_i}{\partial w_j}\frac{w_j}{Z_i}\right\}$$

Table 3 presents long run elasticities, averaged over the whole sample, whereas the corresponding sector-specific elasticities are shown in Table B of Appendix 2.

Table 3: Long run elasticities (average over the sample)

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0318	0.0274	0.0059	-0.0012	-0.0002
CAPITAL	0.0385	-0.3927	0.4308	-0.0212	-0.0580
MATERIALS	0.0204	0.3478	-0.4379	0.0211	0.0509
ELECTRICITY	-0.1044	-0.2960	-0.1040	-0.0398	-0.0460
FUELS	-0.0197	-0.4940	0.6079	-0.0302	-0.0672

Results are similar to those shown in Table 2 for the short run, but long run elasticities are greater, suggesting (as expected) a larger effect among inputs in the long run. Again a positive effect implies substitutes, while a negative effect complements.

The own effect is correctly negative. Electricity appears to complement all inputs in the long run, while fuels are complements with labor, capital and electricity and substitute for raw materials.

Sectoral results suggest that these effects differ among sectors and subsectors, so careful examination is needed before any policy-relevant conclusions are drawn: an increase in the price of electricity or fuels as a result of e.g. GHG reduction commitments will affect the other inputs differently in each sector.

In summary, our results indicate that in order to derive policy-relevant conclusions one should examine each economic sector (and perhaps its subsectors) separately since the effect of a change in the price of electricity and fuels appears to vary considerably across sectors. Overall, our results for Cyprus are in line with those of Berndt and Wood (1975; 1979) for the United States and Canada. The latter estimated higher elasticities, but this difference is expected because our model distinguishes between short run and long run behavior and also accounts for adjustment costs, which tend to reduce the effect of energy on other factor demands.

6. SIMULATIONS

Assuming a change in prices, and using the elasticities obtained as explained in the previous Section, one can calculate the effect of price changes on the quantity demanded of each input (expressed as a percentage change). The change in total production cost can also be computed.

The percentage change of the demand of input i is given by:

$$\frac{\partial \mathrm{v_i}}{\mathrm{v_i}} = \varepsilon_{\mathrm{ij}} \, {}^{\partial \mathrm{w_j}}\!/_{\mathrm{w_j}}$$

$$\Rightarrow change\ in\ price_j * elasticity_{ij}$$

The above relationship shows that when the cross elasticity is negative then a price increase will tend to reduce the input quantity demanded, while a positive elasticity suggests a positive effect (i.e. an increase in the input demand).

In this way it is possible to calculate the percentage change in quantities demanded of each input for given changes in end-user prices of electricity and automotive fuels. Zachariadis and Shoukri (2011) have conducted a preliminary review of the direct effects of the EU energy and climate package on energy prices in Cyprus, which was based on consultation with public authorities and local experts. The simulations presented here have used the assumed price increases that were included in that report, which are also summarized in Table 4. Two scenarios have been simulated:

- A 'baseline', which assumes that energy prices in Cyprus will develop up to the year 2020 as expected by authorities and experts in 2011, without any unexpected events (such as sharp increases in compliance costs or shortages in the supply of biofuels) that would further raise the prices;

- A 'high impacts' case, assuming that international energy and environmental agreements or regulations may cause energy prices to grow more strongly than initially expected (e.g. due to an increase in oil and gas prices or in the prices of CO_2 emission allowances, or because of higher biofuel prices as a result of rising global demand for biofuels).

Table 4: Assumed end-user price increases as a result of the implementation of the EU energy and climate package in Cyprus

	Year 2013		Year 2020	
Scenarios	Baseline	High impacts	Baseline	High impacts
Change in price of:				
electricity	4.7%	10.0%	12.6%	20.0%
automotive petrol	0.0%	3.0%	6.0%	10.0%
automotive diesel	3.0%	6.0%	8.0%	15.0%
other fuels	0.0%	0.0%	0.0%	0.0%

Source: Zachariadis and Shoukri (2011).

6.1. Effects on input demand

As shown above, relative changes in input demand are calculated as the product of the change in energy prices and the corresponding elasticity of demand. Detailed tables with simulated change in demand by sector and subsector for the baseline and the high impacts scenario are presented in Appendix 3.

If one accounts for the change in electricity prices only, among the five production inputs, demand for electricity and fuels is affected most. In the baseline case, demand for labor, capital, fuels and electricity decreases, while the demand for materials increases. As a result of the low elasticities reported in Section 5, all changes in input demand are very small. On average for the total economy, demand for labor, capital, fuels and electricity drops by 0.004%, 0.087%, 0.124% and electricity 0.162% respectively, whereas demand for raw materials grows by 0.087%. Similar effects (though even smaller in magnitude) are observed when the increase in automotive fuels is simulated. The effects are somewhat stronger in the 'high impacts' scenario, since the simulated price increase is higher.

As regards sectoral impacts, the strongest drop in electricity demand is simulated in the trade sector. Agriculture is expected to reduce demand for fuels and capital investments more than other economic sectors, followed by manufacturing. The strongest negative effects in labor demand are expected in the mining and transport/communication sectors. Coming to individual manufacturing subsectors, the results show that capital investments increase slightly, perhaps because industries adapt to rising electricity prices by investing in more energy efficient equipment. Demand for labor and materials fall quite uniformly across subsectors, but the effect on labor is particularly small. Obviously electricity demand falls in all subsectors, whereas fuel demand rises in some cases, i.e. in those subsectors where electricity and other fuels are substitutes as it came out from the empirical estimations of Section 5.

6.2. Effects on production cost

We now turn to the simulation of the effects of price increases on total production costs. To calculate these, we use the cost formula (equation 4); the effect is given by:

$$\frac{\partial C}{C} = \left\{ s_j + \sum s_i e_{ij} \right\} {}^{\partial w_j}\!/_{w_j}, \mathrm{i = j \ and \ i \neq j}$$

Table 5 displays the resulting changes in production costs by sector according to the two scenarios, assuming that prices of all other inputs remain constant. Despite slightly decreasing demand for some inputs, as described in section 6.1, rising electricity prices will increase production cost across all sectors and subsectors. The economy-wide increase is expected to reach 2.7% in the baseline scenario and 6.7% in the high impacts scenario. Mining and quarrying, hotels and restaurants and non-metallic minerals turn out to be the most vulnerable industries, i.e. those expected to experience the highest cost increases, a reasonable result since all three sectors are electricity-intensive and have little possibility for substitution in the short run. Conversely, the construction sector is the one affected the least from changing electricity prices.

Table 5: Change in production costs (%) by economic sector of Cyprus in the year 2020, for an increase in electricity prices

	Baseline scenario	*High Impacts scenario*
Electricity price increase in 2020:	*12.6%*	*20.0%*
Agriculture, hunting and forestry	1.67	4.21
Mining and quarrying	6.70	16.90
Electricity, Gas and Water	2.44	6.15
Construction	0.41	1.03
Wholesale, Retail Trade	2.49	6.29
Hotels and Restaurants	4.53	11.42
Transport and Communication	0.97	2.46
Manufacturing	2.61	6.58
Food, Beverages and Tobacco	1.85	4.67
Chemicals, Petroleum, Rubber, Plastic	2.15	5.43
Non-Metallic Mineral Products	9.93	25.05
Metal products, Machinery, Equipment	1.10	2.78
Other manufacturing industries	0.87	2.21
Total Average	**2.66**	**6.71**

We now proceed with simulations under the assumption of a combined increase in prices of both electricity and other fuels. This combined effect can be computed through the following formula:

$$\frac{\partial C}{C} = \left\{ s_j + \sum s_i e_{ij} \right\} {}^{\partial w_j}\!\big/_{w_j} + \left\{ s_g + \sum s_i e_{ig} \right\} {}^{\partial w_g}\!\big/_{w_g}, \mathrm{i} = \mathrm{j} = \mathrm{g} \text{ and } \mathrm{i} \neq \mathrm{j} \neq \mathrm{g}$$

Table 6 reports the results. Compared to the electricity-only case reported in Table 5, economy-wide production costs are expected to rise further, reaching 4.3% in the baseline scenario and 9.6% in the high impacts scenario. Mining and quarrying, hotels and restaurants and non-metallic minerals are still the most vulnerable industries due to the increase of both electricity prices and fuel prices, whereas the chemicals and metal products industries are expected to remain the least affected in this case. It turns out that, compared to Table 5, higher fuel prices make a greater difference to transport and communications sector as well as construction – two sectors that are highly dependent on fuel use.

Assuming that energy prices will grow gradually between years 2013 and 2020 in line with the information of Table 4, and that the prices of all other production factors will not change, we have assessed the annual evolution of production cost increases during this 8-year period. These are illustrated in Table 7. Costs increase mildly in the first years, because the Cypriot power generation sector can still acquire a substantial portion of free CO_2 emission allowances and automotive biofuel mandates are not stringent during the first years; this leads to a smooth increase in end-user prices of fuel and electricity. Then prices grow more strongly and hence production cost rises by 2020 up to the levels shown in the last row of Table 6.

Table 6: Change in production costs (%) by economic sector of Cyprus in the year 2020, for a combined increase in electricity and fuel prices

	Baseline scenario	*High Impacts scenario*
Electricity price increase in 2020:	*12.6%*	*20.0%*
Fuel price increase in 2020:	*7.0%*	*13.0%*
Agriculture, hunting and forestry	3.32	7.16
Mining and quarrying	8.54	20.19
Electricity, Gas and Water	4.03	8.99
Construction	2.24	4.30
Wholesale, Retail Trade	2.50	6.29
Hotels and Restaurants	6.96	15.78
Transport and Communication	2.09	4.45
Manufacturing	4.42	9.82
Food, Beverages and Tobacco	2.93	6.60
Chemicals, Petroleum, Rubber, Plastic	1.99	1.97
Non-Metallic Mineral Products	10.72	26.47
Metal products, Machinery, Equipment	1.38	3.28
Other manufacturing industries	2.76	5.57
Total Average	**4.28**	**9.61**

Table 7: Annual increases in economy-wide production costs (%) for a combined increase in electricity and fuel prices in the period 2013-2020

Year	*Baseline scenario*	*High Impacts scenario*
2013	1.47	4.40
2014	1.74	5.05
2015	2.09	5.72
2016	2.51	6.43
2017	2.85	7.15
2018	3.27	7.93
2019	3.71	8.69
2020	4.28	9.61

Table 8 presents the forecast change in production costs in monetary terms. The manufacturing sector is projected to experience the highest cost increase, with additional costs exceeding 110 million Euros (at constant prices of year 2010) in year 2020; in the high impacts scenario manufacturing costs increase by over 250 million Euros'2010. The second largest burden in absolute terms is borne by the hotels and restaurants sector. These additional costs will most probably be passed through to final consumers, thereby increasing the end-user prices of products and services produced by Cypriot firms.

Finally, to put the numbers of Table 8 in perspective, we have computed the projected changes in average unit cost by sector for this period, assuming that output will remain unchanged throughout the 2013-2020 period. Table 9 presents these calculations. Although all cost increases are expected to be modest, it becomes evident that two sectors are projected to bear the highest increases in unit cost as a result of higher energy prices: Hotels and Restaurants, and Mining and Quarrying. The implications for the competitiveness of these two sectors of the Cypriot economy are obvious.

Table 8: Annual increases in economy-wide production costs for a combined increase in electricity and fuel prices in the period 2013-2020, in million Euros at constant prices of year 2010

Baseline scenario	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Agriculture, hunting and forestry	7.2	8.7	10.5	12.6	14.3	16.4	18.7	21.8
Mining and quarrying	1.7	2.0	2.3	2.8	3.2	3.7	4.1	4.7
Electricity, Gas and Water	4.3	5.2	6.2	7.4	8.5	9.7	11.0	12.7
Construction	9.2	11.3	13.8	16.8	18.8	21.8	25.1	30.3
Wholesale, Retail Trade	14.2	16.5	19.5	23.1	26.7	30.3	33.9	37.7
Hotels and Restaurants	29.9	35.5	42.6	51.0	58.1	66.5	75.4	86.8
Transport & Communication	7.7	9.3	11.3	13.6	15.3	17.6	20.1	23.6
Manufacturing	38.5	45.9	55.2	66.2	75.3	86.3	98.0	113.5
Total	**112.8**	**134.2**	**161.3**	**193.5**	**220.0**	**252.2**	**286.3**	**331.1**
High impact scenario	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Agriculture, hunting and forestry	20.8	24.0	27.3	30.8	34.5	38.4	42.2	47.0
Mining and quarrying	5.3	6.0	6.8	7.6	8.4	9.3	10.1	11.1
Electricity, Gas and Water	13.0	14.9	16.9	19.0	21.1	23.4	25.7	28.4
Construction	22.9	27.0	31.1	35.6	40.5	45.8	50.7	58.1
Wholesale, Retail Trade	47.6	53.8	60.4	67.1	73.8	80.9	88.1	95.2
Hotels and Restaurants	90.7	103.8	117.7	132.0	146.8	162.6	178.1	196.6
Transport and Communication	22.0	25.4	28.9	32.7	36.6	40.8	44.9	50.2
Manufacturing	114.4	131.4	149.2	167.7	186.8	207.4	227.4	252.1
Total	**336.6**	**386.2**	**438.4**	**492.5**	**548.4**	**608.7**	**667.2**	**738.8**

Table 9: Annual increases in the unit cost of production for a combined increase in electricity and fuel prices in the period 2013-2020, expressed in Euros at constant prices of year 2010

Baseline scenario	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Agriculture, hunting and forestry	0.023	0.028	0.034	0.041	0.046	0.053	0.060	0.071
Mining and quarrying	0.078	0.091	0.109	0.130	0.149	0.170	0.191	0.218
Electricity, Gas and Water	0.042	0.049	0.059	0.071	0.081	0.093	0.105	0.122
Construction	0.028	0.034	0.042	0.051	0.057	0.066	0.076	0.092
Wholesale, Retail Trade	0.032	0.037	0.044	0.052	0.060	0.069	0.077	0.085
Hotels and Restaurants	0.094	0.111	0.133	0.160	0.182	0.209	0.236	0.272
Transport and Communication	0.033	0.040	0.049	0.058	0.066	0.076	0.087	0.102
Manufacturing	0.035	0.042	0.050	0.060	0.069	0.079	0.089	0.104
Total	**0.040**	**0.047**	**0.057**	**0.068**	**0.077**	**0.088**	**0.100**	**0.116**
High impact scenario	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Agriculture, hunting and forestry	0.067	0.078	0.088	0.100	0.112	0.124	0.137	0.152
Mining and quarrying	0.246	0.280	0.316	0.353	0.390	0.430	0.470	0.515
Electricity, Gas and Water	0.124	0.142	0.162	0.181	0.202	0.224	0.246	0.272
Construction	0.070	0.082	0.095	0.108	0.123	0.139	0.154	0.177
Wholesale, Retail Trade	0.108	0.122	0.137	0.152	0.167	0.183	0.199	0.216
Hotels and Restaurants	0.284	0.326	0.369	0.414	0.460	0.510	0.558	0.616
Transport and Communication	0.095	0.109	0.125	0.141	0.158	0.176	0.194	0.216
Manufacturing	0.104	0.120	0.136	0.153	0.170	0.189	0.207	0.230
Total	**0.118**	**0.135**	**0.154**	**0.173**	**0.192**	**0.213**	**0.234**	**0.259**

7. CONCLUSIONS

The European Union's energy and climate policy package, which was legally adopted in early 2009, will have significant effects on the European economy. In the case of Cyprus, it is expected to cause a considerable increase in end-user electricity prices and a less pronounced – but still substantial – rise in the retail prices of automotive fuels. In this paper we tried to assess the effects of these price increases on the economy of Cyprus. We specified and estimated econometrically a production model with five factors of production (capital, labor, raw materials, electricity and fuels) which embodies rational expectations and dynamic optimization in the presence of efficiency gains and adjustment costs; it is probably the first time that such a dynamic model is employed to explore the effect of energy on the economy. For this purpose we constructed a comprehensive dataset, the most detailed that was possible to compile in view of the data that are available in the country. Estimation results are generally in line with the international literature and with economic theory. The estimated efficiency parameters suggest that technical efficiency levels increase with factor additions.

Efficiency growth rates are 0.13% for raw materials, 2.04% for electricity, 6.52% for capital, 4.71% for labor and 46.6% for fuels.

On average, it turns out that labor and electricity and labor and fuels are complements, while labor and materials and labor and capital are substitutes. The relationship between capital and electricity as well as capital and fuels is complementary. Materials and electricity, as well as materials and fuels appear to be substitutes. Finally, electricity and fuels are complements in the production process. A more detailed analysis reveals a substantial sectoral variation of the relationship between electricity price and other input demands, as well as between fuel price and input demands. This underlines the need to study the effects of energy-related inputs on the demand of other factors of production on a sector by sector basis.

We then carried out simulations of changes in sectoral input demands and production costs in Cyprus up to the year 2020 as a result of the assumed energy price increases. Economy-wide, demand for all production factors except materials is projected to decline as a result of higher electricity and fuel prices. The trade sector is expected to experience the strongest drop in electricity demand, agriculture is expected to reduce demand for fuels and capital investments more than other economic sectors, and the strongest negative effects in labor demand are expected in the mining and transport/communication sectors. Overall, the effects on demand on the production side are expected to be small, which means that most of the impact of higher energy prices in Cyprus will be passed through to final consumers through higher product prices.

We calculate that production costs may grow by 4.3-9.6% over the entire economy in the year 2020 as a result of the combined effect of higher electricity prices and higher automotive fuel prices. In absolute terms, the manufacturing sector and the hotels and restaurants sector are projected to incur two thirds of the total cost increases. Per unit of output, the greatest cost increases are expected in two sectors: mining and quarrying and hotels and restaurants. Observing relative increases in production costs, we find that mining and quarrying, hotels and restaurants and non-metallic minerals are the sectors most vulnerable to these price increases – they are expected to experience cost increases of up to 26%. As the latter two sectors (which are related to tourism and cement exports respectively) are exposed to international competition, this finding indicates that their competitiveness may be seriously endangered due to the increased costs associated with the implementation of energy and climate policies.

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APPENDIX 1: DATA DESCRIPTION

To estimate the model in line with the methodology described in the previous Section, one needs data for the prices and quantities of both the output and the inputs included in the cost function. We obtained relevant data from several publications of the Statistical Service of Cyprus. The data cover the period 1976 to 2008. All prices are expressed in constant Euros of year 2000.

We collected data for each major sector of the Cyprus economy: Agriculture, hunting and Forestry, Mining and Quarrying, Electricity, Gas and Water Supply, Construction, Wholesale and Retail Trade, Hotels and Restaurants, Transport and Communication and Manufacturing. In order to study the manufacturing sector in more detail, and according to data availability, Manufacturing has been split in several subsectors. These are: Food, Beverages and Tobacco, Chemicals, Petroleum, Rubber and Plastic Products, Non-Metallic Mineral Products, Metal products, Machinery and Equipment and Other Manufacturing Industries.

Those sectors and subsectors were chosen based on the availability of official fuel and energy related data. Our analysis uses five inputs: labor, capital, electricity, fuels and materials.

The variables used for our analysis are: Gross output in current prices, Price Deflator for Gross output, Value Added in current prices, Value added in constant 2000 prices, Employment, Total hours of employment, Investment in current prices, Investment in 2000 prices, Labor Cost, Cost of Raw materials, Cost of Electricity, Cost of Fuels used in production, prices of petroleum products (gasoline, kerosene, gasoil, light fuel oil, heavy fuel oil and LPG) and Average price of electricity per KWh by category (Domestic, Commercial, Industrial, Agriculture).

For the construction of the output variable, we use the Gross output variable of each sector in current prices (used as the value of output, VY_{it}), along with the price deflator. The quantity of output is calculated as follows:

$$\mathrm{VY_{it}} = \mathrm{PY_{it}} \times \mathrm{QY_{it}} \Rightarrow \mathrm{QY_{it}} = \frac{\mathrm{VY_{it}}}{\mathrm{PY_{it}}}$$

We also obtained the value added in constant and current prices.

For labor, necessary data are the price and quantity of labor. We used employment and hours of employment to construct employment in man-hours: $EMH_{it=}E_{it} * hours$. The cost of labor was used as the compensation of employees (value of labor). Having the value of labor and employment in man-hours the price of labor was obtained, which was transformed in order to be expressed in 2000 prices. Combining labor price and labor value one can derive the quantity of labor in 2000 prices.

Investments, in current and constant prices, were used in order to construct the capital stock. The value of capital was obtained using the value added in current prices and the value of labor. The perpetual inventory method was followed with a constant depreciation rate of 5%, to get the quantity of capital:

$$\mathrm{K_{it}} = \mathrm{I_{it}} + (1 - \delta)\mathrm{K_{it-1}}$$

For the initial value (initial period *t* = 0) of the quantity of capital we use:

$$\mathrm{K_0} = {}^{\mathrm{I_0}}/_{(\delta + \mathrm{mean}(\mathrm{g_Y}))}$$

where g_Y is the growth rate of output and δ is the depreciation rate.

For the first variable of interest, fuels, we used the cost of fuels used in production (to approximate the value of fuels in current prices), along with the prices of petroleum products (gasoline, kerosene, gasoil, light fuel oil, heavy fuel oil and LPG) to obtain a weighted average fuel price. The weights were based on the use of each petroleum product in the specific industry. Having the price (expressed in constant terms), the quantity of fuel was calculated.

For electricity we use the cost of electricity (to approximate the value of electricity in current prices), along with the average price of electricity per kWh by category (Domestic, Commercial, Industrial, Agriculture). Transforming the prices to be expressed in constant terms, along with the value of electricity, the quantity of electricity is calculated.

Finally, we derived the price index for materials (again using 2000 as the base year) using the following formula:

$$\mathrm{PM_{it}} = \frac{1}{\mathrm{SM_{it}}}\left\{\mathrm{PY_{it}} - \sum\nolimits_{\mathrm{z=K,L,F,E}} \mathrm{PZ_{it}}\,\mathrm{SZ_{it}}\right\}$$

where *S* are the output shares of each input, and the cost of raw materials (the value of raw materials in current prices) to obtain the quantity of raw materials.

The total cost was constructed using:

$$\mathrm{C_{it}} = \sum\nolimits_{\mathrm{z=K,L,M,E,F}} \mathrm{PZ_{it}QZ_{it}}$$

To obtain this information we collected data from the following official publications of the Statistical Service of Cyprus.

APPENDIX 2

TABLE A: SHORT RUN ELASTICITIES BY INDUSTRY (AVERAGE OVER TIME)

AGRICULTURE, HUNTING AND FORESTRY

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0035	-0.0110	0.0140	-0.0033	-0.0112
CAPITAL	-0.0008	-0.0360	0.0364	-0.0597	-0.0549
MATERIALS	0.0296	0.4082	-0.4315	0.5678	0.5841
ELECTRICITY	-0.0008	-0.0145	0.0154	-0.0188	-0.0206
FUELS	-0.0001	-0.0018	0.0019	-0.0026	-0.0027

MINING, QUARRYING

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0077	-0.0135	0.0155	-0.0297	-0.0101
CAPITAL	-0.0066	-0.0360	0.0348	0.0495	-0.0675
MATERIALS	0.0980	0.3811	-0.3876	-0.2247	0.6234
ELECTRICITY	-0.0020	-0.0079	0.0087	-0.0014	-0.0125
FUELS	-0.0002	-0.0013	0.0013	0.0011	-0.0023

ELECTRICITY, GAS AND WATER

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0111	0.0796	-0.0212	0.0164	-0.0279
CAPITAL	0.0237	-0.1497	0.0710	-0.0702	-0.0656
MATERIALS	-0.1141	0.6816	-0.4045	0.4646	0.5391
ELECTRICITY	0.0008	-0.0049	0.0033	-0.0073	-0.0021
FUELS	0.0003	-0.0021	0.0009	-0.0016	-0.0010

CONSTRUCTION

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0011	0.0052	-0.0030	0.0276	0.0135
CAPITAL	0.0025	-0.0441	0.0388	-0.1148	-0.0783
MATERIALS	-0.0148	0.3365	-0.3055	0.7876	0.5713
ELECTRICITY	0.0003	-0.0068	0.0062	-0.0152	-0.0115
FUELS	0.0001	-0.0013	0.0012	-0.0032	-0.0022

WHOLESALE, RETAIL TRADE

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0007	-0.0010	-0.0007	-0.1559	-0.0007
CAPITAL	0.0146	0.0265	0.0138	0.3367	0.0153
MATERIALS	-0.0932	-0.1702	-0.0877	-0.1241	-0.0981
ELECTRICITY	-0.0003	-0.0005	-0.0003	-0.0330	-0.0003
FUELS	0.0001	0.0001	0.0001	0.0036	-0.0001

HOTELS AND RESTAURANTS

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0050	-0.0094	0.0137	0.0005	-0.0072
CAPITAL	-0.0053	-0.0554	0.0578	-0.0867	-0.0850
MATERIALS	0.0622	0.4700	-0.5070	0.6747	0.6908
ELECTRICITY	-0.0002	-0.0063	0.0063	-0.0109	-0.0101
FUELS	-0.0001	-0.0010	0.0009	-0.0018	-0.0016

TRANSPORT AND COMMUNICATION

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0103	-0.0151	0.0225	-0.0125	-0.0158
CAPITAL	-0.0141	-0.0360	0.0485	-0.0530	-0.0463
MATERIALS	0.1614	0.3621	-0.4990	0.4874	0.4479
ELECTRICITY	-0.0020	-0.0056	0.0078	-0.0084	-0.0072

FUELS	-0.0003	-0.0008	0.0010	-0.0012	-0.0010

MANUFACTURING

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0047	0.0184	-0.0127	0.0125	0.0321
CAPITAL	0.0150	-0.0870	0.0690	-0.0869	-0.1434
MATERIALS	-0.0873	0.5740	-0.4707	0.6325	0.4355
ELECTRICITY	0.0010	-0.0093	0.0082	-0.0125	-0.0150
FUELS	0.0002	-0.0017	0.0014	-0.0022	-0.0027

SELECTED MANUFACTURING INDUSTRIES

FOOD, BEVERAGES AND TOBACCO

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.00023	-0.00001	-0.00024	-0.02742	0.08281
CAPITAL	0.00002	-0.00011	0.00016	0.00882	-0.02752
MATERIALS	-0.00152	0.00378	-0.00637	-0.37673	0.23108
ELECTRICITY	-0.00017	0.00026	-0.00050	-0.03457	0.09906
FUELS	0.00070	-0.00119	0.00225	0.14784	-0.45613

CHEMICALS, PETROLEUM RUBBER AND PLASTIC

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.00034	0.00096	-0.00044	-0.01291	-0.11735
CAPITAL	0.00010	-0.00065	0.00023	0.00562	0.00715
MATERIALS	-0.00368	0.01619	-0.00632	-0.16973	-0.77313
ELECTRICITY	-0.00029	0.00111	-0.00043	-0.01375	-0.03814
FUELS	0.00133	-0.00489	0.00197	0.05918	-0.27816

NON-METALLIC MINERAL PRODUCTS

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.00023	0.00004	-0.00052	-0.00078	0.00105
CAPITAL	0.00002	-0.00029	0.00035	0.00098	-0.00163
MATERIALS	-0.00174	0.00710	-0.01099	-0.02762	0.04351
ELECTRICITY	-0.00016	0.00043	-0.00075	-0.00183	0.00271
FUELS	0.00075	-0.00192	0.00348	0.00829	-0.01248

METAL PRODUCTS, MACHINERY AND EQUIPMENT

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.00022	0.00085	-0.00059	-0.16654	-0.02747
CAPITAL	0.00006	-0.00068	0.00033	0.05627	-0.02097
MATERIALS	-0.00195	0.01399	-0.00750	-0.45904	0.07462
ELECTRICITY	-0.00016	0.00091	-0.00051	-0.13629	-0.00403
FUELS	0.00071	-0.00386	0.00223	0.54097	-0.04649

OTHER MANUFACTURING INDUSTRIES

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.00030	0.00077	-0.00054	-0.00230	0.01245
CAPITAL	0.00009	-0.00045	0.00026	0.01366	-0.03311
MATERIALS	-0.00258	0.00922	-0.00569	-0.13580	0.44696
ELECTRICITY	-0.00024	0.00071	-0.00044	-0.01183	0.02876
FUELS	0.00096	-0.00280	0.00181	0.02541	-0.09206

TABLE B: LONG RUN ELASTICITIES BY INDUSTRY (AVERAGE OVER TIME)

AGRICULTURE, HUNTING AND FORESTRY

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0200	-0.0058	0.0336	-0.0025	-0.0052
CAPITAL	-0.0636	-0.2704	0.4623	-0.0442	-0.0859
MATERIALS	0.0807	0.2735	-0.4887	0.0467	0.0897
ELECTRICITY	-0.0189	-0.4489	0.6430	-0.0573	-0.1208
FUELS	-0.0645	-0.4129	0.6616	-0.0627	-0.1242

MINING, QUARRYING

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0443	-0.0494	0.1110	-0.0059	-0.0116
CAPITAL	-0.0780	-0.2710	0.4316	-0.0241	-0.0602
MATERIALS	0.0896	0.2618	-0.4389	0.0264	0.0627
ELECTRICITY	-0.1718	0.3720	-0.2545	-0.0043	-0.0523
FUELS	-0.0585	-0.5073	0.7060	-0.0381	-0.1053

ELECTRICITY, GAS AND WATER

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0644	0.1784	-0.1293	0.0025	0.0139
CAPITAL	0.4603	-1.1257	0.7720	-0.0148	-0.0991
MATERIALS	-0.1223	0.5335	-0.4581	0.0101	0.0402
ELECTRICITY	0.0947	-0.5276	0.5261	-0.0221	-0.0746
FUELS	-0.1612	-0.4930	0.6105	-0.0063	-0.0468

CONSTRUCTION

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0064	0.0191	-0.0168	0.0010	0.0032
CAPITAL	0.0300	-0.3318	0.3811	-0.0206	-0.0608
MATERIALS	-0.0174	0.2919	-0.3460	0.0189	0.0544
ELECTRICITY	0.1593	-0.8630	0.8919	-0.0463	-0.1474
FUELS	0.0778	-0.5889	0.6470	-0.0349	-0.1049

WHOLESALE, RETAIL TRADE

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0038	0.1097	-0.1056	-0.0009	0.0013
CAPITAL	-0.0057	-0.1990	-0.1927	-0.0014	0.0021
MATERIALS	-0.0041	0.1036	-0.0993	-0.0009	0.0013
ELECTRICITY	-0.9010	5.5392	-4.6706	-0.1003	0.1681
FUELS	-0.0041	0.1154	-0.1111	-0.0009	-0.0014

HOTELS AND RESTAURANTS

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0286	-0.0395	0.0705	-0.0007	-0.0019
CAPITAL	-0.0541	-0.4169	0.5323	-0.0192	-0.0449
MATERIALS	0.0794	0.4347	-0.5741	0.0191	0.0437
ELECTRICITY	0.0028	-0.6516	0.7641	-0.0330	-0.0864
FUELS	-0.0416	-0.6393	0.7823	-0.0307	-0.0748

TRANSPORT AND COMMUNICATION

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0593	-0.1062	0.1828	-0.0060	-0.0120
CAPITAL	-0.0874	-0.2708	0.4101	-0.0170	-0.0366
MATERIALS	0.1303	0.3645	-0.5651	0.0237	0.0490
ELECTRICITY	-0.0724	-0.3987	0.5520	-0.0254	-0.0580
FUELS	-0.0911	-0.3480	0.5073	-0.0219	-0.0486

MANUFACTURING

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0271	0.1129	-0.0988	0.0029	0.0108
CAPITAL	0.1066	-0.6539	0.6501	-0.0284	-0.0786
MATERIALS	-0.0733	0.5190	-0.5330	0.0249	0.0658
ELECTRICITY	0.0720	-0.6533	0.7163	-0.0380	-0.1013
FUELS	0.1858	-1.0780	1.0594	-0.0457	-0.1284

SELECTED MANUFACTURING INDUSTRIES

FOOD, BEVERAGES AND TOBACCO

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0005	0.0005	-0.0030	-0.0027	0.0057
CAPITAL	-0.0012	-0.0020	0.0074	0.0043	-0.0096
MATERIALS	-0.0005	0.0030	-0.0124	-0.0082	0.0181
ELECTRICITY	-0.0569	0.1663	-0.7358	-0.5667	1.1922
FUELS	0.1718	-0.5192	2.4045	1.6239	-3.6785

CHEMICALS, PETROLEUM RUBBER AND PLASTIC

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0007	0.0019	-0.0072	-0.0048	0.0107
CAPITAL	0.0020	-0.0123	0.0316	0.0182	-0.0395
MATERIALS	-0.0009	0.0044	-0.0123	-0.0071	0.0159
ELECTRICITY	-0.0268	0.1060	-0.3315	-0.2255	0.4773
FUELS	-0.2435	0.1348	-1.5100	-0.6253	-2.2433

NON-METALLIC MINERAL PRODUCTS

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0005	0.0004	-0.0034	-0.0025	0.0060
CAPITAL	0.0085	-0.0055	0.0139	0.0070	-0.0155
MATERIALS	-0.0011	0.0067	-0.0215	-0.0122	0.0281
ELECTRICITY	-0.0016	0.0186	-0.0539	-0.0299	0.0668
FUELS	0.0022	-0.0308	0.0850	0.0444	-0.1006

METAL PRODUCTS, MACHINERY AND EQUIPMENT

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0005	0.0012	-0.0038	-0.0027	0.0057
CAPITAL	0.0018	-0.0128	0.0273	0.0149	-0.0311
MATERIALS	-0.0012	0.0062	-0.0147	-0.0084	0.0180
ELECTRICITY	-0.3455	1.0617	-2.8497	-2.2343	4.3627
FUELS	-0.0570	-0.3956	0.1457	-0.0661	-0.3749

OTHER MANUFACTURING INDUSTRIES

	QUANTITY				
PRICE	**LABOR**	**CAPITAL**	**MATERIALS**	**ELECTRICITY**	**FUELS**
LABOR	-0.0006	0.0018	-0.0050	-0.0039	0.0078
CAPITAL	0.0016	-0.0086	0.0180	0.0116	-0.0226
MATERIALS	-0.0011	0.0049	-0.0111	-0.0073	0.0146
ELECTRICITY	-0.0048	0.2578	-0.2652	-0.1939	0.2049
FUELS	0.0258	-0.6247	0.8730	0.4714	-0.7424

APPENDIX 3: DETAILED RESULTS OF SIMULATIONS

Table A3-1: Change in input demand (%) by economic sector of Cyprus in the year 2020, for an increase in electricity prices in line with the 'baseline' scenario

Sector	Labor	Capital	Materials	Electricity	Fuels
Agriculture, hunting and forestry	-0.0105	-0.1830	0.1933	-0.2372	-0.2598
Mining and quarrying	-0.0246	-0.0999	0.1094	-0.0176	-0.1577
Electricity, Gas and Water	0.0103	-0.0611	0.0418	-0.0914	-0.0260
Construction	0.0040	-0.0854	0.0781	-0.1918	-0.1445
Wholesale, Retail Trade	-0.0037	-0.0058	-0.0037	-0.4155	-0.0038
Hotels and Restaurants	-0.0030	-0.0793	0.0793	-0.1367	-0.1272
Transport and Communication	-0.0247	-0.0705	0.0983	-0.1053	-0.0907
Manufacturing	0.0122	-0.1177	0.1033	-0.1574	-0.1893
Total Average	**-0.0042**	**-0.0870**	**0.0870**	**-0.1615**	**-0.1243**

Table A3-2: Change in input demand (%) by economic sector of Cyprus in the year 2020, for an increase in electricity prices in line with the 'high impacts' scenario

Sector	Labor	Capital	Materials	Electricity	Fuels
Agriculture, hunting and forestry	-0.0167	-0.2906	0.3071	-0.3768	-0.4128
Mining and quarrying	-0.0391	-0.1586	0.1738	-0.0280	-0.2505
Electricity, Gas and Water	0.0163	-0.0971	0.0664	-0.1452	-0.0412
Construction	0.0064	-0.1357	0.1241	-0.3048	-0.2296
Wholesale, Retail Trade	-0.0059	-0.0093	-0.0059	-0.6600	-0.0061
Hotels and Restaurants	-0.0048	-0.1260	0.1260	-0.2172	-0.2021
Transport and Communication	-0.0392	-0.1120	0.1561	-0.1672	-0.1441
Manufacturing	0.0194	-0.1870	0.1641	-0.2500	-0.3007
Total Average	**-0.0066**	**-0.1382**	**0.1382**	**-0.2566**	**-0.1974**

Table A3-3: Change in input demand (%) by manufacturing subsectors of Cyprus in the year 2020, for an increase in electricity prices

	Labor	Capital	Materials	Electricity	Fuels
I. Baseline scenario					
Food, Beverages and Tobacco	-0.0021	0.0033	-0.0063	-0.4352	1.2471
Chemicals, Petroleum Rubber, Plastic	-0.0037	0.0140	-0.0054	-0.1732	-0.4802
Non-Metallic Mineral Products	-0.0020	0.0054	-0.0094	-0.0230	0.0341
Metal products, Machinery, Equipment	-0.0020	0.0115	-0.0064	-1.7159	-0.0508
Other manufacturing industries	-0.0030	0.0089	-0.0056	-0.1489	0.3620
II. High Impacts scenario					
Food, Beverages and Tobacco	-0.0033	0.0052	-0.0100	-0.6913	1.9812
Chemicals, Petroleum Rubber, Plastic	-0.0058	0.0222	-0.0086	-0.2751	-0.7628
Non-Metallic Mineral Products	-0.0031	0.0086	-0.0149	-0.0365	0.0542
Metal products, Machinery, Equipment	-0.0032	0.0182	-0.0102	-2.7259	-0.0807
Other manufacturing industries	-0.0047	0.0141	-0.0089	-0.2366	0.5751

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