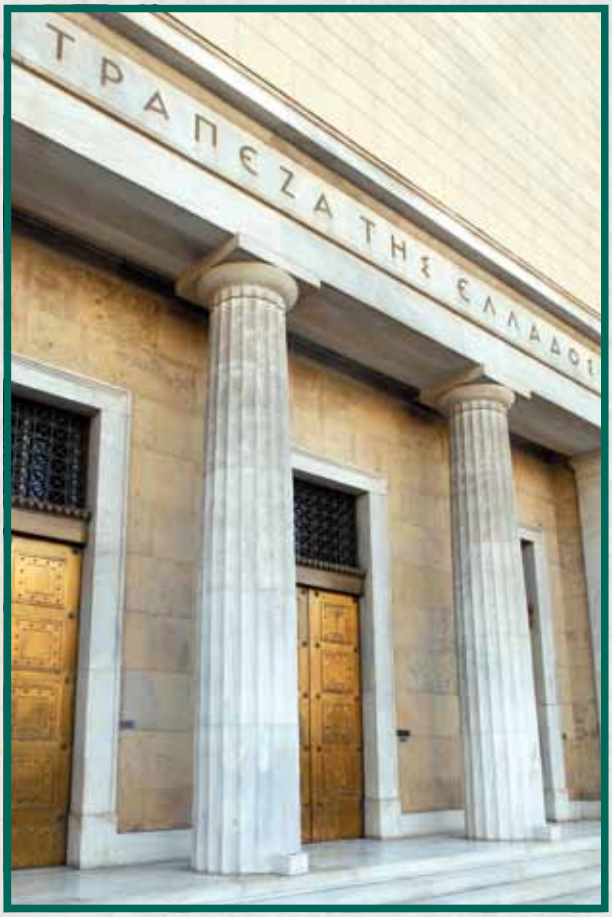
ECONOMIC BULLETIN

No 40

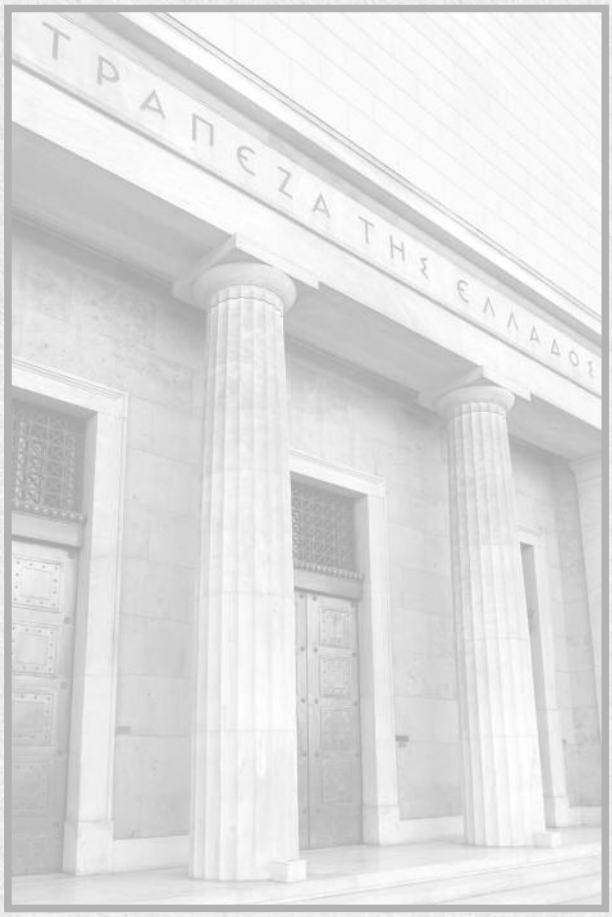


DECEMBER
2014

BANK OF GREECE
EUROSYSTEM

ECONOMIC BULLETIN

No 40



DECEMBER
2014

BANK OF GREECE
EUROSYSTEM

BANK OF GREECE
21, E. Venizelos Avenue
GR-102 50 Athens

www.bankofgreece.gr

Economic Analysis and Research Department - Secretariat
Tel. +30 210 320 2393
Fax +30 210 323 3025

Printed in Athens, Greece
at the Bank of Greece Printing Works

ISSN 1105 - 9729

CONTENTS

TAX BUOYANCY IN GREECE

Athanasios Tagkalakis[1]
Economic Analysis and Research Department

I INTRODUCTION

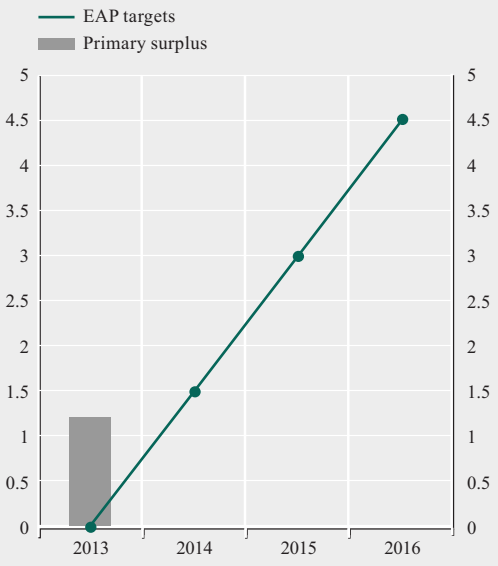
Greece has made substantial progress in recent years in putting its fiscal house in order. In 2013 a primary surplus (in Economic Adjustment Programme – EAP terms) amounting to 1.2% of GDP was achieved for the first time since 2002. Moreover, the primary balance improved by 11.0 percentage points in the period 2010-2013, despite the deepening recession. Nevertheless, significant fiscal challenges lie ahead given that Greece should meet increasing primary surplus goals in the period 2014-2016 —i.e. primary surpluses of 1.5% of GDP in 2014, 3.0% of GDP in 2015 and 4.5% of GDP in 2016— which should then be sustained at levels close to 4-4.5% for a number of years.

On the positive side, the economy is showing signs of stabilisation and a recovery is projected for 2014, while robust and accelerating growth and a narrowing of the output gap are projected for 2015-2016 (IMF 2014; European Commission 2014a and 2014b). This creates expectations of improved revenue performance in the years to come (which possibly exceeds current projections), contributing to the achievement of future fiscal targets. The source of such additional revenue can be found in the fact that revenue from total tax (or certain tax categories) increases at a rate which is faster than the increase in nominal GDP (or their respective tax base). This situation is described as tax buoyancy and refers to the increase in the tax revenue to GDP ratio without considering additional tax policy changes.

Given the demanding primary surplus goals for the years to come (see Chart 1), tax buoyancy gains are of utmost importance for Greece, as they will contribute to meeting future fiscal goals without continually resorting to new fiscal measures. However, before making a prediction for the materialisation of future tax

Chart 1 Primary surplus and Economic Adjustment Programme (EAP) targets

(% of GDP)



Source: Bank of Greece.

buoyancy effects, we have to examine the historical evolution of the relation between tax revenue and GDP. Chart 2 shows that the rate of change of the tax burden (the sum of direct and indirect taxes, social contributions and capital taxes) was larger than the rate of change of nominal GDP in the late 1990s and the early 2010s. During the first period, this was attributed to the fact that the tax burden rose at a faster rate compared to GDP. In the second period this was due to the fact that the tax burden declined at a slower rate compared to the GDP decline – this is explained by the EAP-driven tax policy changes.

On the contrary, in the 2000s both tax burden and nominal GDP increased at approximately the same rate, which led to a stabilisation of

1 The author would like to thank Heather Gibson, Dimitris Malliaropulos and Hiona Balfoussia for their very helpful comments and suggestions. The views in the paper are those of the author and do not necessarily reflect those of the Bank of Greece.

Chart 2 The evolution of nominal GDP and the tax burden

Source: Bank of Greece.
Note: The tax burden is the sum of social security contributions, direct, indirect and capital taxes.

the tax burden to GDP ratio. The extensive tax policy changes that took place in the period 2010-2013, coupled with the prospective faster output growth in the near future, could result in sizeable tax buoyancy effects.

In the current study we first evaluate the impact of cyclical economic conditions on VAT tax efficiency. Next, using updated data, we re-estimate the tax elasticity of Corporate Income Tax (CIT) and Personal Income Tax (PIT) revenues vis-à-vis the output gap.

The rest of the paper is organised as follows. The next two sections briefly discuss the factors that could lead to tax buoyancy effects and the different methodological approaches to studying them. The current analysis focuses on three revenue categories: Value Added Tax (VAT), Corporate Income Tax (CIT) and Personal Income Tax (PIT), which are discussed in three separate sections. The last section summarises the main findings and concludes.

2 THE DETERMINANTS OF TAX BUOYANCY EFFECTS

As pointed out by earlier studies (e.g. Sancak et al. 2010, Belinga et al. 2014) tax buoyancy effects depend on various factors. A non-exclusive list is the following:

- Buoyancy effects are larger for progressive taxes such as PIT. The more progressive the PIT tax scale, the more likely for PIT revenue to increase faster than its tax base in a boom. Furthermore, bracket-creeping effects can boost PIT revenue in periods of expansion.

- Buoyancy effects are smaller for regressive taxes, such as indirect taxes (e.g. necessities)[2] and social security contributions.

- VAT revenue increases at a faster pace in periods of expansion, because people consume more luxury and durable goods (compared to necessities) that are taxed at the top VAT rate.

- On the contrary, in bad economic times the share of necessities (that are taxed at the low VAT rate) in total consumption increases, which in turn dampens revenue performance.

- An economic recovery that goes hand in hand with a declining labour income share (or an increase in profit share) could lead to CIT revenue increasing faster than GDP growth (while PIT and social security revenue will increase at a lower rate compared to GDP).

- In times of recession coupled with liquidity shortages tax revenue falls on account of declining tax compliance and tax evasion problems (Brondolo 2009).[3]

2 Excise taxes (e.g. on alcohol, tobacco, gasoline etc.) do not vary automatically with GDP growth.
3 Property taxes are affected by changes in asset prices (e.g. house prices) and by changes in the volume of transactions. In the case of Greece, there is no 1:1 relationship between changes in asset prices and property taxes. This is due to the fact that the relevant tax base e.g., in the case of a house, is the objective price which is set by the tax administration and can differ substantially from the market price.

3 METHODOLOGICAL APPROACHES TO STUDYING TAX BUOYANCY EFFECTS

3.1 TAX BUOYANCY AND TAX EFFICIENCY

Earlier studies have employed various means of investigating the presence of tax buoyancy effects. IMF studies such as Sancak et al. (2010) look at tax efficiency as a way of analysing tax buoyancy effects.

Tax efficiency is the ratio of the revenue collected to the tax base, divided by the (representative) tax rate. In particular:

Tax efficiency = (tax revenue/tax base)/representative tax rate (1)

In the case of VAT, equation (1) becomes:

VAT Collection efficiency = (VAT revenue/private consumption)/standard VAT rate (2)

Re-arranging equation (2) we get:

*VAT Collection efficiency = VAT revenue/(Private consumption * standard VAT rate)* (3)

VAT Collection efficiency (C-efficiency) equals 1 when VAT revenue equals the product of the standard rate and private consumption, a situation that can only occur if 100% of private consumption is taxable (see Ebrill et al. 2001). Changes in the middle and lower VAT rates and exemptions are not fully reflected here.

Countries that have positive tax buoyancy show a tax efficiency that moves with the business cycle. Hence, in an upturn tax revenue increases at a faster rate compared to the tax base – and vice versa in a downturn. The output gap is considered to be the variable tracking closest the different states of the business cycle (a positive output gap implies good economic conditions, a negative output gap signals bad economic conditions).

The most important advantage of this approach is that it takes into account tax policy changes, as the representative tax rate is included in equation (1). Nevertheless, the entire structure of the tax system is not fully reflected in this tax efficiency measure. For example, in the case of VAT C-efficiency in equation (3) we use the standard VAT rate (currently at 23%). However, there are many exemptions in the VAT system in Greece (e.g. islands face lower rates), while several goods and services are taxed at the lower rate of 6.5%. These exemptions imply that the VAT C-efficiency measure will be low, irrespective of the state of the business cycle.

Despite this obvious disadvantage, the relatively simple structure of the VAT system (compared to the income tax systems) implies that tax efficiency measures can be employed in studying VAT-related buoyancy effects.

On the contrary this should be avoided in the case of personal and corporate income taxes, because that tax system is far more complex. In these cases other approaches are preferable when studying PIT and CIT buoyancy effects.

3.2 OTHER APPROACHES

A recent IMF study (Belinga et al. 2014) estimates short- and long-run tax buoyancy by examining the relationship between tax revenue and nominal GDP. Their sample comprises 34 OECD countries covering the period between 1965 and 2012. The approach adopted by Belinga et al. (2014) does not fully reflect the extensive tax policy and tax administration changes that took place in Greece in recent years.

Earlier OECD studies, such as Van den Noord (2000) and Girouard and André (2005), examine the relationship between tax revenue and the state of the business cycle. These studies consider that the state of the business cycle is better measured by the output gap concept, rather than the real or nominal GDP growth rate. This is due to the fact that an economy might be growing, but still facing a negative output gap – which implies that the economy

is operating below its potential. Consequently tax revenue might be increasing, while remaining below its potential level.

The two OECD studies calculate tax elasticities with respect to the output gap, which are then used to calculate the cyclically adjusted fiscal position of an economy and to evaluate its fiscal stance. These tax elasticities are calculated as follows:

- First, we estimate the elasticity of each tax revenue component vis-à-vis each tax base, and

- Second, we estimate the elasticity of each tax base to the output gap.

The product of these two is the elasticity of a certain tax revenue category to the output gap. A tax elasticity above 1 implies that the narrowing of the output gap by one percentage point leads to a more than 1:1 increase in tax revenue, paving the way for the likely presence of buoyancy effects.

However, the OECD methodology has some limitations in the case of Greece. In particular:

- First, the PIT tax elasticities are considered to be outdated. Girouard and André (2005) relied on the 2003 tax system, while Van den Noord (2000) relied on the 1996 tax system.

- Second, Girouard and André (2005) used euro area average figures for the PIT tax elasticity in Greece, because their econometric analysis returned implausible estimates. Despite the fact that we would not expect Greece to divert systematically from other euro area countries, the recent sovereign debt crisis revealed that idiosyncratic, country-specific factors should be taken into account.

Following the above discussion we update the OECD estimates for Greece by employing the latest available data set – which incorporates the impact of the policy changes that have been undertaken in recent years. These updated PIT and CIT tax elasticities will be used for the investigation of tax buoyancy effects.

4 EVIDENCE OF VAT-RELATED BUOYANCY EFFECTS

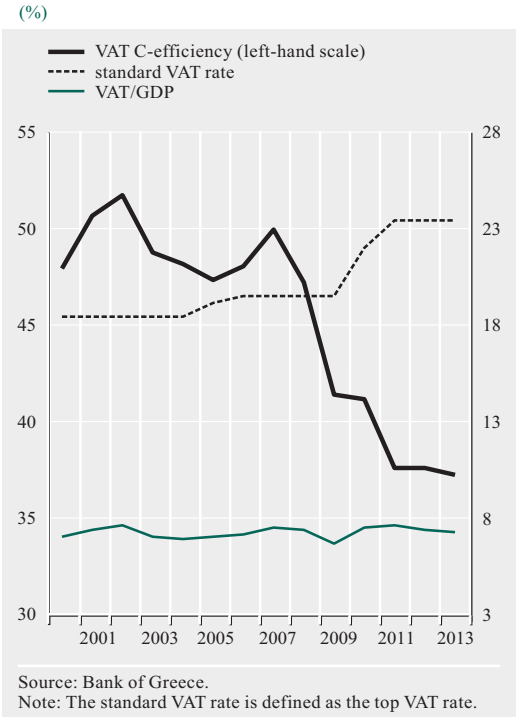
In this section we investigate the determinants of VAT tax efficiency (see equation 3) as a way of understanding whether tax buoyancy effects are likely in VAT revenue.

VAT rate hikes played a prominent role at the beginning of the fiscal consolidation effort in 2010-2011.[4] Nevertheless, the successive increases in VAT rates did not bring about a higher VAT to GDP ratio (see Chart 3). Meanwhile, the collection efficiency of VAT has deteriorated dramatically in recent years, i.e. from about 50% in 2007 it declined to about 41% in 2009-2010 and further down to 38% in 2011-2013. This downward course has decelerated recently.

Several studies (see Sancak et al. 2010, Bank of Greece 2013b, 2014b, OECD 2013 and Tagkalakis 2014b) have pointed out that VAT collection efficiency varies across the business cycle (see Charts 4 and 5). This could be related to behavioural changes by consumers, who increase consumption of necessities (that carry a lower VAT rate) in particular during recessions. In addition, during difficult economic times, characterised by low economic confidence and liquidity constraints, tax compliance deteriorates and tax evasion problems are exacerbated (IMF 2013, Poghosyan 2011, Brondolo 2009, Sancak et al. 2010). The tax evasion and avoidance problems become more

4 There have been a series of VAT rate changes over the Economic Adjustment Programme in particular in 2010-2011. For example, in 2010 Q1 VAT rates were raised to 21%, 10% and 5% from 19%, 9% and 4.5% respectively, in effect since 2005. In 2010 Q2 the rates increased to 21%, 11% and 5.5%. In 2010 Q3 the top rate was raised to 23%. In 2011 Q1 the middle and lower rates came to 13% and 6.5%, and from 2011 Q3 the higher rate of 23% became applicable to a wider range of products, i.e. catering and restaurant services (food and drinks that were previously taxed at 13%). However, since 1 August 2013, catering and restaurant services were transferred back to the middle VAT rate of 13% (see Bank of Greece 2010-2014).

Chart 3 VAT C-efficiency

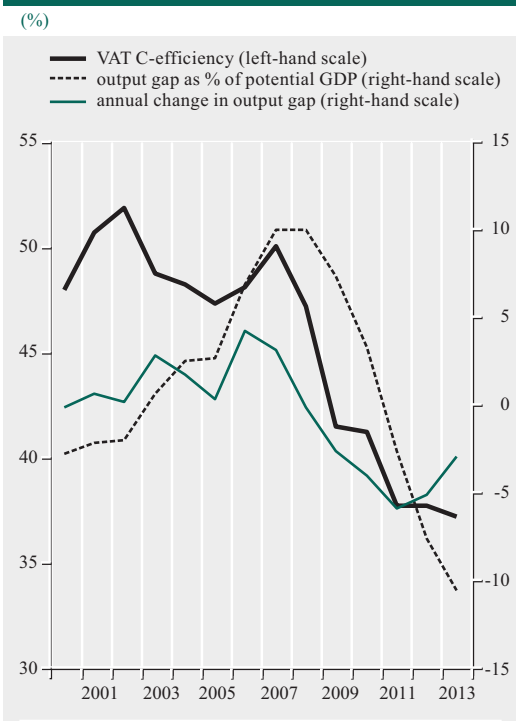


Source: Bank of Greece.
Note: The standard VAT rate is defined as the top VAT rate.

Chart 4 VAT C-efficiency and growth rate

Source: Bank of Greece.

Chart 5 VAT C-efficiency and output gap



Source: Bank of Greece.

pronounced in the case of weak tax administration.

4.1 DATA AND METHODOLOGY

We use quarterly data on VAT revenue, private consumption and GDP over the period 2000:Q1-2013:Q4. Following earlier IMF studies we investigate the effect of cyclical economic activity on VAT C-efficiency. More specifically, we estimate the following equation (4):[5]

$$\Delta log(VAT\ C\text{-}efficiency)t = \alpha + \beta^{*}\Delta(economic\ activity)t + \gamma^{*}Other\ control\ variables + \varepsilon_t \quad (4)$$

In order to avoid the impact of seasonal factors, annual changes are examined, e.g.: Δlog (VAT C-efficiency)t = log (VAT C-efficiency)t - log (VAT C-efficiency)t-4. Coefficient β, which measures the change in VAT C-

5 Using OLS (with robust standard errors).

efficiency following a change in economic conditions, will be used in the following sections for the examination of possible tax buoyancy effects.

The key issue in estimating equation (4) is finding the appropriate economic activity indicator that reflects the gap of current economic conditions from potential output. For annual data the natural candidate is the output gap, which is the difference between real GDP and the potential output of the economy calculated by means of the production function (PF) approach. Unfortunately, in the case of quarterly data there is no estimate of the potential output calculated by the PF approach, making it difficult to have a reliable quarterly estimate of the output gap.[6] In order to address this challenge three proxy variables reflecting economic conditions are constructed in Annex A and are considered in equation (4).

We examine several variants of equation (4) considering other control variables. First, we add the "EAP" dummy variable (equal to 1 from 2010 Q2 onwards, 0 otherwise), which captures the period during which Greece is under joint EU-IMF surveillance. During that period Greece had to take several measures to improve revenue administration and to fight tax evasion.

Second, we add three dummy variables:

- d2010 equal to 1 from 2010Q2 on, 0 otherwise;
- d2011 equal to 1 from 2011Q1 on, 0 otherwise;
- d2012 equal to 1 from 2012Q1 on, 0 otherwise; and
- d2013 equal to 1 from 2013Q1 on and 0 otherwise.

These four dummy variables control for permanent policy measures initiated in 2010, 2011, 2012, and 2013, respectively, i.e. it is assumed that each of the policy changes in 2010, 2011 and 2012 have a carry-over effect in subsequent years.

Building on earlier studies we also investigate the effect of possible shifts in consumption patterns (Sancak et al. 2010), as well as the effect of the ability to fight tax evasion (Tagkalakis 2013). We take into account possible shifts in consumption patterns by including the year-on-year difference of the share of necessities in total household consumption.[7] We account for the fight against tax evasion by incorporating in the analysis the log of the number of VAT-related audits that have been concluded in recent years.[8]

4.2 FINDINGS

The findings are reported in Tables 1-3. A 1 percentage point (p.p.) increase in the first economic conditions (output gap) proxy (based on potential GDP) increases VAT C-efficiency by about 0.70% (Table 1, column 1). After controlling for the EAP and the d2010-d2013 dummy variables the coefficient estimate of the quarterly output gap proxy increases above 1, i.e. to about 1.17% in columns 2 and 3 of Table 1. Taking into account the effect of the shift in consumption patterns towards necessities (columns 4-6) the coefficient estimate of the economic conditions proxy shows a slight variability compared to columns 1-3, but overall the effect is not substantially different.

When we take into account both VAT-related audits and shifts in consumption patterns, the output gap coefficient estimate is about

6 Actually, we could calculate potential output by means of the production function using quarterly data, but this approach is avoided by international organisations because of the high variability/volatility of data and seasonal fluctuations.

7 Necessity goods are: food and non-alcoholic beverages, housing, water, electricity, gas and other fuels.

8 These data are available at the General Secretariat of Information Systems (GSIS) website and cover the period 2012-2013. Due to the limited data availability and in order to make use of the tax audit data in our estimation, we resort to the assumption that prior to 2012 there were no targeted VAT-related tax audits. This simplifying assumption possibly underestimates the importance of tax audits and caution should be exercised in assessing their impact.

Table 1 VAT C-efficiency and the output gap (on the basis of potential GDP)

	1	2	3	4	5	6	7	8
Dependent variable	Δlog (VAT C-efficiency)							
Δ(output gap)	0.701 (2.321)**	1.174 (1.84)*	1.168 (1.62)	0 .641 (2.09)**	1.311 (2.00)*	1.123 (1.64)	1.019 (3.23)***	1.212 (1.87)*
EAP		0.047 (0.99)			0.069 (1.30)			0.0247 (0.46)
D2010			0.046 (0.78)		0.039 (0.72)			
D2011			-0.045 (-1.43)		-0.036 (-1.12)			
D2012			0.095 (1.95)*		0.094 (2.06)**			
D2013			-0.050 (-0.96)		0.018 (0.41)			
Δ(share of necessities)				-0.267 (-2.03)**	-0.404 (-2.25)**	-0.601 (-3.22)***	-0.5199 (-3.34)***	-0.538 (-2.96)***
log(VAT audits)							0.0115 (2.61)**	0.0101 (2.61)**
Constant	-0.015 (-1.52)	-0.0256 (-1.43)	-0.025 (-1.34)	-0.0164 (-1.64)	-0.032 (-1.71)*	-0.033 (-1.69)*	-0.0294 (-2.41)**	-0.034 (-1.74)
R^2	0.0966	0.1259	0.1820	0.12354	0.1810	0.2613	0.2476	0.2530
N	52	52	52	52	52	52	52	52

Note: OLS with robust typical errors. ***, **, * statistically significant at 1%, 5% and 10% respectively (t-statistics into parentheses).

Table 2 VAT C-efficiency and the output gap (on the basis of the HP trend of real GDP)

	1	2	3	4	5	6	7	8
Dependent variable	Δlog (VAT C-efficiency)							
Δ(output gap)	1.003 (1.91)*	0.941 (1.71)*	0.902 (1.30)	1.32 (2.35)**	1.387 (2.08)**	1.060 (1.52)	1.3491 (2.45)**	1.161 (1.73)*
EAP		-0.0143 (-0.63)			0.0081 (0.30)			0.029 (-0.96)
D2010			-0.006 (-0.19)			-0.006 (-0.19)		
D2011			-0.054 (-1.79)*			-0.044 (-1.42)		
D2012			0.089 (1.85)*			0.087 (1.91)*		
D2013			-0.047 (-0.88)			0.024 (0.55)		
Δ(share of necessities)				-0.497 (-3.32)***	-0.532 (-2.33)**	-0.685 (-2.91)***	-0.659 (-3.32)***	-0.620 (-2.72)**
log(VAT audits)							0.006 (1.60)	0.009 (2.27)**
Constant	-0.018 (-1.74)*	-0.0140 (-1.01)	-0.014 (-0.96)	-0.019 (-1.92)*	-0.022 (-1.41)	-0.023 (-1.46)	-0.027 (-2.25)**	-0.023 (-1.46)
R^2	0.0711	0.0777	0.1283	0.1597	0.1617	0.2301	0.2033	0.2165
N	52	52	52	52	52	52	52	52

Note: OLS with robust typical errors. ***, **, * statistically significant at 1%, 5% and 10% respectively (t-statistics in parentheses).

Table 3 VAT C-efficiency and growth (ΔLog (real GDP))

	1	2	3	4	5	6	7	8
Dependent variable	Δlog (VAT C-efficiency)							
Δlog (output gap)	0 .497 (2.26)**	1.007 (1.76)*	0.995 (1.59)	0.438 (1.89)*	1.018 (1.81)*	0.870 (1.44)	0.741 (3.08)***	0.942 (1.68)*
EAP		0.066 (1.12)			0.079 (1.28)			0.033 (0.53)
D2010			0.061 (0.90)			0.047 (0.72)		
D2011			-0.042 (-1.34)			-0.035 (-1.11)		
D2012			0.095 (1.94)*			0.095 (2.05)**		
D2013			-.0468 (-0.91)			0.016 (0.33)		
Δ(share of necessities)				-0.225 (-1.59)	-0.315 (-2.07)**	-0.519 (-2.96)***	-0.450 (-2.96)***	-0.456 (-2.88)***
log (VAT audits)							0.012 (2.65)**	0.010 (2.59)**
Constant	-0.020 (-1.87)*	-0.039 (-1.59)	-0.039 (-1.47)	-0.020 (-1.93)*	-0.044 (-1.74)*	-0.043 (-1.63)	-0.036 (-2.75)***	-0.044 (-1.73)*
R^2	0.0956	0.1429	0.1998	0.1139	0.1772	0.2573	0.2417	0.2504
N	52	52	52	52	52	52	52	52

Note: OLS with robust typical errors. ***, **, * statistically significant at 1%, 5% and 10% respectively (t-statistics into parentheses).

1.019% (column 7) and increases to 1.212% (column 8) when we include the EAP dummy. Overall, if the output gap closes by 1 p.p., the VAT C-efficiency ratio will increase by about 0.29 p.p. to 0.55 p.p. (which corresponds, respectively, to the 0.641% and 1.212% estimates in columns 4 and 8).[9]

It is worth highlighting that an increase in the share of necessities, which are usually taxed at the lower VAT rate, reduces VAT collection efficiency (see columns 4-8). On the contrary, an increase in the number of tax audits exerts a positive effect on VAT C-efficiency (see columns 7-8).

Table 2 presents the findings for the second output gap proxy which is based on the HP trend of real GDP. In this case there is a more pronounced positive association between VAT C-efficiency and economic conditions. Similar evidence is reported in Table 3 based on the third economic conditions proxy (i.e. the real GDP growth rate).

The evidence presented in Tables 1-3 becomes weaker (the statistical significance of the coefficients declines) when taking into account permanent policy initiatives (other than top VAT rate changes) captured by the four dummy variables. However, the conclusions are qualitatively the same. Interestingly, the policy initiatives undertaken in 2012 (or when the Economic Adjustment Programme got back on track over the second half of 2012) exerted a positive effect on VAT C-efficiency.

Overall, a 1% increase in real GDP raises VAT C-efficiency by about 0.20 p.p. to 0.43 p.p. (which correspond, respectively, to the 0.438% and 0.942% estimates in columns 4 and 8 of Table 3).[10]

9 The calculations are based on the sample average VAT C-efficiency ratio of 45.4%. Using the 2011-2013 average of VAT C-efficiency of 37.5% the incremental change is, respectively, 0.24 p.p. and 0.45 p.p.

10 The calculations are based on the sample average VAT C-efficiency ratio of 45.4%. Using the 2011-2013 average of VAT C-efficiency of 37.5% the incremental change is, respectively, 0.16 p.p. and 0.35 p.p.

4.3 A BACK OF THE ENVELOPE CALCULATION OF THE LIKELY GAINS FROM BUOYANCY

We now use some of the abovementioned estimates to better understand the impact of buoyancy effects on VAT revenue. Specifically, we use the VAT C-efficiency elasticities 0.44% (low value) and 0.94% (high value) estimated when the variable of interest is output growth (Table 3) and the VAT C-efficiency semi-elasticities 0.64% (low value) and 1.21% (high value) when the variable of interest is the output gap proxy in Table 1.

In order to calculate the likely VAT buoyancy gains over the period 2014-2016 we rely on the following realised data for 2013 regarding VAT C-efficiency, the ratio VAT revenue/private consumption (or effective VAT rate), as well as on the IMF (2013) and European Commission (2014a) assumptions for 2014-2016 as regards the narrowing of the output gap, real GDP growth and change in private consumption. The back of the envelope exercise relies on the assumption that the top VAT rate of 23% will remain unchanged over the period 2014-2016.

The back of the envelope exercise is conducted as follows:

- By multiplying the estimated semi-elasticities (elasticities) with the projected narrowing of the output gap (change in output growth) in 2014 we obtain the following: $\beta^{*}(\Delta(\text{output gap})_{2014}$ *and* $\beta^{*}(\text{GDP growth rate})_{2014}$.
- The above calculation returns the change in VAT C-efficiency in 2014: $\Delta(\text{VAT C-efficiency})_{2014}$ {based on output gap} and $\Delta(\text{VAT C-efficiency})_{2014}$ {based on real GDP growth}.
- Using the abovementioned value and the actual level of VAT C-efficiency in 2013 we obtain the estimated VAT C-efficiency level in 2014.
- Assuming that the standard VAT rate of 23% will not change in the period under examination we use the following relation: *VAT C-efficiency (2014) = (VAT revenue/private consumption)/23%* in order to calculate the ratio: *VAT revenue/private consumption (effective VAT rate)* for 2014.
- Next, using the private consumption and VAT revenue data for 2013, the projection for the evolution of private consumption in 2014 and the estimated effective VAT rate in 2014, we obtain a projection for the VAT revenue in 2014.
- By repeating the same procedure, we obtain projections for the VAT revenue in 2015-2016.

Table 4 summarises the findings regarding the evolution of VAT C-efficiency and the effective VAT rate in 2014-2016. The projections based on the output gap proxy are presented in columns 1 and 3, while the projections based on output growth are shown in columns 2 and 4. The values reported in Table 4 are the aver-

Table 4 VAT C-efficiency and effective VAT rate (annual averages of low and high elasticities and semi-elasticities)

	1	2	3	4
Year	Effective VAT rate (on the basis of the output gap)	Effective VAT rate (on the basis of the growth rate)	VAT C-efficiency (on the basis of the output gap)	VAT C-efficiency (on the basis of the growth rate)
2013	8.56%	8.56%	37.22%	37.22%
2014	8.65%	8.60%	37.62%	37.37%
2015	8.86%	8.77%	38.53%	38.12%
2016	9.06%	8.99%	39.41%	39.10%

Table 5 VAT C-efficiency (cumulative VAT revenue for 2014-2016)

Dependent variable	On the basis of the growth rate (billion euro)	On the basis of the growth rate (as % of 2013 GDP)	On the basis of the output gap (billion euro)	On the basis of the output gap (as % of 2013 GDP)
Mean	0.9	0.52%	1.0	0.58%
Low	0.7	0.39%	0.8	0.45%
High	1.2	0.65%	1.3	0.70%

ages of the estimates on VAT C-efficiency (and the effective VAT rate) based on the low and high values of the semi-elasticities (elasticities) that were employed in the back of the envelope exercise.

Based on the abovementioned exercise, we find that the prospective improvement in economic conditions in 2014-2016 will increase the VAT C-efficiency. The cumulative revenue gains are estimated to be, on average, around 0.91-1.0 billion euro or 0.52-0.58% of 2013 GDP (see Table 5). Using the high values of the estimated elasticities the revenue gains could reach about 1.3 billion euro or 0.7% of 2013 GDP, while based on the low values the revenue gains will amount to about 0.7 billion euro or 0.39% of 2013 GDP (see Table 5).

The likely gains from the improvement in the tax administration and the fight against tax evasion (which raises VAT C-efficiency) are not reflected here. The same applies for a likely reversal in consumption patterns away from necessities. These two factors could yield additional gains in terms of VAT revenue.

The share of necessities in total household consumption reached 29.0% in 2013 vis-à-vis a pre-crisis level of 26.0% in 2007. A continuation of this trend will be harmful for VAT revenue given that these goods are taxed at the low VAT rate. However, the projected improvement in economic conditions, to the extent that it is accompanied by higher employment, increases in wages and lower unemployment, could stop this trend and eventually lead to higher VAT revenue.

Moreover, the return to growth and the resolution of uncertainty will increase consumer confidence. This in turn will increase the consumption of durable goods that was postponed during the crisis. As these goods are taxed at the top VAT rate, this composition effect will boost VAT revenue performance.[11] All in all, the economic recovery is projected to have positive direct and indirect (composition) effects on future VAT revenue.

4.4 EVALUATION OF THE TAX BUOYANCY EFFECTS

In order to evaluate the impact of our estimates on future VAT revenue we consider as a baseline scenario the OECD findings, i.e. that the elasticity of VAT revenue with respect to the output gap is 1 (Girouard and André 2005).[12]

We then assume that the projected VAT revenue for 2014-2016 can be decomposed into two components. The first is driven by economic conditions (i.e. the prospective narrowing of the output gap) and the second is driven by other reasons, including tax policy changes. The simple back of the envelope exercise that we discuss below places emphasis on the first part and compares the additional revenue generated in the baseline scenario vis-à-vis the alternative scenario (which rely on the estimates reported in Table 5).

11 By employing the previous methodology and estimates from Table 1 (output gap on the basis of the production function) one can estimate that, if the share of necessity goods in total household consumption drops to 2007 levels by 2016, then total tax gains in 2014-2016 could even come to €1.6 billion (from €1.3 billion).

12 In practice Girouard and André (2005) consider total indirect taxes. However, it is considered that no significant differentiation will emerge when only VAT revenue is examined.

To calculate the additional VAT revenue of the period 2014-2016 we rely on the GDP and output gap projections of the European Commission (2014b) and the IMF (2014). Specifically, the output gap is projected to narrow by 1.13 p.p. in 2014, 2.59 p.p. in 2015 and 2.43 p.p. in 2016. In addition, VAT rates are assumed to remain unchanged over the projection period.

Following the back of the envelope exercise described in Annex B we calculate that in the baseline scenario the VAT revenue gains (compared to the 2013 levels) are projected to be about 0.8 billion euro (or 0.42% of GDP) over the period 2014-2016. However, as reported in Table 5, the alternative scenario that assumes improvements in VAT C-efficiency can lead to revenue gains that amount to 1.3 billion euro (or 0.7% of GDP) over the projection period.

Using the nominal GDP projections of the aforementioned IMF and EC studies we find that the implied estimated elasticity of VAT revenue with respect to GDP can reach, on average, up to 1.2-1.3 (vis-à-vis 0.8 in the baseline scenario) over the period 2014-2016.[13] Hence, assuming unchanged VAT rates, the VAT to GDP ratio is projected to increase in 2015-2016 in relation to 2013 levels. It should be noted that the Bank of Greece had underlined a possible increase in indirect tax elasticity to GDP to levels higher than 1 (see Bank of Greece 2013b and Tagkalakis 2014a).

4.5 CONCLUSIONS

The main conclusions that come out of the analysis are the following: the economic recovery in 2014 and prospective acceleration of growth in 2015-2016 are expected to boost VAT collection efficiency. The cumulative revenue gains are projected to reach up to 1.3 billion euro in the period 2014-2016, i.e. about 0.5 billion euro above revenue gains in the baseline scenario.

By employing the nominal GDP projections of the IMF and EC we find that the implied elasticity of VAT revenue to GDP is projected to be 1.2-1.3 on average in the period 2014-2016 (compared to 0.8 in the baseline scenario).[14] This implies that, with unchanged VAT rates, the VAT to GDP ratio is projected to increase in 2015-2016 compared to its 2013 levels.

Additional revenue gains could be realised from a likely shift in consumption patterns away from necessities, as well as from improvements in tax administration that contribute to the fight against tax evasion. Of course it should be mentioned that the low VAT C-efficiency in Greece vis-à-vis its OECD peers is also affected by numerous exemptions (reduced rates etc.) from the standard VAT rate. A rationalisation of the VAT system is therefore required (see IMF 2014; OECD 2013) in order to improve its collection efficiency.

5 TAX BUOYANCY IN CORPORATE INCOME TAX REVENUE

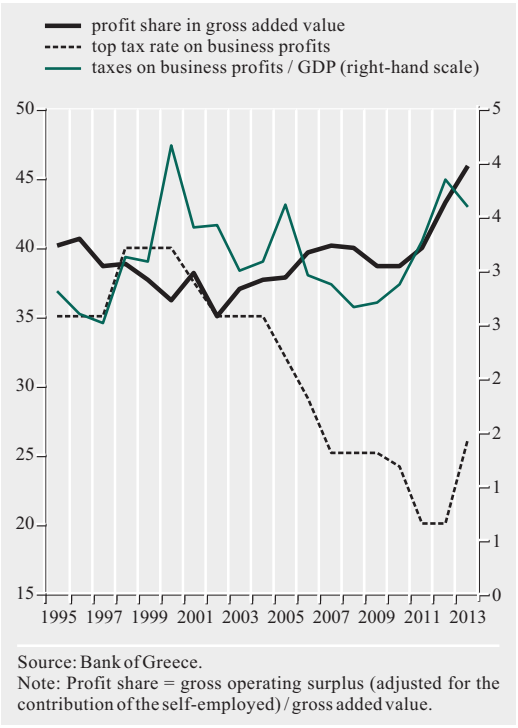
Belinga et al. (2014) investigate the presence of tax buoyancy effects in 34 OECD countries (over the period 1965-2012) and find significant evidence of buoyancy effects, in particular in corporate income taxes (CIT).[15] A possible explanation put forward is that CIT is a good automatic stabiliser in the short run, as well as that CIT revenue shows strong buoyancy effects in the long run due to the decreasing labour income share in past decades. This trend decline in the labour income share (or the increase in the capital income share) might have been much faster in countries following EU-IMF programmes (e.g. Greece) due to the significant part of fiscal measures targeting labour-income (and the high unemployment rates).

13 Belinga et al. (2014) examine 34 OECD countries (period 1965-2012), and find an elasticity of 0.92 in the short run and 0.98 in the long run (see Table 3, p. 14 of the article).

14 Taking into account the possible revenue gains from the shift of consumption patterns away from necessity goods and a return to pre-crisis levels by 2016, additional VAT revenue (against the baseline scenario) could come up to €800 million and the implied elasticity would end up close to 1.5.

15 According to Belinga et al. (2014) the elasticity of corporate income tax revenue to GDP is estimated to be 1.96 in the short run and 1.26 in the long run (see Table 3, p. 14 of the article).

Chart 6 Profit share and taxes on business profits to GDP



Source: Bank of Greece.
Note: Profit share = gross operating surplus (adjusted for the contribution of the self-employed) / gross added value.

Chart 6 shows that in recent years the share of corporate income taxes as a percentage of GDP moves closely together with the profit share, as well as that the profit share has increased in the course of the crisis in Greece.

Driven by the abovementioned findings we investigate whether there is any evidence of buoyancy effects in CIT in Greece by following the approach adopted in the seminal work by Girouard and André (2005). In particular, first we estimate the elasticity of corporate income taxes to profit share (gross operating surplus/gross value added); and second, we estimate the relationship between the profit share and the output gap. The product of these two elasticities returns the elasticity of CIT revenue with respect to the output gap, which will be used for the evaluation of tax buoyancy effects.

According to OECD work by Girouard and André (2005) the elasticity of corporate income taxes to the output gap was estimated to be 1.08 in Greece vis-à-vis 1.5 in the OECD, while earlier work by Van den Noord (2000) reports an elasticity of 0.9. Based on these findings there is limited evidence of buoyancy effects in Greece.

5.1 DATA AND METHODOLOGY

We use quarterly data on CIT revenue, profit share, real GDP and potential GDP over the period 2000:Q1-2013:Q4.[16] Along the lines of Girouard and André (2005) we calculate the elasticity of CIT taxes to output gap as the product of two elasticities:

*Elasticity of CIT taxes to output gap = Elasticity of CIT taxes to profit share * Elasticity of profit share to output gap* (5)

We regress by means of OLS:[17]

$$\Delta log(CIT)t = \alpha_1 + \beta_1 * \Delta log(Profit\ share)_{t-4} + \gamma_1 * \Delta(Top\ Corporate\ Income\ Tax\ Rate)\ t + D2010 + D2011 + D2012 + D2013 + \varepsilon_t \quad (6)$$

We focus on the year-on-year rather than on the quarter-on-quarter growth rate in order to avoid seasonal effects, i.e. $\Delta log(CIT)_t = logCIT_t - logCIT_{t-4}$. The profit share is the gross operating surplus (adjusted for the imputed contributions of the self-employed) over gross value added (GVA). Alternatively, we also considered two variant definitions where the nominator is gross operating surplus (total economy) and gross operating surplus (corporations). Moreover, we also considered the case with GDP being in the denominator instead of GVA.

The coefficient β_1 *captures the elasticity of CIT to profit share*. It should be noted that we consider the fourth lag $\Delta log(Profit\ share)_{t-4}$ of the profit share rather than the contemporaneous value because it gave more reasonable esti-

16 ELSTAT, European Commission and IMF data. The top corporate tax rate on undistributed profits is taken from the OECD database (see OECD 2014 and European Commission 2014c).
17 With robust standard errors.

mates, indicating the presence of a particular lag structure in the payment of corporate income taxes.

To control for tax policy changes we incorporate the annual change in the top CIT rate on undistributed profits (26% in 2013). To control for these we add the four dummy variables: D2010, D2011, D2012, D2013 considered before.

Building on the abovementioned studies we estimate the relationship between the profit share and the output gap as follows:[18]

$$\Delta log(Profit\ share)t = \alpha_2 + \beta_2 * \Delta(output\ gap)\ ^{19}{}_t + \Sigma^{N=4}_{i=1}\ \gamma_{2i} * \Delta(output\ gap)_{t-i} + \delta_2 * \Delta(output\ gap)_{t+1} + \varepsilon_t \quad (7)^{20}$$

The coefficient β_2 *is the elasticity of profit share to output gap. In this estimation we use four lags (t-1 to t-4) and one lead (t+1) of the year-on-year change of the output gap*.[21]

The key issue in estimating equation (7) is finding the appropriate economic activity indicator that reflects the gap of current economic conditions from potential output (output gap). To this end we employed the three proxy variables presented in Annex A.

5.2 FINDINGS

The estimates for equations (6) and (7) are reported in Tables 6 and 7, respectively. As shown in Table 1, after controlling for the D2010-D2013 dummy variables an increase in the profit share (at time t-4) can boost CIT revenue (at time t). The value of the elasticity varies depending on the definition of the profit share. When we use the gross operating surplus of the total economy in constructing the profit share, the elasticity is 1.508, while it marginally declines to 1.502 when we use the gross operating surplus of corporations. It declines further down to 0.956 when we use the gross operating surplus adjusted for the imputed contribution of the self-employed to construct the profit share.

18 By means of OLS (with robust standard errors).
19 Alternatively, instead of Δ(output gap) we have used Δlog[(real GDP)/(potential GDP)]. The findings are qualitatively and quantitatively similar.
20 We use Δlog(real GDP) when we consider real GDP instead of the output gap.
21 See Blanchard and Perotti (2002) for a similar exercise.

Table 6 Corporate Income Tax and the profit share in Gross Value Added (GVA)

	1	2	3
	Δlog(CIT)		
Dependent variable	Profit share = gross operating surplus (total economy) / GVA	Profit share = gross operating surplus (adjusted for the contributions of the self-employed) / GVA	Profit share = gross operating surplus (corporate) / GVA
Δlog (profit share) t-4	1.508 (2.23)**	0.956 (3.21)***	1.503 (5.71)***
D2010	-0.009 (-0.14)	0.012 (0.20)	0.044 (0.69)
D2011	-0.004 (-0.05)	-0.0038407 (-0.05)	-0.108 (-1.29)
D2012	0.0614 (0.64)	0.0337 (0.36)	0.150 (1.82)*
D2013	-0.234 (-2.00)**	-.258 (-2.29)**	-0.174 (-1.83)*
Δ (upper tax rate)	-0.575 (-0.53)	-0.224 (-0.21)	-2.088 (-3.07)***
Intercept	0.024 (1.42)	0.017 (1.14)	-0.174 (-1.37)
R^2	0.2996	0.3351	0.5138
N	48	48	48

Note: OLS with robust typical errors. ***, **, * statistically significant at 1%, 5% and 10% respectively (t-statistics into parentheses).

Table 7 Profit share in Gross Value Added (GVA) and the output gap (or the growth rate)

	1		2		3	
	Δlog (profit share)					
Dependent variable	Profit share = gross operating surplus (total economy) / GVA		Profit share = gross operating surplus (adjusted for the contributions of the self-employed) / GVA		Profit share = gross operating surplus (corporate) / GVA	
Δ(output gap)$_t$	1.032 (1.90)*		1.284 (2.50)***		0.933 (1.90)*	
Δ(output gap)$_{t-1}$	-0.874 (-1.81)*		-0.940 (-1.99)**		-0.755 (-1.69)*	
Δ(output gap)$_{t-2}$	-0.402 (-1.15)		-0.453 (-1.00)		-0.364 (-0.73)	
Δ(output gap)$_{t-3}$	0.292 (0.74)		0.288 (0.53)		0.333 (0.58)	
Δ(output gap)$_{t-4}$	-0.156 (-0.69)		-0.391 (-1.08)		-0.066 (-0.17)	
Δlog(real GDP)$_t$		1.075 (2.17)**		1.336 (3.00)***		0.976 (2.21)**
Δlog(real GDP)$_{t-1}$		-0.797 (-1.96)*		-0.869 (-2.21)**		-0.670 (-1.77)*
Δlog(real GDP)$_{t-2}$		-0.432 (-1.15)		-0.454 (-0.93)		-0.406 (-0.76)
Δlog(real GDP)$_{t-3}$		0.136 (0.37)		0.152 (0.29)		0.152 (0.27)
Δlog(real GDP)$_{t-4}$		-0.093 (-0.39)		-0.341 (-0.91)		-0.041 (-0.10)
Intercept	0.0037 (0.51)	0.0048 (0.73)	0.015 (2.05)**	0.018 (2.35)**	0.004 (0.51)	0.004 (0.51)
R^2	0.3203	0.3613	0.3009	0.3422	0.1552	0.1731
N	53	53	53	53	53	53

Note: OLS with robust typical errors. ***, **, * statistically significant at 1%, 5% and 10% respectively (t-statistics into parentheses).

It is worth highlighting that the top CIT rate enters with a negative sign (but is significant only in column 3), implying that top CIT rate hikes have a negative effect on CIT revenue.

Turning now to the estimates of equation (7) we see in Table 7 that the elasticity of the profit share to the output gap (real GDP) takes values from 0.93 (0.98), when we use the gross operating surplus of corporations to construct the profit share, to 1.03 (1.08) when we use the gross operating surplus of total economy and reaches up to 1.28 (1.34) when the profit share is based on the gross operating surplus adjusted for the imputed contribution of the self-employed.[22]

Combining the above information in Tables 6 and 7 we can now compute the elasticity of CIT to output gap. The values of the estimated elasticities are reported in Table 8. The average values are 1.39 when we use the output gap, 1.45 when we use real GDP and the mean value comes to 1.42.[23]

5.3 EVALUATION OF THE TAX BUOYANCY EFFECTS

Next we use the abovementioned estimates (see Table 8), the CIT revenue and the economic outlook projections of the OECD in order to better understand the CIT revenue buoyancy effects compared to the baseline, i.e. the case where we use the Girouard and André (2005) estimate (1.08).

We then assume that the projected CIT revenue proceeds for 2014-2016 can be decom-

22 Due to space limitation we present the estimates for two out of the three output gap proxies.

23 It should be noted that the European Commission recently moved to an upward revision of elasticity of CIT to output gap. More specifically, its new estimate is 1.90, i.e. much higher than previous OECD estimates or the high values in Table 8 (see European Commission 2014d, p. 44, Table II.3.2). Therefore, estimates in the present paper could be considered conservative.

Table 8 Elasticity of tax revenue from business activity to the output gap (or the growth rate)

Profit share	Output gap	Growth rate	Mean
Gross operating surplus (total economy) / GVA	1.55	1.62	1.59
Gross operating surplus (adjusted for the contributions of the self-employed) / GVA	1.23	1.28	1.25
Gross operating surplus (corporate) / GVA	1.40	1.47	1.43
Mean	1.39	1.45	1.42

posed into two components. The first is driven by economic conditions and the second is driven by other reasons, including tax policy changes. The simple back of the envelope exercise that we discuss below emphasises on the first part and compares the additional revenues generated in the baseline scenario vis-à-vis the alternative scenario (which rely on the estimates reported in Table 8).

In order to estimate the projected revenue gains, we employ the European Commission (2014b) and IMF (2014) assumptions on the projected narrowing of the output gap: i.e. by 1.13 p.p. in 2014, 2.59 p.p. in 2015 and 2.43 p.p. in 2016. Over the same period the output growth is projected to be 0.6%, 2.9% and 3.7%, respectively. Moreover, it is assumed that the top CIT rate will remain unchanged at 26% over the period 2014-2016.

On the basis of the simple back of the envelope exercise described in Annex B, we compute the additional CIT revenue over the period 2014-2016 that is in line with the baseline scenario and then we compare it with that implied in the alternative scenarios shown in Table 8. In particular, we consider three alternative cases, i.e. that the elasticity of CIT revenue to output gap is 1.23, 1.39 and 1.55 respectively (see Table 8).

The difference between these three elasticity scenarios and the baseline of 1.08 provides us with the gains in terms of additional CIT revenue relative to the OECD baseline attributed to the use of a higher elasticity estimate. Findings are reported in Table 9A – in the case of the high elasticity value (1.55) the additional (relative to the baseline) revenue is 206.3 million euro or 0.11% of GDP up until 2016.[24]

We repeat the same exercise (described in Annex B) for the elasticity of CIT revenue with respect to real GDP (using the following values: 1.28, 1.45 and 1.62 – see Table 8). For the findings to be comparable with those in the baseline scenario (1.08 is an elasticity with respect to output gap) we must transform them in terms of the output gap. This is done by dividing the output gap with the IMF output growth forecast for 2014-2016; doing that we obtain 1.88 for 2014, 0.89 for 2015 and 0.65 for 2016. For example, in 2014 a 1% increase in output growth narrows the output gap by 1.88 p.p. and so on.

The findings are shown in Table 9B. Revenue gains, on top of the baseline scenario, can reach up to 237.3 million euro in 2016 or about 0.12% of GDP.

5.4 CONCLUSIONS

According to the evidence presented above, the elasticity of CIT revenue to the output gap (real GDP) is estimated to be (on average) 1.4, i.e. about 30% larger compared to the findings of Girouard and André (2005).

Based on the high elasticity values reported in Table 9, the most recently published IMF and EC projections on output growth and the narrowing of the output gap, and assuming unchanged tax policies, we project that CIT revenue can

24 According to the baseline scenario, the cumulative gain in CIT revenue is 460.0 million euro or 0.24% of GDP.

Table 9 Tax gains from CIT (additional revenue in relation to the baseline scenario, in million euro)

	Part A		
	Low elasticity (1.23)	Mean elasticity (1.39)	High elasticity (1.55)
2014-2016	65.4	135.6	206.3
	Part B		
	Low elasticity (1.28)	Mean elasticity (1.45)	High elasticity (1.62)
2014-2016	87.3	162.1	237.3

Note: In the baseline scenario, cumulative revenue from the reduction of the output gap comes to €460.0 million or 0.24% of GDP by 2016.

increase by about 666.2-697.2 million euro or 0.35-0.37% of GDP over the period 2014-2016 compared to the baseline scenario according to which CIT revenue increases by about 460.0 million euro or 0.24% of GDP vis-à-vis their 2013 levels. If this materialises, it could contribute towards achieving future fiscal targets.

Building on the most recently published IMF and EC projections on the evolution of nominal GDP, we find that the implied elasticity of CIT revenue with respect to GDP is projected to average 1.2-1.3 over the period 2014-2016 (compared to 0.8 in the baseline scenario).[25] Hence, assuming unchanged tax policies, the ratio of CIT revenue to GDP is projected to increase over the course of 2015-2016 (compared to the 2013 levels).[26]

Moreover, we report evidence of a negative association between CIT revenue and the top CIT rate. This implies that a decrease in the top CIT rate might not exert negative effects on CIT revenue. On the contrary, it could actually boost them if it is translated into increased economic activity (see Arnold et al. 2011).

6 TAX BUOYANCY IN PERSONAL INCOME TAX REVENUE

In order to investigate the presence of tax buoyancy effects in personal income tax revenue (PIT) it should be recalled that since 2010 there have been significant changes in the tax system, e.g. changes in tax rates, abolishment of tax deductions, imposition of extraordinary levies etc. All these policy interventions have increased the progressivity of the tax system, which implies that tax revenue is likely to increase faster following the prospective pick-up in economic activity, leading to positive buoyancy effects. On the other hand, a great part of the policy measures undertaken in the context of the Economic Adjustment Programme, compounded by the impact of the recession and the high unemployment, have exerted a downward pressure on the labour income share. A continuation of this trend works in the opposite direction relative to the increased progressivity of the tax system, dampening possible positive buoyancy effects.

The point of departure in studying tax buoyancy effects are two OECD studies, one by Van den Noord (2000) and the other by Girouard and André (2005). These studies have investigated the relationship between tax revenue and the output gap (which reflects the state of the business cycle), i.e. they calculate the elasticity of each tax revenue component vis-à-vis the output gap. They do that in two steps: first, they estimate the elasticity of tax revenue to its

25 The implied CIT elasticity with respect to GDP is comparable with the long-run estimate of Belinga et al. (2014) (1.26 – Table 3, p. 14).

26 The implied elasticity value is reduced to 1.1 if we use the average estimated reported in Table 9, while it is lowered to 0.9-1.0 if we use the low values reported in Table 9.

tax base and, second, they estimate the elasticity of the tax base to the output gap. The product of these two elasticities generates the elasticity of tax revenue to output gap.

As discussed before, the two OECD studies have some drawbacks. Nevertheless, their findings point to the likely presence of positive buoyancy effects. According to Girouard and André (2005) the elasticity of the income tax relative to the output gap is estimated to be 1.8 (down from 2.2 in Van den Noord 2000). This implies that the increase in PIT revenue will be more than 1:1 vis-à-vis the narrowing of the output gap (the improvement of the cyclical economic conditions). This elasticity is the product of the estimated elasticity of income tax to earnings (2.0) times the elasticity of the wage bill relative to the output gap (0.9).

Interestingly, the recent IMF study by Belinga et al. (2014) examining buoyancy effects over the period 1965-2012 in a group of 34 OECD counties shows that there is limited, if any, evidence of buoyancy effects in personal income taxes (PIT). In more detail, in the short run a 1% increase in nominal GDP will be followed by a 1.1% increase in PIT revenue – reflecting the automatic stabiliser role played by the tax system. However, in the long run, PIT revenue will increase by only 0.97%, i.e. below one, which implies gradually declining PIT to GDP ratios.[27] This reflects the gradually declining labour-income share in advanced economies. Nevertheless, the study of Belinga et al. (2014) does not take into account the policy interventions undertaken in recent years.

Taking into account the abovementioned studies we re-estimate, relying on undated data information, the PIT elasticity with respect to earnings reported by the OECD. The findings will be used to assess the likely presence of PIT-related buoyancy effects over the period 2014-2016.

6.1 DATA AND METHODOLOGY

We have repeated the OECD exercise relying on quarterly macroeconomic data for personal income taxes and compensation of employees, while controlling for tax policy changes (by including the top personal income tax rate or the top marginal personal income tax rate). Unfortunately, the analysis was inconclusive.

Nevertheless, we did manage to get an estimate of the elasticity of personal income tax with respect to earnings by relying on data from income tax statements. More specifically, we used data from income tax statements reported by the General Secretariat of Information Systems (GSIS).

The tax data reported by GSIS cover the 13 regions of Greece according to the NUTS-II[28] classification over the period 2005-2010.[29] Therefore, using region-specific data we have estimated the following specification (allowing for time dummy variables):[30]

$$\Delta log(Income\ tax/number\ of\ tax\ payers)_{ti} = \alpha_3 + \beta_3 * \Delta log(Declared\ income/number\ of\ tax\ payers)_{ti} + time\ effects + \varepsilon_{ti} \quad (8)$$

Where t=2005-2010 and i=1-13.

6.2 FINDINGS

The findings are reported in Table 10. In column 1 we first report the baseline specification where we just pool all available data and run a (robust) OLS regression. In this case the estimated elasticity of income tax to gross earning (β_3) is 3.58, i.e. almost twice as high as the OECD findings (2.0). Nevertheless, when we control for time effects in the period 2005-2010 (incorporating tax policy changes), the coefficient estimate decreases to 1.99, quite close to the one reported by Girouard and André (2005). In column 3, we take into account

27 See Belinga et al. (2014), Table 3, p. 12.
28 NUTS-II stands for Nomenclature of Territorial Units for Statistics by regional level. The 13 regions are: Attica, Central Macedonia, Crete, East Macedonia and Thrace, Epirus, Western Greece, Western Macedonia, Sterea Ellada, Ionian Islands, North Aegean, Peloponnese, South Aegean and Thessaly.
29 GSIS data refer to the financial years 2006-2011 that in national account terms correspond to years 2005-2010.
30 Standard errors are robust – we control for the likely presence of heteroskedasticity or within-panel serial correlation in the idiosyncratic error term.

Table 10 The relationship between PIT and declared income

Dependent variable	1	2	3
	Δlog (income tax / number of tax payers)		
Estimation method	OLS (pooled regression)	OLS (pooled regression)	Fixed effects
Δlog (declared income/ number of tax payers)	3.58 (12.08)***	1.99 (3.18)***	2.45 (2.59)**
Pseudo time series	NO	YES	YES
F-test (p-value)	F(1.63) = 145.81 (0.0000)	F(5.59) = 372.42 (0.0000)	F(5.12) = 392.09 (0.000)
R^2	0.7597	0.9694	0.9690
N	65	65	65

Note: OLS with robust typical errors. ***, **, * statistically significant at 1%, 5% and 10% respectively (t-statistics into parentheses).

unobserved heterogeneity among regions by estimating a fixed-effects version of specification (1) (i.e. α_{3i} in specification (8)). In this case the estimated elasticity of income tax data relative to earnings is β_3=2.45, i.e. about 22.5% above the OECD estimates. The last specification incorporating both time and fixed effects is the preferred one and will be used for the evaluation of possible tax buoyancy effects.

6.3 EVALUATION OF THE TAX BUOYANCY EFFECTS

By using our basic estimate of PIT to earnings elasticity (β_3 = 2,455) and the elasticity of the wage bill to the output gap (0.9-1.0), we find that the elasticity of income tax with respect to output gap can range from 2.205 to 2.45.[31]

In order to assess the impact of our estimate on tax revenue, we use the OECD estimate, i.e. that the CIT elasticity to the output gap comes to 1.8 (Girouard and André 2005).

Next we repeat the same exercise described in Section 5.3 for CIT revenue and in Annex B, i.e. we compare the revenue gains in the baseline scenario with the ones in the alternative scenarios (2.205 and 2.45).[32] The additional revenue gains in the alternative scenarios compared to the baseline are attributed solely to the larger estimated elasticities (that is, without taking into consideration possible policy changes). Results are summarised in Table 11. These additional revenue gains can range from an estimated €314.3 million to €506.9 million (or 0.17-0.27% of GDP) accrued by 2016.

Unfortunately, the available tax statement data cover only the period 2005-2010, i.e. they do not reflect the dramatic changes that took place in the subsequent years (increase in tax burden also on account of extraordinary taxes (solidarity tax), abolition of tax exemption, as well as decline in incomes). For example, according to the OECD (2014) the top marginal PIT rate increased from about 37.8% in 2010 (the last year in our tax statements dataset) to 46% in 2013, i.e. by 8.2 p.p. or 21.7% (see Chart 7).

Therefore, given the subsequent decline in gross earnings and the increase in tax obligations in 2011-2013, it can be inferred that the tax data at hand may underestimate *the true elasticity (β_3) of income tax relative to earnings*. A naïve back-of-the-envelope exercise implies that if the estimated elasticity increases in line with the pick-up in the top marginal PIT rate (of 21.7%), then it would end up being about

31 It should be noted that the European Commission recently revised CIT to output gap elasticity to 2.22, i.e. considerably higher than previous OECD estimates (see European Commission 2014d, p. 44, Table II.3.2).

32 The narrowing of the output gap will improve PIT revenue by about 1,338.7 million euro or 0,70% of GDP in the baseline scenario.

Table 11 Tax gains from CIT (additional revenue in relation to the baseline scenario) for 2014-2016

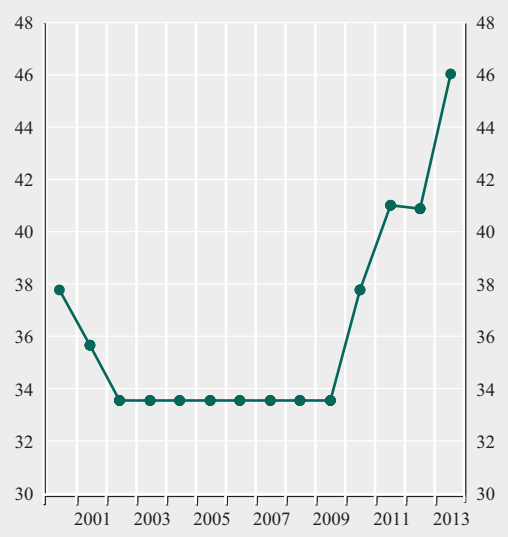
(million euro)

Elasticity	2.205	2.45
2014-2016	314.3	506.9

Note: Under the baseline scenario, the reduction of the output gap adds €1,338.7 million to tax revenue (or 0.70% of GDP) by 2016.

Chart 7 Top marginal tax rate on Personal Income Tax

(%)



Source: OECD (2014).

2.98.[33] In this case the PIT elasticity to the output gap would end up being 2.68. Consequently, the additional revenue gains compared to the baseline could reach up to 691.9 million euro or 0.36% of GDP.[34]

In order to evaluate the credibility of our estimates we use *ex ante* and *ex post* information on the revenue impact of tax measures. Such information comes from the revised Medium-Term Fiscal Strategy Frameworks (MoF 2014) as well as Bank of Greece Annual Reports for 2011, 2012 and 2013. Excluding the impact of these measures we compute the change in PIT revenue from 2009 to 2012. This is then divided by the change in wages and salaries and self-employed income over the same period. This ratio (2.4), which is the implicit elasticity of PIT revenue (excluding discretionary tax policy changes) with respect to wages/salaries and self-employed income, comes pretty close to the value estimated using 2005-2010 income tax data.

6.4 CONCLUSIONS

Using income tax and gross earnings data from tax statements aggregated at the regional level we estimate the elasticity of income tax to gross earnings over the period 2005-2010. We find an elasticity of 2.45, which is 22.5% larger compared to the findings of Girouard and André (2005). This translates into an elasticity of the income tax with respect to the output gap, which ranges from 2.205 to 2.45, against 1.8 as estimated by Girouard and André (2005).

Based on this evidence, and the IMF estimations for the narrowing of the output gap in 2014-2016, the PIT revenue gains could range from 1,653.1 million euro to 1,845.6 million euro (or 0.87-0.97% of GDP) up until 2016 compared to the baseline scenario (1338.7 million or 0.70% of GDP) that relies on the OECD elasticities. However, the analysis does not fully reflect the important policy changes of 2011-2013.

The analysis suggests that a revision of tax elasticities (benefiting from the use of updated statistics) can lead to higher estimated revenue

33 According to the estimation by Van de Noord (2000) the estimated income tax to earning elasticity was 3.1 in Greece (calculated on the basis of the 1996 tax code).

34 However, the PIT elasticity with respect to earnings might have declined in crisis years because of adverse "bracket creeping" effects, i.e. as earnings decline, more people are taxed at lower tax rates, generating lower income taxes. However, as the recovery gathers pace, bracket creeping effects will boost income taxes.

(because of a narrowing of the output gap) than that derived from earlier OECD estimates. Based on these findings and the projected course of economic activity, it is estimated that the implied elasticity of PIT revenue with respect to nominal GDP will be about 1.7-1.9 in 2014-2016 – substantially above the elasticity (1.4) implied by the OECD baseline scenario and recent IMF estimates (see Belinga et al. 2014). Hence, on the basis of a scenario that relies on unchanged tax policies over the period 2014-2016, we find that the share of PIT revenue to GDP is projected to increase in 2015-2016 compared to its 2013 value.

7 CONCLUDING REMARKS

In this study we have investigated whether there are tax buoyancy effects in VAT, CIT and PIT revenue in Greece. Following previous IMF studies we examine the effect of cyclical economic conditions on VAT tax efficiency. Based on our findings we anticipate that VAT C-efficiency will increase as economic conditions improve, leading to higher VAT revenue. In particular, the implied estimated elasticity of VAT revenue to GDP is projected to be 1.2-1.3 on average in 2014-2016. Hence, based on an unchanged policy scenario, the ratio of VAT revenue to GDP is expected to increase as the recovery gathers pace in 2015-2016 (compared to its 2013 level).

Turning to CIT and PIT revenue, the analysis relied on OECD methodology to estimate the elasticity of CIT/PIT revenue to the output gap. In the case of CIT revenue, the analysis was conducted using national accounts data, while the analysis based on PIT was conducted using income tax statements data. Our findings imply that previous OECD studies underestimate the elasticity of CIT/PIT revenue to the output gap. In the case of CIT, additional revenue should be expected in the future on account of the projected increase in the profit share. In the case of PIT, the increased progressivity of the tax system will yield additional revenue, despite the declining labour share. The broadening of the tax base through the fight against tax evasion will also yield additional revenue compared to the past.

In particular, the implied estimated elasticity of PIT (CIT) revenue to GDP is projected to be 1.7-1.9 (1.2-1.3), on average, over the period 2014-2016. Therefore, under a no-policy change scenario, both the CIT to GDP and the PIT to GDP ratios are projected to increase in 2015-2016 (compared to their 2013 levels).

Taking into account the updated tax elasticity of CIT and PIT revenues and the projected increase in VAT tax efficiency, we find that the additional revenue gains (compared to 2013) due to the narrowing of the output gap and economic recovery could reach up to 3.9 billion euro or 2.1% of GDP – compared to 2.6 billion euro or 1.36% of GDP in the baseline scenario employing OECD elasticities. Alternatively, this additional revenue can be decomposed to a) 2.5 billion euro that correspond to a 1:1 increase in nominal GDP and b) 1.4 billion euro that is due to the fact that the elasticity of the sum of these three revenue categories to GDP is above 1 (about 1.5-1.55).

Taking into account the abovementioned estimates, the implied elasticities of the three revenue categories to GDP and the most recently published nominal GDP projections by the IMF and the EC, we find that the ratio of the sum of VAT, CIT and PIT revenue to GDP is projected to increase in 2014-2016. This is evidence of possible positive buoyancy effects.

According to Belinga et al. (2014) the elasticity of tax revenue to GDP in Greece is 0.89 in the short run and 1.09 in the long run (see Table 1, p.13 of the present article).[35] Using the average values of the implied estimated elasticities of VAT, CIT and PIT to GDP, the OECD elasticities of excise taxes, social secu-

35 Besides VAT, CIT and PIT revenue, the study of Belinga et al. (2014) also includes regressive taxes such as excise taxes, property taxes and social security contributions.

rity contributions and property taxes to GDP computed by Belinga et al. (2014 – Table 3, p. 12), as well as the share of its revenue category to total revenue (see European Commission 2014c) we find that the implied elasticity of tax revenue to GDP will be 1.06 in the short run and 1.22 in the long run.[36] These findings imply that the tax buoyancy effects over the coming year could be larger than those estimated in the aforementioned IMF study.

Concluding, economic recovery and the narrowing of the output gap in the years to come could lead to positive tax buoyancy effects. This implies that under a no-policy change scenario the ratio of tax revenue to GDP is projected to increase in the years to come.

However, as pointed out in the Bank of Greece *Interim Report on Monetary Policy* (published in December 2014), it is absolutely necessary to promote reforms in order to ensure that the economy gets back on track in the years to come (see Bank of Greece 2014c). Therefore, the abovementioned gains will materialise only under these conditions.

36 When using the implied elastities of the VAT, CIT and PIT revenue to GDP from the baseline scenario, we find an elasticity of 0.86 in the short run and 1.02 in the long run.

REFERENCES

Arnold, J.M., B. Brys, C. Heady, A. Johansson, C. Schwellnus and L. Vartia (2011), "Tax policy for economic recovery and growth", *The Economic Journal*, 121(550), 59-80.

Bank of Greece (2010), *Annual Report 2009*, Tax Policy Measures, April.

Bank of Greece (2011), *Annual Report 2010*, Tax Policy Measures, April.

Bank of Greece (2012), *Annual Report 2011*, Tax Policy Measures, April.

Bank of Greece (2013a), *Annual Report 2012*, Tax Policy Measures, February.

Bank of Greece (2013b), *Monetary Policy 2012-2013*, Box IV.2 "The relationship between indirect taxes and economic activity", pp. 69-70, May.

Bank of Greece (2014a), *Annual Report 2013*, Tax Policy Measures, February.

Bank of Greece (2014b), *Monetary Policy 2013-2014*, Box IV.1 "The impact of economic activity on VAT tax efficiency", pp. 74-75, June.

Bank of Greece (2014c), *Monetary Policy – Interim Report 2014*, December.

Belinga, V., D. Benedek, R. de Mooij and J. Norregaard (2014), "Tax Buoyancy in OECD Countries", IMF Working Paper 14/110.

Blanchard, O. and R. Perotti (2002), "An empirical characterization of the dynamic effects of changes in government spending and taxes on output", *Quarterly Journal of Economics* 117, 1329-68.

Brondolo, J. (2009), "Collecting Taxes During an Economic Crisis: Challenges and Policy Options", IMF Staff Position Note 09/17 (Washington: International Monetary Fund).

Ebrill, L., M. Keen, J.P. Bodin and V. Summers (2001), *The modern VAT*, Washington, DC: International Monetary Fund.

European Commission (2014a), *European Economic Forecast, Winter 2014*, Brussels.

European Commission (2014b), *The Second Economic Adjustment Programme for Greece. Fourth Review – April 2014*, Occasional Paper 192, April.

European Commission (2014c) *Taxation Trends in the EU*, Brussels, http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_structures/country_tables/el.pdf.

General Secretariat of Informations System – GSIS (2014), Tax Administration Monitor: http://www.gsis.gr/gsis/info/gsis_site/PublicIssue/TaxAdmin.html.

Girouard, N. and C. André (2005), "Measuring cyclically-adjusted budget balances for OECD countries", *OECD Economics Department Working Papers*, vol. 434.

IMF (2013), "Greece: Third Review Under the Extended Arrangement Under the Extended Fund Facility", IMF Country Report No. 13/20.

IMF (2014), "Greece: Fifth Review Under the Extended Arrangement Under the Extended Fund Facility", IMF Country Report No. 14/151.

Ministry of Finance (2014), *MTFS 2015-2018*, Athens.

OECD (2013), *Economic Surveys: Greece*, November, Paris.

OECD (2014), *Tax database*, OECD, Paris: http://www.oecd.org/tax/tax-policy/tax-database.htm#C_CorporateCapital.

Poghosyan, T. (2011), "Assessing the variability of tax elasticities in Lithuania", IMF Working Paper 11/270.

Sancak, C., R. Velloso and J. Xing (2010), "Tax Revenue Response to the Business Cycle", IMF Working Paper 10/71.

Tagkalakis, A. (2013), "Audits and tax offenders: recent evidence from Greece", Bank of Greece, Working Paper No. 152.

Tagkalakis, A. (2014a), "Assessing the variability of indirect tax elasticity in Greece", Bank of Greece, Working Paper No. 171.

Tagkalakis, A. (2014b), "The determinants of VAT revenue efficiency: recent evidence from Greece", Bank of Greece, Working Paper No. 181.

Van den Noord, P. (2000), "The Size and Role of Automatic Fiscal Stabilizers in the 1990s and Beyond", *OECD Economics Department Working Papers*, No. 230, Paris.

ANNEX A

PROXY VARIABLES OF THE OUTPUT GAP AT A QUARTERLY FREQUENCY

We consider three alternative proxies:

- First, we convert the annual potential output calculated using the Production Function approach into quarterly frequency by considering the quadratic match sum approach. The quarterly output gap is calculated as: $ygap1_t = [(real\ GDP\text{-}potential\ real\ GDP)/potential\ real\ GDP]$ and the year-on-year difference is: $\Delta ygap1_t = gap1_t - gap1_{t-4}$.

- Second, we proxy the quarterly potential GDP with the trend real GDP that has been extracted by means of an HP filter. In this case, the quarterly output gap is calculated as: $ygap2t = [(real\ GDP\text{-}trend\ real\ GDP)/trend\ real\ GDP]$] and the year-on-year difference is: $\Delta ygap2_t = ygap2_t - ygap2_{t-4}$.

- Last but not least, we also consider real GDP growth (as in Sancak et al. 2010) as our cyclical economic activity variable, i.e.: $\Delta log(Real\ GDP)_t = log\ Real\ GDP_t - log\ Real\ GDP_{t-4}$.

ANNEX B

A BACK OF THE ENVELOPE EXERCISE OF THE REVENUE GAINS GENERATED FROM THE PROSPECTIVE NARROWING OF THE OUTPUT GAP

The exercise is as follows:

- We first multiply the elasticity (ε_i) of each revenue category (TR_i) with respect to the output gap (where i = VAT, CIT, PIT revenue) by the narrowing of the output gap project by the IMF (in July 2014) ($E(\Delta OG_{t+1}/I_{t+1})$[37] and then in turn by the ratio of each tax revenue category (TR_i) to GDP (Y_t) in 2013 (t=2013) and obtain an estimate of the budgetary sensitivity (BSi_{t+1}), i.e. the amount by which the general government deficit will decline in percentage points (p.p.) of GDP as a consequence of the increase in tax revenue component i due to the narrowing of the output gap in t+1=2014 by the p.p. projected by the IMF. Hence: $\varepsilon_i * (E(\Delta OG_{t+1}/I_{t+1}) * (TR_{it}/Y_t) = BS_{it+1}$.

- Multiplying this estimate by the nominal GDP for 2014 projected by the IMF (in July 2014) $E(Y_{t+1}/I_{t+1})$ we find the increase in tax revenue of category i in million euro: $E(Y_{t+1}/I_{t+1}) * (BS_{it+1}) = \Delta(TR_{it+1})$.

- We add the previous value $\Delta(TR_{it+1})$ to the tax revenue of category i for t=2013 and obtain the respective value for t+1: $TR_{it} + \Delta(TR_{it+1}) = TR_{it+1}$. This projection incorporates solely changes in tax revenue due to the change in economic conditions (policy changes are not reflected here).

- The tax revenue projection TR_{it+1} is then expressed in percent of GDP using the IMF projection $E(Y_{t+1}/I_{t+1})$, i.e. $(TR_{it+1})/E(Y_{t+1}/I_{t+1})$ and then we repeat the exercise from the start: $(\varepsilon_i) * E(\Delta OG_{t+2}/I_{t+1}) * (TR_{it+1})/E(Y_{t+1}/I_{t+1}) = BS_{it+2}$ etc. until we get an estimate for the tax revenue of each category i for t+2=2015 and t+3=2016.

37 I_{t+1} denotes that the projection for t+1=2014 is conducted with the within the year information. According to the IMF, the output gap is projected to narrow by 1.13 p.p. in 2014, 2.59 p.p. in 2015 and 2.43 p.p. in 2016.

AN EMPIRICAL INVESTIGATION OF THE RELATIONSHIP BETWEEN UNIT LABOUR COST AND PRICE DEVELOPMENTS: THE CASE OF GREECE

Zacharias G. Bragoudakis*
Economic Analysis and Research Department

I INTRODUCTION

The changes taking place in employees' wages and labour productivity are considered to be factors that shape inflation expectations, and largely impact on inflation's current and future paths. The main assumption is that wage dynamics plays a central role in determining price developments. In particular, if nominal wages grow faster than labour productivity, price stability is undermined, since firms face higher production costs, which they will finally have to pass through to the end prices charged. Although energy and raw material costs represent considerable fractions of total costs as well, labour costs form a large part of a firm's production costs, especially in labour-intensive economies. Consequently, indices measuring labour cost developments, such as unit labour costs, are treated and used as forward-looking indicators of future inflation.

In the Greek economy, the rate of change in prices seems to respond with a lag and disproportionately to the large reductions of labour costs[1] recently brought about in the country in the context of fiscal consolidation and internal devaluation[2] adopted with a view to regaining losses in competitiveness and balancing the current account. The Greek economy continues to be expensive in basic consumption goods, despite recession, declining incomes and a high unemployment rate. Based on recent surveys, the prices of several goods in the domestic market deviate considerably from those in other countries – even EU countries under fiscal consolidation regimes (see e.g. European Commission 2013, and Petroulas and Kosma 2014). According to the EC report, an examination of indicative prices for 20 basic consumption goods in supermarkets in Greece, Portugal, the Netherlands and Luxembourg leads to the conclusion that in essence Greece has the most expensive basket of goods. Compared with consumers in the other three countries, Greek consumers need a larger share of their wages to buy the same quantity of goods. The fact that prices in the country do not adjust proportionately to the decline in unit labour costs has limited any benefits gained in terms of competitiveness and has reduced consumers' purchasing power, further weakening total demand across the Greek economy.

Nevertheless, it should be noted that such disconnection between unit labour costs and consumer price developments is a phenomenon typical not only in Greece but in several euro area countries as well (Wolff 2012).

The present paper attempts an empirical investigation of the relationship between unit labour costs (i.e. nominal wages per employee adjusted for labour productivity) and price developments. More specifically, it empirically explores the existence of cointegration between price and wage levels in the economy as a whole, as well as in its major sectors. If a

* The views expressed in this study are those of the author and do not necessarily reflect those of the Bank of Greece. Warm thanks are extended to BoG Deputy Governor I. Papadakis, H. Gibson, S. Kalyvitis, H. Balfoussia, D. Sideris and E. Kondelis for their useful comments. Any errors or omissions are the responsibility of the author.

1 According to Hellenic Statistical Authority (ELSTAT) national accounts (ESA 95) data, GDP at constant prices (base year 2005=100) fell by 16.92% in the period 2010-2013, while the total wages of dependent employees dropped by 28.7%. Also, according to European Commission and European Central Bank (ECB) data, compensation per employee for the total economy fell by 13.2% in the period 2010-2013, while nominal unit labour costs correspondingly declined by 13.3%. By contrast, in the same period, inflation as measured by the Consumer Price Index rose by 3.3%, whereas inflation as measured using the GDP deflator fell only by 2.1%. Section 4 of this paper describes in more detail this disconnection between inflation and changes in unit labour costs.

2 In its report on Greece (IMF Country Report No. 13/20, January 2013), the International Monetary Fund characteristically states: "Large external liabilities ultimately require large trade surpluses in order to service them, and achieving these surpluses requires a more depreciated level of the real exchange rate. In a currency union the depreciation has to be achieved largely through deflation, which necessitates a larger negative output gap (though measures to increase flexibility of wages and prices can lessen this effect). For Greece, the reduction in the cost of debt servicing (through lower interest rates) and increasing the maturity of the debt will partly alleviate the short-term problem of resource transfers, but it is still there".

cointegration relationship exists, the paper estimates the rate of adjustment of prices to changes in wages, and vice versa, as well as the speed at which the system adjusts to its long-run equilibrium. In addition, it examines the direction of causality based on tests for weak, short-term and strong exogeneity between prices and wages. To the best of the author's knowledge, at least with respect to the Greek economy, no other empirical study has so far undertaken such a detailed and definition-consistent investigation of the interaction between prices and unit labour costs at the sectoral level.

The findings of both the descriptive analysis and the econometric investigation support the conclusion that, for the total economy, price developments not only affect unit labour cost developments, but also unit labour costs affect price developments practically across the entire economy.

The rest of this paper is structured as follows: Section 2 discusses the theoretical background of the connection between unit labour costs and price developments and briefly reviews the relevant literature; Section 3 presents the data; Section 4 provides a descriptive analysis of the data and draws some initial conclusions regarding the existence of the disconnect between prices and unit labour costs; Section 5 discusses a number of methodological issues and describes the econometric methodology; Section 6 presents the empirical results; and finally, Section 7 concludes.

2 THE INTERCONNECTION BETWEEN UNIT LABOUR COSTS AND PRICES

2.1 THEORETICAL SETTING OF THE RELATIONSHIP BETWEEN UNIT LABOUR COSTS AND PRICES

It is often argued that labour cost developments drive price developments. This view stems from the well-known "cost-push theory of inflation", according to which any increase in labour costs (employees' wages and employers' social security contributions) — which form a considerable part of a firm's variable production costs — will eventually pass through to intermediate (wholesale) prices and retail prices (the CPI or the respective sectoral deflators).

In more detail, if nominal wages per employee grow faster than labour productivity, firms are forced to pass through the higher costs to retail prices, which leads to an upward price adjustment. In the real economy, however, this pass-through is neither automatic nor full. The literature on nominal rigidities shows that in many cases firms tend to avoid changing their prices frequently. Firms' tendency to avoid repeated price changes depends mainly on the sector's degree of oligopoly (firms' market power) and the potential reactions of customers.

The more oligopolistic the structure of the economic sector in which the firm operates, the higher the firm's degree of monopoly power, and the larger the room for frequent price changes with a correspondingly lower risk of market share losses. In addition, an oligopolistic structure encourages market-pricing collusion, a phenomenon manifested via a nominal downward rigidity of prices in cases where a unit labour cost reduction would justify a lowering of prices. By contrast, frequent price changes foster a climate of uncertainty that increases the customer reaction effect, particularly for products with a high elasticity of demand. The rate of pass-through and the speed of adjustment depend on several factors, such as the magnitude and persistence of price increases, the size of profit margins, the elasticity of demand for the sector's products, and competitors' expected behaviour. In the short run, firms may be willing to accept a narrowing of their profit margins and partly absorb the rise in labour costs, but over the medium term, persistent increases in nominal wages render an upward price adjustment inevitable. According to the cost-push theory of inflation, wage dynamics is exogenous and the price adjustment entailed is strongly

affected by wage fluctuations. Nevertheless, this view cannot sufficiently explain how an acceleration of labour costs can be seen as the driver of price developments and not the other way around.

The majority of explanations regarding inflation originate in demand-side theories (demand-pull inflation), according to which the exogenous determinant of inflationary pressures is an excessively expansionary fiscal policy (higher public expenditure or lower taxes), or an excessively expansionary monetary policy (stronger money supply growth or lower policy rates), or a combination of both. This approach does not rule out bidirectional causality, but argues that a change in demand is what primarily triggers the spiral relationship between price and wage developments.

As firms compete to hire employees so as to meet increasing demand, wages will tend to rise, unless the labour supply elasticity is sufficient to satisfy the initial increase in demand. In other words, when higher demand reduces unemployment and the economy performs close to its potential output, firms are willing to raise nominal wages in order to attract employees. Moreover, in such cases employees are in a relatively better position to negotiate higher wages. Higher wages raise production costs, thereby increasing the prices of goods and services.

However, the direction of this causal relationship could very well be reversed, meaning that in cases where excess total demand coincides with inadequate production capacity, the overall market supply shortage may allow firms to raise their prices, which leads to higher profit margins. This in turn pushes employees to ask for wage increases in order to maintain their purchasing power. This view implies that wage developments follow developments in demand. From this point of view, wages as a forward-looking indicator of future inflation risks being underestimated, and our focus would turn to developments in fiscal and monetary aggregates that affect total demand.

In fact, the various interaction mechanisms described above may possibly operate simultaneously in an economy, allowing for a bi-directional feedback between wages and prices. In general, economic theory provides no clear view on the direction of the effect that links unit labour costs and prices. The following subsection presents a brief review of the literature, which investigates this issue empirically.

2.2 LITERATURE REVIEW

According to existing reports in the literature, attempts to investigate the interaction between nominal wages and prices empirically have produced contradictory results. The majority of relevant studies seem to provide limited empirical support for the hypothesis that higher nominal wages or unit labour costs affect price dynamics.

Table 1 summarises the empirical findings of part of the international literature on the feedback relationship between labour costs and price dynamics. Even briefly inspected, it reveals a lack of consensus regarding the direction of the causality. In general, the results of the empirical studies are quite sensitive to the selected sample, the econometric method applied, and the policy measures that followed.

2.3 THE THEORETICAL MODEL OF AN EXPECTATIONS-AUGMENTED PHILLIPS CURVE

There are two alternative theoretical approaches generally used to describe the interaction between wages and prices: the Phillips curve and the wage curve (see Layard et al. 1991; Blanchard and Katz 1999; Bardsen et al. 2005). While the Phillips curve approach relies on a negative relationship between the rate of change in nominal wages and the unemployment rate or some broader indicator of fluctuations in economic activity (e.g. the output gap), the wage curve implies a negative relationship between the level of real wages and the unemployment rate.

Table 1 Summary of findings in the international literature

Year	Researchers	Country	Findings
1977	Mehra	USA	The findings support the existence of a bidirectional causal relationship between average nominal wages and CPI, irrespective of the industry market structure.
1988	Gordon	USA	Changes in nominal wages are not relevant in explaining price inflation when the latter is measured using the GDP deflator.
1991	Mehra	USA	Changes in nominal wages are not important in explaining price inflation when the latter is measured using the GDP deflator.
1992	Gaillard	Switzerland	Unit labour cost plays a highly significant role for the short-run dynamics of prices in all the sectors examined. In addition, lagged price changes are a key determinant of short-run wage developments.
1993	Mehra	USA	Unit labour cost growth affects prices when they are measured by the Consumer Price Index (CPI). In contrast, there is no impact on inflation when the latter is measured based on the rate of change in the GDP deflator.
1995	Rissman	USA	The direction of causality runs from prices to unit labour costs, except in manufacturing and retail trade where wages Granger-cause inflation, i.e. it has some predictive power for future inflation developments.
1996	Arora and Blackley	USA	In all sectors except non-durable manufacturing, estimates indicate there is bidirectional causality between ULC and prices.
1996	Emery and Chang	USA	Unit labour cost included as an explanatory variable in the inflation equations provides no significant improvement in the models' out-of-sample predictive power. In contrast, strong evidence suggests that inflation helps predict (Granger-causes) wage increases across all sample periods.
1997	Brauer	USA	While compensation per employee in the industrial sector seems to have little predictive power for goods prices, compensation per employee in the private services sector can help to predict prices for a specific group of services; therefore it helps predict changes in the CPI.
1999	Chan-Lau and Tokarick	USA	The small rise in unit labour costs is necessary to explain the low inflation puzzle in the second half of the 1990s, since the widened output gap and the continuous fall in unemployment can explain this phenomenon only partly.
1999	Ghali	USA	Causality is found to run from wages to prices, which supports the case for systematically monitoring labour costs for controlling inflation.
2000	Mehra	USA	Wage growth helps to predict inflation, only during periods when wage growth is high. By contrast, inflation always helps to predict wage growth over a much longer time horizon, covering various inflation regimes.
2000	Hess and Schweitzer	USA	There is more evidence that inflation helps to predict unit labour cost growth rather than vice versa.
2001	Aaronson	USA	There is evidence that the impact of minimum wage hikes affects food and restaurant prices.
2007	Zanetti	Switzerland	Prices (as measured by the CPI) systematically influence wages, whereas the impact of wages on prices is more sensitive to the choice of the sample period.
2012	Wolff	Euro area	Unit labour cost adjustment has been largely disconnected from CPI developments. The absence of a strong transmission mechanism between ULC, wage adjustments and inflation significantly hampers policy making in the euro area.

This paper follows Gordon (1982, 1985, 1988), Stockton and Glassman (1987), Ghali (1999), and Mehra (1993, 2000), and specifies the relationship between the rate of change in prices (inflation) and the average cost of labour per unit of output (unit labour costs) using the methodological framework of an augmented Phillips curve. The structure of the model implies a systematic, long-term relationship between prices and unit labour costs.

According to this model, prices are set based on a profit margin (mark-up) applied over wages, as specified in equation (1). In turn, wages depend on expected inflation, as described in equation (2). In addition, both

equations include variables that reflect possible shocks attributable to total demand and/or supply.

The two reduced-form equations described above are specified as follows:

Price equation:

$$\Delta p_t = a_p + \beta_{1p}\Delta(wun - lprod)_t + \beta_{2p} ds_t + \beta_{3p} ss_{pt} \quad (1)$$

Wage equation:

$$\Delta(wun - lprod)_t = a_w + \beta_{1w}\Delta p_t^e + \beta_{2w} ds_t + \beta_{3w} ss_{wt} \quad (2)$$

given that

$$\Delta p_t^e = \sum_{i=1}^{n} \lambda_i \Delta p_{t-i} \quad (3)$$

(adaptive inflation expectations)

where p_t stands for the level of prices, wun_t for the level of nominal wages per employee, and $lprod_t$ for labour productivity. Δ denotes the first difference operator. The variable $\Delta(wun - lprod)_t$ expresses changes in the productivity-adjusted wages per employee, i.e. changes in unit labour costs $\Delta(ulc)_t$, where $\Delta(ulc)_t = \Delta(wun - lprod)_t$. Δp_t^e denotes the inflation expectations, assuming an adaptive relationship of inflation expectations based on past inflation (backward-looking adjustment) as described by equation (3). The rate of change in unit labour costs $\Delta(ulc)_t$ is therefore affected by the time lags of inflation. The specification of equations (1), (2) and (3) indicates that unit labour costs and prices systematically interact, i.e. that a long-term relationship connects them.[3] The variable ds_t denotes a measure of the cyclical phase of total demand (subdued or excess), which can be proxied by output gap. A positive output gap means that the economy is overheated and operates above its long-term trend (potential output), thereby suggesting that excess demand will create inflationary pressures. A negative output gap means that the economy is in recession and operates below its potential output, thereby suggesting that subdued demand will generate deflationary trends. ss_{pt} denotes any supply-side shocks to prices (e.g. an increase in marginal cost due to rising oil prices, or higher prices of imported intermediate goods in industry), while ss_{wt} denotes any supply-side shocks to wages.

3 THE DATA

The empirical analysis is based on quarterly data extending over the period 2000-2013. The study examines the interaction between unit labour costs and prices both at an aggregate level and in individual sectors of the economy.

According to the national accounts compiled and published by the Hellenic Statistical Authority (ELSTAT) in accordance with the European System of Accounts (ESA 1995), Gross Domestic Product (GDP) at basic prices,[4] based on the production method, is broken down into ten major sectors, presented in detail in Table 2.

Dividing output value at current prices by output value at constant prices (taking as base year 2005=100), we calculate the sectoral deflators for each of these ten sectors, in addition to the GDP deflator calculated for the whole economy. These deflators along with the Harmonised Index of Consumer Prices (HICP), also compiled and published by ELSTAT, constitute the group of prices p_t.

3 The price equation (1) and the wage equation (2) used in this study should be seen as reduced-form equations. More specifically, the price equation (1) relies on a pricing model based on the firm's profit margin (mark-up). Nordhaus (1972) shows that the specification of equation (1) is derived from an optimisation process of a Cobb-Douglas production function. On the assumption of constant returns to scale and a constant relative price of capital, the production function results in a long-term coefficient equal to unity, $\beta_{1p}=1$ in the price equation (1). Coefficient $\beta_{1p}=1$ indicates that prices and wages increase at similar rates in the long run. Following the same line of reasoning, in the wage equation (2), if the sum of the coefficients of lagged prices is equal to unity, $\beta_{1w}\sum_{i=1}^{n}\lambda_i = 1$, this also indicates that wages and prices grow at similar rates in the long run. According to Gordon (1985), the wage equation (2) is derived from a labour demand and supply model in which the rate of change in wages is each time adjusted to correct for labour market imbalances.

4 GDP at basic prices (total gross value added) equals GDP at market prices, minus taxes on production plus subsidies.

Table 2 Definitions of labour cost and price variables by production sector and for the total economy

	Labour cost variables			Price variables		
Sectors	Unit labour cost (ulc_t)	Compensation per employee (wun_t)	Labour productivity ($lprod_t$)	Deflators (p_t)	Harmonised CPI (p_t)	Profit margin (pm_t)
GDP-total economy (gross value added at basic prices)	TT_ULC	TT_WUN	TT_LPROD	YFD	HICP	TT_PM
Agriculture, forestry and fishing	AGR_ULC	AGR_WUN	AGR_LPROD	AGRD		AGR_PM
Mining and quarrying, manufacturing, energy, water supply, sewerage, waste management and remediation	IND_ULC	IND_WUN	IND_LPROD	INDD		IND_PM
Construction	CON_ULC	CON_WUN	CON_LPROD	COND		CON_PM
Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and accommodation and food services	TR_ULC	TR_WUN	TR_LPROD	TRD		TR_PM
Information and communication	COM_ULC	COM_WUN	COM_LPROD	COMD		COM_PM
Financial and insurance activities	FI_ULC	FI_WUN	FI_LPROD	FID		FI_PM
Real estate activities	RE_ULC	RE_WUN	RE_LPROD	RED		RE_PM
Professional, scientific and technical activities, administrative and support service activities	SC_ULC	SC_WUN	SC_LPROD	SCED		SC_PM
Public administration and defence, compulsory social security, education, human health and social assistance activities	PA_ULC	PA_WUN	PA_LPROD	PAD		PA_PM
Arts, entertainment and recreation, repair of household appliances and other services	ART_ULC	ART_WUN	ART_LPROD	ARTD		ART_PM

Sources: Calculations based on ELSTAT data.

Table 2 presents the abbreviations of the variables used for the couples of labour costs (ulc_t, wun_t, $lprod_t$) and prices p_t (deflators, HICP and profit margin) for the total economy and the individual sectors.

It should be noted that HICP was added to the group of prices although there is no exact methodological correspondence (as to the composition of goods and services) with the various measures of total labour costs, as derived in total gross value added terms. The reason for the inclusion of HICP in the analysis is that price stability, as defined by the European Central Bank (ECB) (inflation below, but close to, 2% over the medium term), is calculated based on the rate of change in HICP prices.[5]

For the total economy and the ten individual sectors labour costs are measured using the respective indexes. The data on nominal unit labour costs ulc_t (index using as base year 2005=100) for the total economy and the ten individual sectors are taken from the Statistical Data Warehouse (SDW) of the ECB. According to the standard definition provided by Eurostat,[6] nominal unit labour costs are defined as follows:

5 The primary objective of the European System of Central Banks (ESCB) is to maintain price stability (Article 127 of the Treaty on the functioning of the European Union). The ECB Governing Council aims to keep inflation rates below, but close to, 2% over the medium term. In order to achieve its primary objective, the Governing Council bases its decisions on a two-pillar monetary policy strategy and implements them using its operational framework.

6 Source: Eurostat, http://epp.eurostat.ec.europa.eu.

$$ulc_t = \frac{wun_t}{lprod_t} = \frac{\frac{wind_t}{led_t}}{\frac{yer_t}{let_t}}$$

where $wind_t$ represents the total compensation of employees, led_t the total number of employees, and $wun_t = wind_t/led_t$ the average compensation per employee, while yer_t denotes GDP at constant prices (base year 2005=100), let_t total employment in the economy, and finally $lprod_t = yer_t/let_t$ average total productivity. The data on average compensation per employee and average total productivity, the two main components of nominal unit labour cost, are also published in the SDW database of the ECB broken down by sector.

The unit profit margin indicator for a specific sector is defined as follows: $pm_t = p_t/ulc_t$, i.e. as the ratio of the level of prices (deflator at basic prices) in the sector to the respective unit labour costs in the same sector.

Total demand shocks are proxied by the output gap[7] variable $Ogap_t$, which reflects the cyclical phase of demand in relation to the real economy's long-term trend (potential output). In addition, the rate of change in money supply to the economy *M3*[8] is taken into account as a proxy of the cyclical phase of demand.

Shocks attributable to total supply are proxied by the relative prices variable $RP_t = IM\_PPI_t / TT\_PPID_t$, wherein relative prices RP_t are defined as the ratio of the import price index in industry IM_PPI_t to the industrial producer price index for the domestic market TT_PPID_t. All series are seasonally adjusted (X_SA) using the X-12 method, and all variables examined in the empirical analysis are logarithmised.[9]

4 DESCRIPTIVE ANALYSIS. IS THERE EVIDENCE OF A DISCONNECTION BETWEEN PRICE DEVELOPMENTS AND UNIT LABOUR COST?

4.1 SECTORAL PRODUCTION SHARES AS PERCENTAGES OF GDP

As can be seen in Table 3, in the period covered by the present study (2000-2013), four production sectors account for comparatively

7 The output gap is the ratio of GDP (gross value added at basic prices, 2005=100) to the economy's potential output. Potential output is calculated by applying the Hodrick-Prescott (HP) filter to GDP.

8 M3=time deposits with an agreed maturity of up to 2 years + deposits redeemable at a period of notice of up to 3 months + repurchase agreements (repos) + money market fund shares/units + debt securities with a maturity of up to 2 years.

9 On the one hand, the logarithmic transformation of series eliminates any quadratic trends and on the other hand, the coefficients in the equations of the models estimated in the paper's empirical part express elasticities.

Table 3 Sectoral production shares as percentages of GDP

(% of GDP at basic prices, period average)

Sector	2000-2013	2000-2007	2008-2013
Agriculture	4.70	5.00	4.30
Industry	12.30	12.80	11.80
Construction	6.10	7.70	4.10
Trade	24.50	25.00	23.90
Information and communication	4.40	3.80	5.10
Financial sector	5.40	5.10	5.70
Real estate activities	12.90	12.00	14.20
Professional and other activities	6.30	6.90	5.40
Public administration and defence	19.60	18.60	20.90
Arts, entertainment and recreation	4.30	4.30	4.40

Sources: Calculations based on ELSTAT, ECB and European Commission data.

larger average shares in GDP: industry (12.3%); trade (24.5%); real estate (12.9%); and public administration and defence (19.6%). The combined share of these four sectors stands at 69.3% of GDP.

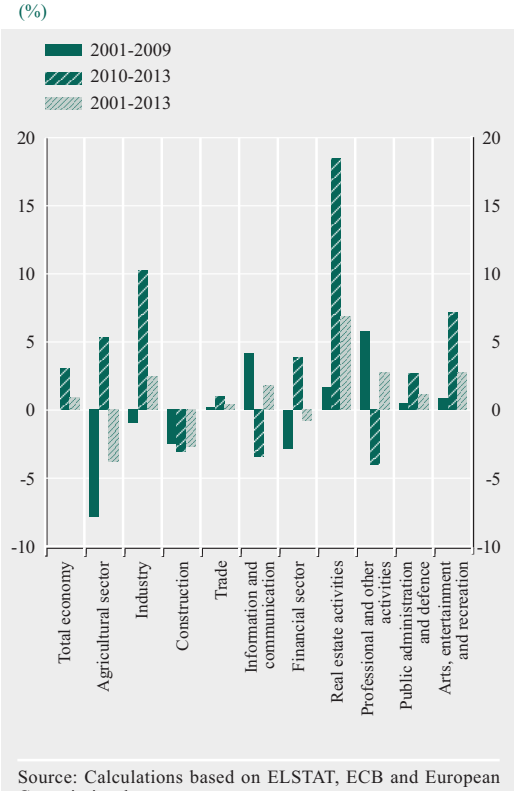
At the same time, no significant changes can be observed in sectoral shares during the two subperiods: 2000-2007 (pre-crisis period) and 2008-2013 (recession period). It should be noted that in the whole period examined (2000-2013), services —including trade; information and communication; financial services; real estate services; professional, scientific and technical services; public administration and defence; and arts, entertainment and recreation— is the most important sector of the economy, with a share of 77%, while the remaining sectors, i.e. agriculture (4.7%), industry (12.3%) and construction (6.1%), account for a combined share of approximately 23%.

In light of the above clarifications regarding the importance of each sector in terms of share in GDP, the following subsection, as well as the econometric investigation in Section 5, focuses only on the analysis for the total economy and its four major sectors: industry, trade, real estate, and public administration and defence.

4.2 DEVELOPMENTS IN PRICES, UNIT LABOUR COSTS AND UNIT PROFIT MARGIN INDICATORS OVER TIME

Examining the economy in two subperiods, before and after 2010, Table 4 along with Charts 1, 2.A and 2.B provide an extensive range of information as regards price, unit labour cost and profit margin developments over time, for the total economy and for its major sectors.[10] Year 2010 was selected as a structural breakpoint that splits the sample into two subperiods (2000-2009: first subperiod; and 2010-2013: second subperiod), based on the fact that since mid-2010 (with the signing of the first Memorandum[11]) Greece has seen a gradual implementation of fiscal consolidation measures.

Chart 1 Developments in the unit profit margin indicator in all sectors of the economy



Source: Calculations based on ELSTAT, ECB and European Commission data.

The profit margin indicator per unit is calculated as $pm_t=p_t/ulc_t$, i.e. as the ratio of the basic price in the respective sector (excluding taxes on production) to the respective unit labour costs. Compared with other definitions used for calculating a sector's profit margins, the above definition, albeit seemingly simplistic, offers the following advantages: data collection availability, computational ease, and relative consistency in terms of comparability, allowing for the study of different sectors and economies. On the other hand, this approach ignores the cost of other inputs in the pro-

10 Table 12 in the Annex presents the same information for all sectors of the economy.

11 Memorandum of Understanding on financial assistance to the Hellenic Republic – along with its integral parts, namely: (i) Memorandum of Economic and Financial Policies; (ii) Memorandum of Understanding on Specific Economic Policy conditionality; and (iii) Technical Memorandum of Understanding – signed on 3 May 2010 on the one hand by the IMF, the ECB and the European Commission acting on behalf of the euro area countries, and on the other hand by the Greek Government.

Table 4 Developments in prices, unit labour costs and profit margins in the major sectors of the economy

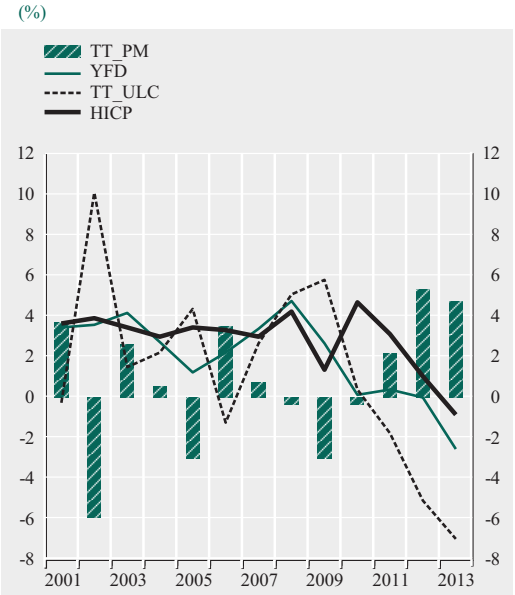
(annual percentage changes %)

	Total economy				Industry		
	HICP (HICP)	Deflator (YFD)	Unit labour cost (TT_ULC)	Profit margin (TT_PM)	Deflator (INDD)	Unit labour cost (IND_ULC)	Profit margin (IND_PM)
2001	3.6	3.5	-0.2	3.7	2.5	1.8	0.6
2002	3.9	3.6	10.1	-5.9	4.5	14.9	-9.1
2003	3.5	4.2	1.5	2.6	0.8	-1.7	2.6
2004	3.0	2.7	2.2	0.5	7.1	3.3	3.7
2005	3.5	1.3	4.4	-3.0	-1.9	13.2	-13.4
2006	3.3	2.2	-1.2	3.5	8.9	5.3	3.4
2007	3.0	3.4	2.7	0.7	2.4	4.6	-2.2
2008	4.2	4.8	5.1	-0.3	13.0	10.1	2.7
2009	1.3	2.7	5.8	-3.0	-3.1	-5.7	2.8
2010	4.7	0.1	0.4	-0.3	4.1	-3.2	7.6
2011	3.1	0.4	-1.7	2.2	-0.1	-5.7	5.9
2012	1.0	0.0	-5.0	5.3	4.6	-12.6	19.6
2013	-0.9	-2.5	-7.0	4.8	0.8	-6.3	7.6
Period average	**HICP**	**YFD**	**TT_ULC**	**TT_PM**	**INDD**	**IND_ULC**	**IND_PM**
2001-2013	2.9	2.0	1.3	0.8	3.3	1.4	2.4
2001-2009	3.3	3.1	3.4	-0.1	3.8	5.1	-1.0
2010-2013	2.0	-0.5	-3.3	3.0	2.3	-6.9	10.2

	Trade			Real esate activities			Public administration and defence		
	Deflator (TRD)	Unit labour cost (TR_ULC)	Profit margin (TR_PM)	Deflator (RED)	Unit labour cost (RE_ULC)	Profit margin (RE_PM)	Deflator (PAD)	Unit labour cost (PA_ULC)	Profit margin (PA_PM)
2001	2.7	-10.2	14.4	4.1	145.2	-57.5	6.2	3.5	2.6
2002	-0.7	-0.7	0.0	4.3	61.8	-35.5	9.9	12.2	-2.0
2003	3.4	-4.6	8.4	5.1	-32.1	54.8	5.1	0.5	4.5
2004	0.7	-2.4	3.2	5.5	56.8	-32.7	7.4	13.0	-5.0
2005	-12.8	4.8	-16.7	8.1	-32.1	59.1	1.5	1.6	0.0
2006	2.4	1.3	1.1	3.5	10.5	-6.3	-0.9	-1.1	0.2
2007	4.0	2.5	1.4	4.8	-10.3	16.8	4.5	4.7	-0.2
2008	5.0	6.0	-1.0	4.8	1.2	3.6	8.4	5.3	2.9
2009	2.1	12.6	-9.3	4.7	-6.6	12.1	8.0	6.9	1.1
2010	1.5	5.0	-3.4	3.3	-0.9	4.2	-5.5	-7.1	1.7
2011	2.9	0.8	2.1	3.2	-18.8	27.0	-4.7	-4.8	0.0
2012	0.4	0.5	-0.1	-2.1	-10.3	9.2	-0.3	-5.5	5.5
2013	-1.3	-6.3	5.3	-6.7	-29.9	33.0	-4.0	-7.2	3.4
Period average	**TRD**	**TR_ULC**	**TR_PM**	**RED**	**RE_ULC**	**RE_PM**	**PAD**	**PA_ULC**	**PA_PM**
2001-2013	0.8	0.7	0.4	3.3	10.3	6.8	2.7	1.7	1.1
2001-2009	0.8	1.0	0.2	5.0	21.6	1.6	5.6	5.2	0.5
2010-2013	0.9	0.0	1.0	-0.6	-15.0	18.4	-3.6	-6.1	2.7

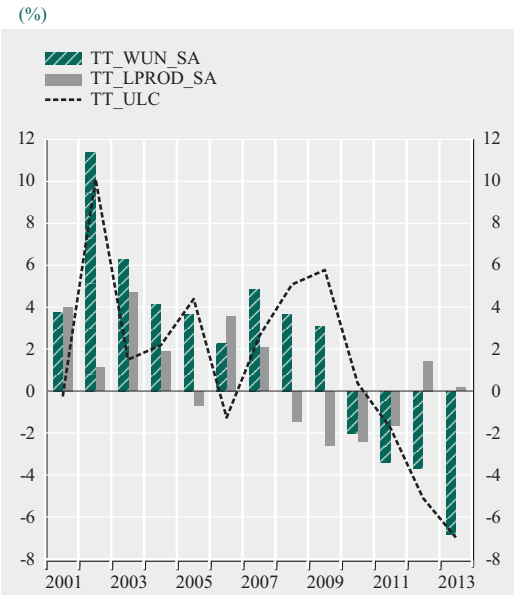
Sources: Calculations based on ELSTAT, ECB and European Commission data.

Chart 2.A Rates of change in GDP deflator (YFD), HICP, unit labour costs (TT_ULC) and profit margin indicator (TT_PM) in total economy



Source: Calculations based on ELSTAT, ECB and European Commission data.

Chart 2.B Rates of change in unit labour costs (TT_ULC), total compensation per employee (TT_WUN_SA) and labour productivity (TT_LPROD_SA) in total economy



Source: Calculations based on ELSTAT, ECB and European Commission data.

duction process (raw materials, intermediate goods and energy), firms' tax burden, as well as financial costs.

Data in Table 4 in combination with Chart 1 show that for the total economy the profit margin per unit rose on average by 3.0% in the subperiod 2010-2013, against an average of only 0.8% in the whole period 2001-2013.

This implies a disconnection between the rate of change in unit labour costs and inflation. In other words, in the subperiod 2010-2013, whereas unit labour costs fell on average by 3.3%, prices fell by only 0.5% when measured using the GDP deflator, and rose by 2.0% when measured based on the HICP. This disconnection is more visible in the years 2012 and 2013, when profit margins widened by 5.3% and 4.8% respectively (see Table 4).

As for the total economy, in Chart 2.A it can be seen that the rates of change in the GDP deflator, the HICP and the unit labour cost indicator follow a relatively common path in the subperiod 2000-2009.

From mid-2010 onwards, with the gradual implementation of fiscal consolidation measures (after the signing of the first Memorandum), the series examined changed significantly, trending downwards. Nevertheless, they strongly deviate from each other, with unit labour costs recording a much steeper fall compared with the two inflation measures in the subperiod 2010-2013. This is attributable to the large cumulative reduction (14.9%) of total compensation per employee in the subperiod 2010-2013, while labour productivity also fell by 2.3% (see Chart 2.B). Evidently therefore, two different patterns can be observed: a first pattern (2001-2009) in which the series co-fluctuate, and a second pattern (2010-2013) characterised by a common but disproportionate downward trend. Industry (10.2%) and real estate (18.4%) show the widest average profit margins in the subperiod 2010-2013 (see Chart 1).

Table 5 Pearson correlation coefficient between deflators and unit labour costs

	Total economy	Industry	Trade	Real estate activities	Public administration
2000-2013	***YFD_SA***	***INDD_SA***	***TRD_SA***	***RED_SA***	***PAD_SA***
TT_ULC_SA	*0.92*	0.81	0.37	0.91	0.96
IND_ULC_SA	0.70	*0.58*	-0.05	0.69	0.81
TR_ULC_SA	0.68	0.74	*0.66*	0.71	0.51
RE_ULC_SA	-0.10	-0.24	-0.25	*-0.15*	0.10
PA_ULC_SA	0.80	0.66	0.12	0.77	*0.93*
2000-2009	***YFD_SA***	***INDD_SA***	***TRD_SA***	***RED_SA***	***PAD_SA***
TT_ULC_SA	*0.97*	0.91	0.07	0.95	0.98
IND_ULC_SA	0.95	*0.95*	-0.08	0.95	0.90
TR_ULC_SA	0.32	0.40	*0.22*	0.34	0.29
RE_ULC_SA	0.28	0.21	0.16	*0.22*	0.33
PA_ULC_SA	0.97	0.91	0.05	0.95	*0.98*
2010-2013	***YFD_SA***	***INDD_SA***	***TRD_SA***	***RED_SA***	***PAD_SA***
TT_ULC_SA	*0.65*	-0.86	-0.33	0.75	0.81
IND_ULC_SA	0.41	*-0.88*	-0.56	0.54	0.76
TR_ULC_SA	0.73	-0.28	*0.37*	0.68	0.35
RE_ULC_SA	0.60	-0.73	-0.47	*0.62*	0.90
PA_ULC_SA	0.55	-0.80	-0.52	0.61	*0.88*

Source: Author's own calculations.

Table 5 presents the Pearson linear correlation coefficient between prices and unit labour costs in the total economy and the individual sectors. It should be noted that the coefficient is calculated using the levels of the two series,[12] and for all three periods selected.

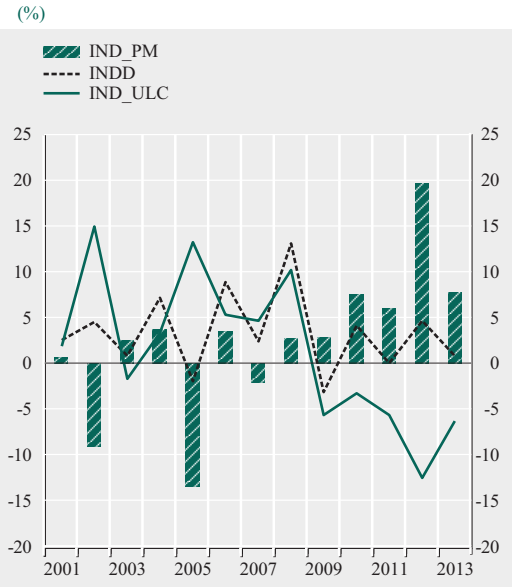
In the subperiod before the signing of the Memorandum (2000-2009), the Pearson correlation coefficient (see Table 5) between prices and unit labour costs in the total economy is high, $p_{yfd,tt\_ulc} = 0.97$. In the subperiod after the signing of the Memorandum (2010-2013), the correlation coefficient in the total economy declines, $p_{yfd,tt\_ulc} = 0.65$, providing support for the observation that there is, in general, a partial disconnection of the series after 2010.

In particular, the disconnection between inflation (2.3%) and the rate of change in unit labour costs (-6.9%) in the subperiod 2010-2013 becomes more evident in industry (see Chart 3), which produces the bulk of the economy's tradable (exportable) goods. This disconnection is more apparent in 2012 and 2013, when the profit margin rose by 19.6% and 7.6% respectively. This was due to the rapid fall in unit labour costs (down by 12.6% and 6.3%) in 2012 and 2013, with the rates of change in prices standing at 4.6% and 0.8%, respectively.

The decline in unit labour costs in 2012 and 2013 is attributable to a 5.5% and 4.2% reduction of total compensation per employee, respectively, and to an 8.2% and 2.1% pick-up in labour productivity at the same time. This disconnection hindered the country's efforts to regain competitiveness based on the policy of

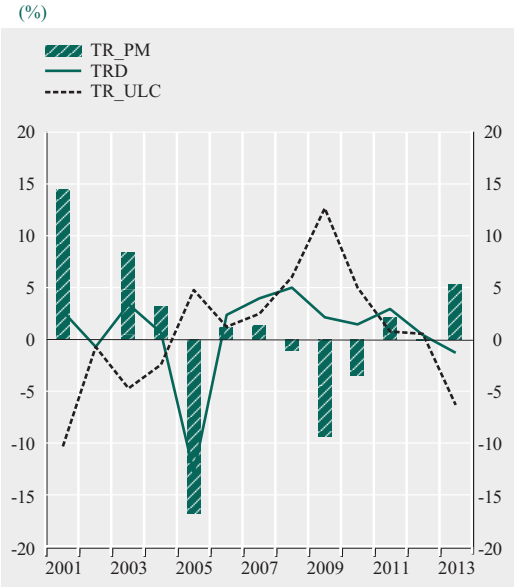
12 The Pearson linear correlation coefficient was calculated at the levels of the two series so as to provide a forward-looking indication of the existence or otherwise of a constant long-term relationship between prices and unit labour costs.

Chart 3 Rates of change in industry deflator (INDD), unit labour costs (IND_ULC) and profit margin indicator (IND_PM)



Source: Calculations based on ELSTAT, ECB and European Commission data.

Chart 4 Rates of change in trade deflator (TRD), unit labour costs (TR_ULC) and profit margin indicator (TR_PM)



Source: Calculations based on ELSTAT, ECB and European Commission data.

internal devaluation pursued from 2010 onwards, since prices in the industrial sector seem not to have sufficiently responded to adjustments in labour costs.

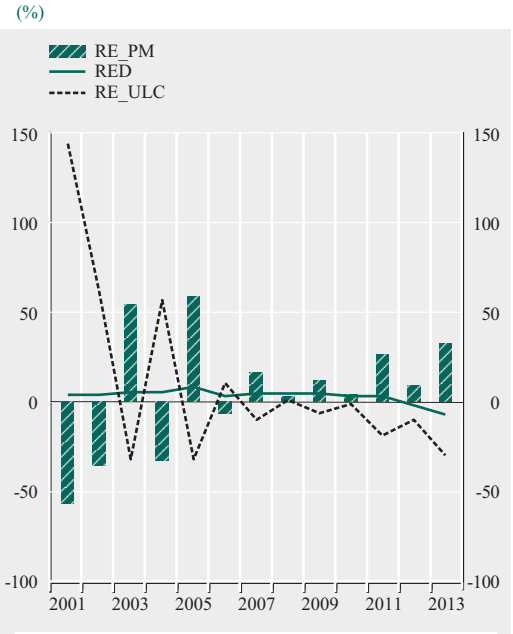
In industry, whereas the Pearson correlation coefficient (see Table 5) is high $p_{ind,indd\_ulc}$=0.95 in the subperiod 2000-2009, it becomes quite negative $p_{ind,indd\_ulc}$=-0.81 in the subperiod 2010-2013, thus suggesting a strong disconnection between prices and unit labour costs. Over the whole period 2000-2013, this coefficient is relatively high $p_{ind,indd\_ulc}$=0.58, implying that there is considerable interconnection between prices and labour costs in the sector. This finding indicates that a constant long-term relationship might be detected.

With respect to the trade sector, as can be observed in Chart 4, mainly after 2010 the rate of changes in the deflator and unit labour costs follow a relatively common trend.

The average profit margin per unit in the subperiod 2000-2009 was 0.2%, while it rose by 1.0% in the subperiod 2010-2013. Unit labour costs in the subperiod 2010-2013 remained unchanged. The average compensation per employee fell by 4.3%, while average labour productivity also declined by 4.1%. It can be argued that this sector shows no strong disconnection between prices and wages in the subperiod 2010-2013, with the exception of 2013 during which the profit margin widened by 5.3% due to a 6.3% decline in unit labour cost amidst negative inflation (-1.3%). It should however be noted that the Pearson correlation coefficient (see Table 5) in the subperiod 2000-2009 is much lower for the trade sector (p_{trd,tr_ulc}= 0.22) than for the industrial sector ($p_{ind,indd\_ulc}$=0.95) or the total economy (p_{yfd,tt_ulc}=0.97). This means that the trade sector exhibits a weaker interconnection between prices and labour costs, implying that the existence of a constant long-term relationship cannot be detected. In the subperiod 2010-2013, the linear correlation coefficient increases (p_{trd,tr_ulc}=0.37).

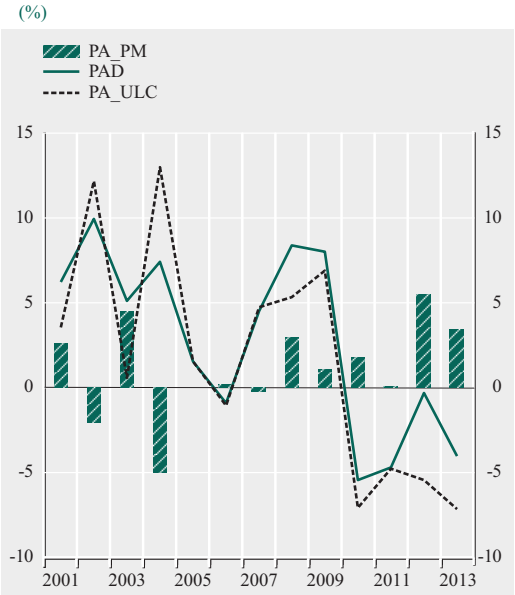
In real estate (see Chart 5), labour costs fluctuate strongly up to 2006 (perhaps due to sta-

Chart 5 Rates of change in real estate deflator (RED), unit labour costs (RE_ULC) and profit margin indicator (RE_PM)



Source: Calculations based on ELSTAT, ECB and European Commission data.

Chart 6 Rates of change in the public administration and defence deflator (PAD), unit labour costs (PA_ULC) and profit margin indicator (PA_PM)



Source: Calculations based on ELSTAT, ECB and European Commission data.

tistical reasons as well), while the deflator changes more smoothly, by 5.0% on average in the subperiod 2001-2009.

For this reason, and given also that prices in the real estate activities sector may possibly be largely implied, we should be cautious about drawing conclusions with respect to the profit margin in this sector. In the subperiod 2010-2013 the average profit margin seems to have widened to 18.4%, on account of a 15.0% drop in unit labour costs, while inflation was on average negative (-0.6%). This large reduction of unit labour costs is attributable to an apparent pick-up in labour productivity, which rose on average to 14.6% in the subperiod 2010-2013, while wages per employee fell to 4.9%. It is possible that, with the collapse in building activity and the large recession in the real estate market, the very steep decrease in employment in this sector leads to overestimated labour productivity. In addition, it should also be noted that the Pearson correlation coefficient is relatively low (p_{red,re_ulc}= 0.22) in the subperiod 2000-2009, and rises considerably (p_{red,re_ulc}=0.62) in the subperiod 2010-2013, as strong volatility levels out after 2006. This means that there is no constant interconnection between prices and labour costs in this sector, thus indicating that the existence of a long-term relationship is not likely to be detected in the empirical part of the study.

Turning now to public administration and defence, it can be seen in Chart 6 that up to 2011 the rates of change in the deflator and the unit labour cost index follow a common path. From mid-2009 onwards, a change of course is recorded for both rates. They exhibit a strong downward trend, but also appear disconnected from each other after 2011. This is attributable to the rapid fall (-6.1% on average) in unit labour costs in the subperiod 2010-2013 on account of lower wages per employee by 4.9% on average, while labour productivity in the sector picked up by 1.4% mainly due to a large decline in employment in the context of public sector consolidation measures. Profit mar-

Table 6 Degree of disconnection between prices and unit labour costs in 2010-2013 compared with 2000-2009

Sectors	Couples of prices and unit labour costs by production sector	Pearson correlation coefficient			Degree of disconnection in 2010-2013 compared with 2000-2009
		2000-2013	2000-2009	2010-2013	
Total economy	(YFD, TT_ULC)	0.92	0.97	0.65	Partial disconnection
Industry	(INDD, IND_ULC)	0.58	0.95	-0.88	Strong disconnection
Trade	(TRD, TR_ULC)	0.66	0.22	0.37	Partial reconnection
Real estate activities	(RED, RE_ULC)	-0.15	0.22	0.62	Partial reconnection
Public administration and defence	(PAD, PA_ULC)	0.93	0.98	0.88	Partial disconnection

Source: Author's own calculations.

gin in the subperiod 2010-2013 widened by 2.7% as a result of a larger decrease in unit labour costs (down by 6.1%) compared to the decline in the rate of change in prices (by 3.6%). The Pearson correlation coefficient (see Table 5) fell from p_{pad,pa_ulc}=0.98 in the subperiod 2000-2009 to p_{pad,pa_ulc}=0.88 in the subperiod 2010-2013, providing support for the observation regarding a partial disconnection between inflation and labour costs mainly after 2011. On the other hand, the value p_{pad,pa_ulc}=0.88 remains still high, thereby indicating that in general, despite the disconnection observed in recent years, prices and labour costs in this sector follow a common long-term path.

Table 6 summarises the above conclusions and intends to characterise the degree of disconnection between prices and unit labour costs observed in the total economy and the individual sectors.

In light of all the above, we arrive at the conclusion that for the total economy in the subperiod 2010-2013, unit labour cost adjustments are largely disconnected from price measures, at both the levels of the series and their rates of change. The considerable fall in unit labour costs is mainly attributable to the reduction of nominal wages per employee rather than the pick-up in average labour productivity. Strengthening productivity is the crucial factor that will help improve the economy's competitiveness, since any further downward adjustment of wages is rather unlikely to benefit the economy while it risks undermining social cohesion. The disconnection between prices and labour costs hinders the monetary policy transmission channel (Wolff 2012) from acting as a catalyst that would speed up the intended adjustments in terms of competitiveness and consumer purchasing power so as to faster cure any distortions in the economy's smooth operation, growth and stability.

5 METHODOLOGICAL ISSUES AND ECONOMETRIC METHODOLOGY

5.1 METHODOLOGICAL ISSUES

The econometric method used distinguishes between a long-term and a short-term price adjustment mechanism. This enables the exploration of two different questions: the pass-through rate and the speed of adjustment to long-run equilibrium level.

The pass-through rate is the part of the increase or decrease in unit labour costs that moves on to prices, or vice versa, i.e. the part of the increase or decrease in prices passed through to unit labour costs. For instance, if an increase in unit labour costs leads to an equal increase in prices, then it is considered that the adjustment rate is 100%, i.e. full pass-through

is achieved and long-term elasticity takes a value equal to unity. Long-term elasticity depends on the pattern of demand firms have to meet and the strength of competition in the sector. In a perfectly competitive environment, this value equals marginal cost. Given that unit labour cost represents a key component of the marginal cost a firm needs to cover, we would expect a long-term elasticity value close to unity, or in other words a pass-through rate of almost 100%.

The speed of adjustment of prices and wages to the long-run equilibrium is affected by many factors. Market structure reflects a firm's degree of power and offers a good explanation of the phenomenon. The existence of only a small number of firms engaged in a given market generates incentives for cartel-forming collusion deals,[13] with a view to ensuring an excessive (non-normal) profit margin. In such a case, a price reduction by one firm when unit labour cost is shrinking may be seen by the other firms as an aggressive move that breaches their agreement. As a consequence, in periods of declining labour costs firms tend to keep their prices unchanged (rigid), or delay any changes, so as to achieve the continuation of a higher profit margin. In contrast, when labour costs are rising there is no misinterpretation about any cartel-breaking move, and firms tend to raise their prices immediately and proportionately.

Employees, on the other hand, when they see that prices go up tend to ask in advance for "precautionary" larger wage increases than their labour productivity would justify, in fear of a further price increase in the future and with a view to offsetting possible losses of their purchasing power. But when prices go down, nominal wages are not adjusted as quickly (wage rigidity), causing a lag in the speed of adjustment of wages.

5.2 ECONOMETRIC METHODOLOGY

The study applies an econometric methodology that comprises the following steps:

The first step is to test the series' integration order, determining whether it possesses a unit root, by carrying out the DF-GLS (Elliott et al. 1996) tests and the PP (Phillips and Perron 1988) tests.[14]

The second is to investigate the existence of possible long-run equilibrium relationships among the variables, using the JJ (FIML) maximum likelihood cointegration method proposed by Johansen and Juselius (Johansen 1998 and 1992; and Johansen and Juselius 1990). The JJ test for cointegration is based on an autoregressive vector error correction model (VECM) and is methodologically preferable to the test proposed by Engle and Granger (1987).[15] For the purposes of the present study we estimate a bivariate VAR (2), in which unit labour costs and prices are seen as endogenous variables of the system. The results of the JJ method are known to be sensitive to the number of lags (Banerjee et al. 1993) included in the VAR model. The appropriate number of lags in the vector autoregressive VAR system is determined using the AIC, SBC, HQ and LR information criteria.[16] Whether the model specification should include deterministic components (trends and constant terms) or not is determined following the Pantula (1989) principle.

Third, assuming the existence of a long-run equilibrium or a cointegration relationship

13 A typical example would be the oligopolistic structure of the wholesale trade market, with the poultry market cartel detected by the Competition Commission in 2012.

14 The DF-GLS (Elliott et al. 1996) and PP (Phillips and Perron 1988) tests for unit root are generally considered statistically more reliable than the DF-ADF (Dickey and Fuller 1979, 1981) tests.

15 The Engle and Granger (1987) test for cointegration examines regression between series of the same integration order I(n), and then, if the residuals from this regression are stationary – i.e. I(0) – the series are considered to be cointegrated. But this test has some weaknesses: First, the results are sensitive to the specific series selected as the dependent variable. Second, it disallows testing the number of cointegration relationships, i.e. if there are one or more. Third, the classical statistical tests of hypotheses regarding the cointegration vectors cannot be run, since the estimated coefficients follow an unknown non-standardised distribution. In contrast, the JJ test proposed by Johansen and Juselius (1990) is free of all these problems: it allows for a direct investigation of the number of cointegration vectors and enables the application of classical statistical tests of hypotheses on the estimated cointegration vectors.

16 LR: sequential modified LR test statistic (Sims' Test); AIC: Akaike information criterion (1973); SC: Schwarz information criterion (1978); HQ: Hannan-Quinn information criterion (1979).

between prices and unit labour costs using the JJ method, the cointegration relationship to be estimated has the following specification:

$$p_t = \delta\ (wun - lprod)_t + U_{1t} \qquad (4)$$

with $\delta > 0$ and $ulc_{t-1} = (wun - lprod)_{t-1}$

where U_{1t} is the random disturbance term. Granger (1988, 1995) has shown that if two series are cointegrated, then Granger-causality[17] must be present, running at least in one direction.

Consequently, the existence of a cointegration relationship such as (4) suggests that there is an error correction model between prices and wages, which can be written as follows:

$$\Delta p_t = \alpha_0 + \sum_{s=1}^{k1} \alpha_{1s} \Delta p_{t-s} + \sum_{s=1}^{k2} \alpha_{2s} \Delta (wun - lprod)_{t-s} + \lambda_1 (p - \delta (wun - lprod)_{t-1} + \varepsilon_{1t} \qquad (5.1)$$

and

$$\Delta (wun - lprod)_t = \beta_0 + \sum_{s=1}^{k1} \beta_{1s} \Delta (wun - lprod)_{t-s} + \sum_{s=1}^{k2} \beta_{2s} \Delta p_{t-s} + \lambda_2 (p - \delta (wun - lprod)_{t-1} + \varepsilon_{2t} \qquad (5.2)$$

where λ_1 and $\lambda_2 \neq 0$. The model of equations (5.1) and (5.2) implies that anytime the level of prices p_{t-1} deviates from the long-run equilibrium level of $\delta(wun - lprod)_{t-1}$, either prices or unit labour costs adjust so that the series move together in the long run. The time lag at the levels of the series is introduced in the VAR (2) via the error correction term $p_{t-1} - \delta(wun - lprod)_{t-1} = U_{t-1}$.

The test for the hypothesis that unit labour costs show no causal relationship with prices (cannot help predict prices) is that all $\alpha_{2s} = 0$ and/or $\lambda_1 = 0$. Respectively, the test for the hypothesis regarding a causal relationship between prices and unit labour costs is that all $\beta_{2s} = 0$ and/or $\lambda_2 = 0$. Therefore, the existence of causality (or absence of weak exogeneity) is examined by testing whether λ_1 and $\lambda_2 \neq 0$, or whether at least one of them is statistically significant (not equal to zero).

In case the JJ test reveals the existence of a long-run equilibrium or cointegration relationship between prices and unit labour costs, we use the dynamic ordinary least squares (DOLS) method proposed by Stock and Watson (1993) to estimate the long-term elasticities. The JJ method also provides maximum likelihood estimates for the cointegration relationships of the price equations and the wage equations. However, even though the JJ method asymptotically is superior, it does not perform well with small samples. The sample of 56 observations (Q1 2000-Q4 2013) is considered to be rather small in order to test for (long-term) cointegration relationships. In contrast, DOLS method proposed by Stock and Watson (1993) to test for cointegration is effective and well-fitted to small samples.

The specifications of the long-term equations are respectively written as follows:

Price equation:

$$p_t = a_0 + a_1 (wun - lprod)_t + \sum_{s=-k}^{k} \alpha_{2s} \Delta (wun - lprod)_{t-s} + U_{1t} \qquad (6.1)$$

Wage equation:

$$(wun - lprod)_t = \beta_0 + \beta_1 p_t + \sum_{s=-k}^{k} \beta_{2s} \Delta p_{t-s} + U_{2t} \qquad (6.2)$$

where $ulc_t = (wun - lprod)_t$.

Given that the random disturbance terms U_{1t} and U_{2t} may be linearly autocorrelated, equations (6.1) and (6.2) are typically submitted to the standard tests for autocorrelation and appropriately corrected. The correlation between unit labour cost and the level of prices

17 A variable X_{1t} Granger-causes variable Y_{2t}, if prediction regarding Y_{2t} improves including X_{1t} information and time lags of X_{1t}.

is not statistically significant in the long run if $\alpha_1 = 0$ and is statistically significant if $\beta_1 = 0$.

Fourth, the existence and nature of short-term interactions between unit labour costs and prices are Granger-tested in the context of an expectations-augmented Phillips curve. In the tests for weak, strict (short-term) and strong exogeneity we use an autoregressive vector error correction model VECM (2) with prices and unit labour costs as endogenous variables, and the output gap, money supply and relative prices as exogenous variables. In their augmented version, the equations of the bivariate system VECM (2) have the following specifications:

Dynamic price equation:

$$\Delta p_t = \alpha_0 + \sum_{s=1}^{k1} \alpha_{1s} \Delta p_{t-s} + \sum_{s=1}^{k2} \alpha_{2s} \Delta ulc_{t-s} + \sum_{s=1}^{k3} \beta_{3s} Ogap_{t-s} + \sum_{s=1}^{k4} \alpha_{4s} \Delta M3_{t-s} + \sum_{s=1}^{k5} \alpha_{5s} \Delta RP_{t-s} + \lambda_1 \hat{U}p_{t-1} + \varepsilon_{1t} \quad (7.1)$$

and

Dynamic wage equation:

$$\Delta ulc_t = \beta_0 + \sum_{s=1}^{k1} \beta_{1s} \Delta ulc_{t-s} + \sum_{s=1}^{k2} \beta_{2s} \Delta p_{t-s} + \sum_{s=1}^{k4} \beta_{4s} \Delta M3_{t-s} + \sum_{s=1}^{k5} \beta_{5s} \Delta RP_{t-s} + \lambda_2 \hat{U}w_{t-1} + \varepsilon_{2t} \quad (7.2)$$

where $\hat{U}p$ is the residual from the cointegration relationship of the long-term price equation and $\hat{U}w$, respectively, the residual from the cointegration relationship of the long-term wage equation. Lag lengths k_1, k_2, k_3, k_4 and k_5 denote the time lags of the explanatory variables needed for the disturbance terms (ε_1, ε_2) to become linearly uncorrelated. Unit labour costs do not Granger-cause prices if all $\alpha_{2s}=0$ and/or $\lambda_1 = 0$, whereas prices do not Granger-cause unit labour costs if all $\beta_{2s}=0$ and/or $\lambda_2=0$.

6 THE EMPIRICAL RESULTS

6.1 TEST FOR LONG-RUN EQUILIBRIUM

The results of the DF-GLS and PP tests for the existence of unit roots[18] lead to the conclusion that the unit root hypothesis cannot be rejected at the levels of the series, while, by contrast, in their first differences it is rejected in all cases, in favour of the alternative hypothesis of stationarity. The results show that all the series examined are I(1) integration order, which means that they are stationary in their first differences.

The results of the JJ test support the existence of cointegration between the levels of prices and unit labour costs in the total economy and in the industrial and public administration and defence sectors. In contrast, no cointegration was found in the sectors of trade and real estate activities. Table 8 presents the cointegration vectors based on the DOLS method. Briefly inspected, it shows that long-term elasticities seem to stand very close to unity for the total economy and the public administration and defence sector, whereas they are not as close for the industrial sector. However, testing for the hypothesis of long-term unit elasticity using the Wald test statistic, we find that this hypothesis cannot be accepted in all cases (see Table 9).

Table 7 presents the results of the test for cointegration of the series and more specifically between the level of the unit labour cost indicator and the level of prices in the respective sector and in the total economy. The test is run using the JJ maximum likelihood method.

As regards price equations, the hypothesis of long-term unit elasticity can only be accepted in the cases of the total economy when prices are measured based on the GDP deflator, in the public administration and defence sector. This means that the adjustment rate is 100%, i.e. an increase in unit labour costs leads to an equal increase in prices in these sectors. By contrast, in the cases of the total economy when prices are measured based on the HICP, and of the industrial sector, the hypothesis of long-term unit elasticity cannot be accepted.

18 Unit root test results are not presented here for brevity reasons, but are available on request.

Table 7 JJ cointegration test

Sectors	System	Lags	Test hypothe-sis	Trace test (λ)	p-value	Max-eigenvalue test (λ max)	p-value	Result
Total economy	(YFD, TT_ULC)	1	H_0:r=0	30.08**	0.00	27.29**	0.00	Cointegration
Total economy	(HICP, TT_ULC)	1	H_0:r=0	74.96**	0.00	70.94**	0.00	Cointegration
Industry	(INDD, IND_ULC)	5	H_0:r=0	22.60**	0.02	16.92**	0.03	Cointegration
Trade	(TRD, TR_ULC)	5	H_0:r=0	9.27	0.71	8.55	0.48	No cointegration
Real estate activities	(RED, RE_ULC)	1	H_0:r=0	25.51**	0.00	13.99	0.06	No cointegration
Public administration and defence	(PAD, PA_ULC)	8	H_0:r=0	28.42**	0.00	22.13**	0.00	Cointegration

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
Note: Time lags for no autocorrelation of the residuals in the system were selected using the SIC (Schwarz 1978), AIC (Akaike 1973) and HQ (Hannan and Quinn 1979) information criteria.

More specifically, the long-term elasticity of prices based on the HICP is α_1=1.18, implying[19] that an increase of 1% in unit labour costs raises prices by 1.18%.

On the other hand, in industry the long-term elasticity of prices is α_1 = 0.62, implying that an increase of 1% in unit labour costs raises prices by 0.6%. A value of 0.62 for α_1 leads us to the conclusion that the industrial sector is possibly characterised by an oligopolistic market structure and the adjustment rate depends predominantly on the shape of the demand curve firms in the sector have to meet and the strategy they follow with respect to profit margins. It should be recalled that in the subperiod 2010-2013, mainly due to the large fall in unit labour costs, the unit profit margin in industry rose on average by 10.2%, while in the total economy only by 3.0%. Partial price adjustment is expected in oligopolistic structured sectors, wherein firms have already chosen the price that maximises their profits.

19 Nevertheless, this result should be treated with caution, given that, as already noted, HICP was included in the group of prices examined, despite the lack of an exact methodological correspondence (as to the composition of goods and services) with the variables of total labour costs, since price stability (inflation close to 2% over the medium term) according to the ECB definition is measured based on the rate of change in HICP prices.

Table 8 Cointegration vectors using the DOLS method

Sectors	Price equations	Wage equations
Total economy	YFD = 0.10 + 0.98 TT_ULC (0.46) (20.16)	TT_ULC = -0.12 + 1.01 YFD (-0.39) (15.21)
Total economy HICP	HICP= -0.76 + 1.18 TT_ULC (-3.43) (24.60)	TT_ULC = 1.24 + 0.70 HICP (4.53) (11.95)
Industry	INDD= 1.86 + 0.62 IND_ULC (3.93) (6.12)	IND_ULC = 1.50 + 0.64 INDD (1.37) (2.74)
Public administration and defence	PAD= 0.21 + 0.96 PA_ULC (0.93) (19.23)	PA_ULC = 0.29 + 0.92 PAD (2.01) (28.43)

Note: t-statistic values in brackets; long-term equations have been estimated using the DOLS method (Stock and Watson 1993); time lags and leads are based on the SIC information criterion; variance-covariance matrix estimators have been corrected for heteroscedasticity and autocorrelation using the HAC method.

Table 9 Test for long-term unit elasticity

	Price equations	Wage equations
Wald t-statistic test	$H_0: \alpha_1=1$	$H_0: \beta_1=1$
Production sectors	p-value	p-value
Total economy	0.77	0.77
Total economy	0.00	0.00
Industry	0.00	0.14
Public administration and defence	0.45	0.02

Note: The null hypothesis (H_0)) is accepted for p-value>0.05.

As regards the wage equations, the hypothesis of a long-term unit elasticity can only be accepted in the cases of the total economy, when prices are measured based on the GDP deflator, and the industrial sector. In the latter, the elasticity of wages was estimated at α_1=0.64, but is statistically insignificantly different than 1, which would imply that a 1.0% increase in prices could raise unit labour costs by 1.0% in the long run. This full adjustment rate of unit labour costs to changes in the level of prices, as much in the total economy as in industry, could reflect the extensive bargaining power of employees' representatives (i.e. trade unions and confederations) in collective wage negotiations. In other words, there is evidence that in the Greek economy employees' institutional representatives manage to adjust wages in proportion to changes in the level of prices. On the other hand, in the public administration sector, the long-term elasticity of unit labour costs is α_1=0.92, possibly reflecting difficulties in determining prices in the specific sector.

6.2 CAUSALITY TESTS

The results of the cointegration tests provide empirical evidence that prices and unit labour costs exhibit a long-run equilibrium relationship. But this finding cannot help us discern which of the two series adjusts to changes in the other, or if this adjustment is bidirectional. Granger-tests for weak, strict and strong exogeneity provide evidence of a causal relationship between the two variables.

In the specification of the price equation (5.1), the existence of weak (long-term) exogeneity is tested with the hypothesis H_0:λ_1=0. The existence of strict (short-term) exogeneity is Granger-tested with the hypothesis H_0:$\sum_{s=1}^{k2}\alpha_{2s}=0$. The existence of strong exogeneity is Granger-tested with the test of the combined hypotheses that H_0:λ_1=0 and H_0:$\sum_{s=1}^{k2}\alpha_{2s}=0$.

Respectively, in the specification of the wage equation (5.2), the existence of weak (long-term) exogeneity is tested with the hypothesis H_0:λ_2=0. The existence of strict (short-term) exogeneity is Granger-tested with the hypothesis $H_0: \sum_{s=1}^{k2}\beta_{2s}=0$. The existence of strong exogeneity is Granger-tested with the combined hypotheses that $H_0: \lambda_2 = 0$ and $\sum_{s=1}^{k2}\beta_{2s}=0$.

Table 10 summarises the tests for Granger-causality (running from unit labour costs to prices) for the augmented dynamic price equation based on (7.1). The VECM (2) system includes as exogenous variables the output gap (Ogap), money supply (M3) and relative prices (RP). According to the results, the existence of weak exogeneity is rejected in all cases (since the error correction term is statistically significant) with the exception of the industrial

Table 10 Augmented dynamic price equations: Results of Granger-causality test running from unit labour costs to prices

(whole period: 2000Q1-2013Q4)

	System					Granger-causality tests				
	VECM(2)	Lags		Lags	Long-run equilibrium adjustment coefficients	Weak exogeneity	Strict exogeneity		Strong exogeneity	
					λ_1	$\lambda_1=0$	$\sum\alpha_{x1}=\sum\alpha_{x2}=\sum\alpha_{x3}=\sum\alpha_{x4}=0$		$\lambda_1 \wedge \sum\alpha_{x1}=\sum\alpha_{x2}=\sum\alpha_{x3}=\sum\alpha_{x4}=0$	
Sectors		Endogenous variables	Exogenous variables	k_3,k_4,k_5	Error correction term	t-stat	χ^2-stat	p-value	χ^2-stat	p-value
Total economy	(YFD, TT_ULC)	(2,2)	Ogap, M3, RP	(1,1,1)	-0.12	-2.32**	11.19	0.08*	13.43	0.06*
Total economy	(HICP, TT_ULC)	(4,4)	Ogap, M3, RP	(1,1,1)	-0.10	-3.42**	16.87	0.03**	28.00	0.00**
Industry	(INDD, IND_ULC)	(1,1)	Ogap, M3, RP	(1,1,1)	-0.02	-0.64	9.96	0.08*	10.67	0.09*
Public administration and defence	(PAD, PA_ULC)	(1,1)	Ogap, M3, RP	(3,3,3)	-0.16	-3.00**	12.48	0.33	22.05	0.03**

Note: ** and * denote rejection of the null hypothesis (for the existence of weak, strict and strong exogeneity in each case) at 5% and 10% level of significance, respectively.

sector. This means that unit labour costs affect the dynamic behaviour of prices, thereby indicating the existence of a long-term causal relationship running in the direction from unit labour costs to prices. The highest speed of adjustment of prices to the long-run equilibrium is observed in the sector of public administration and defence, since the error correction coefficient is λ_1=-0.16, which means that any deviations from the equilibrium level are corrected in approximately 6 quarters. In industry, the error correction coefficient is statistically insignificant, which means that prices evolve in the long run irrespective of unit labour cost developments. Perhaps in this sector there are other factors —such as cost of capital, energy costs, oligopolistic structure, etc.— that affect price developments to a larger extent, creating adjustment rigidities.

The existence of short-term causality, i.e. absence of strict (short-term) exogeneity, is found in all sectors except the public sector, and implies that the rates of change in lagged unit labour costs can be used to help predict inflation in the short run. Moreover, no strong exogeneity is observed in any sector, therefore unit labour cost affects (Granger-causes) jointly developments in price levels and inflation across all sectors of the economy.

Table 11 summarises the tests for Granger-causality (running in the direction from prices to unit labour costs) for the augmented dynamic wage equation based on equation (7.2). The VECM (2) system also includes the output gap (Ogap), money supply (M3) and relative prices (RP) as exogenous variables.

According to the results presented in Table 11, the existence of weak exogeneity is accepted in all cases, except the industrial sector (in which the error correction coefficient is statistically significant). The error correction coefficient is λ_2=-0.07, which means that any deviations from equilibrium are corrected in roughly 14 quarters (3.5 years). This entails that developments in the level of basic prices in industry affect long-term developments in unit labour costs in this sector, thereby implying the existence of a long-term causal relationship running in the direction from prices to unit labour

Table 11 Augmented dynamic wage equations: Results of Granger-causality test running from prices to unit labour costs

(whole period: 2000Q1-2013Q4)

	System					Granger-causality tests				
	VECM(2)	Lags	Lags		Long-run equilibrium adjustment coefficients	Weak exogeneity	Strict exogeneity		Strong exogeneity	
					λ_1	$\lambda_1=0$	$\sum\beta_{2i}=\sum\beta_{3i}=\sum\beta_{4i}=\sum\beta_{5i}=0$		λ_2^ $\sum\beta_{2i}=\sum\beta_{3i}=\sum\beta_{4i}=\sum\beta_{5i}=0$	
Sectors		Endoge-nous variables	Exogenous variables	k_3,k_4,k_5	Error correction term	t-stat	χ^2-stat	p-value	χ^2-stat	p-value
Total economy	(YFD, TT_ULC)	(2,2)	Ogap, M3,RP	(1,1,1)	-0.02	-0.17	12.75	0.04**	12.80	0.07*
Total economy	(HICP, TT_ULC)	(4,4)	Ogap, M3,RP	(1,1,1)	-0.14	-1.05	15.50	0.05**	17.70	0.03**
Industry	(INDD, IND_ULC)	(1,1)	Ogap, M3,RP	(1,1,1)	-0.07	-2.20**	7.58	0.18*	17.12	0.00**
Public administration and defence	(PAD, PA_ULC)	(1,1)	Ogap, M3,RP	(3,3,3)	-0.12	-1.637	7.58	0.66	11.88	0.37

Note: ** and * denote rejection of the null hypothesis (for the existence of weak, strict and strong exogeneity in each case) at 5% and 10% level of significance, respectively.

costs. This last finding supports the view that institutional representatives in this sector manage to adjust employees' wages in proportion to changes in the level of prices. The statistically significant adjustment rate of wages to changes in prices observed in the industrial sector may reflect trade unions' extensive bargaining power that allows them to negotiate wage increases proportional to price dynamics, as well as their ability to predict price developments correctly.

The evidence shows no strict (short-term) exogeneity in all cases, with the exception of public administration and defence (possibly reflecting correct price-setting difficulties in this sector). The existence of short-term causality, i.e. rejection of strict exogeneity, means that the rates of change in lagged prices can be used to predict changes in unit labour costs in the short run. Moreover, no strong exogeneity is observed in any sector but that of public administration and defence, therefore price dynamics affect (Granger-cause) jointly developments in unit labour cost practically across all activity sectors of the economy.

7 CONCLUSIONS

The main argument of the expectations-augmented Phillips curve model regarding the inflation mechanism is that prices are set on the basis of a profit margin (mark-up) applied over unit labour costs. If this argument is correct, then long-term developments in the levels of prices and unit labour costs should be correlated.

Nevertheless, in the Greek economy the rate of change in prices seems to respond with a lag and disproportionately to the large reductions of labour costs recently observed in the context of fiscal consolidation and internal depreciation. In the subperiod 2010-2013, unit labour cost adjustments are largely disconnected from price indices, at both the levels of the series and their rates of change.

The large decline in unit labour costs is mainly attributable to the reduction in nominal wages per employee rather than the pick-up in average labour productivity. Strengthening productivity is the crucial factor that will help to

improve the economy's competitiveness, since any further downward adjustment of wages is unlikely to benefit the economy, while social cohesion is undermined.

For the total economy in the subperiod 2010-2013, the disconnection between inflation (up by 2.0% on average) and the rate of change in unit labour costs (down by 3.3% on average) is obvious, resulting in a 3.0% increase in the unit profit margin indicator.

Particularly in industry, which produces the bulk of the economy's tradable (exportable) goods, the disconnection between inflation (up by 2.3%) and the rate of change in unit labour costs (down by 6.9%) becomes more evident in the subperiod 2010-2013, resulting in a 10.2% increase in the unit profit margin indicator. This disconnection is more evident in 2012 and 2013, when the unit profit margin indicator rose by 19.6% and 7.6%, respectively. This was attributable to the rapid fall in unit labour costs (down by 12.6% and 6.3%) in 2012 and 2013, with inflation standing at 4.6% and 0.8%, respectively.

The partial price adjustment compared with the considerable decline in unit labour costs may largely be attributable to the oligopolistic structure of the economy, which still remains strong in several sectors related to the production or trade of goods, such as for instance the fuel market (Bragoudakis and Sideris 2012; Polemis 2012) or the food sector (OECD 2013; European Commission 2013; and Competition Commission 2011). This phenomenon of a disconnect between prices and labour costs impedes the monetary policy transmission channel from acting as a catalyst that would speed up the intended adjustments in terms of competitiveness and consumer purchasing power so as to faster remedy any distortions in the economy's smooth operation, growth and stability. Targeted structural reforms are crucial to lifting price rigidity. Therefore, reforms in product markets aimed at breaking these oligopolies should be highly prioritised within the economic policy implemented.

The econometric investigation of the relationship between unit labour costs and prices produced the following findings.

As regards the price equations, the hypothesis of long-term unit elasticity can only be accepted in the cases of the total economy when prices are measured based on the GDP deflator, and in public administration and defence. By constrast, the long-term elasticity of prices in industry is statistically lower than unity, suggesting that this sector shows traces of an oligopolistic structure. It should be noted that the unit profit margin indicator over 2010-2013 rose by 10.2% in industry, compared with 3.0% in the total economy, only 1% in the trade sector, and 2.7% in public administration and defence.

As regards the wage equations, the hypothesis of a long-term unit elasticity can only be accepted in the cases of the total economy, when prices are measured based on the GDP deflator, and the industrial sector. In industry, the elasticity of wages was estimated at a level lower than unity, but the hypothesis that it may be equal to unity cannot be statistically rejected, thereby suggesting that a 1.0% increase in prices could raise unit labour costs by 1.0% in the long run. The full adjustment of unit labour costs to changes in the level of prices, as much in the total economy as in the industrial sector, possibly reflects the extensive bargaining power of employees' institutional representatives (i.e. trade unions and confederations) in collective wage negotiations. In other words, there is evidence that in the Greek economy over a long-term horizon workers' representatives managed to adjust employees' wages close to changes in the level of prices. In addition, the Granger-tests for strong exogeneity provide evidence of a strict causal relationship between the two variables. In the total economy, prices affect unit labour cost developments, but unit labour costs also affect price developments.

REFERENCES

Aaronson, D. (2001), "Price Pass-Through and the Minimum Wage", *Review of Economics and Statistics*, 83:1, 158-169.

Arora, H.K. and P.R. Blackley (1996), "An Empirical Analysis of the Unit Labour Cost-Product Price Relation in the U.S. Economy", *Atlantic Economic Journal*, 24:4, December, 321-335.

Banerjee, A., J. Dolado, J. Galbraith and D. Hendry (1993), *Co-integration, Error-Correction and the Econometric Analysis of Non-Stationary Data*, Oxford University Press, Oxford.

Bardsen, G., O. Eitrheim, E.S. Jansen and R. Nymoen (2005), *The Econometrics of Macroeconomic Modelling*, Oxford University Press.

Barth, J.R. and J.T. Bennett (1975), "Cost-push versus Demand-pull Inflation: Some Empirical Evidence", *Journal of Money, Credit and Banking*, 7:3, August, 391-397.

Blanchard, O. and L. Katz (1999), "Wage Dynamics: Reconciling Theory and Evidence", NBER Working Paper No. 6924.

Bragoudakis, Z. and D. Sideris (2012), "Do retail gasoline prices adjust symmetrically to crude oil price changes? The case of the Greek oil market", Bank of Greece, *Economic Bulletin*, 37.

Brauer, D.A. (1997), "Do Rising Labor Costs Trigger Higher Inflation?", Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, September.

Brayton, F., J.M. Roberts and J.C. Williams (1999), "What's Happened to the Phillips Curve?", *Finance and Economics Discussion Series*, Federal Reserve Board, Washington.

Chan-Lau, J.A. and S. Tokarick (1999), "Why Has Inflation in the United States Remained So Low? Reassessing the Importance of Labor Costs and the Price of Imports", IMF Working Paper No. 99/149.

Chow, G.C. and A. Lin (1971), "Best Linear Unbiased Interpolation, Distribution and Extrapolation of Time Series by Related Series", *The Review of Economics and Statistics*, 53:4, 372-375.

Dickey, D.A. and W.A. Fuller (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 74(366), 427-31.

Dickey, D.A. and W.A. Fuller (1981), "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", *Econometrica*, 49, 1057-1072.

Elliott, G., T.J. Rothenberg and J.H. Stock (1996), "Efficient Tests for an Autoregressive Unit Root", *Econometrica*, 64, 813-836.

Emery, K.M. and C.-P. Chang (1996), "Do Wages Help Predict Inflation?", Federal Reserve Bank of Dallas, *Economic and Financial Policy Review*, First Quarter, 2-9.

Engle, R.F. (1984), "Wald, Likelihood Ratio and Lagrange Multiplier Tests in Econometrics", in Z. Griliches and M.D. Intriligator (eds), *Handbook of Econometrics*, Vol. 2. New York: Elsevier, 775-826.

Engle, R.F. and C.W.J. Granger (1987), "Co-Integration and Error-Correction: Representation, Estimation and Testing", *Econometrica*, 55, 251-76.

Competition Commission (2011), *Sectoral Survey in the Industry of Fresh Fruit and Vegetable Products* [in Greek].

European Commission (2013), *Detailed Average Prices Report*, November.

Gaillard, S. (1992), "Lohn- und Preisdynamik: Eine empirische Studie für die Schweiz", *KOF/ETH*, 43, December.

Ghali, K. (1999), "Wage Growth and the Inflation Process: A Multivariate Cointegration Analysis", *Journal of Money, Credit and Banking*, 31:3, August, 417-431.

Gordon, R.J. (1982), "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980", *Journal of Political Economy*, 90(6), 1087-1117.

Gordon, R.J. (1985), "Understanding Inflation in the 1980s", *Brookings Papers on Economic Activity*, 1, 263-269.

Gordon, R.J. (1988), "The Role of Wages in the Inflation Process", *American Economic Review*, 78:2, 276-283.

Granger, C.W.J. (1986), "Developments in the Study of Cointegrated Economic Variables", *Oxford Bulletin of Economics and Statistics*, 48, 213-28.
Granger, C.W.J. (1988), "Some Recent Developments in a Concept of Causality," *Journal of Econometrics*, 39, 199-211.
Granger, C.W.J. and J.L. Lin (1995), "Causality in the Long-Run", *Econometric Theory*, 11, 530-536.
Hannan, E.J. and B.G. Quinn (1979), "The Determination of the Order of an Autoregression", *Journal of the Royal Statistical Society*, 1341, 1990-95.
Hess, G.D. and M.E. Schweitzer (2000), "Does Wage Inflation Cause Price Inflation?", Federal Reserve Bank of Cleveland, Policy Discussion Paper No.1.
Johansen, S. (1988), "Statistical Analysis of Cointegrating Vectors", *Journal of Economic Dynamics and Control*, 12.
Johansen, S. (1991), "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, 59:6, 1551-1580.
Johansen, S. (1992),"Determination of Cointegration Rank in the Presence of a Linear Trend", *Oxford Bulletin of Economics and Statistics*, 54, 383-397.
Johansen, S. and K. Juselius (1990), "Maximum Likelihood Estimation and Inference on Cointegration – With Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, 52, 169-210.
Layard, R. and S. Nickell (1986), "Unemployment in Britain", *Economica*, 53:210, 121-169.
Layard, R., S. Nickell and R. Jackman (1991), *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press.
Mehra, Y. (1977), "Money Wages, Prices, and Causality", *Journal of Political Economy*, 85(6), 1227-1244.
Mehra, Y. (1991), "Wage Growth and the Inflation Process: An Empirical Note", *American Economic Review*, 81:4, 931-937.
Mehra, Y. (1993), "Unit Labor Costs and the Price Level", Federal Reserve Bank of Richmond, *Economic Quarterly*, 79, Fall, 35-51.
Mehra, Y. (2000), "Wage-Price Dynamics: Are They Consistent with Cost Push?", Federal Reserve Bank of Richmond, *Economic Quarterly*, 86, Summer, 27-43.
Nordhaus, W.D. (1972), "Recent Developments in Price Dynamics", in O. Eckstein (ed.), *The Econometrics of Price Determination*, Washington: Board of Governors of the Federal Reserve System.
OECD (2013), *Competition Assessment Reviews: Greece. Preliminary Version.*
Pantula, S.G. (1989), "Testing for Unit Roots in Time Series Data", *Econometric Theory*, 5, 256-271.
Petroulas P. and T. Kosma (2014), "Analyzing price level difference in the euro area: Competition structures and consumer behavior", *ECB Working Paper Series* (forthcoming).
Phillips, P.C.B. and P. Perron (1988), "Testing for a Unit Root in Time Series Regression", *Biometrika*, 75, 335-346.
Polemis, M. (2012), "Competition and price asymmetries in the Greek oil sector: an empirical analysis on gasoline market", *Empirical Economics*, September.
Rissman, E. (1995), "Sectoral Wage Growth and Inflation", Federal Reserve Bank of Chicago, *Economic Perspectives*, 19, 1995:4, 3rd quarter.
Sims, C.A. (1980), "Macroeconomics and Reality", *Econometrica*, 48, 1-48.
Stock, J.H. (1991), "Confidence Intervals for the Largest Autoregressive Root in U.S. Macroeconomic Time Series", *Journal of Monetary Economics*, 28, 435-59.
Stock, J.H. and M.W. Watson (1993), "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems," *Econometrica*, 61, 783-820.

Stockton, D.J. and J.E. Glassman (1987), "An Evaluation of the Forecast Performance of Alternative Models of Inflation", *Review of Economics and Statistics*, 69, 108-17.
Wolff, G.B. (2012), "Arithmetic is absolute: euro-area adjustment", *Bruegel Policy Contribution*, Issue 2012/9, 1-7.
Zanetti, A. (2007), "Do Wages Lead Inflation? Swiss Evidence", *Swiss Journal of Economics and Statistics*, 143(I), 67-92.

Price, unit labour cost and profit margin developments in all the sectors of the economy

(annual rates of change %)

Share (%) in GDP (at basic prices)	Total economy			Agriculture			Industry		
2000-2013	100%			4.7%			12.3%		
2000-2007	100%			5.0%			12.8%		
2008-2013	100%			4.3%			11.8%		
	Deflator (YFD)	**Unit labour cost (TT_ULC)**	**Profit margin (TT_PM)**	**Deflator (AGRD)**	**Unit labour cost (AGR_ULC)**	**Profit margin (AGR_PM)**	**Deflator (INDD)**	**Unit labour cost (IND_ULC)**	**Profit margin (IND_PM)**
2001	3.5	-0.2	3.7	4.7	12.7	-7.1	2.5	1.8	0.6
2002	3.6	10.1	-5.9	2.8	22.1	-15.9	4.5	14.9	-9.1
2003	4.2	1.5	2.6	13.1	36.6	-17.2	0.8	-1.7	2.6
2004	2.7	2.2	0.5	-12.3	-11.4	-1.0	7.1	3.3	3.7
2005	1.3	4.4	-3.0	1.5	1.4	0.1	-1.9	13.2	-13.4
2006	2.2	-1.2	3.5	-6.5	21.2	-22.8	8.9	5.3	3.4
2007	3.4	2.7	0.7	11.6	12.0	-0.4	2.4	4.6	-2.2
2008	4.8	5.1	-0.3	-8.2	-1.2	-7.0	13.0	10.1	2.7
2009	2.7	5.8	-3.0	-5.3	-5.3	0.0	-3.1	-5.7	2.8
2010	0.1	0.4	-0.3	-5.0	-9.1	4.5	4.1	-3.2	7.6
2011	0.4	-1.7	2.2	3.1	-1.2	4.3	-0.1	-5.7	5.9
2012	0.0	-5.0	5.3	-6.0	-4.3	-1.7	4.6	-12.6	19.6
2013	-2.5	-7.0	4.8	2.4	-10.1	13.8	0.8	-6.3	7.6
Period average									
2001-2013	2.0	1.3	0.8	-0.3	4.9	-3.9	3.3	1.4	2.4
2001-2009	3.1	3.4	-0.1	0.2	9.8	-7.9	3.8	5.1	-1.0
2010-2013	-0.5	-3.3	3.0	-1.4	-6.2	5.2	2.3	-6.9	10.2

Sources: Calculations based on ELSTAT, ECB and European Commission data.

Price, unit labour cost and profit margin developments in all the sectors of the economy *(continued)*

(annual rates of change %)

	Construction			Trade			Information and communication			Financial sector		
Share (%) in GDP (at basic prices)												
2000-2013	6.1%			24.5%			4.4%			5.4%		
2000-2007	7.7%			25.0%			3.8%			5.1%		
2008-2013	4.1%			23.9%			5.1%			5.7%		
	Deflator (COND)	**Unit labour cost (CON_ULC)**	**Profit margin (CON_PM)**	**Deflator (TRD)**	**Unit labour cost (TR_ULC)**	**Profit margin (TR_PM)**	**Deflator (COMD)**	**Unit labour cost (COM_ULC)**	**Profit margin (COM_PM)**	**Deflator (FID)**	**Unit labour cost (FI_ULC)**	**Profit margin (FI_PM)**
2001	0.3	-3.6	4.1	2.7	-10.2	14.4	-0.4	6.9	-6.8	3.3	10.9	-6.9
2002	2.6	45.6	-29.5	-0.7	-0.7	0.0	-1.2	-5.1	4.1	18.9	23.4	-3.7
2003	2.9	-3.4	6.5	3.4	-4.6	8.4	-0.5	3.4	-3.8	10.4	9.5	0.8
2004	0.5	-4.0	4.7	0.7	-2.4	3.2	0.4	1.0	-0.6	1.4	-13.1	16.6
2005	15.1	-1.6	17.0	-12.8	4.8	-16.7	-7.0	-2.4	-4.7	4.6	24.3	-15.8
2006	0.5	-13.5	16.2	2.4	1.3	1.1	-1.3	-12.9	13.4	3.8	8.1	-4.0
2007	1.8	16.8	-12.8	4.0	2.5	1.4	1.7	-3.2	5.0	-5.9	2.2	-7.9
2008	2.4	9.6	-6.6	5.0	6.0	-1.0	0.6	-13.4	16.2	-7.6	-3.2	-4.5
2009	0.6	30.1	-22.6	2.1	12.6	-9.3	1.5	-11.2	14.3	0.8	1.1	-0.3
2010	-5.3	11.8	-15.3	1.5	5.0	-3.4	3.5	9.0	-5.1	1.1	-2.8	4.0
2011	-5.9	3.9	-9.4	2.9	0.8	2.1	2.3	3.7	-1.4	5.3	-0.3	5.6
2012	-0.6	-7.9	7.9	0.4	0.5	-0.1	-1.1	-2.9	1.8	1.3	-0.1	1.4
2013	-1.1	-5.1	4.3	-1.3	-6.3	5.3	-2.5	7.3	-9.1	-2.4	-6.2	4.1
Period average												
2001-2013	1.1	6.0	-2.7	0.8	0.7	0.4	-0.3	-1.5	1.8	2.7	4.1	-0.8
2001-2009	3.0	8.4	-2.6	0.8	1.0	0.2	-0.7	-4.1	4.1	3.3	7.0	-2.9
2010-2013	-3.2	0.7	-3.1	0.9	0.0	1.0	0.5	4.3	-3.4	1.3	-2.4	3.8

Sources: Calculations based on ELSTAT, ECB and European Commission data.

Price, unit labour cost and profit margin developments in all the sectors of the economy *(continued)*

(annual rates of change %)

	Real estate activities			Professional and other activities			Public administration and defence			Arts, entertainment and recreation		
Share (%) in GDP (at basic prices)												
2000-2013	12.9%			6.3%			19.6%			4.3%		
2000-2007	12.0%			6.9%			18.6%			4.3%		
2008-2013	14.2%			5.4%			20.9%			4.4%		
	Deflator (RED)	**Unit labour cost (RE_ULC)**	**Profit margin (RE_PM)**	**Deflator (SCED)**	**Unit labour cost (SC_ULC)**	**Profit margin (SC_PM)**	**Deflator (PAD)**	**Unit labour cost (PA_ULC)**	**Profit margin (PA_PM)**	**Deflator (ARTD)**	**Unit labour cost (ART_ULC)**	**Profit margin (ART_PM)**
2001	4.1	145.2	-57.5	5.4	22.5	-14.0	6.2	3.5	2.6	3.7	5.0	-1.2
2002	4.3	61.8	-35.5	-0.6	11.1	-10.5	9.9	12.2	-2.0	4.1	6.1	-1.9
2003	5.1	-32.1	54.8	5.5	42.2	-25.8	5.1	0.5	4.5	3.9	5.5	-1.5
2004	5.5	56.8	-32.7	3.6	9.9	-5.8	7.4	13.0	-5.0	4.7	6.6	-1.8
2005	8.1	-32.1	59.1	82.0	-2.9	87.4	1.5	1.6	0.0	16.5	-3.2	20.4
2006	3.5	10.5	-6.3	3.1	-3.2	6.5	-0.9	-1.1	0.2	4.5	5.3	-0.7
2007	4.8	-10.3	16.8	3.4	-5.9	9.9	4.5	4.7	-0.2	4.6	18.4	-11.6
2008	4.8	1.2	3.6	2.0	10.9	-8.0	8.4	5.3	2.9	4.3	8.7	-4.0
2009	4.7	-6.6	12.1	3.7	-7.0	11.5	8.0	6.9	1.1	2.6	-6.2	9.4
2010	3.3	-0.9	4.2	1.1	16.3	-13.1	-5.5	-7.1	1.7	1.1	1.0	0.1
2011	3.2	-18.8	27.0	-2.4	11.7	-12.6	-4.7	-4.8	0.0	1.9	-1.3	3.1
2012	-2.1	-10.3	9.2	-0.7	0.2	-0.8	-0.3	-5.5	5.5	-0.9	-8.8	8.7
2013	-6.7	-29.9	33.0	-0.5	-10.0	10.6	-4.0	-7.2	3.4	-2.7	-16.5	16.5
Period average												
2001-2013	3.3	10.3	6.8	8.1	7.4	2.7	2.7	1.7	1.1	3.7	1.6	2.7
2001-2009	5.0	21.6	1.6	12.0	8.6	5.7	5.6	5.2	0.5	5.4	5.1	0.8
2010-2013	-0.6	-15.0	18.4	-0.6	4.5	-4.0	-3.6	-6.1	2.7	-0.2	-6.4	7.1

Sources: Calculations based on ELSTAT, ECB and European Commission data.

THE INTERNATIONAL FINANCIAL MARKETS AS A SOURCE OF FUNDING FOR GREEK NON-FINANCIAL CORPORATIONS

Petros M. Migiakis*
Economic Analysis and Research Department

INTRODUCTION

In the period following the global financial crisis, the funds raised by euro area non-financial corporations (NFCs) through bank loans decreased, whereas those raised through capital markets increased. Correspondingly in Greece as well, since end-2012 capital market-based financing became possible for large and robust firms of the non-financial sector through the issuance of corporate bonds abroad, a fact which resulted in a considerable increase of this type of financing in 2013 and 2014. If continued, these interconnected trends should contribute to a recovery of economic activity in both the euro area and Greece.

In light of the above, the present study describes developments in Greek NFC financing through international bond markets, in the context of respective developments in the euro area. In addition, it presents the Bank of Greece (BoG) corporate bond index, aimed at capturing trends in the prices and the yields of Greek corporate bonds of the non-financial sector.

Using the aforementioned bond index, the study examines developments in the yields of bonds issued by Greek corporations of the non-financial sector after the end of 2012 and analyses the factors affecting these yields ever since such securities started being traded. It shows that the long-term trend of the yields of Greek corporate bonds in the period from their issuance to the present day has entered into an equilibrium relationship with the yields of low-rated investment grade (BBB) corporate bonds issued in the other euro area countries. Also, domestic systemic risks may be leading to a structural change in the specification of Greek NFC bond yields.

I THE IMPORTANCE OF FINANCING FOR ECONOMIC ACTIVITY

The financing of investment and consumption has a multiple impact on both the economy's equilibrium level and long-term growth rates, through its effect on factor productivity. Broken down by source, it is decomposed into internal financing (e.g. own funds) and external financing (e.g. loans); however, it has been put forward that its impact on economic activity is greater when its source lies in the financial sector, compared with the process of internal capital formation[1] by corporations via a more streamlined use of resources (see Beck et al. 2000). The financial sector acts as an intermediary between money supply and demand for funds, and its contribution to economic activity results from the conversion of (innately short-term) money into long-term investment, and from the allocation of funds to producers and consumers.

In this context, empirical studies of the financial system's contribution to economic growth show that the financial sector's effective operation is associated with the allocation of available funds to the most productive economic entities. More specifically, it is argued that the effect is greater when funding is directed to enterprises rather than households (see Beck et al. 2005 and 2008). The reason is that NFC financing is channelled towards investments of higher productivity compared to household investments. Also, in the case of large enterprises the benefits of financing are more likely to be associated with higher investment in innovation, whereas in the case of small and medium-sized enterprises (SMEs) they mostly relate to improved returns on funds.

With respect to selecting the source of funding, international experience regarding market- or bank-based corporate financing has shown that

* Thanks are extended to Mrs Heather Gibson and Mrs Hiona Balfoussia for their valuable comments. The views in the paper are those of the author and do not necessarily reflect those of the Bank of Greece. Any errors or omissions are the responsibility of the author.

1 Capital formation by adding own funds and previous years' profits.

source optimisation depends on many factors, as information asymmetry concerns may call for a different combination of bank loans and market-based financing to be used in each case (see, among others, James 1987). Nevertheless, the extent to which bank lending or market financing[2] covers the funding needs of NFCs may affect the equilibrium level of economic activity. For instance, raising funds through the financial markets could lead NFCs to a more effective operation (see, among others, Demirgüç-Kunt and Levine 2001), while it has been suggested that the benefits of financing are optimised when both sources are mixed, provided that corporations are closely monitored by banks (see Besanko and Kanatas 1993).[3]

Finally, it should be noted that financial market-based financing is associated as much with systemic factors, i.e. related to the economic environment in which all the corporations operate, as with factors specific to each individual corporation. The former include the reliability of the institutions or the effectiveness and transparency of the framework within which corporations operate, while the latter involve each corporation's level of investment in innovation, its dynamism and relative prospects within its sector of activity (see EFC High Level Expert Group 2013).

In this general context, the aim of the present analysis is to explore the possibility of having bond markets used a source of financing for Greek NFCs. With this in mind, Section 2 summarises developments in international corporate bond markets before and after the global financial crisis; Section 3 describes the conditions under which funds are raised by Greek NFCs through bond issuances in Greece and abroad; Section 4 presents the BoG index for monitoring corporate bonds issued by Greek NFCs and discusses the results of an econometric exploration of the factors determining the yield level of existing corporate bonds; and finally, Section 5 sums up the study and draws a number of conclusions.

2 THE IMPACT OF THE GLOBAL FINANCIAL CRISIS ON THE FINANCING OF EURO AREA NON-FINANCIAL CORPORATIONS

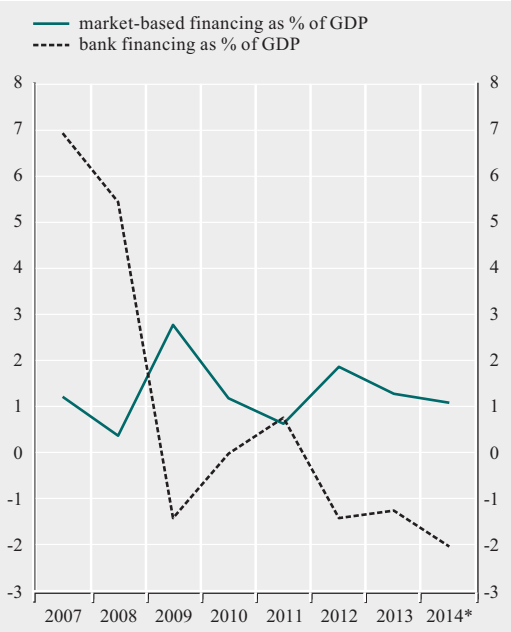
The global financial crisis (2007-2009) was a strong shock to the operation of the international financial system and brought about structural changes in financing flows compared with the previous period. In particular, the crisis brought to light the need for a change in the institutional framework governing the operation of the financial sector, aimed at linking leverage with the economy's growth prospects (see Buttiglione et al. 2014). Against this background, in the aftermath of the crisis advanced economies saw a decline of $1.5 trillion in bank lending between 2007 and 2012 (see International Capital Market Association 2013). This decline was partly offset by the increased value of existing NFC bond issuances, which rose from $600 billion in 2007 to $1.8 trillion in 2012.[4]

In the euro area, after the global financial crisis capital markets continued to represent a source of funding for NFCs, while financing flows from the banking sector decreased substantially (see Chart 1.A). This development led to increased financing of NFCs through the markets compared with bank lending. As a result, in the post-crisis period the importance of capital markets as a source of financing for the euro area has increased compared with that of the banking sector (see Chart 1.B).[5]

On the side of investment fund supply, this change is associated with risk re-pricing and the ensuing process of the investment portfolios' risk diversification through higher placements in additional categories of busi-

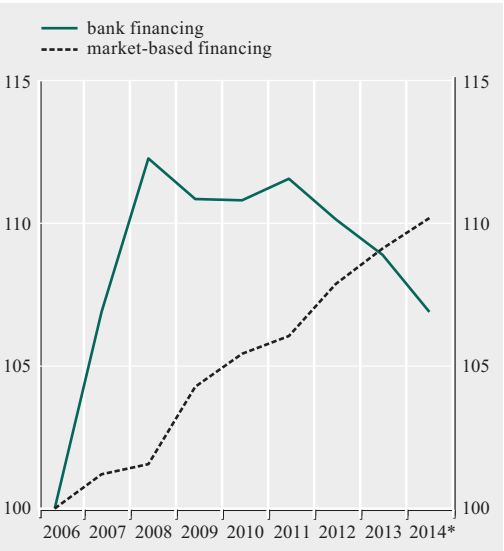
2 Corporations raise funds through the financial markets either by sale of shares, which represent rights on their net position, or by issue of bonds, which represent rights on their total assets.
3 Of course, identifying the optimum mix of financing sources is a matter to be explored that goes beyond the scope of this study.
4 Data obtained from the Dealogic platform.
5 Of course, it should be noted that higher levels of market-based financing and in particular of funds raised through corporate bond markets are not unprecedented; e.g. a considerably higher corporate bond issuing activity had been observed following monetary integration in Europe in 1999 (see Galati and Tsatsaronis 2003).

Chart 1.A Market-based and bank financing of euro area non-financial corporations



Source: European Central Bank, Statistical Data Warehouse.
Note: Financing flows as a percentage (%) of GDP per annum.
* Data for 2014 refer to the January-September period.

Chart 1.B Ratio of aggregate financing flows as a percentage of GDP in the euro area (2006=100)



Source: European Central Bank, Statistical Data Warehouse.
* Data for 2014 refer to the January-September period.
Note: Bank financing is calculated as the sum of net flows of loans to NFCs. Market-based financing is derived from the sum of net issuance activity by NFCs in the respective period, for both shares and long-term securities other than shares.

ness activity. As regards bank lending, in the same period a series of factors have had a deleveraging effect, imposing restrictions on bank-based financing. Banks face considerable difficulties in raising funds through money markets due to stricter lending criteria and higher risk aversion, while the restrictions are expected to persist due also to the gradual implementation from 2015 onwards of the institutional framework for capital requirements, leveraging and available liquidity (see EFC High Level Expert Group 2013).

Therefore, investment portfolio diversification combined with lower asset values and restructuring in the banking sector have increased the importance of the corporate bond market as a source of financing worldwide (see European Commission 2013). This fact, against the background of the aforementioned deleveraging trend, has led to the adoption of initiatives with a view to facilitating NFC financing. These measures aim at supporting the financing of NFCs using market tools, either directly by the corporations or indirectly by way of bank loans and funds raised through the markets via securitisations.

Indicatively, a study by the Institute of International Finance (IIF) argues in favour of securitising bank loans to SMEs, along with further developing EIB credit lines and aids (see Institute of International Finance and Bain Company 2013); in this context, a reactivation of securitisation markets could facilitate banks in increasing their lending to the European economy. Securitisation of bank loans to SMEs is considered by credit rating agencies to be a valid investment choice, provided that the standards ensuring high credit ratings are met (see Standard and Poor's 2013). The latter include the provision of collateral for loans to SMEs, possible guarantees by supranational organisations or sovereigns with a high credit rating, and overcollateralisation (collateral val-

ues higher than the loan values) at covered bond level.[6]

Moreover, the decisions of the ECB to expand the list of eligible collateral to assets backed by securitised loans to SMEs move along similar lines. Specifically, ECB decisions in the second half of 2013 lowered (i) the credit quality threshold required for the acceptance of asset-backed securities linked to SMEs as collateral in the Eurosystem refinancing operations and (ii) the haircuts applicable.[7] Also, more recent decisions of the ECB relate to liquidity provision through targeted longer-term refinancing operations (TLTROs),[8] and the purchase of securitised loans to enterprises of the non-financial sector.[9] The aim of these decisions is to enhance the impact of the measures for improving funding conditions so as to enable NFCs in vulnerable Member States to benefit as well.

In relation to potential initiatives at the national level, Holton et al. (2013) formulate proposals with a view to further developing the funding possibilities of Irish enterprises. For instance, one proposal involves the establishment of an Internal Credit Assessment System by the central bank of Ireland and its use in order to assess securitised loans to SMEs, with a view to facilitating the Irish economy's financing through funds raised by the Irish banks under the Eurosystem refinancing operations. It is worth noting that, in the context of its economic adjustment programme, Ireland committed to launching a credit registry in order to reduce creditors' information asymmetry and broaden the scope of sources of funding for the enterprises of the Irish economy. According to Djankov et al. (2007), the credit registry represents an important factor for economic growth and offers greater benefits to less developed economies operating under a legal framework based on a civil (Roman) law tradition.

A study carried out on behalf of the European Commission regarding the long-term financing of the European economy has proposed interventions in the capital markets with a view to facilitating SMEs in raising funds (see EFC High Level Expert Group 2013). Among other things, such interventions relate to a deepening of corporate data transparency, an improvement of the procedures laid down in national bankruptcy codes and the provision of guarantees of high credit standards as a means to better borrowing terms.

The same study considers it important to increase the degree of transparency by providing prospective investors with corporate data (e.g. through the establishment of a credit registry), so as to facilitate corporations' credit rating. Finally, it should be noted that the implementation of the above so as to enable corporations to directly raise funds through the markets takes time, whereas the securitisation of loans to SMEs can push financing up within a shorter period and is expected to reduce bank lending costs.

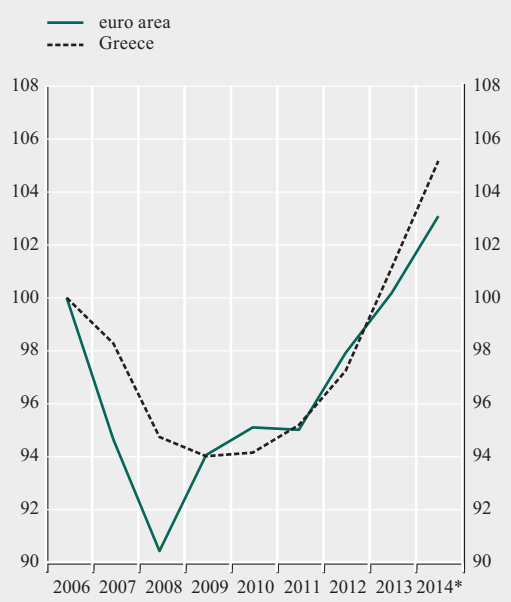
3 BOND ISSUANCE BY GREEK NON-FINANCIAL CORPORATIONS

Before the global financial crisis and the Greek debt crisis, Greek NFCs relied mainly on bank lending to finance the segment of their activities that was externally funded. Over the same period, the ratio of financing through capital markets to financing through the banking sector was declining, following the trend observed in the euro area (see Chart 2), while financing through capital markets was mainly carried out by issuance of shares (see Chart 3).

After the global financial crisis, the possibilities for Greek enterprises in general to raise funds through international money and capital markets diminished rapidly, due to extreme investor uncertainty as to the Greek economy's position within the euro area. But starting from end-

6 See Capital Requirements Directive (CRD) on covered bonds, as defined in Article 22 paragraph 4 of the UCITS Directive.
7 See ECB Governing Council decisions of 18/07/2013 and 09/09/2013.
8 See ECB Governing Council decision of 05/06/2014.
9 See ECB Governing Council decision of 04/09/2014.

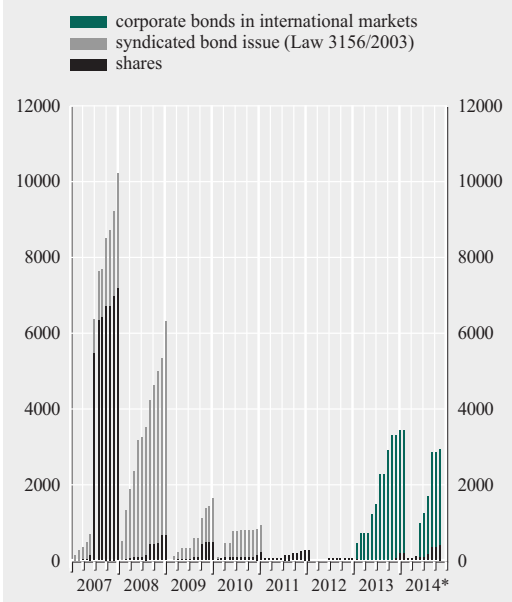
Chart 2 Ratio of market-based financing to bank financing (2006=100)



Source: European Central Bank, Statistical Data Warehouse.
* Data for 2014 refer to the January-September period.

Chart 3 Greek NFC financing through the issuance of bonds or shares (cumulative net flow data per annum)

(million euro)



Source: European Central Bank, Statistical Data Warehouse.
* Data for 2014 refer to the January-September period.

2012 Greek enterprises' financing through capital markets increased (see Charts 4.A and 4.B), whereas financing through the banking sector in Greece kept decreasing. In fact, the ratio of market-based financing to bank lending for Greek enterprises in 2014 is higher than the euro area average (see Chart 2).

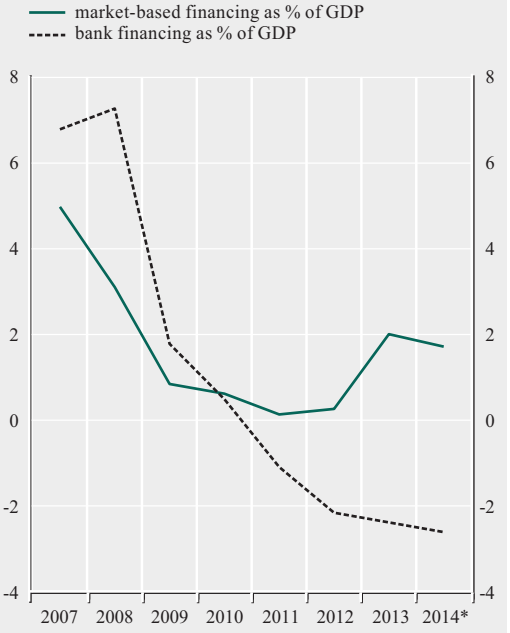
This development is almost exclusively attributable to the funds raised by large Greek enterprises through international bond markets. In more detail, between end-2012 and October 2014 the value of funds raised by means of bond issuances in markets abroad stood at €6.2 billion (see Table 1). The issuance of bonds by subsidiaries of Greek enterprises abroad accounts for roughly 90% of the funds raised through sources outside the banking sector. However, it should be noted that —based on the available data obtained from these enterprises' financial accounts— nearly two thirds of the funds raised are estimated to have been used to repay previous bank loans.

Funds are raised by financially robust enterprises, mostly industrial corporations charac-

Table 1 Bonds issued by Greek NFCs

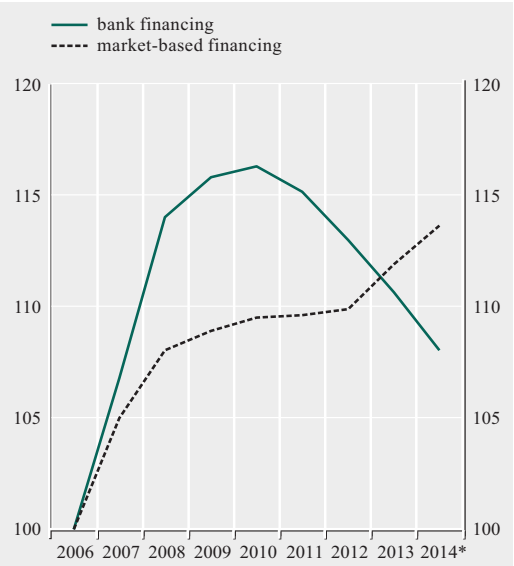
Year	Weighted average interest rate	Amount raised (million euro)	Average maturity
2012	9.30%	400	7.5 years
2013	7.10%	3,250	5.1 years
2014	4.60%	2,519	4.6 years

Chart 4.A Market-based and bank financing of Greek NFCs



Source: Bank of Greece.
* Data for 2014 refer to the January-September period.
Note: Value of financing flows as a percentage of GDP per annum.

Chart 4.B Ratio of aggregate financial flows as a percentage of GDP in Greece (2006=100)



Source: Bank of Greece.
* Data for 2014 refer to the January-September period.
Note: Market-based financing is derived from the sum of net issuance activity in the respective period, for both NFC shares and long-term securities other than shares in the Greek market, as well as the value of bond issues by Greek NFCs in Eurobond markets.

terised by export activity and a high tangible-to-total assets ratio, which enjoy further advantages, such as monopolistic conditions, in their sectors of activity. In spite of all the above, in terms of borrowing costs the bonds issued by such corporations diverged considerably from bonds issued by comparable enterprises in other euro area countries. This is largely attributable to the considerably higher cost of government borrowing in Greece than in other euro area economies, which implies relatively higher investor uncertainty surrounding the Greek economy.

The borrowing rates for Greek NFCs that issued bonds in markets abroad gradually came down in 2013 and 2014 compared with the rates on initial issuances, in parallel with the improvement seen in the pricing process applied to Greek government bonds. This gradual fall is associated with all corporate bond issuers and especially with those enterprises that carried out multiple issuances in the last three years, thus significantly lowering their weighted average borrowing costs, while the average maturity of the latest issuances by recurrent issuers has increased in the period 2012-2014. The above observations coincided with higher investor confidence in the Greek economy. Indicatively, between 2012 and 2014 the Greek economy considerably improved its position in terms of the World Bank's investor protection indices (see Table 2).

4 DEVELOPMENTS IN THE PRICES AND THE YIELDS OF CORPORATE BONDS ISSUED BY GREEK NON-FINANCIAL CORPORATIONS

4.1 THE INDEX OF CORPORATE BONDS ISSUED BY GREEK NON-FINANCIAL CORPORATIONS

Developments in the prices and the yields of existing bonds in the secondary market provide

Table 2 Investor Protection Index

	Strength			Rank		
Country	2012	2014	Change	2012	2014	Change
Greece	*4.7/10*	*5.3/10*	↑	*100/148*	*68/144*	*improved*
Italy	6/10	4.2/10	↓	41/148	99/144	worsened
Ireland	8.3/10	8.3/10	-	6/148	6/144	unchanged
Spain	5/10	5/10	-	84/148	83/144	improved
Portugal	6/10	6/10	-	41/148	45/144	worsened
Cyprus	6.3/10	6.3/10	-	31/148	34/144	worsened
France	5.3/10	5.3/10	-	69/148	68/144	improved
Germany	5/10	5/10	-	84/148	83/144	improved
Croatia	4/10	3.3/10	↓	116/148	123/144	worsened
Czech Republic	5/10	5/10	-	84/148	83/144	improved
Poland	6/10	6/10	-	41/148	43/144	worsened
Hungary	4.3/10	4.3/10	-	107/148	105/144	improved
Turkey	5.7/10	6.3/10	↑	57/148	34/144	improved

Note: According to the Global Competitiveness Report (GCI) for years 2012 and 2014. The GCI Investor Protection index is estimated as a combination of World Bank indices on (a) transparency of transactions, (b) liability of self-dealing and (c) shareholders' ability to sue officers and directors for misconduct.

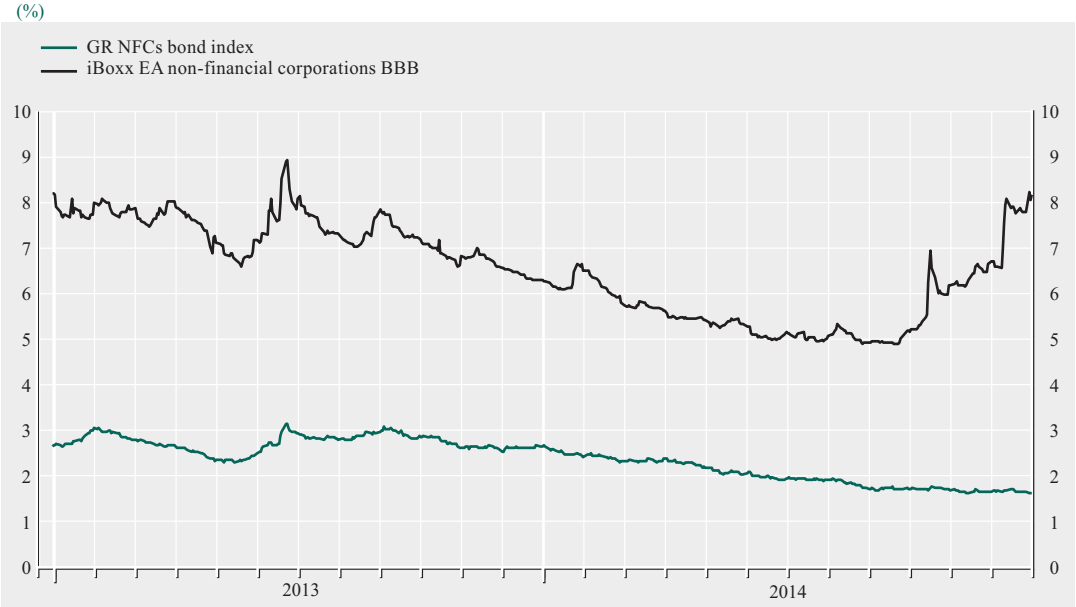
information on the conditions any new issuance of corporate bonds by Greek NFCs is likely to face. Specifically, it is assumed that the increase in funds raised in 2014 is associated with the aforementioned improved conditions of investor confidence in the Greek economy, the robust economic data released by the corporations in question, and the improved pricing process applied on existing issuances.

In order therefore to systematically monitor developments in the pricing process applied to bonds issued by Greek NFCs, we construct an index of the yields of such existing bonds, with suitable weights calculated daily on the basis of these securities' market value (see Annex A). The criteria taken into account in order to select the weights include the index's information content (economic explicability of its movements), its purpose of use (see Fabozzi 2007 and Brown 2002) and the stability of its technical features.

The selection of the securities that make up the bond index is associated with the nature of the information the index is intended to reflect. In connection with this criterion, it should be noted that the issuances included in the index of bonds issued by Greek NFCs after 2012 are homogeneous in terms of (i) the issuers' sector of activity (NFCs); (ii) credit ratings (between B and BB, i.e. subinvestment category); and (iii) trading in similar highly liquid international markets with daily valuations by primary dealers – thus ensuring the similarity required to enable an economic interpretation of the index's movements.

In this setting, Chart 5 depicts developments in the weighted average yields of the bonds issued by Greek NFCs between 1 January 2013 and 31 December 2014, as captured by the relevant GR NFC bond index. At first glance, it reveals the downward trend observed in such bond yields in the secondary market throughout 2013 and in the first half of 2014. In addition, the existence of a downward trend is equally observed in the same period with reference to the respective iBoxx index of the low-rated investment category (i.e. BBB) NFC

Chart 5 Corporate bond yields in Greece and the euro area



Sources: Bank of Greece (GR NFCs bond index) and Datastream (iBoxx EA non fin corp BBB).

bonds for the euro area. This observation implies that Greek NFCs that issued bonds in international markets have been considerably affected during most of the period under review by factors that have also impacted on comparably rated bonds issued by NFCs in the other euro area countries.

Equally obvious is an increase in the Greek NFC bond yields from end-October 2014 to the sample's cut-off date. This observation coincides with the heightened uncertainty surrounding the Greek economy, as reflected in the increased yields of Greek government bonds and the decreased share prices in the same period. Of course, a chart illustration cannot suffice for safe conclusions to be drawn as regards the factors that shape yields and, by extension, borrowing costs for Greek NFCs in the bond market. To this end, the next subsection econometrically analyses the effect of factors common across the euro area, as opposed to factors that had an impact on large capitalisation shares listed on the Athens Exchange.

4.2 ECONOMETRIC INVESTIGATION OF THE FACTORS AFFECTING THE YIELDS OF BONDS ISSUED BY GREEK NON-FINANCIAL CORPORATIONS

4.2.1 Specification of the structure of the interaction and causality relationships of the Greek NFC bond yields

The analysis focuses on an investigation of the impact of systemic factors that affect financial market conditions in the euro area, as well as of specific factors that reflect the conditions prevailing in domestic financial markets, on the yields of bonds issued by Greek NFCs. As such an investigation aims at capturing the determinants of the conditions prevailing for all Greek NFCs, we use the BoG "GR NFCs bond index". The sample contains daily data for the period from 1 October 2013 to 31 December 2014.

As regards the overall factors with a common impact on euro area NFC bond yields, i.e. the systemic factors, we use the composite indicator of systemic stress of the ECB (see Hollo et

al. 2012)[10] and the yields of the iBoxx euro area NFC BBB index. As for the factors reflecting the effects of the conditions prevailing in the Greek stock market on large capitalisation shares, these were isolated using the β coefficient[11] of the daily yields of the shares of Greek large capitalisation corporations.

Initially, we examine the properties of the aforementioned time series in order to establish the use of an appropriate econometric methodology. The following table presents the results of the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests for unit roots and of the DF-GLS and PP-GLS tests for near-unit-roots.

The results of Table 3 show that the time series of the yields of bonds of Greek and European NFCs (GR NFCs and iBoxx EA NFCs, respectively) are non-stationary, contrary to the cases of the series of coefficient β of the shares of Greek large capitalisation corporations and of the ECB systemic stress indicator. In light of this, the design of the econometric examination must take into account both the non-stationarity of the former and the stationarity of the latter series.

In this context, Hjalmarsson and Osterholm (2010) argue in favour of using methodologies suitable for the examination of the non-stationary time series, so as to ensure that the econometric estimates remain unaffected by the properties of the series characterised by a higher integration order, i.e. I(1). In fact, this argument for series with local unit root properties also covers the possibility of a non-stationarity finding attributable to the sample's and not the population's properties – a likely possibility for the series of the present sample as well; specifically, it is expected that as the fluctuation of the sample's time series is by definition finite and has specific limits, the persistence of the series' autoregressive features may decline with the sample's expansion (see Lima and Xiao 2007).

According to the aforementioned argument, the most acceptable method for investigating relationships between series characterised by non-stationarity, even if this is a property of the sample, is the Engle and Granger (1987) cointegration method for up to two variables, or the Johansen (1988) cointegration analysis in case the sample includes more than two variables. In more detail, under cointegration analysis the relationships of the non-stationary series (i.e. Greek and European bond yields in this case) represent the long-run equilibrium relationship, while the other two series are taken as exogenous in the long run due to their different integration order.

Consequently, we test for the existence of a long-run equilibrium relationship that leads to the emergence of a stationary vector cor-

10 More precisely, we use the indicator's component measuring volatility in euro area financial markets.
11 Coefficient β reflects the sensitivity of yields on large capitalisation shares to the movements of the Athens Exchange composite index and was repetitively estimated with a monthly estimation "window" and a daily frequency.

Table 3 Unit root and near-unit root tests

	ADF	DF-GLS	PP	PP-GLS
GR NFCs bond yields	-1.796	-2.205	-1.649	-2.634*
iBoxx EA NFCs BBB	-1.868	-0.921	-1.979	-0.916
CISS-equities	-4.116**	-3.316**	-4.628**	-3.239**
GR-large cap beta	-3.014**	-2.979**	-2.339	-2.981**

Note: ** and * suggest statistical rejection of the null hypothesis for the existence of unit root (statistical significance: 5% and 10%, respectively). Critical values for series including a constant (no trend) have been used.

Table 4 Johansen cointegration tests

	n=0		n=1	
H0: r≤n	Value	5% critical value	Value	5% critical value
Trace	21.091	20.262	6.259	9.164
max. eigenvalue	14.831	15.892	6.259	9.164

Note: Values refer to cointegrating relationships with a constant and no trend; similar results are obtained from tests without a constant term, while tests for the existence of a cointegrating relationship with a different structure give sub-optimal results for both series. Critical values are derived from MacKinnon et al. (1999).

recting deviations between the series of the Greek and the European bond yields, while limiting the other two variables to the short-run period. In a first step, the cointegrating relationship between the yields of the Greek and the European corporate bond indices (GR NFCs bond index and iBoxx EA NFCs BBB, respectively) is tested for the entire period under review. Table 4 presents the results of the two Johansen cointegration tests (trace and maximum eigenvalue statistics).

The trace test indicates the existence of a cointegrating relationship between the two series. But given that, as Chart 5 shows, near the sample's cut-off date a considerable deviation appears between the yields of Greek and European NFC bonds, it is important to examine the constancy of the relationship. To this end, we apply the Gregory and Hansen (1996) test for the existence of a regime shift in the cointegrating relationships of the two series (see Table 5).

Table 5 Tests for cointegration with a structural break

Parameters	ADF value	Date
C and T	-7.018**	4.11.2014

Note: ** and * suggest statistical rejection of the null hypothesis for the existence of a unit root in residuals (statistical significance 5% and 10%, respectively). Tests against critical values for a cointegrating relationship with a structural break due to a change in the constant term or the trend.

As Table 5 shows, the test for a cointegrating relationship with a structural shift during the period under review indicates a minimisation of the test value on 4 November 2014. It should be noted that the period since mid-October is characterised by heightened volatility in the market for Greek government bonds. Owing to the identification of a structural break, we then examine the relationship between the yields of Greek and European corporate bonds separately for the periods before and after the regime shift.

4.2.2 The period before the regime shift in the cointegrating relationship

We first estimate the relationship for the period up to 31 October 2014. The results of the estimation of the relationship between the two series are presented below.

$$\underset{}{\text{GR NFCs}} = \underset{(0.122)}{1.129^{**}}\,\text{iBoxx} + \underset{(0.368)}{4.881^{**}}\,\text{const. term} - \underset{(0.0003)}{0.005^{**}}\,\text{trend} + e_t$$

Estimation of the relationship using the Fully Modified Least Squares (FMLS) method indicates the existence of a statistically significant relationship between the yields of corporate bonds issued by Greek NFCs and the yields of the BBB-rated bonds included in the iBoxx index for euro area enterprises of the non-financial sector. The level of the constant term is a proxy of the average spread between the two variables, which in the reference period stood at 4.1%.

Table 6 Residual constancy test

	ADF	PP
e_t	-3.697**	-3.631**

Note: ** and * suggest statistical rejection of the null hypothesis for the existence of a unit root (statistical significance 5% and 10%, respectively). Tests against critical values for series with a constant, no trend.

Also, the downward trend observed in Greek corporate bond yields in the period under review is reflected in the negative sign of the statistically significant coefficient of the linear trend that was included in the sample, while the level of the coefficient implies that the yields of Greek NFC bonds converged to those of the other corporate bonds of a higher rating (BBB) in the specific subperiod (1 October 2013 to 31 October 2014). Finally, examination of the relationship's residuals confirms the feature of stationarity and consequently indicates that the relationship is a long-run cointegrating relationship between the series of the yields of Greek and European corporate bonds.

We then examine the short-term relationships between the series of the first differences of Greek and European corporate bond issuances, as well as of systemic stress in the European stock markets and coefficient β of the Greek large capitalisation shares. To carry out the relevant analysis, we model a system of autoregressive equations (VAR) with eight time lags (presented in detail in Table B of the Annex).[12] Estimation of the equations in question allows for running Granger causality tests, as well as estimating the rate of adjustment to the long-run equilibrium (error correction term), obtained by the cointegration relationship. Table 7 presents the relevant results.

The results of Table 7 show that the daily changes in the yields of European BBB-rated corporate bonds and the sensitivity of large capitalisation shares to systemic factors in the Greek stock exchange, as captured by parameter beta, represent key determinants of the daily changes in the yields of Greek corporate bonds. Furthermore, the statistically significant error correction term implies that any deviations of the yields of such bonds from the equilibrium relationship are only short-term and gradually adjusted to the common trend of the yields of the European bonds. Consequently, combining these results we come to the conclusion that in the period under review changes in the yields of Greek corporate bonds were considerably affected by the conditions shaped in the Athens Exchange, but mostly by the favourable conditions prevailing in the European market for corporate bonds.

Finally, we run diagnostic tests on the residuals in order to verify the integrity and effec-

12 Selected on the basis of the Akaike and the Bayesian information criteria.

Table 7 Causality in changes in Greek corporate bond yields

	Δ(iBoxx EA NFCs BBB)	CISS-equities	beta
χ^2	20.131**	1.596	17.771**
p-value	0.000	0.450	0.026
	Error correction term		
	Coefficient	**Standard error**	**p-value**
et-1	-0.075**	0.021	0.001

Note: * and ** suggest statistical significance of the variable (confidence intervals of 10% and 15% respectively).

Table 8 Diagnostic tests

Test	Jarque-Berra	Autocorrelation	Heteroscedasticity
Value	5473.67	12.584	936.25
p-value	0.000	0.703	0.000

tiveness of the specification of the yields based on the structure of the underlying relationships (see Table 8, as well as Table B of the Annex). Although the results reveal that the residuals are non-normal, this fact is attributable not so much to the existence of autocorrelation between the residuals as to heteroscedasticity; a finding which is also confirmed by examination of the autocorrelation and eigenvalue specification charts of the underlying relationships (see Chart A of the Annex). Therefore, the coefficients are unbiased, while the detection of heteroscedasticity can also be explained by the different volatility conditions that prevailed in financial markets in the sample's reference period.

4.2.3 The period after the regime shift in the cointegrating relationship

As a next step, we repeat the analysis for the rest of the sample, i.e. for the period between 4 November 2014 and 31 December 2014. The results of the estimation of the relationship using the FMLS method are presented below.

$$\underset{}{\text{GR NFCs}} = \underset{(0.746)}{3.770^{**}\,\text{iBoxx}} - \underset{(1.229)}{0.504\,\text{const. term}} + \underset{(0.0003)}{0.032^{**}\,\text{trend}} + u_t$$

The estimation of the relationship reveals that after 4 November 2014 the coefficient of the linear trend included in the relationship has a positive sign. Consequently, there is evidence of a deviation of the yields of Greek NFC bonds from those of European corporate bonds and a reversal of the previous converging trend. In addition, an examination of the residuals (u_t) of the relationship using the ADF tests confirms the existence of a unit root (see Table 9).

Table 9 Residual constancy test (cointegrating relationship)

	ADF	PP
u_t	-2.385**	-2.454**

Note: * and ** suggest statistical rejection of the null hypothesis for the existence of a unit root (statistical significance 5% and 10% respectively). Tests against critical values for series with a constant, no trend.

Thus, there is evidence that the shift that took place in the period from early November 2014 to the sample's cut-off date leads to a disconnection of the yields of Greek NFC bonds from those of European NFC bonds. This shift coincides with the period during which volatility in the market for Greek government bonds increased as a result of deteriorated investor confidence in the Greek economy. Consequently, it can be concluded that the domestic factors affecting developments in investor confidence in the Greek economy also affect developments in the yields of Greek NFC bonds, through a change in the overall yield level required for investment in the Greek economy.

5 CONCLUSIONS

After the global financial crisis the euro area has seen a trend towards higher NFC financing through capital markets than through bank lending. This development is mostly associated with the decline in bank financing, as well as with changes in the institutional framework and initiatives taken both at the European and at the national level. A corresponding trend was also observed in the Greek economy, as large and robust Greek enterprises of the non-

financial sector managed to raise higher funds through international bond markets.

The present study sets out to capture developments in the yields of the bonds issued by large Greek NFCs in the period between end-2012 and end-2014. To this end, it constructed a relevant corporate bond index characterised by homogeneity and reflecting the conditions that have an overall impact on such bond yields. In this setting, using cointegration analysis techniques, it investigated the specification capacity of factors affecting developments in the yields of bonds of the respective European NFCs.

The findings indicate the existence of a long-run equilibrium relationship between the yields of the European and the Greek corporate bonds and a short-term effect of the conditions prevailing in the Greek stock market on large capitalisation shares, up to November 2014. Thereafter, a shift is observed in the structure of the yields' specification relationship, with the yields of Greek corporate bonds deviating from those of the other European NFC bonds.

Overall, there is evidence that an improved (deteriorated) level of investor confidence in the Greek economy should facilitate (hinder) the access of Greek NFCs to international capital markets for financing. In this context, the broader conditions that shape bond borrowing costs for European NFCs are expected to also affect borrowing costs for Greek NFCs, in conditions of high investor confidence. In contrast, in conditions of heightended volatility, the costs of borrowing through international capital markets for Greek NFCs are expected to decouple from those of European corporate bonds.

Needless to note that the present analysis is subject to limitations, as the results of the econometric estimation can only refer to the factors affecting all Greek corporate bonds in common, and not to factors affecting only specific individual issuers. Finally, a promising avenue for future research would be the specification of additional factors with a potentially considerable impact on Greek corporate bond yield developments.

REFERENCES

Beck, T., A. Demirgüç-Kunt and V. Maksimovic (2005), "Financial and legal constraints to firm growth: Does firm size matter?", *The Journal of Finance*, 60(1), 137-177.

Beck, T., A. Demirgüç-Kunt and V. Maksimovic (2008), "Financing patterns around the world: Are small firms different?", *Journal of Financial Economics*, 89(3), 467-487.

Beck, T., R. Levine and N. Loyaza (2000), "Finance and the sources of growth", *Journal of Financial Economics*, 58, 261-300.

Besanko, D. and G. Kanatas (1993), "Credit market equilibrium with bank monitoring and moral hazard", *Review of Financial Studies*, 6(1), 213-232.

Brown, P.J. (2002), *Constructing and calculating bond indices*, Cambridge, Gilmour Drummund Publishing.

Buttiglione, L., P. Lane, L. Reichlin and V. Reinhart (2014), "Deleveraging? What deleveraging?", *Geneva Reports on the World Economy*, 16, International Center for Monetary and Banking Studies (ICBM) and Centre for Economic Policy Research (CEPR).

Demirgüç-Kunt, A. and R. Levine (2001), *Financial structures and economic growth: A cross-country comparison of banks, markets, and development*, Cambridge MA, MIT Press.

Djankov, S., C. McLiesh and A. Shleifer (2007), "Private credit in 129 countries", *Journal of Financial Economics*, 84(2), 299-329.

EFC High Level Expert Group on SME and infrastructure financing (2013), *Finance for Growth, Report for the Economic and Financial Committee*, Brussels, December.

Engle, R.F. and C.W.J. Granger (1987), "Co-integration and error-correction: Representation, estimation and testing", *Econometrica*, 55(2), 251-276.

European Commission (2013), "Long-term financing of the European economy", Green Paper, COM/2013/0150 final.

Fabozzi, F.J. (2007), *Fixed Income Analysis*, 2nd Edition, John Wiley & Sons.

Galati, G. and K. Tsatsaronis (2003), "The impact of the euro on Europe's financial markets", *Financial Markets, Institutions and Instruments*, 12(3), 165-222.

Gregory, A.W. and B. Hansen (1996), "Residual-based tests for cointegration in models with regime shifts", *Journal of Econometrics*, 70(1), 99-126.

Hjalmarsson, E. and P. Osterholm (2010), "Testing for cointegration using the Johansen methodology when variables are near-integrated: size distortions and partial remedies", *Empirical Economics*, 39(1), 51-76.

Hollo, D., M. Kremer and M. Lo Duca (2012), "CISS – a composite indicator of systemic stress in the financial system", European Central Bank, Working paper No. 1426.

Holton, S., F. McCann, K. Prendergast and D. Purdue (2013), "Policy measures to improve access to credit for SMEs: a survey", Central Bank of Ireland, *Quarterly Bulletin,* Q4, 91-110.

Institute of International Finance and Bain Company (2013), *Restoring financing and growth to Europe's SMEs*.

International Capital Market Association (2013), *Economic importance of the corporate bond markets*, 1st edition, March.

James, C. (1987), "Some evidence on the uniqueness of bank loans", *Journal of Financial Economics*, 19(2), 217-235.

Johansen, S. (1988), "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, 12(2-3), 231-254.

Lima, L.R. and Z. Xiao (2007), "Do shocks last forever? Local persistency in economic time series", *Journal of Macroeconomics*, 29(1), 103-122.

MacKinnon, J., A. Haug and L. Michelis (1999), "Numerical distribution functions of likelihood ratio tests for cointegration", *Journal of Applied Econometrics*, 14(5), 563-577.

Standard and Poor's (2013), "Credit FAQ: Could SME-backed covered bonds gain popularity with investors?", 4 February.

World Economic Forum (2012), *Global Competitiveness Report 2012-2013*, September.

World Economic Forum (2014), *Global Competitiveness Report 2014-2015*, September.

ANNEX

A. BOND YIELD INDEX CALCULATION METHOD

I Description of alternative methodologies for constructing bond indices

The construction of a bond index can be based on a number of methodologies, ranging from extremely simple to complex in terms of calculating the weights assigned to the bonds that make up the index and of the period (and the conditions) for their re-estimation. Estimation of the weights on the basis of each bond's relative market value is the most commonly applied methodology, while alternative ways for calculating the weights of the indices relate to the underlying issuers' fundamentals or the Macaulay duration of each bond taken as a basis for calculating the weights in a homogeneous portfolio-index. These methodologies can be summarised as follows:

1. Weights calculated on the basis of the total number of bonds in the index, or "equal weights method":

$$w_i = 1/n$$

2. Weights calculated on the basis of par value (value at issuance):

$$w_i = K_i \Big/ \sum_{i=1}^{n} K_i$$

3. Weights calculated on the basis of market value:

$$w_i = K_i \cdot \frac{P_i}{100} \Big/ \sum_{i=1}^{n} \left(K_i \cdot \frac{P_i}{100} \right)$$

4. Weights calculated on the basis of the issuer's fundamentals:

$$w_i = F_i \Big/ \sum_{i}^{n} F_i$$

With F = total cash flows or total book value of assets or dividend payments, etc.

5. Weights calculated on the basis of the underlying interest rate risk (duration based):

$$w_i = MD_i \Big/ n \cdot \bar{MD}_i$$

where

$$\text{MD=Macauley Duration=} \frac{\sum_{t=1}^{n} \frac{t \cdot C}{(1+y)^t} + \frac{n \cdot M}{(1+y)^n}}{P_i}$$

Table A Bond index construction methodologies worldwide

Index	Weight calculation	Components	Weight readjustment period
Euro-Bond Inv. Grade (Citigroup)	Market value	Bonds in euro, with rating BBB-/Baa or higher	End-of-month, with a daily rebalancing
iBoxx Euro Corp. (Markit)	Market value	Corporate bonds in euro with a credit rating (total)	End-of-month, with a daily rebalancing
NASDAQ OMX Iceland	Market value	Bonds issued by the Icelandic government and regions	Depending on the case: it is effected when Macauley duration ceases to be within a predefined band of values
Euro Aggregate Bond Index (Barclays Capital)	On the basis of statistical data (broader than values) on underlying bond yields	Sovereign and corporate bonds and securitisation, with a value higher than €300 million, from the euro area and a credit rating of BBB-/Baa or higher and at least one year to maturity	End-of-month, with a daily rebalancing

Sources: Fact sheets of different bond indices.

y = yield

C = coupon payment

t = respective time period

n = total number of periods

M = maturity value

6. Weights calculated on the basis of other types of risk (e.g. liquidity risks).

The table presents examples of bond indices categorised based on the methodology used for their construction.

Index readjustment

Readjustment of the weights of the portfolio represents one of the key features governing the construction of a bond index. Specifically, compared with the constituents of stock market indices, bond index constituents can change more often and for different reasons, e.g. due to maturities or new issuances, resulting in a high probability of reflecting movements unrelated to the pricing process that takes place in the secondary market. As a result, regular index readjustment periods are set, ranging from daily to six months. Selection of the index readjustment periodicity is associated with the underlying method for estimating the weights, as well as with the purposes the index will be used for.

For instance, in the case of the weights' estimation method on the basis of the underlying bonds' relative market value, adjustment should be carried out at least on a monthly basis, so as to introduce any new issues, but can also be carried out daily, although this option may increase the index's "noise". In addition, in cases where the indices are used for portfolio management purposes,

adjustment should be carried out at least once in each period of estimation of the portfolio's return for the purpose of informing investors according to the international accounting standards (e.g. quarterly). In the case of the BoG NFCs bond index, adjustment is carried out daily.

II Selection criteria and desirable features of the indexes

Criterion 1: Economic interpretation of the indices

The index's features determine the interpretation of the movements of its weighted average values and its performance. For example, the movements of a US mortgage loan securitisations index can be used as an indication of upcoming conditions in the US real estate market as perceived by investors. On the other hand, the movements and the performance of the "iBoxx NFCs EA BBB" (i.e. the iBoxx index for BBB-rated euro area NFCs) when compared with the respective movements of the "iBoxx NFCs EA AAA" can capture credit risk conditions in the category of euro area enterprises of the non-financial sector as perceived by investors.

The purpose for which indices are used is accounted for through the issuers' and the securities' homogeneity. For instance, all underlying securities must constitute either senior or subordinated debt of the corporations, as in the latter case credit risk is higher due to higher loss given default. Correspondingly, it must be clear that the underlying securities include no features that would adversely affect their pricing process, such as issuer's or bondholder's options (e.g. call or put options).

Finally, the type of the coupon based on which interests are paid (e.g. fixed, floating) is another factor that can lead to movements which have no economic explanation but rather increase "noise". In light of the above, indices should include securities with similar features as regards the coupon.

Criterion 2: Purpose of the index

The goals expected to be served by the construction of a bond index represent a key criterion for the methodology to be selected. For instance, if the index is expected to be used as a criterion for placing investment portfolio funds, then the methods for estimating the weights on the basis of underlying risks become particularly important. In such a case, account should also be taken of other criteria related to the portfolios' performance, such as coupon payments and detachment periods. For the purposes of valuating the "market" —i.e. the total of a number of issuances with common features (e.g. sector and country of activity)— this is not indispensable, as underlying values in the secondary market have already discounted the coupon yields (see Fabozzi 2007, Chapter 5). On the other hand, the method for constructing bond indices on the basis of the ratio of the bonds' market value to the total "market" value represents one of the most commonly applied methodologies, preferred for its simplicity and the ease it affords for understanding the movements of the indices' performance and values (for more details on the relevant arguments, see Brown 2002). Finally, for this same purpose, the method that relies on the par value of the underlying bonds would be equally usable.

Criterion 3: Stability of the index's technical features

The application of the method for estimating weights on the basis of par value has the weakness of not reflecting economic events that may have adversely affected the pricing process since the

time of issuance, thereby rendering probable a sudden change in the index's value due to events (e.g. bankruptcy) that had already changed the bonds' pricing process in the secondary market. At the same time, stability of the index's features, i.e. noise minimisation, is desirable.

Thus, as market value is subject to daily fluctuations, it becomes obvious why the most reliable indices (such as iBoxx, CGBI, etc.) are readjusted based on a re-estimation of the weights at a lower frequency (e.g. on a monthly basis). In addition, index readjustment may also depend on the indices' purpose of use. For instance, if the indices are used for investment purposes, then the investor information requirement necessitates a readjustment at least every three (or in some cases six) months, while performance maximisation may even lead to more frequent readjustments.

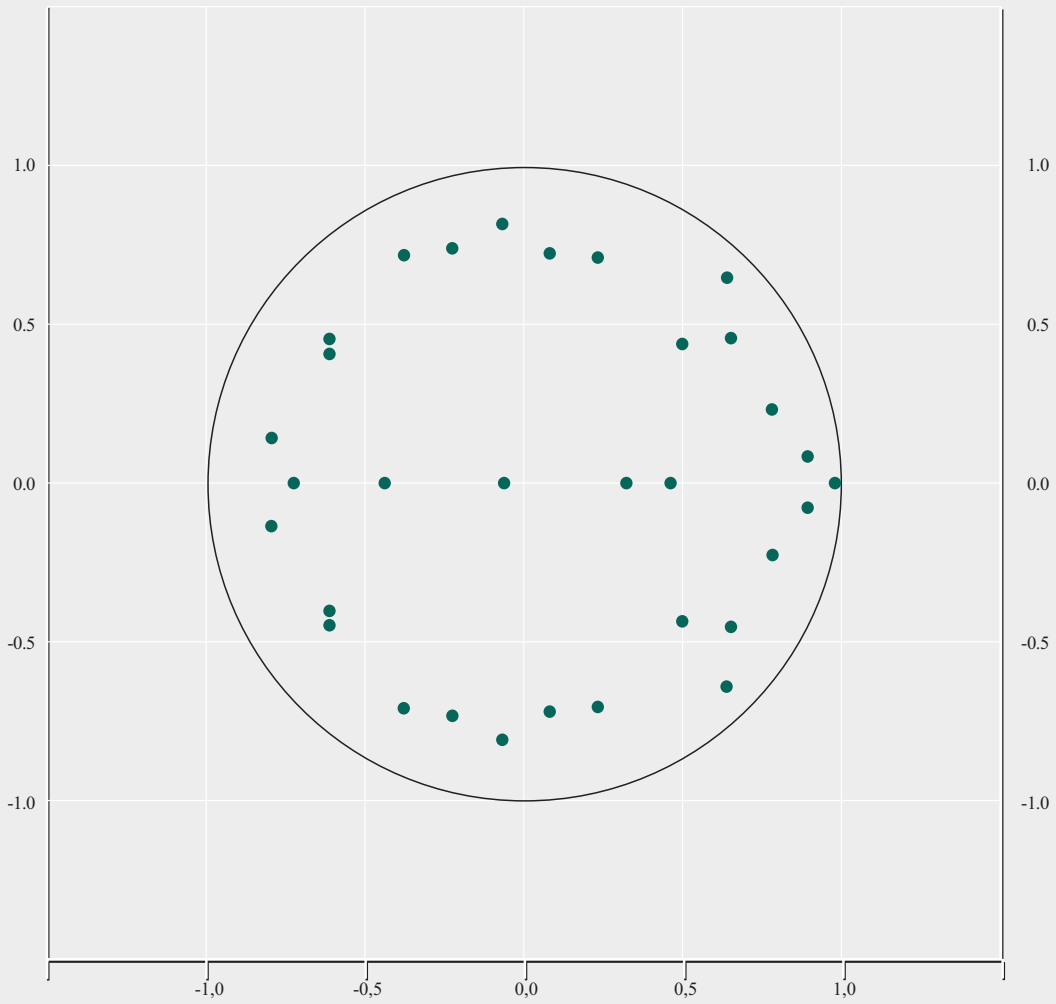
B. ANALYTIC RESULTS OF THE (VAR) AUTOREGRESSIVE EQUATIONS MATRIX

Table B Results of the estimation of (VAR) autoregressive equations

	Δ(IBOXX)	Δ(GR NFCs)	CISS	BETA
Δ(IBOXX) (-1)			0.028* (0.016)	-0.091** (0.027)
Δ(IBOXX) (-2)		0.154* (0.156)		
Δ(IBOXX) (-3)		0.227* (0.156)		
Δ(IBOXX) (-4)		-0.380** (0.156)		0.048* (0.026)
Δ(IBOXX) (-5)	-0.108** (0.054)	-0.263* (0.157)		0.001551 (0.02666)
Δ(IBOXX) (-6)				
Δ(IBOXX) (-7)	-0.125** (0.054)	-0.322** (0.156)		0.032* (0.024)
Δ(IBOXX) (-8)		0.225* (0.154)		
Δ(GR NFCs) (-1)	0.038** (0.019)	0..192** (0.055)		
Δ(GR NFCs) (-2)	0.043** (0.019)		-0.019* (0.006)	
Δ(GR NFCs) (-3)		-0.085* (0.056)		
Δ(GR NFCs) (-4)				-0.019** (0.009)
Δ(GR NFCs) (-5)				
Δ(GR NFCs) (-6)			0.009* (0.005)	
Δ(GR NFCs) (-7)	0.117** (0.019)	0.271** (0.054)		-0.020** (0.009)
Δ(GR NFCs) (-8)		0.095* (0.057)	0.010* (0.005)	0.014* (0.009)
CISS (-1)			0.956** (0.052)	
CISS (-2)				0.251** (0.122)
CISS(-3)				
CISS(-4)				
CISS(-5)			-0.198** (0.071)	
CISS(-6)			0.187** (0.072)	
CISS(-7)				
CISS(-8)				
BETA (-1)				1.670** (0.052)
BETA(-2)				-0.733** (0.100)
BETA(-3)		1.299** (0.63074)		
BETA(-4)		-1.394** (0.635)		
BETA(-5)			-0.102* (0.064)	
BETA(-6)			0.109* (0.063)	
BETA(-7)				0.139* (0.098)
BETA(-8)				
C	-0.099** (0.040)	-0.223** (0.114)	-0.039** (0.012)	0.034* (0.01964)
ECT2(-1)	-0.007965 (0.007)	-0.075** (0.021)	0.003024 (0.00211)	-0.002096 (0.00358)
R-squared	0.20	0.27	0.88	0.99
Adj. R-squared	0.13	0.21	0.87	0.99
Sum sq. resids	0.263	2.205	0.022	0.063
S.E. equation	0.026	0.077	0.007	0.013
F-statistic	2.821	4.242	82.833	1165.94
Log likelihood	917.0274	484.3874	1422.526	1207.066
Akaike AIC	-4.34	-2.21	-6.82	-5.76
Schwarz SC	-4.00	-1.88	-6.49	-5.43

Note: ** and * suggest statistical rejection of the null hypothesis for the existence of a unit root in residuals (statistical significance 5% and 10%, respectively). Standard errors in parentheses.

Chart A System Residual Roots



Source: Author's econometric estimations.

ESTIMATING THE QUALITY OF GREEK EXPORTS: A NON-PRICE-BASED APPROACH

Sarantis Kalyvitis*
Athens University of Economics and Business

1 INTRODUCTION

Sustainable development requires the continuous transformation of a country's economic structure and, among other factors, a number of recent studies have pointed out the importance of the *quality* of goods produced and exported for economic outcomes. In particular, product quality is a key feature that affects how countries specialise in production and the direction of trade between countries, as higher-quality varieties of existing products help build on existing comparative advantages to boost productivity and export revenues (see, among others, Schott, 2004; Hummels and Klenow 2005; Hallak 2006; Hausmann et al. 2007; Sutton and Trefler 2011).

The main challenge faced by this literature is that product quality is unobserved. Research in the international trade literature has attempted to exploit the availability of trade data at a highly disaggregated level for many countries and has used readily observable prices (or unit values), defined as the ratio of export value over quantity for a given product category, as a proxy for export quality. However, unit values suffer from several shortcomings generated by differences in the composition of goods, their production costs, or pricing strategies within a given product category across exporters. Moreover, standard supply or demand shocks will affect equilibrium prices, and hence unit values, without necessarily affecting product quality. Indeed, some recent papers, which have developed strategies for quality estimation using explicit microeconomic foundations, have established that observed unit value ratios can be a poor approximation for export quality (Khandelwal 2010; Hallak and Schott 2011; Henn et al 2013; Feenstra and Romalis 2014).

This study estimates a quality price index for Greek exports based on a modified version of the approach followed by Khandelwal (2010), who develops an estimation strategy that utilises both unit value and quantity information to infer quality and has a straightforward intuition extensively used in the industrial organisation literature: "*conditional on price, [...] higher market shares are assigned higher quality*" (Khandelwal 2010, p. 1451). To this end, we use disaggregated trade data covering the period 1998-2012 to obtain a quality index based on estimated regressions for 21 products. The index shows that substantial changes in export quality have occurred over this period, both at the aggregated and disaggregated product levels.

The rest of the study is structured as follows: Section 2 reviews the related theoretical and empirical literature on the quality of exports. Section 3 presents the empirical strategy and Section 4 describes the data. Section 5 presents the empirical results and, finally, Section 6 draws the main conclusions.

2 LITERATURE REVIEW ON EMPIRICAL ESTIMATES OF QUALITY IN TRADE

Empirical research in trade models has consistently found that product quality influences cross-border trade; richer countries consume and export higher-quality products than developing countries, with most studies using observable unit prices as proxies for quality. Hummels and Klenow (2005) infer quality by assuming that if large exporters systematically sell high quantities at high prices, this is consistent with these exporters producing higher-quality goods, and show that richer countries export higher-quality goods at modestly higher

* Financial support by the Bank of Greece (EP-2106-01) is acknowledged. I thank Evi Zervoudi for excellent research assistance and seminar participants at the Bank of Greece for useful comments and suggestions. The views in the paper are those of the author and do not necessarily reflect those of the Bank of Greece.

prices. Fontagné et al. (2008) report that, on average, Japanese unit values are 2.9 times higher than the Chinese ones, for the same products, shipped to the same markets, in the same year. They analyse unit prices of HS 6-digit[1] products for 200 countries and find that the products of developed countries are not directly competing with those of developing countries. Schott (2004, 2008) has documented a large difference in product prices within the most disaggregated level of product classification, as well as that US consumers pay less for similar goods that are "Made in China" than for similar goods "Made in the OECD".[2] Crozet et al. (2012) obtain direct measures of quality for one industry and show that firms with higher measured quality have a higher ratio of consumer benefits to producer costs and are more likely to export, at higher quantities, and also charge higher prices.

These findings indicate that world trade is highly characterised by quality-goods trade. Johnson (2012), Martin (2012), and Hallak and Sivadasan (2013) find that exports to more distant markets have higher unit values on average. Bastos and Silva (2010) and Harrigan et al. (2011) find that unit values within products increase systematically with distance and tend to be higher in shipments to richer nations. These relationships reflect both the sorting of heterogeneous firms across markets and the within-firm variation of unit values across destinations. Within product categories, higher-productivity firms tend to ship greater quantities at higher prices to a given destination, consistent with higher quality. In addition, firm productivity tends to magnify the positive effect of distance on within-product unit values, suggesting that higher-productivity, higher-quality firms are more able to serve markets with higher access costs. This is a broad manifestation of the "Alchian-Allen hypothesis", under which goods of higher quality are shipped longer distances, as per unit transportation costs lead firms to ship high-quality goods abroad while holding lower-quality goods for domestic consumption (Hummels and Skiba 2004).

Baldwin and Harrigan (2011) summarise the difference in the predictions of various trade models on the incidence of zeros, i.e. lack of trade, and on the determinants of unit prices. They find that export unit values at the HS10 product level are positively related to distance and negatively related to market size, and show that no single model perfectly explains these facts. Their theoretical explanation for these findings comes from a variation of the Melitz (2003) core structure with heterogeneous firms in trade by introducing a taste for quality. Heterogeneous firms compete on quality-adjusted prices, so that the lowest priced goods are not necessarily the most competitive. In equilibrium the most profitable firms produce high-quality, high-price goods, which are able to better penetrate toughest markets, i.e. small, distant, and well-served by other exporters. The empirical findings are then explained as a composition effect: since only the best firms sell in the toughest markets, and these firms charge high prices, average prices at the product level will be increasing in measures of market toughness. Johnson (2012) checks if quality is "homogeneous" (meaning that there is no difference in quality and thus firms compete only on price) or heterogeneous (meaning that quality varies and thus firms compete on quality-adjusted price) at the Standard International Trade Classification (SITC) 4-digit level and shows that heterogeneous quality is dominant.

As pointed out by Harrigan et al. (2011), these stylised facts are broadly supportive of models where consumers value quality, but quality is expensive to produce. Consumers choose goods on the basis of "quality-adjusted" prices: an expensive, high-quality good may have a lower "quality-adjusted" price than a cheap,

1 HS 6-digit refers to a system for classifying products into groups as used by the World Customs Organisation.
2 In vertical differentiation models with a quality margin, richer countries produce and export higher-quality goods (Flam and Helpman 1987; Grossman and Helpman 1991). Verhoogen (2008) proposes a Melitz-type model featuring vertical product differentiation and differences in consumer income across countries and hence in willingness to pay for product quality. Fajgelbaum et al. (2011) allow trade patterns to depend on the distributions of income in trading partners and predict that richer countries will be net exporters (importers) of higher (lower)-quality goods. See also Choi et al. (2009) and Sutton and Trefler (2011) for the links between income and quality in trade flows.

shoddy good. In turn, the marginal firm sells low-quality goods at a low price. Market entrants charge lower prices and thus average unit value in a market will fall. When markets differ in their level of competition, higher entry implies lower average prices in less competitive markets. Yet a simple comparison of average nominal prices across markets will have misleading implications, since the quality-adjusted price index can be lower when the average nominal price is higher.

The importance of export quality in analysing the determinants of trade flows sparked an interest in estimating export quality. In the context of a cross-country setup, Hallak and Schott (2011) rely on trade balances to identify quality: holding observed export prices constant, countries with trade surpluses are inferred to offer higher quality than countries running trade deficits. Consumers are assumed to care about price relative to quality in choosing among products and hence two countries with the same export prices but different global trade balances must have products with different levels of quality. Among countries with identical export prices, the country with the highest trade balance is revealed to possess the highest product quality. This procedure requires extensive data on tariffs, which is unavailable even for many relatively large countries before 1989. Feenstra and Romalis (2014) exploit supply-side features of trade data to decompose available unit values of internationally traded goods into quality and quality-adjusted price components using an endogenous quality decision. Based on two different unit-value observations for each product, derived from import and export data, they are able to aggregate individual products to industry-level indices of export quality and prices covering the period 1984-2011. Vandenbussche (2014) develops an export quality indicator based on Di Comité et al. (2014), which disentangles quality from cost and taste effects to generate quality ranks of EU manufacturing products at the CN8 level[3] over the period 2007-2011. Its rankings suggest that quality upgrading results in a higher willingness to pay by consumers and therefore offers a way to escape cost competition.

In terms of country time-series estimates of export quality, Henn et al. (2013) use reduced-form quality-augmented gravity equations based on Hallak (2006) to estimate export quality indices for 178 countries covering the period 1962-2010 at the product and aggregate levels. In a single-country setup, Khandelwal (2010) exploits price and quantity information to estimate the quality of US imports, where higher quality is assigned to products with higher market shares, conditional on price. He finds that the estimated qualities reveal substantial heterogeneity in product markets' scope for quality differentiation ("quality ladders") and that markets characterised by relatively short quality ladders are associated with larger employment and output declines resulting from low-wage competition.

3 THE EMPIRICAL MODEL FOR THE QUALITY INDEX OF EXPORTS

The empirical identification of export quality relies on the assumption that, conditional on export price, $price_{hd}$, measured by the unit values of variety h (captured by their CN8 classification), shipped to destination d, varieties with higher shares in export markets at the product level (captured by their SITC classification) are assigned higher quality. To assess product quality the following specification is estimated:

$$\ln(S_{hdt}) = \alpha \times \ln(price_{hdt}) + \beta \times \ln(pop_{dt}) + \gamma \times \ln(NS_{hdt}) + \lambda_{1,ht} + \lambda_{2,t} + \lambda_{3,ht} \quad (1)$$

where S_{hd} denotes the share of shipments of variety h to destination d in aggregate shipments of product p (e.g. cotton shirts exported to Germany relative to total exports of shirts), and NS_{hd} denotes the nested share of variety's h shipments to destination d in aggregate shipments of variety h (e.g. cotton shirts exported to

3 CN8 is the classification system for products used by Eurostat.

Germany relative to total exports of cotton shirts). Both S_{hd} and NS_{hd} are measured in terms of quantities. Given that a larger market share of a product may reflect that exports include more "hidden" variables, due to the aggregation of more finely classified products that are unobserved. Suppose that exports to Germany and the Netherlands split the market equally at an observed disaggregation level (e.g. colour of shirts), yet exports to Germany are larger as they include more colours. Aggregation to the observed level (shirts) would assign a larger market share at identical prices to Germany and yield an upwards biased estimate of quality. To account for this potential caveat, destination population pop_d is also included in the estimated regression to proxy for destination size.

The quality of variety h to destination d at time t is defined using the estimated parameters $\lambda_{ht} \equiv \lambda_{1,h} + \lambda_{2,t} + \lambda_{3,ht}$. Since trade data do not record detailed characteristics of varieties, we exploit the panel dimension of the data by specifying a time-invariant component of quality $\lambda_{1,h}$ with variety-fixed effects (some products have better quality than others) and a common quality component $\lambda_{2,t}$ with year-fixed effects (quality might vary through time). The third component of quality, $\lambda_{3,ht}$, is unobservable (for instance, quality might change because of some upgrading of plant and equipment) and plays the role of the estimation error.[4]

Specification (1) is important for inferring quality, because it allows for the plausible correlation structures among consumer preferences through the nested share, NS_{hd}. Consider for instance two varieties, wool shirts exported to France and cotton shirts to Italy. Suppose that they are identical in every dimension (including price) and evenly split the market. We would infer their qualities also to be equal. Now suppose a cotton shirt is exported to Germany: the new market shares for both cotton shirts would be one-fourth each and the wool shirts exported to France would capture the remaining half. In other words, we might expect the market share of cotton shirts exported to Italy to adjust more than the market share of wool shirts exported to France, because shirts exported to Germany are also cotton. However, we do not want the inferred quality of the existing varieties to fall simply because varieties within nests are closer substitutes than varieties across nests. The nested specification alleviates this concern preferences by placing varieties into appropriate nests, with the nested share, NS_{hd}, adjusting to account for changes in market shares.[5]

Given these insights, an alternative interpretation of λ_{ht} is that it represents a shift parameter in the variety's demand schedule: holding price fixed, a variety's quality will rise if its price in a market (destination) can rise without losing market share (Sutton 1991). Quality here represents any attribute that encompasses consumers' willingness to pay for a variety (valuation for quality or "perceived quality") and the technology of the variety (technical efficiency). The associated quality index does therefore not compare the quality of a single country's exports relative to competitors, which would require access and processing of disaggregated global trade flows as in Henn et al. (2013) and Feenstra and Romalis (2014), but rather assesses changes in market (destination) shares of a country's products that cannot be attributed to price changes.

4 DATA

The empirical definition of a product exported follows the SITC classification system, which is a product classification of the United Nations used for external trade statistics (export and import values and volumes

4 The identification of coefficients relies on the assumption that prices are exogenous. Khandelwal (2010) points out that this assumption may not hold if exporters choose prices and quality simultaneously, and instruments prices with transportation costs (captured by the distance of the destination country) and the nested share with the number of destinations per variety. A similar identification strategy for Greek exports did not prove successful, as both instruments contained little information for the variables of interest.

5 In addition, the nested share, NS_{hd}, accounts for trade redirection that is important for quality. Estimated export quality will not change simply because exports to a certain destination are adjusted due e.g. to an external shock, as the nest part will adjust as well. Thus the assessed impact can be considered as a proxy of non-price effects.

of goods), allowing for international comparisons of commodities and manufactured goods. The groupings of the SITC reflect the production materials, the processing stage, market practices and uses of the products, the importance of the goods in world trade, and technological changes. The main categories are *food, drinks and tobacco* (Sections 0 and 1 – including live animals), *raw materials* (Sections 2 and 4), energy products (Section 3), *chemicals* (Section 5), *machinery and transport equipment* (Section 7), *other manufactured goods* (Sections 6 and 8). Following standard practice in the literature, in the analysis we keep only goods from the manufacturing sector (SITC Categories 5-8) and exclude the homogeneous goods defined by Rauch (1999) since these products, by definition, exhibit no quality differentiation. Given the noise in monthly exports, data are trimmed along three dimensions. The first trim excludes varieties (defined as CN8 classifications) that are exported for less than 6 months and also those that are exported for less than 3 months to a single destination. We then calculate unit values as ratios of export value to quantity. The second trim removes varieties with extreme unit values that exceed 10 times, or fall below 10% of, the median product (SITC) price. The third trim allows for variation across nested shares (CN8) within a product category; only products with more than three CN8 classifications per SITC were used in the estimation.[6]

Table A1 of the Annex summarises the products used in the estimation process after excluding those values that are exported for all data years over our sample period (1998-2012).[7] Following Manova and Zhang (2012) and related empirical literature, we obtain characteristics of the destination country, like size, using data on population from the World Bank's World Development Indicators.

5 RESULTS

Equation (1) is run separately for 21 SITC categories in the manufacturing sector that fulfill the criteria described in the previous section. The results of these regressions are summarised in Table 1. The bottom panel shows that 20 of the regressions, or 97% of the total

6 For instance, SITC code 84423 "Jackets and blazers of knitted or crocheted textile fabrics, women's or girls'" comprises the following four CN8 classifications: 61043100 "women's or girls' jackets and blazers of wool or fine animal hair, knitted or crocheted (excl. wind-jackets and similar articles), 61043200 "women's or girls' jackets and blazers of cotton, knitted or crocheted (excl. wind-jackets and similar articles), 61043300 "women's or girls' jackets and blazers of synthetic fibres, knitted or crocheted (excl. wind-jackets and similar articles), 61043900 "women's or girls' jackets and blazers of textile materials, knitted or crocheted, excl. of wool, fine animal hair, cotton or synthetic fibres, wind-jackets and similar articles).

7 Notice that, given the data availability, this approach implies that the observed unit values are averages across firms.

Table 1 Export quality estimation results: coefficient estimates of equation (1)

Statistic	Mean	Median
Price coefficient	-0.728	-0.698
Coefficient on conditional market share	0.609	0.649
Coefficient on population	0.0485	0.0477
R-squared	0.57	0.61
Estimations with statistically significant negative price coefficient	20	
Observations with statistically significant negative price coefficient	19,566	
Total estimations	21	
Total observations across all estimations	20,135	

Note: The top panel reports estimation statistics of running equation (2) separately for each of the 21 products. The bottom panel reports statistics that apply to the entire sample.

Table 2 Quality indices of Greek exports, total and by SITC industry

(1998-2012, 2010=100)

Year	SITC 5 (1)	SITC 6 (4)	SITC 7 (2)	SITC 8 (14)	Total
1998	154.2	153.1	140.7	104.8	**109.4**
1999	150.3	168.3	109.7	98.8	**100.7**
2000	137.1	137.1	133.6	97.1	**100.5**
2001	103.2	167.1	148.5	98.5	**103.2**
2002	103.7	152.0	143.3	92.0	**98.4**
2003	141.1	128.5	117.1	95.8	**100.6**
2004	146.1	115.8	126.5	94.1	**100.6**
2005	143.9	170.7	133.0	99.6	**108.7**
2006	133.7	165.6	117.9	98.2	**106.4**
2007	124.9	147.2	109.3	101.2	**106.0**
2008	118.4	128.6	108.2	105.9	**108.1**
2009	96.6	96.4	106.9	104.7	**104.0**
2010	100.0	100.0	100.0	100.0	**100.0**
2011	103.2	137.2	121.1	113.0	**115.5**
2012	135.8	136.8	123.5	112.0	**118.7**

Note: The column headings denote the aggregate product classifications (at SITC1 level) and the number of products (at SITC5 level) in each category is within parentheses.

Table 3 Quality indices of Greek exports, total and by SITC industry

(1999-2012, year-on-year % change)

Έτος	SITC 5 (1)	SITC 6 (4)	SITC 7 (2)	SITC 8 (14)	Total
1999	-2.6	9.9	-22.0	-5.7	**-7.9**
2000	-8.7	-18.6	21.8	-1.7	**-0.2**
2001	-24.8	21.9	11.2	1.4	**2.7**
2002	0.5	-9.0	-3.5	-6.6	**-4.7**
2003	36.0	-15.4	-18.3	4.2	**2.3**
2004	3.6	-9.9	8.1	-1.8	**0.0**
2005	-1.5	47.4	5.2	5.8	**8.0**
2006	-7.1	-3.0	-11.4	-1.4	**-2.1**
2007	-6.5	-11.1	-7.3	3.0	**-0.4**
2008	-5.2	-12.7	-0.9	4.6	**2.0**
2009	-18.4	-25.1	-1.2	-1.2	**-3.8**
2010	3.5	3.8	-6.5	-4.5	**-3.8**
2011	3.2	37.2	21.1	13.0	**15.5**
2012	31.6	-0.3	1.9	-0.9	**2.8**

Note: The column headings denote the aggregate product classifications (at SITC1 level) and the number of products (at SITC5 level) in each category is within parentheses.

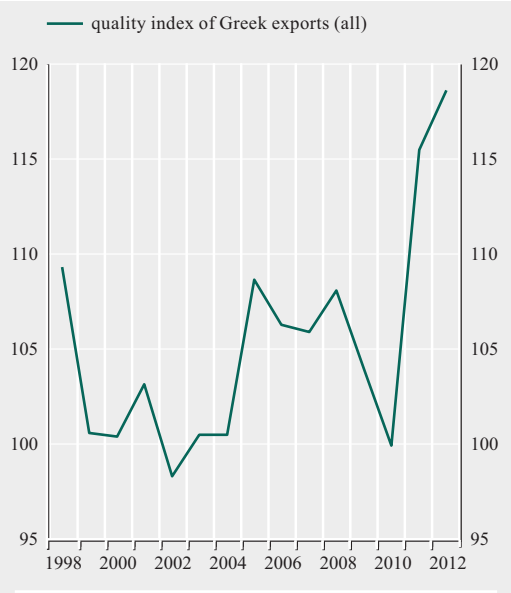
20.135 observations in the entire sample, have a negative and statistically significant price coefficient. Row 1 in the top panel indicates that the average OLS price coefficient amounts to -0.73, yielding a somewhat higher value compared to Khandelwal (2010). Rows 2 and 3 indicate that the average coefficients on the conditional market share and the population also have the expected positive signs. Overall, the R-squared of the regressions are relatively high, suggesting a satisfactory fit.

Tables 2 and 3 display the estimated export quality indices per SITC broad category (5-8) and the aggregate index, calculated as the weighted sum of the industry indices based on the annual revenues for each industry. After 1998, SITC industries 5 (Chemicals and Related Products), 6 (Manufactured Goods Classified Chiefly by Material) and 7 (Machinery and Transport Equipment) displayed a drop in the estimated export quality until 2010. A recovery period is observed in years 2003-2005 for SITC 5, in 2001-2002 and 2005-2006 for SITC 6 and in 2001-2002 for SITC 7. In contrast, SITC industry 8 (Miscellaneous Manufactured Articles) displays a stagnant pattern for the whole period. After 2010, average export quality appears to follow a more positive trajectory, climbing by 15.5% in 2010 and 2.8% in 2012. Export quality at the sectoral level continues to reveal substantial heterogeneity, with the rise mainly driven by SITC categories 5 and 6, which exhibit cumulative increases of 35.8% and 36.8% respectively. The patterns of the aggregate and sectoral export quality indices are depicted in Charts 1 and 2 respectively.[8]

To compare the quality index of Greek exports to the only currently existing measure of export quality given by Henn et al. (2013), Chart 3 plots the two aggregate indices for the common period 1998-2010. As can be readily seen, the indices display similar, though not

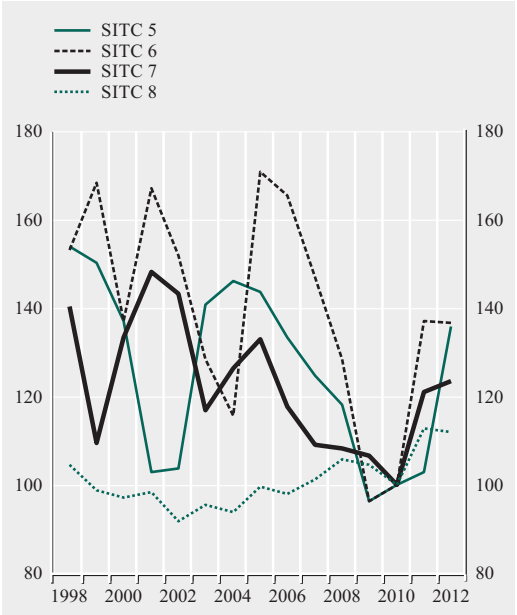
8 Table A2 of the Annex contains the detailed quality estimates per SITC products for the period under consideration.

Chart 1 Aggregate quality index of Greek exports (2010=100)



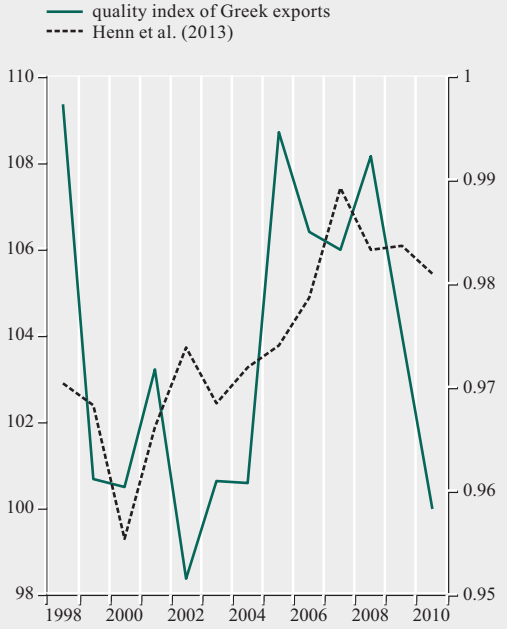
Source: Bank of Greece.

Chart 2 Quality indices of Greek exports by product category (2010=100)



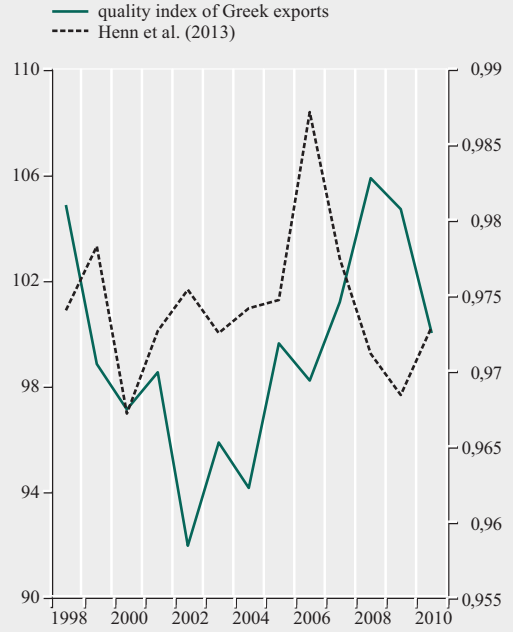
Source: Bank of Greece.

Chart 3 Quality index of Greek exports and Henn et al. (2013) index for Greece (1998-2010)



Source: Bank of Greece.

Chart 4 Quality index of Greek exports and Henn et al. (2013) index for Greece (SITC 8) 1998-2010

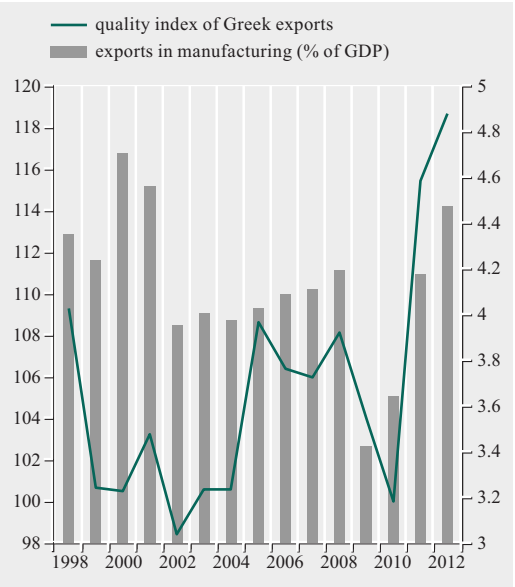


Source: Bank of Greece.

identical, patterns with their correlation amounting to 0.37. In particular, the Henn et al. index displays a smoother pattern, a finding that may be attributed to the fact that it is based on all products exported. Indeed, a look at the underlying indices reveals that the relationship is less clear: Chart 4 depicts the two indices for SITC 8 category products and shows that the correlation is less evident and further investigation is warranted to analyse the underlying determinants of export quality at the sectoral level.

As a final step, we examine the relationship between Greek exports in the manufacturing sector and the export quality index. Chart 5 plots manufacturing exports as a percentage of GDP (obtained from World Development Indicators) and the quality index. Manufacturing exports remained stagnant until 2008, ranging from 4% to 4.3% of GDP, with the exception of 2000 and 2001 when they amounted to 4.7% and 4.6% of GDP respec-

Chart 5 Quality index of Greek exports and manufacturing exports as % of GDP (1998-2012)



Source: World Development Indicators.

tively. After the large drop in 2009, when exports fell to 3.4% of GDP, they picked up sharply over the next years reaching 4.5% of GDP in 2012, a rise that is partly due to the slump in GDP after 2009. The export quality index is mildly correlated with the share of exports over the 1998-2012 period (correlation coefficient: 0.28) and, notably, accompanies the strong rise of exports in years 2011 and 2012. Although this relationship does not necessarily indicate a causal association, the rise in export quality is noteworthy when viewed in conjunction with the concurrent strengthening of the export sector in 2011 and 2012.

6 CONCLUSIONS

This study presented the construction of a new index for export quality in Greece. Based on the premise that a product's quality will rise if its price in a market can rise without losing market share, a specification that relates market shares to prices and other determinants was estimated using Greek export data over the period 1998-2012. Export quality is estimated to have fallen by 0.7 percentage point per year on average for the period 1998-2010, but recovered in 2011 and 2012 when export quality displayed a cumulative rise of 18.7%, yielding an average annual rise of 0.7 percentage point for the period 1998-2012. In conjunction with the observed rise in the value of manufacturing exports in 2011 and 2012, these estimates imply that the rise in exports observed after 2010 went hand in hand with a rise in export quality.

Looking ahead, the inclusion of more products in the construction of the index will be key in confirming its evolution at the aggregate and sectoral levels, and ensuring the robustness of this process. Also, the links between quality ladders and developments in product markets, like wages and other cost components of competitiveness, can reveal important aspects in the determination of export quality. Finally, looking beyond individual Greek products or sectors of economic activity, the examination of the quality of exports across destinations seems a promising route for further investigation, particularly in light of the adoption of the euro. To this end, constructing export quality indices related with flows to euro area and non-euro area countries seems an interesting avenue for future research.

REFERENCES

Baldwin R. and J. Harrigan (2011), "Zeros, quality, and space: trade theory and trade evidence", *American Economic Journal: Microeconomics*, 3(2), 60-88.

Bastos P. and J. Silva (2010), "The quality of a firm's exports: where you export to matters", *Journal of International Economics*, 82(2), 99-111.

Choi Y.C, D. Hummels and C. Xiang (2009), "Explaining import quality: The role of income distribution", *Journal of International Trade*, 77(2), 265-275.

Crozet M., K. Head and T. Mayer (2012), "Quality sorting and trade: firm-level evidence for French wine", *Review of Economic Studies*, 79(2), 609-644.

Di Comité F., J. Thisse and H. Vandenbussche (2014), "Verti-zontal differentiation in export markets", *Journal of International Economics*, 93(1), 50-66.

Fajgelbaum P., G. Grossman and E. Helpman (2011), "Income distribution, product quality, and international trade", *Journal of Political Economy*, 119(4), 721-765.

Feenstra R. and J. Romalis (2014), "International prices and endogenous quality", *Quarterly Journal of Economics*, forthcoming.

Flam H. and E. Helpman (1987), "Vertical product differentiation and North-South trade", *American Economic Review*, 77(5), 810-22.

Fontagné L., G. Gaulier and S. Zignago (2008), "Specialisation across varieties and North-South competition", *Economic Policy*, 23, 51-91.

Grossman G. and E. Helpman (1991), *Innovation and growth in the global economy*, MIT Press.

Hallak J.C. (2006), "Product quality and the direction of trade", *Journal of International Economics*, 68(1), 238-265.

Hallak J.C. and P.K. Schott (2011), "Estimating cross-country differences in product quality," *Quarterly Journal of Economics*, 126 (2011), 417-474.

Hallak J.C. and J. Sivadasan (2013), "Product and process productivity: Implications for quality choice and conditional exporter premia", *Journal of International Economics*, 91(1), 53-67.

Harrigan J., X. Ma and V. Shlychkov (2011), "Export prices of U.S. firms", *NBER Working Paper 17706*.

Hausmann R., J. Hwang and D. Rodrik (2007), "What you export matters", *Journal of Economic Growth*, 12, 1-25.

Henn C., C. Papageorgiou and N. Spatafora (2013), "Export quality in developing countries", *IMF Working Paper No. 13/108*.

Hummels D. and P.J. Klenow (2005), "The variety and quality of a nation's exports", *American Economic Review*, 95(3), 704-723.

Hummels D. and A. Skiba (2004), "Shipping the good apples out? An empirical confirmation of the Alchian-Allen conjecture", *Journal of Political Economy*, 112(6), 1384-1402.

Johnson R.C. (2012), "Trade and prices with heterogeneous firms", *Journal of International Economics*, 86(1) 43-56.

Khandelwal A. (2010), "The long and short (of) quality ladders", *Review of Economic Studies*, 77(4), 1450-1476.

Kugler M. and E. Verhoogen (2012), "Prices, plant size, and product quality", *Review of Economic Studies*, 79(1), 307-339.

Manova K. and Z. Zhang (2012), "Export prices across firms and destinations", *Quarterly Journal of Economics*, 127(1), 379-436.

Martin J. (2012), "Markups, quality, and transport costs", *European Economic Review*, 56(4), 777-791.

Melitz M.J. (2003), "The impact of trade on intra-industry reallocations and aggregate industry productivity", *Econometrica*, 71(6), 1695-1725.

Rauch J. (1999), "Networks versus markets in international trade", *Journal of International Economics*, 48(1), 7-35.

Schott P.K. (2004), "Across-product versus within-product specialisation in international trade", *Quarterly Journal of Economics*, 119(2), 647-678.
Schott P.K. (2008), "The relative sophistication of Chinese exports", *Economic Policy*, 53, 5-49.
Sutton J. (1991), *Sunk Costs and Market Structure*, Cambridge, MIT Press.
Sutton J. and D. Trefler (2011), "Deductions from the export basket: capabilities, wealth and trade", *NBER Working Papers* 16834.
Vandenbussche H. (2014), "Quality in exports", *European Economy, Economic Papers 528*.
Verhoogen E.A. (2008), "Trade, quality upgrading, and wage inequality in the Mexican manufacturing sector", *Quarterly Journal of Economics*, 123(2): 489-530.

ANNEX

Table A1 Product categories used in the estimation (description, SITC code and number of CN8 codes within SITC)

SECTOR (SITC1 code)	SITC 5 (# CN8)	Average weighting
Chemicals and related products, n.e.s. (5)		
Paints & varnishes (including enamels & lacquers) based on synthetic polymers/chemically modified natural polymers, dispersed/dissolved in a non-aqueous medium; plastics in solution	53342 (5)	0.054
Manufactured goods classified chiefly by material (6)		
Other embroidery	65659 (5)	0.007
Non-wovens, whether/not impregnated, coated, covered/laminated, n.e.s.	65720 (9)	0.022
Textile fabrics impregnated, coated, covered/laminated with plastics, other than those of heading 65793	65732 (4)	0.003
Twine, cordage, ropes & cables, whether/not plaited/braided & whether/not impregnated, coated, covered/sheathed with rubber/plastics	65751 (5)	0.007
Machinery and transport equipment (7)		
Refrigerators, household-type (electric/other), whether/not containing a deep-freeze compartment	77521 (5)	0.068
Microwave ovens; other ovens; cookers, cooking plates, boiling rings, grillers & roasters	77586 (5)	0.035
Miscellaneous manufactured articles (8)		
Other travel goods, handbags & similar containers	83199 (6)	0.003
Trousers, bib & brace overalls, breeches & shorts, men's/boys', of textile materials, not knitted/crocheted	84140 (14)	0.050
Dresses, women's/girls', of textile materials, not knitted/crocheted	84240 (6)	0.019
Skirts & divided skirts, women's/girls', of textile materials, not knitted/crocheted	84250 (5)	0.013
Trousers, bib & brace overalls, breeches & shorts, women's/girls', of textile materials, not knitted/crocheted	84260 (13)	0.036
Blouses, shirts & shirt-blouses, women's/girls', of textile materials, not knitted/crocheted	84270 (6)	0.056
Jackets & blazers, women's/girls', knitted/crocheted of textile materials	84423 (4)	0.024
Dresses, women's/girls', knitted/crocheted of textile materials	84424 (4)	0.028
Skirts & divided skirts, women's/girls', knitted/crocheted of textile materials	84425 (4)	0.009
Blouses, shirts & shirt-blouses, women's/girls', knitted/crocheted of textile materials	84470 (4)	0.485
Jerseys, pullovers, cardigans, waistcoats & similar articles, knitted/crocheted	84530 (7)	0.044
Articles of apparel, men's/boys', n.e.s., not knitted/crocheted	84587 (9)	0.003
Paper/paperboard labels of all kinds, whether/not printed	89281 (4)	0.006
Other builders' ware of plastics	89329 (5)	0.028

Notes: Lines in bold denote the aggregate product classifications (at SITC1 level). The remaining lines are the disaggregated product classifications (at SITC5 level).

Table A2 Export quality indices of Greek exports by SITC5 product, 1998-2012

(2010=100)

Year	#53342	#65659	#65720	#65732	#65751	#77521	#77586	#83199	#84140	#84240	#84250	#84260	#84270	#84423	#84424	#84425	#84470	#84530	#84587	#89281	#89329
1998	154.2	137.7	737.0	111.3	97.7	139.7	141.5	320.7	85.9	66.4	157.8	125.7	123.2	107.7	124.9	167.1	98.5	95.0	157.7	85.1	115.4
1999	150.3	181.1	622.6	150.2	69.8	90.5	120.9	309.2	88.9	106.4	164.8	125.5	130.9	107.7	110.3	186.5	85.7	104.6	163.5	86.0	100.4
2000	137.1	106.6	719.5	123.6	83.0	148.3	127.1	261.4	93.6	123.3	165.3	123.9	134.5	118.5	123.6	150.3	81.7	98.9	304.0	79.2	165.3
2001	103.2	133.6	428.3	99.5	75.7	163.4	131.7	246.6	95.0	138.3	132.9	126.2	114.6	132.3	108.6	147.4	91.5	93.1	207.6	72.2	103.4
2002	103.7	136.4	226.8	121.0	57.5	165.0	119.2	171.3	107.0	127.5	118.1	121.5	100.9	111.7	89.0	122.1	85.7	89.6	198.8	73.1	119.3
2003	141.1	143.9	139.6	141.6	62.7	116.8	117.3	253.9	118.6	126.4	185.7	133.3	99.5	124.9	106.4	100.1	89.1	68.8	156.7	72.0	134.2
2004	146.1	146.2	130.6	84.0	53.3	132.1	116.9	235.3	124.9	113.2	117.0	137.7	89.4	117.7	96.0	101.8	86.8	103.3	141.0	76.8	133.7
2005	143.9	152.5	234.3	110.4	77.6	136.4	127.2	235.0	132.2	108.9	113.3	147.5	93.0	121.0	91.4	149.8	86.1	125.4	148.5	74.7	146.3
2006	133.7	124.0	229.6	125.8	80.3	122.6	88.0	190.8	127.1	127.5	119.0	140.6	97.3	117.0	102.7	84.9	86.2	119.1	234.1	91.3	134.1
2007	124.9	114.4	198.9	96.8	76.7	111.2	99.4	196.5	89.5	137.5	131.1	140.7	94.1	125.2	96.9	103.5	92.1	109.6	149.7	97.2	136.6
2008	118.4	127.7	145.1	110.1	89.5	110.0	100.2	130.4	105.5	116.8	149.4	145.9	101.6	117.4	103.0	110.5	95.4	101.1	100.5	100.3	130.6
2009	96.6	117.1	88.5	121.2	99.2	106.0	110.6	162.5	104.9	128.0	158.8	122.0	100.6	114.9	97.0	117.8	96.4	103.7	129.4	110.3	120.4
2010	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2011	103.2	95.7	147.0	79.7	122.7	118.5	128.3	94.2	123.2	107.3	162.8	113.4	106.6	120.2	106.8	170.5	116.8	116.0	118.5	71.3	81.3
2012	135.8	95.4	149.5	79.2	111.3	122.9	124.1	167.1	128.5	127.7	149.8	129.2	101.0	130.9	118.3	148.5	111.6	120.2	142.9	59.1	56.6

Notes: The numbers indicated in the headings refer to the disaggregated product classifications (at SITC5 level).

WORKING PAPERS (JUNE - DECEMBER 2014)

This section contains the abstracts of Working Papers authored by Bank of Greece staff and/or external authors and published by the Bank of Greece. The unabridged version of these texts is available on the Bank of Greece's website (www.bankofgreece.gr).

CONTENTS

Macroeconomic and credit forecasts in a small economy during crisis: A large Bayesian VAR approach

Working Paper No. 184
Dimitrios P. Louzis

The recent experience from the crisis in Southern European countries has highlighted, if nothing else, the importance of economic projections as an essential tool for the implementation of strategic policy action plans. Under this framework, the present study contributes to the growing macroeconomic forecasting literature by assessing the ability of large-scale vector autoregressions (VARs) models to produce accurate macroeconomic (output and inflation) and credit (loans and lending rates) forecasts in Greece, during the latest sovereign debt crisis. Given that the markets played a crucial during the Greek crisis, we also lay particular emphasis on the information content of financial variables and their ability to deliver accurate forecasts. To that end, we implement recently proposed Bayesian shrinkage techniques and we evaluate the information content of forty two (42) monthly macroeconomic and financial variables in a large Bayesian VAR context, using a five-year out-of-sample forecasting period from 2008 to 2013. The empirical results reveal that, overall, large-scale Bayesian VARs, enhanced with key financial variables and coupled with the appropriate level of shrinkage, outperform their small- and medium-scale counterparts with respect to both macroeconomic and credit variables. The forecasting superiority of large Bayesian VARs is particularly clear at long-term forecasting horizons. Finally, empirical evidence suggests that large Bayesian VARs can significantly improve the directional forecasting accuracy of small VARs with respect to loans and lending rates (credit variables).

Industry-level labour demand elasticities across the Eurozone: will there be any gain after the pain of internal devaluation?

Working Paper No. 185
Antonis Adam and Thomas Moutos

In this paper we estimate disaggregated labour demand equations using panel data involving observations across time (1970-2007) for twenty-three industries across eleven euro area countries. By using the EU KLEMS database, which provides data across countries, we provide industry-by-industry estimates of the labour demand function. The values of our estimated (own-price) elasticities of labour demand are substantial, and in accordance with the findings of the empirical literature. Independently of whether we use level or time-differenced data, the (absolute value of the) estimated conditional elasticities are bracketed in the interval [0.05, 0.80], with the (un-weighted) mean elasticity across the various methods ranging from 0.26 to 0.43. The values of the estimated unconditional elasticities are similar in size and range, and the same holds true for country-specific wage-elasticities of labour demand. Our results indicate that the wage declines experienced in the periphery countries of the euro area can, when the contractionary credit and budgetary policies come to an end, have a non-negligible, albeit modest, effect on future employment growth.

Fiscal policy, net exports, and the sectoral composition of output in Greece

Working Paper No. 186
Athanasios O. Tagkalakis

This paper investigates the effects of fiscal policy on net export performance and the sectoral composition of output in Greece in the post-2000 era. Following the SVAR approach of Blanchard and Perotti (2002) and building on Tagkalakis (2013) we examine the effect that government spending and tax policy shocks have on net exports in Greece. Furthermore, in line with Benetrix and Lane (2010) the paper examines whether the downsizing of the public sector can increase the relative share of the tradable sector. In order to do that, we allocate NACE Rev. 2 sections to the non-tradable and tradable sectors following Eurostat (2008) and earlier studies like Gibson and Malley (2008), and Benetrix and Lane (2010).

According to our findings, a reduction in government spending (or a tax hike) exerts a negative response on output which reduces import demand. Following a cut in government spending, exports increase on account of improvements in competitiveness, contributing to a positive net export response profile. However, tax hikes, in particular on social security contributions and other indirect taxes, impact negatively on firms, thus worsening export performance.

Although real aggregate output declines following a cut in government spending, the output of the tradable sector responds positively. This implies which more resources are freed for the private sector, which are in turn directed to the more productive tradable sector, further improving net export performance.

When does it pay to tax? Evidence from state-dependent fiscal multipliers in the euro area

Working Paper No. 187
George Hondroyiannis and Dimitrios Papaoikonomou

The impact of fiscal policy on economic growth is investigated within a panel of euro area member states over the period 2004-2011. We mainly consider fiscal impulses identified by (a) changes in the structural primary balance, complemented by evidence from (b) the IMF narrative shocks developed by Devries et al. (2011) and (c) a VAR-based measure of unanticipated policy announcements. Aggregate fiscal multipliers are estimated in the region of 0.5, although we find considerable variation depending on the fiscal mix, the degree of openness and the state of the economy. During episodes of recession, tax hikes become significantly more costly in terms of output than expenditure cuts. This appears to be related to increases in the share of hand-to-mouth consumers, proxied by the unemployment rate. Fiscal effects are generally more muted in open economies and during periods of positive growth. Country-specific features in Greece lead to significantly higher estimates, possibly in excess of unity in 2011, reflecting predominantly sizeable revenue effects.

On corporate financial distress prediction: What can we learn from private firms in a small open economy?

Working Paper No. 188
Evangelos C. Charalambakis

We use a large panel dataset that includes nearly 31,000 Greek private firms to investigate which variables impact on the prediction of corporate financial distress. Based on a multi-period logit model that accounts for industry effects, we identify six firm-specific variables that best describe the probability of financial distress for Greek private firms. In particular, the results show that profitability, leverage, the ratio of retained earnings to total assets, the ability of a firm to export, liquidity and the ability of a firm to pay out dividends are strong predictors of financial distress. We also find that GDP growth and a dummy variable that considers the effect of the Greek debt crisis affect the probability of financial distress. In-sample and out-of-sample forecast tests show that the model that includes the six firm-specific variables, GDP growth and industry dummies exhibits the highest predictive ability. Finally, the predictive ability of the model remains high when we increase the forecast horizon.

Bank leverage and return on equity targeting: intrinsic procyclicality of short-term choices

Working Paper No. 189
Spyros Pagratis, Eleni Karakatsani and Helen Louri

Return-on-equity (RoE) targeting is a common strategy in the banking industry and is usually publicised in bank strategy statements. Although RoE is considered to be a partial indicator of bank performance, not taking into account any risk assessment, it is still broadly used in the form of a target often reaching unrealistic and unsustainable values. In a sense, RoE is rather a communication tool (simple, easy to access and use for comparisons) than a proper performance benchmark (ECB 2010). Still, management remuneration is often linked to it.

Since RoE = RoA x Leverage, when return-on-assets (RoA) is not satisfactory, an alternative way to increase RoE is by increasing leverage, where leverage is the ratio of total assets to equity. In that sense, leverage can be thought of as an equity multiplier of managerial skill to extract revenue from assets. Motivated by Haldane (2009) we examine the return on equity targeting behaviour of banks based on a sample of 6,180 bank-year observations from consolidated balance sheets and income statements of 1,009 commercial banks and bank holding companies from the Eurozone, the United Kingdom, Switzerland, the Nordics, the US and Canada, for the period 2001-2013. We use a dynamic panel specification of the classic partial adjustment equation to examine if banks target return on equity and use leverage in order to meet their targets.

We find that banks exhibit return on equity targeting behaviour and that leverage is indeed actively used to affect the speed of adjustment towards the return on equity target. This result holds both for the pre- and post-2007 period and especially for banks that tend to operate with leverage above that of the median of their peer group. The active use of leverage for the purpose of targeting return on equity is particularly evident among big banks, it is consistent across regions —especially the US and the EU— and survives an alternative estimation procedure of two-step GMM with finite sample correction.

Overall, the results suggest that return on equity targeting could amplify cyclical fluctuations, as banks take on high leverage to achieve high returns when risk premia are low, while they "rush for the exit" when the cycle turns and reduce leverage to contain losses. This leads to a market failure where bank managers chase the short-term return on equity without internalising the longer-term consequences of leverage on the riskiness of the bank. That behaviour could impose a negative externality on the economy as a whole by affecting leverage dynamics and amplifying cyclical variations. Therefore, recent proposals that aim to align executive pay with long-term performance by restricting the use of short-sighted profitability measures, such as RoE, from remuneration schemes are in the right direction.

ARTICLES PUBLISHED IN PREVIOUS ISSUES OF THE ECONOMIC BULLETIN

Boutos Yannis, "Economic stabilisation and growth prospects", No. 3, February 1994.
Papademos Lucas, "Growth with stability: the role of monetary policy", No. 5, March 1995.
Voridis Hercules, "The special nature of banks and the transmission mechanism of monetary policy: A review of recent literature", No. 5, March 1995.
Filippides Anastasios, Kyriakopoulos Panayotis and Moschos Dimitrios, "Bank of Greece monetary policy instruments", No. 6, November 1995.
Haralabides Michael, Hardouvelis Gikas and Papageorgiou George, "Changeover to the single currency: Prospects and challenges for credit institutions in Greece", No. 6, November 1995.
Karabalis Nikos, "Harmonisation of Consumer Price Indices in EU countries", No. 7, March 1996.
Public Sector Accounts Department, Studies, Planning and Operations Development Office, "Government Securities Markets", No. 7, March 1996.
Saccomanni Fabrizio, "Opportunities and challenges in the process of European monetary integration", No. 7, March 1996.
Papademos Lucas, "Challenges facing monetary policy on the road to EMU", No. 8, November 1996.
Information Systems and Organisation Department, "Developments in EU Payment Systems: TARGET and the Hellenic system Hermes", No. 8, November 1996.
Brissimis Sophocles and Gibson Heather, "Monetary policy, capital flows and Greek disinflation", No. 9, March 1997.
Sabethai Isaac, "From contractual earnings to labour costs: incomes policy, collective bargaining and inflation (1991-1996)", No. 9, March 1997.
Hall S.G. and Zonzilos Nicholas, "The output gap and inflation in Greece", No. 9, March 1997.
Pantelidis Evangelos, "The methodology of the new balance of payments compilation system of the Bank of Greece", No. 9, March 1997.
Papademos Lucas, "The globalisation of financial markets and the conduct of economic and monetary policy", No. 10, December 1997.
Brissimis Sophocles and Kastrisianakis Efstratios, "Is there a credit channel in the Greek economy?", No. 10, December 1997.
Gibson Heather, "The relationship between the financial system and the real economy", No. 10, December 1997.
Hondroyiannis George and Papapetrou Evangelia, "The causal relationship between consumer and wholesale prices in Greece", No. 10, December 1997.
Hardy Daniel and Simigiannis George, "Competition and efficiency of the Greek banking system", No. 11, June 1998.
Brissimis Sophocles and Gibson Heather, "What can the yield curve tell us about inflation?", No. 11, June 1998.
Pantazidis Stelios, "Inflation, investment and economic growth in Greece", No. 11, June 1998.
Mitrakos Theodoros, "The contribution of income sources to overall inequality", No. 11, June 1998.
Garganas Nicholas, "Greece and EMU: prospects and challenges", No. 12, December 1998.
Brissimis Sophocles, Sideris Dimitris and Voumvaki Fragiska, "Purchasing power parity as a long-run relationship: an empirical investigation of the Greek case", No. 12, December 1998.
Manassaki Anna, "European Union transfers to Greece: historical background and prospects", No. 12, December 1998.
Lazaretou Sophia, "The drachma on the metallic monetary standards: lessons from the past", No. 13, July 1999.
Hondroyiannis George, "The causality between government spending and government revenue in Greece", No. 13, July 1999.
Mitrakos Theodoros and Tsakloglou Panos, "The distributional impact of excise duties", No. 13, July 1999.

Dellas Harris, "ECB monetary policy strategy and macroeconomic volatility in Greece", No. 13, July 1999.
Papazoglou Christos, "The real exchange rate and economic activity: is the hard-drachma policy necessarily contractionary?", No. 14, December 1999.
Gibson Heather and Lazaretou Sophia, "Leading inflation indicators for Greece: an evaluation of their predictive power", No. 14, December 1999.
Karapappas Andreas and Milionis Alexandros, "Estimation and analysis of external debt in the private sector", No. 14, December 1999.
Papademos Lucas, "From the drachma to the euro", No. 15, July 2000.
Zonzilos Nicholas, "The Greek Phillips curve and alternative measures of the NAIRU", No. 15, July 2000.
Pantazidis Stelios, "The sustainability of the current account deficit", No. 15, July 2000.
Hondroyiannis George, "Investigating causality between prices and wages in Greece", No. 15, July 2000.
Sabethai Isaac, "The Greek labour market: features, problems and policies (with emphasis on labour market flexibility and on combatting unemployment in the context of non-inflationary growth)", No. 16, December 2000.
Brissimi Dimitra and Brissimis Sophocles, "The problem of unemployment in the European Union", No. 16, December 2000.
Bardakas Joanna, "Financial deregulation, liquidity constraints and private consumption in Greece", No. 16, December 2000.
Lazaretou Sophia and Brissimis Sophocles, "Fiscal rules and stabilisation policy in the euro area", No. 17, July 2001.
Lolos Sarantis-Evangelos, "The role of European structural resources in the development of the Greek economy", No. 17, July 2001.
Papazoglou Christos, "Regional economic integration and inflows of foreign direct investment: the European experience", No. 17, July 2001.
Garganas Nicholas, "The future of Europe and EMU", No. 18, December 2001.
Brissimis Sophocles and Papadopoulou Dafni-Marina, "The physical introduction of euro banknotes and coins in Greece", No. 18, December 2001.
Zonzilos Nicholas, "The monetary transmission mechanism – the ECB experiment: results for Greece", No. 18, December 2001.
Brissimis Sophocles, Kamberoglou Nicos and Simigiannis George, "Bank-specific characteristics and their relevance to monetary policy transmission", No. 18, December 2001.
Tsaveas Nicholas, "Exchange rate regimes and exchange rate policy in South Eastern Europe", No. 18, December 2001.
Demenagas Nicholas and Gibson Heather, "Competition in Greek banking: an empirical study for the period 1993-1999", No. 19, July 2002.
Hondroyiannis George, "Economic and demographic determinants of private savings in Greece", No. 19, July 2002.
Gatzonas Efthymios and Nonika Kalliopi, "Eligible assets and management of collateral in the context of central bank monetary policy operations", No. 19, July 2002.
Voridis Hercules, Angelopoulou Eleni and Skotida Ifigeneia, "Monetary policy in Greece 1990-2000 through the publications of the Bank of Greece", No. 20, January 2003.
Kaplanoglou Georgia and Newbery David, "The distributional impact of indirect taxation in Greece", No. 21, July 2003.
Papapetrou Evangelia, "Wage differentials between the public and the private sector in Greece", No. 21, July 2003.
Athanasoglou Panayiotis and Brissimis Sophocles, "The effect of mergers and acquisitions on bank efficiency in Greece", No. 22, January 2004.

Lazaretou Sophia, "Monetary system and macroeconomic policy in Greece: 1833-2003", No. 22, January 2004.
Karabalis Nikos and Kondelis Euripides, "Alternative measures of inflation", No. 22, January 2004.
Papaspyrou Theodoros, "EMU strategies for new Member States: the role of Exchange Rate Mechanism II", No. 23, July 2004.
Mitrakos Theodoros, "Education and economic inequalities", No. 23, July 2004.
Papapetrou Evangelia, "Gender wage differentials in Greece", No. 23, July 2004.
Gibson Heather, "Greek banking profitability: recent developments", No. 24, January 2005.
Athanasoglou Panayiotis, Asimakopoulos Ioannis and Georgiou Evangelia, "The effect of merger and acquisition announcement on Greek bank stock returns", No. 24, January 2005.
Mitrakos Theodoros and Zografakis Stavros, "The redistributional impact of inflation in Greece", No. 24, January 2005.
Theodossiou Ioannis and Pouliakas Konstantinos, "Socio-economic differences in the job satisfaction of high-paid and low-paid workers in Greece", No. 24, January 2005.
Garganas Nicholas, "Adjusting to the single monetary policy of the ECB", No. 25, August 2005.
Mitrakos Theodoros, Simigiannis Georgios and Tzamourani Panagiota, "Indebtedness of Greek households: evidence from a survey", No. 25, August 2005.
Nicolitsas Daphne, "Per capita income, productivity and labour market participation: recent developments in Greece", No. 25, August 2005.
Nicolitsas Daphne, "Female labour force participation in Greece: developments and determining factors", No. 26, January 2006.
Mitrakos Theodoros and Zonzilos Nicholas, "The impact of exogenous shocks on the dynamics and persistence of inflation: a macroeconomic model-based approach for Greece", No. 26, January 2006.
Athanasoglou Panayiotis, Asimakopoulos Ioannis and Siriopoulos Konstantinos, "External financing, growth and capital structure of the firms listed on the Athens Exchange", No. 26, January 2006.
Mitrakos Theodoros and Nicolitsas Daphne, "Long-term unemployment in Greece: developments, incidence and composition", No. 27, July 2006.
Kalfaoglou Faidon, "Stress testing of the Greek banking system", No. 27, July 2006.
Pantelidis Evangelos and Kouvatseas Georgios, "Frontier survey on travel expenditure: methodology, presentation and output assessment (2003-2005)", No. 27, July 2006.
Brissimis Sophocles and Vlassopoulos Thomas, "Determinants of bank interest rates and comparisons between Greece and the euro area", No. 28, February 2007.
Simigiannis George and Tzamourani Panagiota, "Borrowing and socio-economic characteristics of households: results of sample surveys carried out by the Bank of Greece", No. 28, February 2007.
Papapetrou Evangelia, "Education, labour market and wage differentials in Greece", No. 28, February 2007.
Christodoulakis George, "The evolution of credit risk: phenomena, methods and management", No. 28, February 2007.
Karabalis Nikos and Kondelis Euripides, "Inflation measurement in Greece", No. 28, February 2007.
Kapopoulos Panayotis and Lazaretou Sophia, "Foreign bank presence: the experience of South-East European countries during the transition process", No. 29, October 2007.
Nicolitsas Daphne, "Youth participation in the Greek labour market: developments and obstacles", No. 29, October 2007.
Albani Maria, Zonzilos Nicholas and Bragoudakis Zacharias, "An operational framework for the short-term forecasting of inflation", No. 29, October 2007.

Asimakopoulos Ioannis, Brissimis Sophocles and Delis Manthos, "The efficiency of the Greek banking system and its determinants", No. 30, May 2008.
Balfoussia Hiona, "Stock market integration: the Athens Exchange in the European financial market", No. 30, May 2008.
Mitrakos Theodoros, "Child poverty: recent developments and determinants", No. 30, May 2008.
Asimakopoulos Ioannis, Lalountas Dionysis and Siriopoulos Constantinos, "The determinants of firm survival in the Athens Exchange", No. 31, November 2008.
Petroulas Pavlos, "Foreign direct investment in Greece: Productivity and Technology diffusion", No. 31, November 2008.
Anastasatos Tasos and Manou Constantina, "Speculative attacks on the drachma and the changeover to the euro", No. 31, November 2008.
Mitrakos Theodoros and Simigiannis George, "The determinants of Greek household indebtedness and financial stress", No. 32, May 2009.
Papazoglou Christos, "Is Greece's export performance really low?", No. 32, May 2009.
Zonzilos Nicholas, Bragoudakis Zacharias and Pavlou Georgia, "An analysis of the revisions of first (flash) quarterly national account data releases for Greece", No. 32, May 2009.
Rapanos Vassilis and Kaplanoglou Georgia, "Independent fiscal councils and their possible role in Greece", No. 33, May 2010.
Mitrakos Theodoros, Tsakloglou Panos and Cholezas Ioannis, "Determinants of youth unemployment in Greece with an emphasis on tertiary education graduates", No. 33, May 2010.
Gibson Heather and Balfoussia Hiona, "Inflation and nominal uncertainty: the case of Greece", No. 33, May 2010.
Migiakis Petros, "Determinants of the Greek stock-bond correlation", No. 33, May 2010.
Mitrakos Theodoros, Tsakloglou Panos and Cholezas Ioannis, "Determinants of the wage rates in Greece with an emphasis on the wages of tertiary education graduates", No. 34, September 2010.
Bragoudakis Zacharias and Panagiotou Stelios, "Determinants of the receipts from shipping services: the case of Greece", No. 34, September 2010.
Gibson Heather and Balfousia Hiona, "The impact of nominal and real uncertainty on macroeconomic aggregates in Greece", No. 34, September 2010.
Manesiotis Vasilios, "Numerical fiscal rules in practice", No. 35, June 2011.
Vasardani Melina, "Tax evasion in Greece: an overview", No. 35, June 2011.
Kalfaoglou Faidon, "The usefulness of stress testing exercises for assessing the soundness of the banking system", No. 35, June 2011.
Nicolitsas Daphne, "On-the-job training in Greece: a brief overview", No. 35, June 2011.
Papaspyrou Theodoros, "EMU sustainability and the prospects of peripheral economies", No. 36, April 2012.
Kanellopoulos Costas N., "Employment and worker flows during the financial crisis", No. 36, April 2012.
Kalfaoglou Faidon, "Bank capital adequacy framework", No. 36, April 2012.
Bragoudakis Zacharias and Sideris Dimitris, "Do retail gasoline prices adjust symmetrically to crude oil price changes? The case of the Greek oil market", No. 37, December 2012.
Kanellopoulos Costas N., "The size and structure of uninsured employment", No. 37, December 2012.
Migiakis Petros M., "Reviewing the proposals for common bond issuances by the euro area sovereign states under a long-term perspective", No. 37, December 2012.
Karabalis Nikos and Kondelis Euripides, "Indirect tax increases and their impact on inflation over 2010-2012", No. 38, November 2013.
Vourvachaki Evangelia, "Structural reform of the road haulage sector", No. 38, November 2013.

Kanellopoulos Nikolaos C., Mitrakos Theodoros, Tsakloglou Panos and Cholezas Ioannis, "The impact of the current crisis on private returns to education in Greece", No. 38, November 2013.

Papapetrou Evangelia and Bakas Dimitrios, "The Greek labour market during the crisis: Unemployment, employment and labour force participation", No. 38, November 2013.

Tzamourani Panagiota, "The Household Finance Survey: Description of the 2009 survey and main results on households' income, wealth and debt in Greece", No. 38, November 2013.

Dimitropoulou Dimitra, Koutsomanoli-Filippaki Anastasia, Charalambakis Evangelos and Aggelis Georgios, "The financing of Greek enterprises before and during the crisis", No. 39, July 2014.

Kanellopoulos Costas, "The Greek private sector labour market during the crisis", No. 39, July 2014.

Kalfaoglou Faidon, "European Banking Union: "Europeanising" banks' financial safety net", No. 39, July 2014.

Lazaretou Sofia, "The smart economy: cultural and creative industries in Greece. Can they be a way out of the crisis?", No. 39, July 2014.

Chaireti Aikaterini, "The housing situation in Greece during the crisis years 2008-2012", No. 39, July 2014.

ISSN: 1105 - 9729