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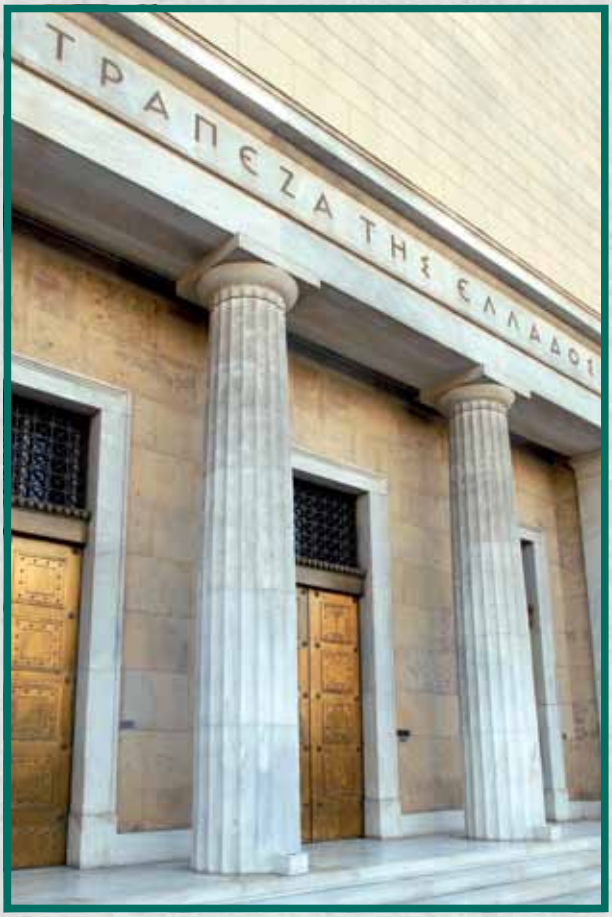

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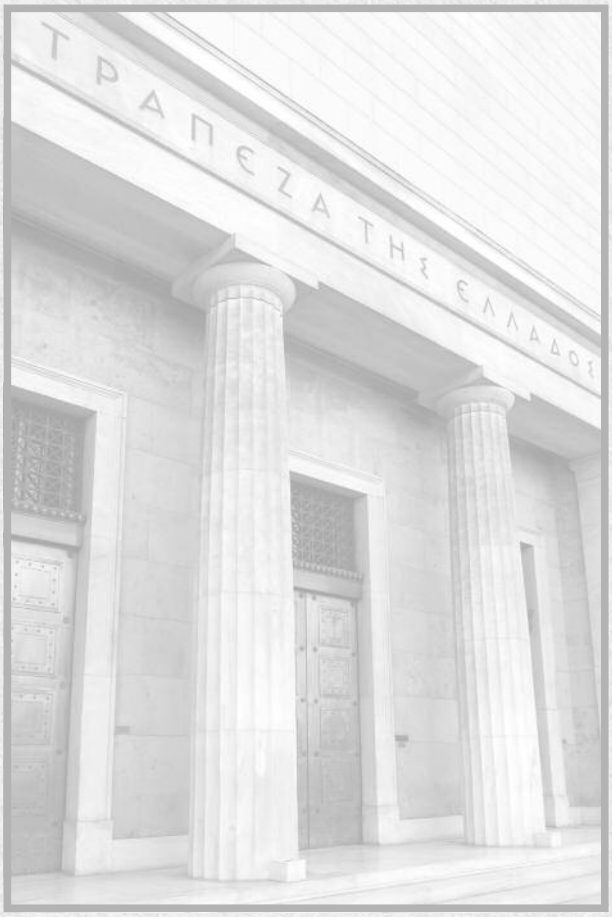

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Printed in Athens, Greece
at the Bank of Greece Printing Works

ISSN 1105 - 9729

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EXPORTING AND PERFORMANCE: EVIDENCE FROM GREEK FIRMS*

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1 INTRODUCTION

Since 2008, Greece has lost over 25% of its GDP as a consequence of a reduction in domestic demand, both consumption and investment. The survival of many companies has thus, to a large extent, been determined by their ability to look to foreign demand to fill the gap. Indeed, macro data point to an increase in exports, especially of goods, from 2010 onwards.[1] Moreover, there are also signs of sectoral reallocation towards tradable goods and services and, more generally, towards the more productive businesses across all economic sectors.[2]

An extensive literature exists exploring differences in performance between firms that export and those that do not. With only a few exceptions, exporters have characteristics which suggest "better" performance than non-exporters, controlling for observed and unobserved heterogeneity. In most empirical studies it is found that exporters are larger, more productive and more capital intensive. Findings also suggest that it is the most productive firms that usually begin exporting and that there is little evidence to support the view that exporting, through learning by doing, brings higher productivity. However, the transition of firms from producing solely for the domestic market to selling abroad involves rapid employment and output and higher productivity growth. Conversely, exiting firms experience sharp declines in output and employment. Other potential benefits of exporting firms may be located in terms of the number of jobs and, through higher plant survival rates, the stability of those jobs.

This paper aims to provide evidence on the differences between exporters and non-exporters in terms of labour productivity and profitability across time, different sectors of economic activity and different size groups, using data from exporting and non-exporting firms incorporated in Greece for the period 2006-2014. We also provide evidence on the effects of transitions in and out of exporting for our sample of firms. The remainder of the paper is organised as follows: Section 2 reviews the relevant literature on the differences between exporters and non-exporters using various measures of firm performance. In Section 3, we move on to the Greek case. Finally, Section 4 concludes presenting some policy implications and avenues for further research.

2 LITERATURE REVIEW: DIFFERENCES BETWEEN EXPORTERS AND NON-EXPORTERS

The literature dealing with the links between productivity and the international activities of firms was pioneered by Bernard and Jensen (1995). They used comprehensive longitudinal data from surveys performed regularly by official statistics in the United States to look at differences between exporters and non-exporters across various dimensions of a firm's performance, including productivity. The results provide evidence in favour of "better" performance of exporters compared to non-exporters: exporters are larger, more productive and more capital intensive. Labour productivity, measured as shipments per worker, was found to be 15% greater for exporters. Exporters are substantially larger than non-exporters even within industries. Employment at exporting plants is about 94% greater than at non-exporters within the same industry and wages are 9% higher on average in exporting

* Warm thanks are extended to our colleagues at the Economic Analysis and Research Department for their very useful comments. The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank of Greece. The authors are responsible for any errors or omissions.

1 Greek exports of goods and services increased by 10.7% between 2010 and 2014, with exports of goods having increased by 18.6% and of services by 3.7%, according to ELSTAT National Accounts.

2 See Bank of Greece (2014), *Annual Report 2013*, Box V.1, and Bank of Greece (2016), *Annual Report 2015*, Box V.3.

establishments than in non-exporters. The total value of shipments is 110% higher at exporters than at non-exporters. It is also found that plants that become exporters grow the most, plants that cease exporting exhibit poor relative performance and movement into exporting is associated with success.

Subsequently, there have been many other studies using firm-level micro data to investigate performance differences between exporting and non-exporting firms and the direction of causality between export activity and firm-level productivity (see Wagner 2007 and 2012a for surveys). More recently, Tavares-Lehmann and Costa (2015) in their paper on performance differences between exporters and non-exporters in Portugal provide an overview of the literature on both the exporter productivity premium and the exporter profitability premium. For the case of Greece, Papadogonas and Voulgaris (2005) investigate the determinants of labour productivity growth at the firm level in the manufacturing sector using a sample of 3,035 firms that were active in the years 1995 and 1999 obtained from the ICAP database. The results show that labour productivity growth is positively related to the growth of net fixed assets per employee (K/L), export orientation and R&D activity. Firm size, employment growth and industry age negatively affect labour productivity growth. To our knowledge, there is no study addressing the issue of export premia for firms' performance in the Greek industry as a whole and for the most recent period.

In the literature the empirical strategies used to investigate the exports/performance relationship (see Wagner 2007) first address the issue of whether there exist exporter premia for plant/firm characteristics, controlling for industry and plant size:

$$\ln X_{it} = \alpha + \beta Export_{it} + \gamma Control_{it} + e_{it} \qquad (1)$$

where i is the firm, t is the year (t=0...T), X_{it} is the plant/firm performance measure, '$Export_{it}$' is a dummy for current export status and '$Control_{it}$' is a set of control variables (usually including industry, region, firm size measured by number of employees, exporter size captured by an interaction term between export status and size and year). The exporter premium, computed from the estimated coefficient β, shows the average percentage difference between exporters and non-exporters controlling for the characteristics included in the vector 'Control'. Export premia are found to be positive and significant for almost every performance characteristic through time and across countries.

With respect to labour productivity, it appears to be a stylised fact that exporters are more productive than non-exporters. Most studies for specific countries find a positive and significant exporter productivity premium: Bernard and Jensen (1995, 1999) for the United States, Bernard and Wagner (1997) and Vogel (2011) for Germany, De Loecker (2007) for Slovenia, Stöllinger et al. (2012) for Austria, Grazzi (2012) for Italy, Fariñas and Martín-Marcos (2007) for Spain, Tavares-Lehmann and Costa (2015) for Portugal and Van Biesebroeck (2005) for nine African countries. By contrast, studies by Girma et al. (2004) for Ireland and Greenaway et al. (2005) for Sweden find no productivity differences between exporters and non-exporters, while Fu and Wu (2013) for China find that exporters are less productive than non-exporters (see Wagner 2012a and Tavares-Lehmann and Costa (2015) for a survey of the relevant literature). The International Study Group on Exports and Productivity (ISGEP 2008) shows that "the average exporter premium in 14 countries, after controlling for individual fixed effects, is 7 per cent". Berthou et al. (2015) provide a cross-country evaluation for a panel of 15 European economies and 23 manufacturing sectors during the 2000s.[3] Exporters are found to be more productive than non-exporters and this productivity premium rises with the export experience of firms, with "always exporters" being much more produc-

3 The study does not include Greece.

tive than starters. The evidence suggests that beyond entry into the export market, productivity is also an important determinant of firms' survival over a longer time period. It is also shown that both the level and the growth of firm-level exports rise with firm productivity, and that the bulk of aggregate exports in each country are made by a small number of highly productive firms. Finally, Berthou et al. (2015) provide evidence that during the crisis, the growth of exports of high-productivity firms contributed to the current account adjustment of European "stressed" economies.

When measuring firm performance by profitability, the results are less clear-cut, as emphasised in Wagner (2012a) and Tavares-Lehmann and Costa (2015). Yet, the majority of the studies in the literature find a positive exporter profitability premium, allowing them to bear the costs of internationalisation. Melitz (2003) in his theoretical model shows that exporters are more profitable than non-exporters because they are also more productive. Fryges and Wagner (2010) demonstrate that there is an exporter profitability premium, allowing exporters of German manufacturing firms to face all costs of internationalisation and still have profits afterwards. Kneller and Pisu (2010), based on survey data for the UK, find that exporting generates higher profitability and this ex-post effect of exporting is greater for always exporters and to a lesser extent for starters. On the contrary, Girma et al. (2004) find that there is no significant exporter profitability premium in Ireland. Helpman et al. (2004) find that exporters are less profitable than firms serving only their domestic market due to the fixed costs associated with internationalisation and the same line of reasoning is shared by Vogel and Wagner (2009) and Vogel (2009) for German business services sector. Grazzi (2012) finds ambiguous evidence about exporter profitability premium, with exporters being more profitable than non-exporters only for some sectors and years. Vu et al. (2014) use quantile regression to find higher profitability growth of exporters only in the highest percentiles (percentiles 70 and 80), but lower for percentile 10, as for firms with low profit growth profitability advantages are absorbed by the costs of internationalisation.

In the literature, to better understand the transformations that occur in firms when they start and stop exporting, and to better identify any potential benefits from exporting, growth rate regressions in the following spirit are estimated:

$$\Delta X_{it} = \alpha + \beta_1 Start_{it} + \beta_2 Both_{it} + \beta_3 Stop_{it} + \gamma\, Control_{it} + \varepsilon_{it} \qquad (2)$$

where ΔX_{it} is the change in the performance measure; '$Start_{it}$' is a dummy which identifies firms that start exporting during the sample period; '$Both_{it}$' identifies firms that exported throughout; '$Stop_{it}$' identifies firms that stop exporting during the period; and '$Control_{it}$' is a set of control variables (usually including industry, region, firm size measured by number of employees, exporter size captured by an interaction term between export status and size and year). Thus, the coefficients β_1, β_2, β_3 give the differential in growth rates for entrants, exporters throughout the sample and exits, relative to firms that never exported.

The conclusions are clear. Movements in and out of exporting generate more substantial changes. Exiting the export market is associated with bad outcomes for plants/firms, with significantly slower growth rates in the dependent variable being recorded compared to firms that do not exit. The year of entry into the export market is also a time of substantial improvement in firm performance.

In the literature, there are two alternative but not mutually exclusive hypotheses why exporters can be expected to be more productive than non-exporting firms (see Clerides et al. 1998, Bernard and Jensen 1999, Bernard and Wagner 1997, ISGEP 2008, Máñez-Castillejo et al. 2010, Yang and Mallick 2010). They differ in terms of the direction of causality between exporting and productivity. In the

"self-selection hypothesis", the causality runs from productivity to exporting in which only firms with high productivity ex-ante choose to export because exporting involves large sunk costs. The theoretical support for this hypothesis can be found in the seminal paper by Melitz (2003), that allows for within-industry heterogeneous productivity firms, in which only the most productive firms export while less productive firms either supply only the domestic market or exit the market. Furthermore, the behaviour of firms might be forward-looking in the sense that the desire to export tomorrow leads a firm to improve performance today to be competitive on the foreign market too. Cross-section differences between exporters and non-exporters may partly be explained by ex-ante differences between firms: the more productive firms become exporters. By contrast, the "learning-by-exporting hypothesis" proposes that firms gain higher ex-post productivity after exporting. This is due to a number of factors such as new knowledge and expertise from buyers (innovation), scale economies, and exposure to competition (which provides incentives to reduce inefficiency).

A standard approach to examine the direction of causality between exporting and productivity is found in Bernard and Jensen (1999).[4] To test the first hypothesis of self-selection of the more productive firms into export markets, they assume that if good firms become exporters then we should expect to find significant differences in performance measures between exporters and non-exporters several years before the former begin to export. To provide evidence on ex-ante characteristics, a subsample of firms is created including only firms that did not export for at least three years in a row, i.e. plants that did not export in years t-3, t-2 and t-1 but may or may not have exported in year t. Then, they regress the levels of performance measures in year t-3 on the export status of the plant in year t, along with fixed effects and time dummies.

$$\ln X_{it-3} = \alpha + \beta \text{Export}_{it} + \varepsilon_{it-3} \qquad (3)$$

The results from their analysis are quite clear. Good firms do become exporters. Future exporters already have most of the desirable performance characteristics several years before they enter the export market.

To test the hypothesis that exporting fosters productivity, the post-entry differences in productivity growth between export starters and non-exporters are investigated (see ISGEP 2008). This test is based on a comparison of firms that did not export in years t-3 to t-1, but exported in year t and in at least two years between the years t+1 and t+3 —these are the export starters— with firms from a control group that did not export in any year between t-3 and t+3. The empirical model used is:

$$\ln LP_{it+3} - \ln LP_{it+1} = \alpha + \beta \text{ Export}_{it} + \gamma \text{ Control}_{it} + e_{it} \qquad (4)$$

where ln LP is the log of labour productivity, 'Export_{it}' is a dummy variable that equals 1 for export starters and that equals zero for the firms from the control group and 'Control_{it}' is a set of control variables (usually including industry, region, firm size measured by number of employees, exporter size captured by an interaction term between export status and size and year). Evidence regarding the hypothesis of post-entry productivity growth of exporters is more mixed; exporting does not necessarily improve a firm's performance.

A further strand of the literature recognises that labour productivity is persistent (Clerides et al. 1998, Helpman et al. 2004 and Fariñas and Martín-Marcos 2007). Clerides et al. (1998), as a robustness check, used a generalised method of moments (GMM) estimator to deal with endogeneity and serial correlation in the estimation of marginal cost functions. Fariñas and Martín-Marcos (2007) apply instrumental variables to address the endogeneity problem in the estimation of production functions. Unobserved heterogeneity and

4 Many studies, such as Wagner (2002), Máñez-Castillejo et al. (2010), Yang and Mallick (2010), use the matching approach to test the direction of causality between exports and productivity.

potential simultaneity in the estimation of the production function are addressed using the GMM first differenced estimator (Arellano and Bond 1991). Thus, to address the persistence of productivity, equation (1) is re-estimated to include a lagged dependent variable. To deal with the possible bias introduced, especially in panels with a short time series (Galvao 2011), it is necessary to use the Arellano-Bond GMM estimator.

Finally, a number of papers use quantile regressions with fixed effects and instrumental variables (Wagner 2012b, Powell and Wagner 2011, Powell 2016). The rationale stems from the observation that there is considerable firm heterogeneity along the distribution with both low and high productivity firms that export and many that do not. Thus, it is better to estimate the export premium along the productivity distribution and not just at the mean. These studies generally show that the export premium does indeed vary along the distribution.

3 EMPIRICAL INVESTIGATION

3.1 DATA AND DESCRIPTIVE STATISTICS

We use data from ICAP with information on annual balance sheets and profit and loss accounts at firm-level, as well as data on the sector of economic activity to which each firm belongs, the number of employees, the year of establishment and exporting status. We delete the consolidated accounts of company groups, preferring to work with individual firms that make up the group. In this way, it is easier to assign firms to a particular industry. The data are available for 2006-2014 and consist of 60,325 firms across all industries. This amounts to 312,734 observations, after having removed outliers in the calculation of financial indices.[5] Since this paper's focus is on the differences distinguishing exporting from non-exporting firms, we created six different binary variables depending on the exporting status of the firm – exporters, non-exporters, "always exporters" (i.e. firms exporting throughout the period), never having exported, starters (firms not exporting in t-1 and engaging in export activity in t) and stoppers (firms initially exporting in t-1, but stopping their exporting activity in t). Table 1 provides a clear overview of firms according to their exporting status: 81% of firms for the whole sample never exported, while 13% of firms always exported and 6% switched status across years. Interestingly, in the period reviewed the percentage of firms entering in export market ("starters") exceeds the percentage of firms exiting the export market ("stoppers"), suggesting that Greek firms were becoming more open; though the number of companies changing status is small.

Table 2 presents a more detailed decomposition of firms by exporting status and sector of

5 We chose not to remove outliers using automatic methods such as winsorising. The period under examination, by its very nature, is likely to contain "outliers". Their automatic removal, however, would introduce a bias into the sample of companies, for example, by removing failing companies that record large negative profits in their last years of life.

Table 1 Number (and percentage) of firms in each category of firm for the 2006-2014 period

Exporters	9,076 (15.1%)
Non-exporters	51,249 (85.0%)
Always exporters	7,676 (12.7%)
Firms that have never exported	48,898 (81.1%)
Starters	2,659 (4.4%)
Stoppers	1,713 (2.8%)

Source: Authors' own calculations from ICAP database.

Table 2 Share of firms by exporting status and sector of economic activity in the 2006-2014 period

(%)

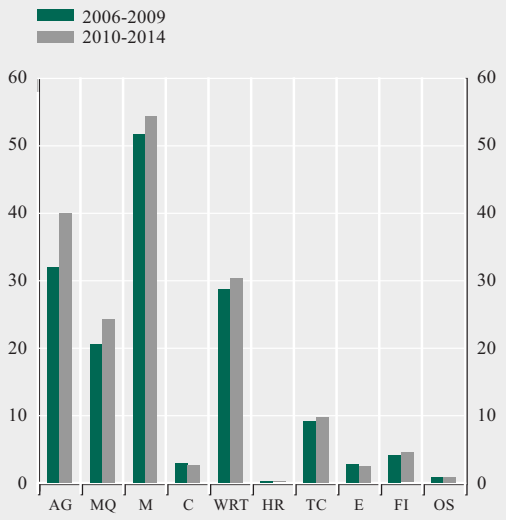
	Exporters	Always exporters	Starters	Stoppers	Never exported
Agriculture, forestry and fishing	35.7	26.5	14.4	10.1	54.7
Mining and quarrying	22.4	20.1	2.3	1.0	76.6
Manufacturing	53.2	44.1	12.8	7.9	38.6
Construction	2.7	1.6	2.0	1.6	95.5
Wholesale and retail trade	29.6	22.0	10.9	7.4	62.6
Accommodation and food service activities	0.3	0.2	0.1	0.1	99.6
Transport and communication	9.5	6.2	5.7	2.4	86.8
Energy	2.6	1.3	2.3	0.9	95.9
Financial intermediation activities	4.3	2.3	3.3	1.7	93.2
Other services	0.9	0.6	0.7	0.4	98.5

Source: Authors' own calculations from ICAP database.
Note: The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

economic activity.[6] As expected, "manufacturing", "agriculture, forestry and fishing" and "wholesale and retail trade" as well as "mining and quarrying" are the sectors mostly involved in exporting activity and register the highest rates of "starters".

Chart 1 Share (in percent total) of exporting firms by sector of economic activity

(%)

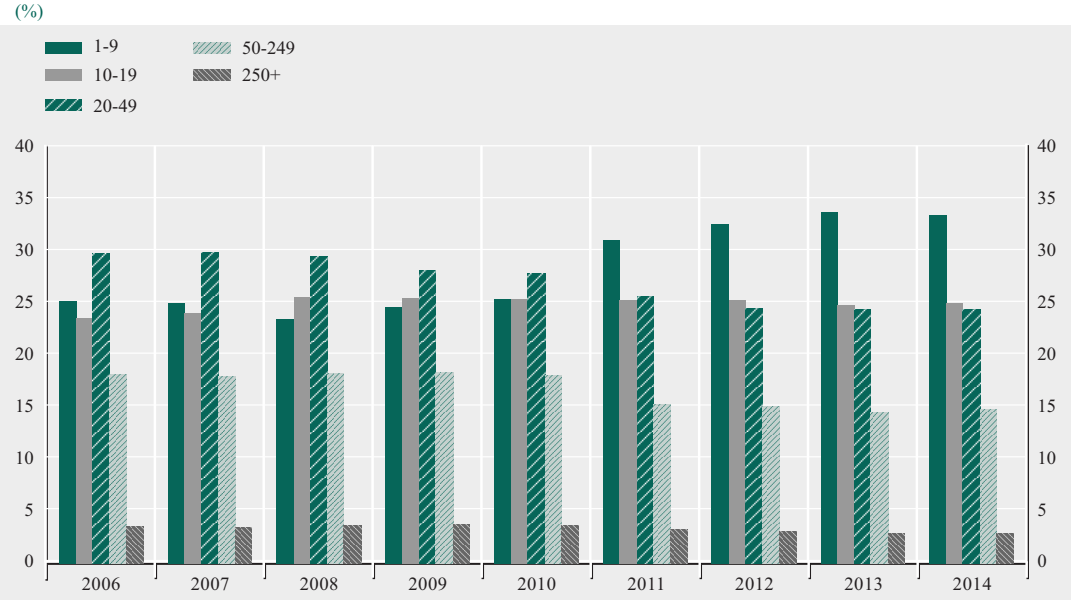


Source: Authors' own calculations from ICAP dataset.
Note: "AG" = Agriculture, forestry and fishing , "MQ" = Mining and quarrying, "M" = Manufacturing, "C" = Construction, "WRT" = Wholesale and retail trade, "HR" = Accommodation and food service activities (Hotels & Restaurants), "TC" = Transport and communication, "E" = Energy, "FI" = Financial intermediation activities and "OS" = Other services (see also footnote 6).

Most sectors of economic activity show increased —albeit slightly higher— exporting activity, measured by the number of exporting firms in our sample, in the crisis period (see Chart 1), with traditionally tradable sectors, such as "agriculture, forestry and fishing", "manufacturing", "mining and quarrying", "wholesale and retail trade" and "transport and communication" sectors, exhibiting higher openness. As the crisis has proceeded there has been a tendency for mainly micro SMEs ("1-9" and "10-19") to become more export-oriented. By contrast, the share of bigger exporting firms in the total number of exporters has declined. This reflects a structural characteristic of Greek industry where SMEs —and in particular micro SMEs— predominate (see Chart 2). Exporting

6 The sectors of economic activity correspond to NACE Rev. 2 classification: "Agriculture, forestry and fishing" ("AG") comprises codes 01-03, "Mining and quarrying" ("MQ") codes 05-09, "Manufacturing" ("M") codes 10-33, "Construction" ("C") codes 41-43, "Wholesale and retail trade" ("WRT") codes 45- 47, "Accommodation and food service activities" ("HR") codes 55-56, "Transport and communication" ("TC") codes 49-53 and 58-63, "Energy" ("E") codes 35-39, "Financial intermediation activities" ("FI") codes 64-66 and 69-82, "Real estate" ("RE") code 68 and "Other services" ("OS") codes 84-96.

Chart 2 Share (in percent total) of exporting firms by size class in the 2006-2014 period



Source: Authors' own calculations from ICAP dataset.

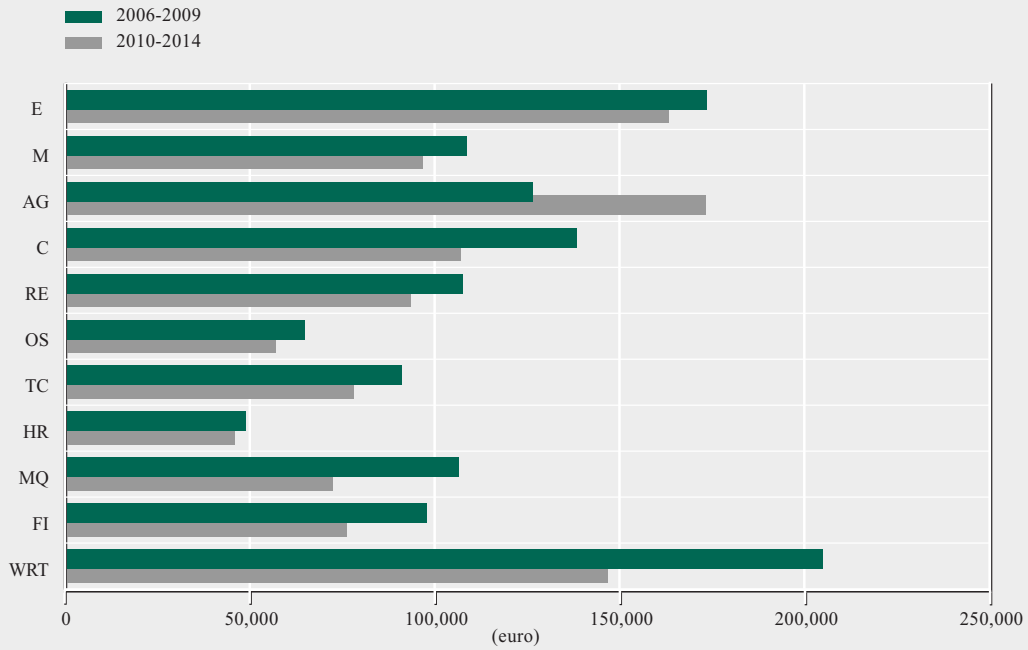
firms with "1-9" employees increased as a share of total exporters from 25.1% in 2006 to 33.3% in 2014 and "10-19" size firms also increased from 23.5% in 2006 to 24.9% in 2014. This finding is in line with Nassr et al. (2016), who also find that Greece has one of the highest shares of micro SMEs in its business demography among OECD countries.

Before proceeding with the estimation of whether exporting firms are more productive and more profitable than non-exporting ones, we provide a descriptive analysis of the two main variables related to firms' performance – namely, labour productivity and profitability.[7] Once the ratios are computed using the firm-level data, they are aggregated along five dimensions: time, 2-digit sectoral level (NACE Rev. 2), 1-digit sectoral level, size class and exporting status.[8] To better assess firms' characteristics before the crisis and during the crisis, the indicators are reviewed for two sub-periods, 2006-2009 and 2010-2014.

Labour productivity is defined as real turnover (sales and other operating income deflated using the output deflator at a 64-sector level from ELSTAT national accounts) over number of employees. This is one of the most important measures of a firm's performance and an index of competitiveness. Charts 3-6 provide some descriptives for our sample of companies. Median labour productivity fell in the crisis period in all sectors with the exception of "agriculture, forestry and fishing" (see Chart 3); nevertheless, exporting firms exhibit a steadily significantly higher labour productivity across time and sectors of economic activity (see Charts 4-5). Labour productivity of exporting firms has followed a downward path since 2008, before registering an upturn in 2012. Sectoral data on labour productivity at the 2-digit level point to higher productivity of exporting firms in the crisis period in "crop and animal production", "fishing and aquaculture", "coke and refined petroleum products", "electricity, gas, steam and air conditioning supply",

7 The description of the data largely follows Ferrando et al. (2015).
8 Gibson and Pavlou (2017) review other additional indicators relating to firm performance. The results are in line with expectations, providing reassurance about the quality of the data.

Chart 3 Median labour productivity by sector of economic activity

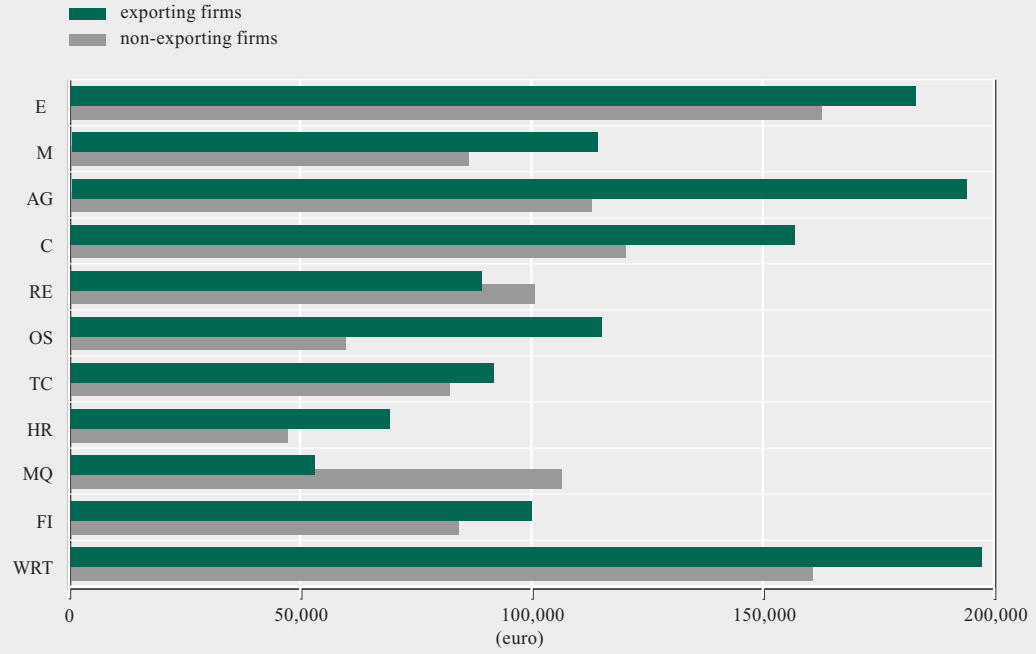


Source: Authors' own calculations from ICAP dataset.
Note: "E" = Energy, "M" = Manufacturing, "AG" = Agriculture, forestry and fishing , "C" = Construction, "RE" = Real estate, "OS" = Other services, "TC" = Transport and communication, "HR" = Accommodation and food service activities (Hotels & Restaurants), "MQ" = Mining and quarrying, "FI" = Financial intermediation activities, and "WRT" = Wholesale and retail trade (see also footnote 6).

"manufacture of food and beverage products", "land transport, "transport via pipelines", "warehousing and support activities for transportation", "programming and broadcasting activities" and "telecommunications". The performance of firms across different size categories indicates that median labour productivity is mostly higher in upper size classes. The smallest companies which exhibited dynamic productivity in the pre-crisis years appear to have been particularly badly hit by the crisis, though this could also reflect that as firms fail and their turnover declines, they lay off workers and move into the smallest size category, that is, it is a compositional effect (see Chart 6).

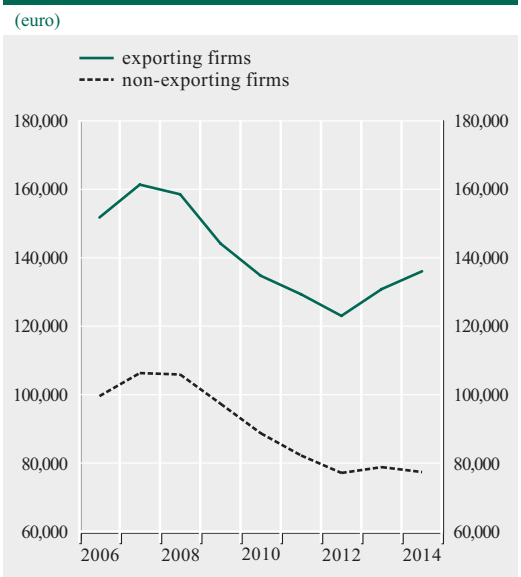
The rate of return on assets (RoA), defined as earnings before interest, taxes and depreciation over total assets, is used to estimate the quality of a company's earnings, as it shows how efficiently the company is using its assets to collect cash from sales and customers. The performance of exporting firms across different size categories shows that medium-sized firms do tend to have higher profitability than very large or very small firms (see Chart 7). Exporters are more profitable than non-exporters throughout time and across all sectors (see Chart 8). Higher profitability was recorded, in terms of median RoA, during the crisis, mainly due to the performance of exporting firms in certain industries; median RoA was higher in the 2010-2014 period in "agriculture, forestry and fishing" (crop and animal production, fishing and aquaculture), in "mining and quarrying", in "manufacture of food products", in "coke and refined petroleum products", in "energy" (sewerage, waste collection and waste management services), in the "tourism" sector, in "financial services" (mainly insurance, reinsurance and pension

Chart 4 Median labour productivity by exporting status and sector of economic activity



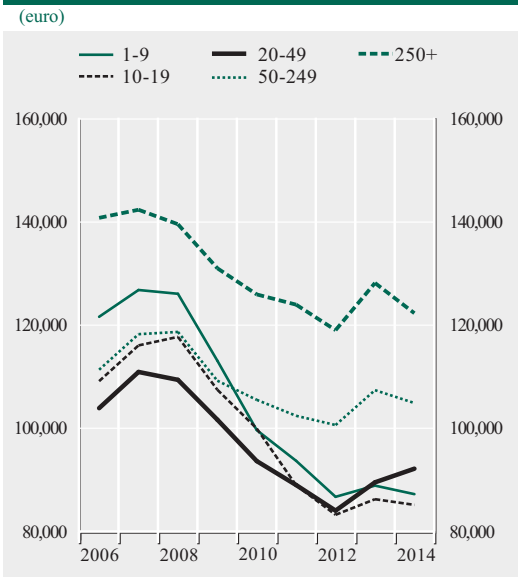
Source: Authors' own calculations from ICAP dataset.
Note: "E" = Energy, "M" = Manufacturing, "AG" = Agriculture, forestry and fishing , "C" = Construction, "RE" = Real estate, "OS" = Other services, "TC" = Transport and communication, "HR" = Accommodation and food service activities (Hotels & Restaurants), "MQ" = Mining and quarrying, "FI" = Financial intermediation activities, and "WRT" = Wholesale and retail trade (see also footnote 6).

Chart 5 Median labour productivity by exporting status



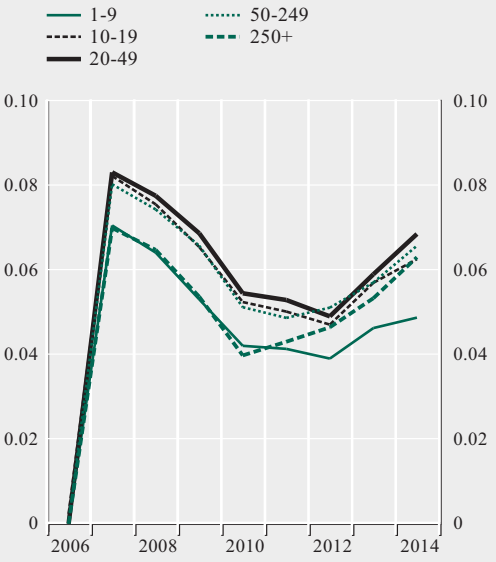
Source: Authors' own calculations from ICAP dataset.

Chart 6 Median labour productivity by size class



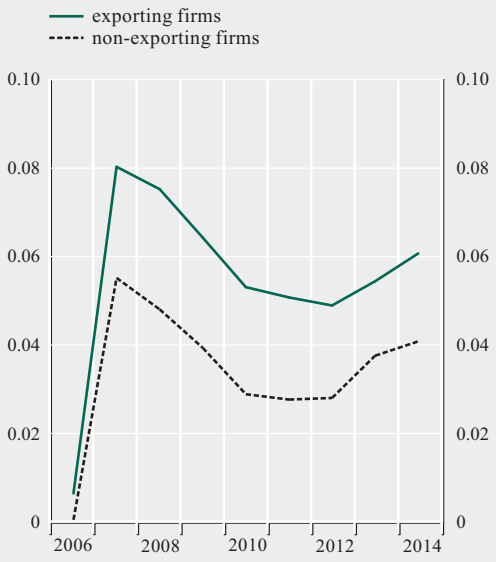
Source: Authors' own calculations from ICAP dataset.

Chart 7 Median RoA by size class



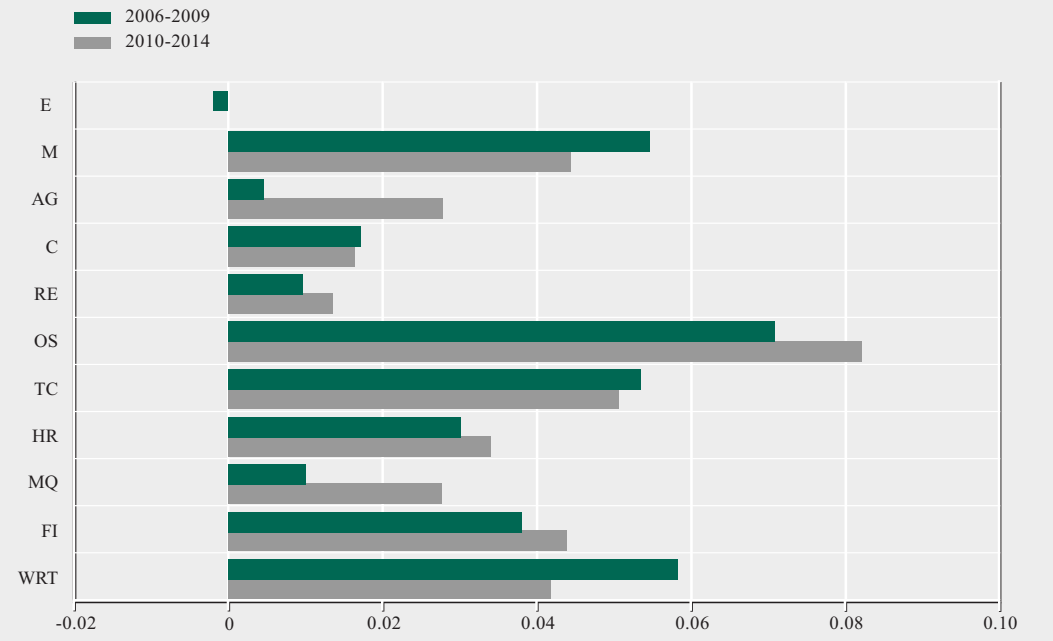
Source: Authors' own calculations from ICAP dataset.

Chart 8 Median RoA by exporting status



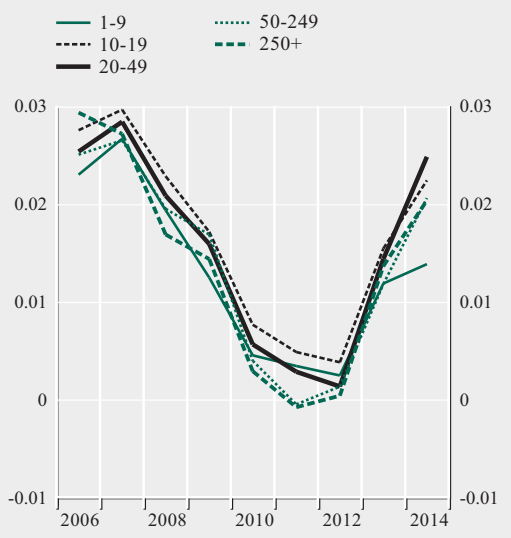
Source: Authors' own calculations from ICAP dataset.

Chart 9 Median RoA by sector of economic activity



Source: Authors' own calculations from ICAP dataset.
Note: "E" = Energy, "M" = Manufacturing, "AG" = Agriculture, forestry and fishing , "C" = Construction, "RE" = Real estate, "OS" = Other services, "TC" = Transport and communication, "HR" = Accommodation and food service activities (Hotels & Restaurants), "MQ" = Mining and quarrying, "FI" = Financial intermediation activities, and "WRT" = Wholesale and retail trade (see also footnote 6).

Chart 10 Operating profits to total assets, median, by size class



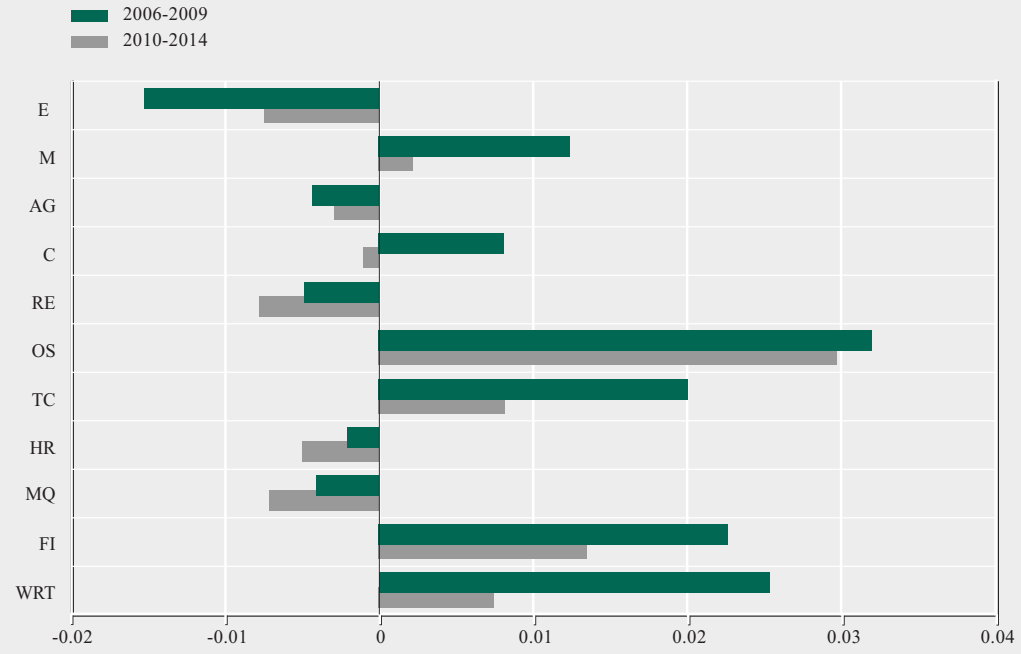
Source: Authors' own calculations from ICAP dataset.

funding) as well as in "other services" sector (see Chart 9).[9]

Our second measure of profitability is median **operating profits to total assets**. It is an important measure of a firm's profitability as it explains how much earnings were generated from operations per se and it is often thought less amenable to accounting manipulation. It followed the same path through time as median RoA, falling and bottoming out in 2012 before rising again. Medium-sized firms had higher profitability compared to small and large firms (see Chart 10). Operating profits fell in all broad sectors in the crisis period (see Chart 11), but when examining the perform-

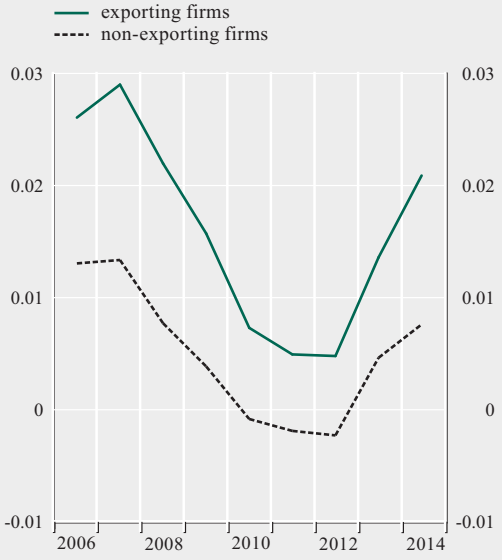
9 Although median RoA slightly fell in 2010-2014 in the broad sector Transport and communication "TC" (see Chart 9), the analysis at 2-digit level shows higher performance in the sectors of "land transport", "transport via pipelines", "air transport", "warehousing and support activities for transportation" and "telecommunications".

Chart 11 Operating profits to total assets, median, by sector of economic activity



Source: Authors' own calculations from ICAP dataset.
Note: "E" = Energy, "M" = Manufacturing, "AG" = Agriculture, forestry and fishing , "C" = Construction, "RE" = Real estate, "OS" = Other services, "TC" = Transport and communication, "HR" = Accommodation and food service activities (Hotels & Restaurants), "MQ" = Mining and quarrying, "FI" = Financial intermediation activities, and "WRT" = Wholesale and retail trade (see also footnote 6).

Chart 12 Operating profits to total assets, median, by exporting status



Source: Authors' own calculations from ICAP dataset.

ance of firms by their exporting status (see Chart 12), exporting firms are more profitable than non-exporting throughout time. At the 2-digit level, firms exhibited higher profitability in "coke and refined petroleum products" mainly as a result of their exporting activity, in "insurance, reinsurance and pension funding", in "telecommunications" and "warehousing and support activities for transportation".

In conclusion, the descriptive statistics are consistent with the hypothesis that exporting firms exhibit superior performance to their purely domestically focused counterparts. However, to understand whether it is exporting per se or some characteristics correlated with being an exporter requires a more formal multivariate analysis.

3.2 ECONOMETRIC MODEL AND ESTIMATIONS

3.2.1 Investigating the exports/productivity relationship[10]

To investigate differences in productivity between exporters and non-exporters, we follow the methodology introduced by Bernard and Jensen (1995 and 1999) and compute the so-called exporter productivity premia, defined as the ceteris paribus percentage difference of labour productivity between exporters and non-exporters. These premia are computed from the regression given in equation (1). To control for unobserved firm heterogeneity due to time-invariant firm characteristics which might be correlated with the variables included in the empirical model, thus leading to a biased estimate of exporter premia, equation (1) is estimated with fixed effects. Time dummies are also included. The current export status dummy takes a value of 1 in time t if the firm exports in time t, and zero otherwise. The set of control variables includes firm size, exporter size and the age of the company. The size of the firm is proxied by the number of employees. To test for the existence of a quadratic relationship between productivity and size, we also add as an independent variable the squared number of employees (a similar test was applied by Fryges and Wagner (2010) and Tavares-Lehmann and Costa (2015)). Following Tavares-Lehmann and Costa (2015), an interaction term for exporter and size is also included, computed as the multiplication between the dummy for export status and total employment. The age of the company from its establishment (company age) is also included. To test for the existence of a quadratic relationship we also add the squared age of the company (company age^2).

The export premium, computed from the estimated coefficient β ($100(\exp(\beta)-1)$), shows the average percentage difference between exporters and non-exporters, controlling for the other characteristics included. Table 3 summarises the results of estimating equation (1), excluding other control variables across sectors. As expected, exporting has a positive effect on labour productivity in full sample and in the sectors of "agriculture, forestry and fishing", "manufacturing", "wholesale and retail

10 We test the sensitivity of our results to dropping banks and insurance companies from the sample. The results are qualitatively similar.

Table 3 Impact of exporting on labour productivity in the 2006-2014 period (total economy and by sector of economic activity)

	Fixed effects equation β (p-value)	Exporter productivity premium 100*(expβ-1)
All sectors	0.05 (0.000)	5.1
Agriculture, forestry and fishing	0.46 (0.000)	58.4
Mining and quarrying	-0.85 (0.063)	-
Manufacturing	0.09 (0.000)	9.4
Construction	-0.17 (0.094)	-
Wholesale and retail trade	0.03 (0.015)	3.0
Accommodation and food service activities	0.58 (0.000)	78.6
Transport and communication	0.005 (0.899)	-
Energy	0.006 (0.967)	-
Financial intermediation activities	0.15 (0.002)	16.2
Other services	-0.002 (0.987)	-

Notes: β is the estimated regression coefficient from a fixed effects regression of the logarithm of labour productivity on a dummy variable for exporting firms and year dummies. The numbers in brackets are p-values. The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

trade", "accommodation and food service activities" and "financial intermediation activities". The impact of exporting strengthens when we control for firm size, exporter companies' size and company age (see Tables 4a and 4b). As regards the size effect, there exists a U-shaped relationship between labour productivity and size. The minimum is at the logarithm of employment equal to 9.8; the logarithm of employment has a range of 0 to 10 in our data. Thus, for the sample, the effect of size on labour productivity is largely negative. This finding is not consistent with most of the literature, which finds that labour productivity rises with size. The negative relationship between firm size and productivity could reflect a structural characteristic of Greek industry where SMEs prevail. Company age and exporter size are not significant (exporter size appears positive and significant only in the sector of "accommodation and food service activities").

To provide a better understanding of the productivity trajectory of firms as a function of their exporting status, differences in productivity growth between exporters and non-exporters are investigated based on the empirical model given in equation (2) where non-exporting in all years is the reference category. The regression coefficients β1, β2 and β3 are estimates of the impact on labour productivity growth of starting exporting, being an exporter throughout and stopping exporting, respectively, controlling for firm characteristics included in the vector 'Control' (employment, employment^2, company age, company age^2, size interacted with export dummy). Tables 5a and 5b present the results. Firms that exported throughout the period have higher labour pro-

Table 4a Impact of exporting on labour productivity with control variables in the 2006-2014 period

Fixed-effects (within) regression — Number of observations = 212,052

Number of firms = 40,491

R^2: within = 0.1234
between = 0.0050
overall = 0.0062

Observations per firm: min = 1
avg = 5.2
max = 9

corr(u_i, Xb) = -0.3803 — F(14.171547) = 1725.37

Prob > F = 0.0000

lnLabour productivity	Coefficient	Standard error	t	P>|t|	[95% confidence interval]	
Export dummy	0.135	0.010	13.34	0.000	0.115	0.155
lnEmployment	-0.633	0.010	-61.23	0.000	-0.653	-0.613
lnEmployment^2	0.032	0.002	16.62	0.000	0.028	0.036
Company age	0.000	0.000	0.85	0.395	0.000	0.001
Company age^2	0.000	0.000	-0.67	0.501	0.000	0.000
Exporter size	0.000	0.000	-1.42	0.156	0.000	0.000
dum06	0.490	0.008	59.33	0.000	0.473	0.506
dum07	0.534	0.008	66.9	0.000	0.518	0.550
dum08	0.503	0.008	64.62	0.000	0.488	0.518
dum09	0.376	0.008	49.3	0.000	0.361	0.391
dum10	0.241	0.008	32.27	0.000	0.227	0.256
dum11	0.094	0.007	13.57	0.000	0.080	0.107
dum12	-0.030	0.007	-4.37	0.000	-0.044	-0.017
dum13	-0.043	0.007	-6.26	0.000	-0.056	-0.030
dum14	0.000	(omitted)				
Constant	12.519	0.017	740.99	0.000	12.486	12.552
sigma_u	1.5111					
sigma_e	0.669					
rho	0.836					

Note: F test significance of fixed effects: F(40490, 171547) = 16.67 Prob > F = 0.0000
Hausman Test: $X^2(13) = 6807.72$ (prob>X^2 = 0.000)

ductivity growth. Starters, however, experience an even bigger effect on labour productivity growth, while stopping has a negative but not significant effect on labour productivity growth. Firm size has a positive effect on the growth of labour productivity; there exists a U-shaped relationship between labour productivity growth and employment. The minimum is at the logarithm of employment equal to 3.86: the logarithm of employment has a range of 0 to 10 in our data. Thus for the sample, firm size has a positive effect on the growth of labour productivity for firms with more than 48 employees. Looking at the results by sector (see Table 5b), starters make the difference in "agriculture, forestry and fishing". In "manufacturing", "wholesale and retail trade" and "transport and communication" sectors, both always exporters and starters have higher productivity growth, while starters have higher productivity growth in the "financial intermediation activities'" sector. Firm size has a positive impact on labour productivity growth in "manufacturing", "wholesale and retail trade" and "transport and communication". Again, there exists a U-shaped relationship between labour productivity growth and employment in these sectors and, for the sample, firm size has a positive effect on

Table 4b Impact of exporting on labour productivity with control variables in the 2006-2014 period (total economy and by sector of economic activity)

	Fixed effects β	Exporter premium 100*(expβ-1)	lnEmploy-ment	lnEmploy-ment^2	Company age	Company age^2	Exporter size
	(p-value)		(p-value)	(p-value)	(p-value)	(p-value)	(p-value)
All sectors	0.135 (0.000)	14.5	-0.632 (0.000)	0.032 (0.000)	0.000 (0.395)	0.000 (0.501)	0.000 (0.156)
Agriculture, forestry and fishing	0.299 (0.021)	34.9	-1.059 (0.000)	0.088 (0.124)	-0.014 (0.566)	0.001 (0.148)	-0.001 (0.683)
Mining and quarrying	-0.110 (0.805)	-	-1.109 (0.000)	0.123 (0.004)	-0.029 (0.287)	0.001 (0.091)	-0.011 (0.029)
Manufacturing	0.168 (0.000)	18.3	-0.575 (0.000)	0.039 (0.000)	0.000 (0.538)	0.000 (0.937)	0.000 (0.004)
Construction	0.049 (0.630)	-	-0.849 (0.000)	0.027 (0.003)	0.005 (0.228)	0.000 (0.206)	0.000 (0.594)
Wholesale and retail trade	0.089 (0.000)	9.3	-0.589 (0.000)	0.044 (0.000)	0.000 (0.647)	0.000 (0.348)	0.000 (0.992)
Accommodation and food service activities	0.441 (0.003)	55.4	-0.885 (0.000)	0.056 (0.000)	-0.011 (0.000)	0.000 (0.000)	0.002 (0.008)
Transport and communication	0.085 (0.040)	8.9	-0.517 (0.000)	0.011 (0.062)	0.003 (0.231)	0.000 (0.539)	0.000 (0.909)
Energy	0.216 (0.127)	-	-0.956 (0.000)	0.084 (0.001)	-0.006 (0.795)	0.000 (0.402)	0.000 (0.018)
Financial intermediation activities	0.302 (0.000)	35.3	-0.719 (0.000)	0.038 (0.000)	0.004 (0.176)	0.000 (0.242)	0.000 (0.565)
Other services	0.206 (0.323)	-	-0.596 (0.000)	0.008 (0.489)	0.004 (0.488)	0.000 (0.271)	0.000 (0.986)

Notes: β is the estimated regression coefficient from a fixed effects regression of the logarithm of labour productivity on a dummy variable for exporting firms controlling for the number of employees and its squared value, exporter size captured by an interaction term between export status and size, and company's age and company's age squared. We also add year dummies. The numbers in brackets are p-values. The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

the growth of labour productivity for firms with more than 33, 14 and 81 employees, in "manufacturing", "wholesale and retail trade" and "transport and communication", respectively.

We then examine whether the relationship between exporting and productivity growth differs across firms of different sizes. The regression on labour productivity growth is estimated by size band (see Table 6).[11] For firm sizes "1-9", "10-19" and "20-49" there is a positive and significant effect of exporting activity on labour productivity growth; when examining the impact of exporting by sector, there is a positive and significant effect in "manufacturing" and "wholesale and retail trade". It should be noted though that the positive effect of exporting on labour productivity growth becomes less strong as we move up size bands. Turning to "50-249" firm size, the findings point to a positive and significant effect of exporting on labour productivity growth for starters in all sectors and in "transport and communication". Finally, for firms "250+" there is no effect of exporting on labour productivity growth. This provides evidence of the importance of exporting for small Greek companies and/or the fact that smaller companies can be very productive and thus not excluded from exporting. This is consistent with Máñez-Castillejo et al. (2010) who find evidence in favour of the existence of a process of self-selection into exporting for small firms, but do not find this result for large firms.

Next, following Bernard and Jensen (1995), we also examine whether exporters also increase

11 Gibson and Pavlou (2015) present the estimated impact of exporting on labour productivity by firm size and sector of economic activity.

Table 5a Impact of exporting on labour productivity growth in the 2006-2014 period

Number of observations =	170,453
F(94, 170358) =	26.87
Prob > F =	0.000
R^2=	0.015
Adj R^2 =	0.014
Root MSE =	0.719

ΔlnLabour productivity	Coefficient	Standard error	t	P>¦t¦	[95% confidence interval]	
Always exporters	0.036	0.005	6.66	0.000	0.025	0.046
Export starters	0.063	0.007	9.38	0.000	0.050	0.076
Export stoppers	-0.004	0.008	-0.53	0.597	-0.020	0.011
lnEmployment	-0.043	0.004	-10.38	0.000	-0.051	-0.035
$lnEmployment^2$	0.006	0.001	7.94	0.000	0.004	0.007
Company age	0.000	0.000	0.73	0.466	0.000	0.000
Company age^2	0.000	0.000	-0.48	0.634	0.000	0.000
Exporter size*	0.000	0.000	-1.21	0.227	0.000	0.000
dum06	0.000	(omitted)				
dum07	0.049	0.007	6.81	0.000	0.035	0.063
dum08	-0.029	0.007	-4.04	0.000	-0.043	-0.015
dum09	-0.128	0.007	-17.87	0.000	-0.142	-0.114
dum10	-0.133	0.007	-18.39	0.000	-0.147	-0.119
dum11	-0.151	0.007	-20.64	0.000	-0.165	-0.136
dum12	-0.141	0.007	-19.27	0.000	-0.156	-0.127
dum13	-0.033	0.007	-4.46	0.000	-0.047	-0.018
dum14	0.000	(omitted)				
Constant	0.098	0.041	2.42	0.016	0.019	0.178

Note: These results are from an OLS regression.

employment faster than non-exporters, considering the relationship between export status and job growth. The dependent variable is employment growth captured by the growth in the number of employees at firm level. Table 7 indicates a positive impact of exporting on employment growth for starters in most sectors and for always exporters in "wholesale and retail trade", in line with the evidence from the literature. We now test the two hypotheses articulated in the literature regarding the direction of causality between labour productivity and exporters, namely the self-selection hypothesis and the learning-by-exporting hypothesis. To shed light on the empirical validity of the hypothesis that firms succeed before they begin exporting —the self-selection hypothesis— we test the differences in labour productivity before firms begin exporting on the basis of equation (3). The estimation is based on a sample of firms with business activity throughout the period 2006-2014. One group of firms never exports. The other was non-exporters in t-1, t-2 and t-3 and started to export in period t (defined as either 2010 or 2011) and continued exporting up to 2014. We end up with a sample of 6,256 observations, of which 146 firms are starters. The estimated coefficient β on the export dummy is negative and insignificant, thus providing no evidence in favour of the self-selection of the most productive firms in the export market. We then provide another check of the relationship between exporting and ex-ante performance in terms of labour productivity growth (see Bernard and Wagner 1997). We consider the

Table 5b Impact of exporting on labour productivity growth in the 2006-2014 period (total economy and by sector of economic activity)

	Always exporters	Starters	Stoppers	Employment	Employment^2	Company age	Company age^2	Exporter size
	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)
All sectors	0.036 (0.000)	0.063 (0.000)	-0.004 (0.597)	-0.043 (0.000)	0.006 (0.000)	0.000 (0.466)	0.000 (0.634)	0.000 (0.227)
Agriculture, forestry and fishing	0.012 (0.897)	0.205 (0.026)	-0.083 (0.475)	-0.058 (0.675)	0.012 (0.700)	-0.005 (0.573)	0.000 (0.675)	0.000 (0.825)
Mining and quarrying	-0.043 (0.751)	-0.116 (0.624)	0.620 (0.112)	0.068 (0.611)	-0.016 (0.536)	-0.003 (0.882)	0.000 (0.966)	0.001 (0.417)
Manufacturing	0.059 (0.000)	0.084 (0.000)	0.001 (0.908)	-0.114 (0.000)	0.016 (0.000)	0.000 (0.989)	0.000 (0.689)	0.000 (0.008)
Construction	0.069 (0.357)	0.041 (0.572)	0.069 (0.360)	-0.078 (0.005)	0.008 (0.128)	0.002 (0.122)	0.000 (0.149)	0.000 (0.448)
Wholesale and retail trade	0.023 (0.000)	0.051 (0.000)	0.000 (0.984)	-0.022 (0.001)	0.004 (0.000)	-0.001 (0.030)	0.000 (0.019)	0.000 (0.224)
Accommodation and food service activities	-0.113 (0.178)	0.172 (0.108)	-0.114 (0.203)	-0.027 (0.012)	0.002 (0.258)	-0.001 (0.165)	0.000 (0.120)	0.000 (0.321)
Transport and communication	0.059 (0.016)	0.051 (0.042)	-0.002 (0.965)	-0.036 (0.010)	0.004 (0.051)	0.000 (0.910)	0.000 (0.891)	0.000 (0.631)
Energy	-0.023 (0.842)	0.012 (0.905)	-0.081 (0.537)	-0.083 (0.097)	0.011 (0.170)	-0.027 (0.001)	0.000 (0.005)	0.000 (0.442)
Financial intermediation activities	0.033 (0.358)	0.059 (0.053)	-0.062 (0.136)	-0.027 (0.034)	0.003 (0.103)	0.000 (0.638)	0.000 (0.413)	0.000 (0.745)
Other services	0.140 (0.905)	0.014 (0.884)	0.065 (0.591)	-0.003 (0.898)	-0.001 (0.777)	-0.005 (0.011)	0.000 (0.019)	0.001 (0.840)

Notes: These results are from an OLS regression. The numbers in brackets are p-values. The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

Table 6 Impact of exporting on labour productivity growth in the 2006-2014 period across different firm sizes

	Always exporters	Starters	Stoppers	Employment	Employment^2	Company age	Company age^2	Exporter size
	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)
"1-9"	0.063 (0.000)	0.097 (0.000)	0.014 (0.379)	-0.123 (0.005)	0.037 (0.014)	0.000 (0.668)	0.000 (0.998)	-0.006 (0.031)
"10-19"	0.059 (0.000)	0.070 (0.000)	0.005 (0.730)	0.128 (0.776)	-0.018 (0.836)	0.000 (0.598)	0.000 (0.421)	-0.003 (0.016)
"20-49"	0.049 (0.001)	0.040 (0.001)	-0.022 (0.072)	-0.014 (0.963)	0.003 (0.939)	0.000 (0.034)	0.000 (0.120)	0.000 (0.319)
"50-249"	0.020 (0.219)	0.026 (0.098)	-0.010 (0.575)	0.033 (0.857)	-0.003 (0.873)	0.000 (0.572)	0.000 (0.199)	0.000 (0.780)
"250+"	0.024 (0.586)	0.022 (0.623)	-0.018 (0.733)	-0.014 (0.938)	0.001 (0.969)	-0.001 (0.278)	0.000 (0.402)	0.000 (0.787)

Notes: These results are from an OLS regression. The numbers in brackets are p-values.

performance of labour productivity growth of future exporters in the years prior to entry, i.e. from year t-3 to t-2 for firms starting exporting in 2010 and from year t-2 to t-1 for firms starting exporting in 2011, in a regression of the following form:

Table 7 Impact of exporting on employment growth in the 2006-2014 period

	Always exporters	Starters	Stoppers	Company age	Company age^2	Exporter size
	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)	(p-value)
All sectors	0.003 (0.208)	0.033 (0.000)	-0.051 (0.000)	-0.001 (0.000)	0.000 (0.000)	0.000 (0.000)
Agriculture, forestry and fishing	0.026 (0.360)	-0.019 (0.544)	0.067 (0.064)	-0.003 (0.346)	0.000 (0.793)	0.000 (0.145)
Mining and quarrying	-0.059 (0.345)	0.018 (0.885)	-0.795 (0.000)	0.019 (0.030)	0.000 (0.064)	0.001 (0.439)
Manufacturing	-0.001 (0.822)	0.036 (0.000)	-0.051 (0.000)	-0.001 (0.000)	0.000 (0.000)	0.000 (0.000)
Construction	-0.05 (0.069)	0.054 (0.036)	-0.066 (0.017)	-0.003 (0.000)	0.000 (0.000)	0.000 (0.000)
Wholesale and retail trade	0.006 (0.047)	0.029 (0.000)	-0.041 (0.000)	-0.003 (0.000)	0.000 (0.000)	0.000 (0.000)
Accommodation and food service activities	-0.016 (0.648)	0.036 (0.414)	-0.049 (0.176)	0.000 (0.004)	0.000 (0.021)	0.000 (0.685)
Transport and communication	-0.013 (0.200)	0.028 (0.009)	-0.050 (0.001)	-0.003 (0.000)	0.000 (0.000)	0.000 (0.315)
Energy	-0.182 (0.641)	0.086 (0.007)	-0.013 (0.766)	-0.007 (0.012)	0.000 (0.087)	0.000 (0.640)
Financial intermediation activities	-0.01 (0.440)	0.03 (0.006)	-0.11 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Other services	-0.066 (0.157)	0.066 (0.094)	-0.136 (0.005)	-0.003 (0.001)	0.000 (0.068)	0.001 (0.691)

Notes: These results are from an OLS regression. The numbers in brackets are p-values. The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

$$\Delta \ln LP_{it\text{-}x(x=1\,|\,x=2)} = \alpha + \beta Export_{it(t=2011\,|\,t=2010)} + \gamma Control_{it} + \varepsilon_{it} \quad (5)$$

Here, we find positive but insignificant coefficient on the export dummy; thus there is no strong evidence in favour of the self-selection hypothesis.

To evaluate the learning-by-doing hypothesis, we estimate equation (4). The results point to negative and insignificant effect of export activity on post-entry productivity growth of export starters. Nevertheless, the number of export starters that can be monitored with the dataset available for this study is too small to offer a solid basis for a reliable empirical investigation.[12]

Finally, we investigate the robustness of our basic results in Table 4 to adding lagged productivity and using different estimators.[13] First, we add lagged productivity and report results for OLS with fixed effects. The results are given in Table 8a and suggest that the export premium is 10.5% for all sectors of the economy and still significant for a number of sectors – "manufacturing", "wholesale and retail trade", "accommodation and food service activities" and "financial intermediation activities". Including lagged productivity, however, introduces a bias because of endogeneity. Hence we also report the results of using the Arellano-Bond GMM estimator. The estimated premium for all sectors is lower at 3.9%, suggesting the presence of bias. However, it is still significant. Second, we investigate whether the exporter premium varies along the distribution of labour productivity, using the quantile regression for panel data developed by Powell (2016). The

12 The drastic reduction in the sample size when investigating the two hypotheses is also a feature of the datasets available for the empirical investigation of ex-ante and ex-post productivity premia by the International Study Group on Exports and Productivity (2008).

13 The detailed results of these robustness tests are presented in Gibson and Pavlou (2017).

Table 8a Exporter productivity premium: robustness checks

	All sectors	AG	MQ	M	C	WRT	HR	TC	E	FI	OS
Exporter premium with lagged productivity	10.5	-	-	15.0	-	6.2	7.7	-	-	23.4	-
Exporter premium using Arellano-Bond estimator	3.9										

Note: "AG" = Agriculture, forestry and fishing, "MQ" = Mining and quarrying, "M" = Manufacturing, "C" = Construction, "WRT" = Wholesale and retail trade, "HR" = Accommodation and food service activities (Hotels & Restaurants), "TC" = Transport and communication, "E" = Energy, "FI" = Financial intermediation activities, and "OS" = Other services (see also footnote 6).

Table 8b Impact of exporting on labour productivity: quantile regressions

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Exporter premia (without instruments)	31.0	16.2	8.3	11.6	10.5	4.1	4.1	44.8	43.3
Exporter premia (with instruments)	49.2	55.3	11.6	31.0	-	-17.3	28.4	11.6	-

Table 9 Impact of exporting on return-on-assets (RoA) in the 2006-2014 period

	Fixed effects equation β (p-value)	Exporter profitability premium
All sectors	0.027 (0.042)	2.8
Agriculture, forestry and fishing	0.357 (0.027)	42.9
Mining and quarrying	-0.542 (0.576)	-
Manufacturing	0.084 (0.000)	8.8
Construction	0.168 (0.074)	-
Wholesale and retail trade	0.028 (0.117)	-
Accommodation and food service activities	0.378 (0.116)	-
Transport and communication	-0.045 (0.423)	-
Energy	-0.559 (0.000)	-
Financial intermediation activities	-0.001 (0.981)	-
Other services	-0.055 (0.793)	-

Notes: β is the estimated regression coefficient from a fixed effects regression of the logarithm of RoA on a dummy variable for exporting firms and year dummies. The numbers in brackets are p-values. The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

Table 10 Impact of exporting on return-on-assets (RoA) with control variables in the 2006-2014 period

	Fixed effects equation β	Exporter premium 100(expβ-1)	Employ-ment	Employ-ment^2	Company age	Company age^2	Exporter size
	(p-value)		(p-value)	(p-value)	(p-value)	(p-value)	(p-value)
All sectors	0.0003 (0.981)	-	0.032 (0.032)	0.016 (0.000)	-0.003 (0.000)	0.000 (0.000)	0.000 (0.215)
Agriculture, forestry and fishing	0.338 (0.059)	40.3	0.427 (0.219)	-0.086 (0.276)	0.018 (0.539)	-0.001 (0.320)	0.022 (0.425)
Mining and quarrying	-0.395 (0.653)	-	0.335 (0.472)	-0.057 (0.462)	0.112 (0.135)	-0.001 (0.233)	-0.026 (0.024)
Manufacturing	0.032 (0.168)	-	0.087 (0.021)	0.025 (0.001)	-0.007 (0.000)	0.000 (0.001)	-0.001 (0.024)
Construction	0.237 (0.013)	26.7	-0.046 (0.341)	0.019 (0.054)	0.000 (0.974)	0.000 (0.897)	0.000 (0.097)
Wholesale and retail trade	-0.005 (0.808)	-	0.012 (0.639)	0.030 (0.000)	-0.005 (0.000)	0.000 (0.018)	0.000 (0.261)
Accommodation and food service activities	-0.134 (0.627)	-	-0.168 (0.010)	0.053 (0.000)	-0.010 (0.067)	0.000 (0.646)	0.006 (0.001)
Transport and communication	-0.043 (0.458)	-	0.073 (0.190)	-0.013 (0.182)	0.002 (0.469)	0.000 (0.652)	0.000 (0.628)
Energy	-0.499 (0.001)	-	0.180 (0.135)	-0.058 (0.024)	0.010 (0.627)	0.000 (0.768)	0.000 (0.423)
Financial intermediation activities	-0.006 (0.931)	-	0.050 (0.246)	0.004 (0.583)	-0.009 (0.025)	0.000 (0.094)	0.001 (0.002)
Other services	-0.356 (0.333)	-	-0.123 (0.257)	0.037 (0.032)	-0.008 (0.349)	0.000 (0.949)	0.015 (0.194)

Notes: β is the estimated regression coefficient from a fixed effects regression of the logarithm RoA on a dummy variable for exporting firms controlling for the ln number of employees and its squared value, exporter size captured by an interaction term between export status and size, and company's age and company's squared age. We also add year dummies. The numbers in brackets are p-values. The sectors of economic activity correspond to NACE Rev. 2 classification (see footnote 6).

results in Table 8b suggest that the exporter premia do differ across the labour productivity distribution, with premia being particularly high in lower labour productivity firms. These results confirm the general finding that firms are very heterogeneous and that relying on results at the mean could be misleading. The results are in line with Powell and Wagner (2011), who also find the largest premium at the bottom of the labour productivity distribution.

3.2.2 Investigating the exports/profitability relationship

To test the hypothesis that exporters are more profitable than non-exporters, we estimate regression (1) using as dependent variable both earnings before interest and taxes over total assets (RoA) and operating profits over total assets. Table 9 summarises the results for the effect of exporting on RoA using fixed effects and time dummies equation. Exporting has a positive and significant effect on RoA in full sample and in the sectors of "agriculture, forestry and fishing" and "manufacturing". When controlling for firm size, company age and exporter size (see Table 10), the effect of exporting activity is still positive but it is insignificant in the full sample. Taking operating profits as a measure of profitability, the impact of exporting becomes insignificant in full sample and across sectors. These results are in line with much of the literature which finds weaker effects of exporting on profitability.

4 CONCLUSIONS

In this paper, we have used firm-level data to explore performance differences between

exporters and non-exporters in Greece. In line with the findings of the extant literature, being an exporter leads to an advantage over domestically oriented firms for productivity (both level and growth rates), profitability and employment growth.

The exporter productivity premium is estimated at 14% for the whole sample, pointing to a significant productivity advantage for exporting firms which is even stronger in certain sectors of economic activity. The existence of an exporter productivity premium is one of the strongest results in the economics literature. We also find evidence in favour of higher productivity growth for always-exporting firms and starters, while there is a negative, though insignificant, effect for stoppers. The relationship between exporting activity and labour productivity growth weakens as we move up the firm size band; the results point to higher productivity growth for exporting SMEs – and in particular for micro SMEs. Finally, we checked the robustness of these results by including lagged productivity to account for productivity persistence and various estimators to correct for endogeneity and the fact that the premium may vary along the productivity distribution. The exporter productivity premia largely remain positive and significant.

The exporter profitability premium, when profitability is proxied by RoA, is estimated at 2.8% for the whole sample in the reviewed period, and even higher in some sectors of economic activity, lending some support to the hypothesis that exporters can be more profitable than companies serving only their home market.

In terms of policy implications, the productivity differentials between exporters and non-exporters suggest that Greece should continue to promote an environment which encourages high-productivity firms and export-oriented production in order to achieve sustainable growth. Given that productivity differentials are particularly significant for SMEs than for large firms, industrial policies should continue to have a firm-size dimension. Different incentives and support services are needed for SMEs and for large firms, given the differences in importance of productivity differentials between exporters and non-exporters. A recent OECD report (Nassr et al. 2016), discussing the export potential of SMEs in Greece, their possible contribution to strengthening Greece's export performance thereby helping economic growth, suggests policy measures in the areas of finance, regulation, R&D and innovation.

Topics for further research would be to identify the impact of firms' export intensity on productivity growth, should firm-level data on export volume become available, and to better assess the direction of causality of exports and measures of firm performance when a larger number of observations is available to allow such an analysis.

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HOW DID THE GREEK FINANCIAL CRISIS IMPACT ON HOUSEHOLDS? A COMPARISON BETWEEN THE TWO WAVES OF THE HFCS*

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1 INTRODUCTION

The impact of the global financial crisis and the sovereign debt crisis in the euro area was substantial, especially in countries with high fiscal and macroeconomic imbalances, such as Greece. In particular, with respect to Greece, the cumulative structural weaknesses of the domestic economy, the country's high external and fiscal debts, political uncertainty and delays in the implementation of the economic adjustment programmes, compounded by the unfavourable global environment, led to a deep and extensive recession. GDP in Greece declined by 24% in nominal terms and by 22% in real terms over the period 2009-2014. This occurred amid intense fiscal consolidation (which had a detrimental effect on the real economy) and radical reforms in labour and product markets in order for the public debt-to-GDP ratio to be reduced and the international cost and price competitiveness of Greece to be restored.

The sharp decline in output was followed by a decrease in employment and a surge in unemployment to historically high levels, from 9.6% in 2009 to 26.5% in 2014. At the same time, a significant drop in the market value of most real and financial assets was observed, in line with falling prices in global capital and real estate markets and the weakening of domestic consumer and investor demand. The decline in Greek GDP largely reflects the drop in consumption, which in turn is due to the considerable decrease in consumers' confidence and the deterioration of households' finances.

The goal of this study is to investigate to what extent the crisis affected the finances of Greek households at the microeconomic level for the period 2009-2014, using data from the two waves of the Eurosystem's Household Finance and Consumption Survey (hereinafter the HFCS). With respect to Greece, the first wave of the HFCS was conducted in 2009 and the sample consists of 2,971 households, whereas the second wave of the HFCS was conducted in 2014 with a sample of 3,003 households.[1]

The HFCS is an important source of microeconomic data at the household level, as it provides detailed information about households' assets, loans, net wealth, income and consumption. The European sample of the first wave comprises more than 62,000 households in 15 euro area countries, including Greece. The European sample of the second wave comprises more than 84,000 households in 18 euro area countries (i.e. all euro area countries except Lithuania), as well as in Hungary and Poland.[2]

A remarkable characteristic of the HFCS dataset is that, due to the microeconomic structure of the data, there is heterogeneity of economic indicators across households, such as wealth, income, assets, debt and consumption, which cannot be captured by aggregate statistics. Also, there is heterogeneity not only across households but also between countries. Therefore, the micro data of the HFCS are of major importance as they enable us to investigate cross-country differences in households' decisions with respect to assets, loans, income and consumption. In addition, the data analysis of the HFCS helps us gain a deeper insight into the effects of monetary policy, financial stability and fiscal adjustment on specific groups of households.[3]

The two waves of the HFCS for Greece in 2009 and 2014, respectively, enable us to examine

* The views expressed in this study are those of the author and do not necessarily reflect those of Bank of Greece. The author is most grateful to Heather Gibson, Hiona Balfoussia and Dimitris Christelis for their valuable comments and suggestions. Any errors or omissions are the responsibility of the author.

1 For the core results of the first wave of the HFCS in 2009, see Tzamourani (2013).

2 More information about the methodology of the HFCS and in particular about the structure and the content of the questionnaire, sample design, weighting and multiple imputation for the first and the second wave of the HFCS is provided in the Household Finance and Consumption Network methodological reports, HFCN (2013) and HFCN (2016), respectively.

3 Christelis and Pérez-Duarte (2013) demonstrate the usefulness of the HFCS data.

whether the key economic indicators of households are affected during the crisis. In particular, this study will explore to what extent Greek households' net wealth, assets, loans, income and consumption have changed over the crisis period. Moreover, the study will test whether the variation in the economic indicators is statistically significant.

The paper is organised as follows: In Section 1 the main sample characteristics of the first and the second wave of the HFCS are presented. In Section 2 a comparative analysis of the distribution of Greek households' net wealth is provided, with respect to the two waves of the HFCS in 2009 and 2014. Moreover, a comparative analysis of the components of net wealth, i.e. assets and loans, is presented. In Section 3 the distribution of household income is described, whereas in Section 4 the distribution of household food consumption for both waves of the HFCS is analysed. In the last section the main conclusions of the study are summarised.

2 MAIN SAMPLE CHARACTERISTICS

Prior to the presentation of households' net wealth, we discuss some characteristics of the household sample structure of the two waves of the HFCS in 2009 and 2014. Table 1 presents descriptive statistics with respect to household size and housing status, whereas Table 2 provides information about the age, education and work status of the household reference person.[4] It should be noted that the Greek HFCS data for both waves are cross-sectional, without a panel component. This means that the second wave of the Greek HFCS does not include households that had participated in the first wave of the Greek HFCS.[5]

In Table 1 we observe that the percentage of Greek households with only one member increased in the second wave of the HFCS compared with the first wave, from 20% in 2009 to 26% in 2014. With respect to housing status, the percentage of households that are outright owners is relatively higher in the first

4 A reference person is defined as the household member who is the most knowledgeable on household assets, loans, income and consumption, associated with both the household as a whole and its individual members. The household reference person is chosen according to the international standards of the so-called Canberra Group (UNECE 2011), which uses the following sequential steps until a unique reference person is identified: one of the partners of a registered or de-facto marriage with dependent children, one of the partners of a registered or de-facto marriage without dependent children, a lone partner with dependent children, the person with the highest income, the eldest person.

5 From the 18 countries of the second wave of the HFCS, seven countries (Belgium, Germany, Spain, Italy, the Netherlands, Cyprus and Malta) used a panel component.

Table 1 Household size and housing status in the 1st and 2nd wave of the HFCS

	1st wave 2009	2nd wave 2014
	%	%
Household size		
1	20.1	25.7
2	28.3	29.5
3	24.2	19.9
4	23.3	19.1
5+	4.1	5.9
Housing status		
Owners-outright	58.5	60.7
Owners with mortgage	13.9	11.4
Renters-others	27.6	27.9

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.

Table 2 Age, education and work status of the household reference person in the 1st and 2nd wave of the HFCS

	1st wave 2009	2nd wave 2014
	%	%
Age of the reference person		
16-34	15.2	12.5
35-44	20.7	18.0
45-54	17.7	19.9
55-64	18.6	18.0
65-74	15.5	16.1
75+	12.4	15.4
Education of the reference person		
Basic education	45.7	39.3
Secondary	33.4	42.4
Tertiary	20.8	18.3
Work status of the reference person		
Employee	39.7	36.5
Self-employed	18.9	14.4
Retired	34.7	39.3
Other not working	6.6	9.8

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.

wave compared with the second wave, from 59% to 61%. The percentage of households that are owners with a mortgage on the household's main residence decreased from 14% to 11% during the crisis period, whereas the percentage of households that are renters has remained the same (28%) for both waves of the HFCS.

In Table 2 we observe that the percentage of reference persons with basic education has visibly declined in the second wave in relation to the first wave, from 46% to 39%, while the percentage of reference persons with secondary education has increased from 33% to 42%. Furthermore, the percentage of reference persons who are retired has increased from 35% in 2009 to 39% in 2014. It is also worth mentioning that the share of reference persons who are not working has increased from 6.6% to 9.8%. This is mainly due to the rise in unemployment during the crisis.

3 HOUSEHOLD NET WEALTH

3.1 NET WEALTH DISTRIBUTION

Comparing the HFCS data in 2009 with the HFCS data in 2014, household net wealth, assets, loans, income and consumption of 2009 are expressed at constant prices of base year 2014, using the harmonised index of consumer prices (HICP) as a deflator.[6] It should be noted that this study is based on the median of the above economic indicators rather than the mean because the median is not affected by extreme values.

Moreover, it is important for our analysis to examine whether any change in household net

6 The questions about assets and loans refer to the time of the interview, whereas the questions about income and consumption refer to the last twelve months prior to the date of the interview. The interviews of the first wave were conducted in 2009, whereas the interviews of the second wave were conducted in 2014.

Table 3 Household net wealth percentiles in the 1st and 2nd wave of the HFCS

Percentiles	1st wave 2009 Household net wealth (in EUR)	2nd wave 2014 Household net wealth (in EUR)	Percentage changes (%)	t-stat of difference in percentiles
P_{10}	2,011	588	-70.8	-2.2**
P_{20}	15,947	6,967	-56.3	-3.1***
P_{30}	51,763	29,369	-43.3	-5.1***
P_{40}	78,474	49,238	-37.3	-7.0***
P_{50}	108,649	65,030	-40.1	-7.9***
P_{60}	138,356	85,266	-38.4	-6.9***
P_{70}	177,281	110,384	-37.8	-6.8***
P_{80}	234,985	151,513	-35.5	-6.7***
P_{90}	353,573	238,900	-32.4	-4.3***

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
Note: We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.
***, **, * denote significance at 1%, 5% and 10%, respectively.

wealth, assets, loans, income and consumption between the two waves of the HFCS is statistically significant. As already mentioned, the HFCS is a sample-based survey and hence the estimations are subject to sampling error. For the estimation of sampling errors, 1,000 replicate weights are produced, using the bootstrap method, based on the sample design. We apply these replicate weights, which are linked to the sample design, to accurately estimate sampling errors. A detailed methodology for the estimation of sampling errors is provided in the Appendix.

Table 3 presents the data from the second wave of the HFCS in 2014 on the net wealth distribution of Greek households, and compares them to those of the first wave HFCS data of 2009. Specifically, the value of household net assets, i.e. household net wealth, which is derived if household debt is deducted from household assets, is shown. As expected, household net wealth has significantly decreased during the crisis period. In particular, the 50th percentile (P_{50}), that is median household net wealth, was €108,649 in 2009, whereas in 2014 it came to €65,030, down by 40%.[7] It is really useful to explore whether this change in net wealth is statistically significant. As shown in Table 3, the t-stat of the change in household net wealth is -7.9, which means that the change in median net wealth is statistically significant at 1%.

It is important to explore whether the decline in household net wealth is reflected across the entire distribution, apart from its median. Table 3 shows that the decrease in household net wealth is noticeable across the range of the distribution. According to the t-statistic, the drop in net wealth is statistically significant from the 10th percentile (P_{10}) to the 90th percentile (P_{90}). In particular, the decline in the net wealth of the 10th percentile is statistically significant at 5%, whereas for the remaining percentiles it is statistically significant at 1%. Overall, we observe that the magnitude of the decrease in wealth is higher in richer households, i.e. from the 60th percentile (P_{60}) upwards, in relation to the corresponding magnitude for poorer households. The 10th percentile of the net wealth dis-

7 We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.

Table 4 Household median net wealth in the 1st and 2nd wave of the HFCS by income percentiles and housing status

	1st wave 2009	2nd wave 2014
Net wealth	Median (in EUR)	Median (in EUR)
Income percentiles		
P_1-P_{20}	54,740	32,532
P_{20}-P_{40}	78,620	50,663
P_{40}-P_{60}	111,879	62,480
P_{60}-P_{80}	130,080	85,045
P_{80}-P_{90}	177,136	106,980
P_{90}-P_{100}	255,583	137,519
Housing status		
Owners-outright	151,784	93,251
Owners with mortgage	127,764	64,263
Renters-others	5,776	3,035

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
Note: We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.

tribution decreased from €2,011 in 2009 to €588 in 2014, that is, by €1,423 in absolute terms or 71% during the crisis. The 90th percentile was €353,573 in 2009, whereas in 2014 it was €239,900. This shows that net wealth decreased by €114,673 or by 32% relative to the upper tail of the net wealth distribution.[8]

3.2 HOUSEHOLD WEALTH BY INCOME AND HOUSING STATUS

Table 4 presents median household net wealth for the two waves of the HFCS, classified by income and housing status. As expected, we observe that median household net wealth increases with household income. The drop in median net wealth in 2014 compared with 2009 is obvious in all income levels. Moreover, we find that in both waves median net wealth for outright owners is higher than median net wealth for owners that have a mortgage on the household's main residence, which is reasonable. As to income percentiles, we find that there is a significant decline in net wealth in 2014 compared with 2009 for outright owners, homeowners with mortgage and renters.

3.3 HOUSEHOLD ASSETS AND LOANS

To deepen our understanding on why household net wealth has decreased during the crisis, we need to analyse its components, specifically assets and loans. Table 5 compares HFCS data on the assets of Greek households in 2014 with the corresponding HFCS data in 2009. In particular, the value of total assets, which comprise real and financial assets, is presented. With regard to real assets, that is fixed assets, the value of total real estate property is shown, which is the major component of fixed assets (90% in 2009 and 88% in 2014) and consists of households' main residence and other real estate property. With respect to financial assets, we report the value of deposits, which constitute the major component of households' financial assets (88.1% in 2014 and 80.7% in 2009).[9]

8 For the wealth distribution, see Avery, Elliehausen and Kennickell (1988), Kennickell (2009), Bover (2010), Honkkila and Kavonius (2013), Piketty and Zucman (2014) and Vermeulen (2016).
9 Many researchers have examined the household asset allocation; see, among others, Chiuri and Jappelli (2003), Campbell (2006), Jappelli (2010), Van Rooij, Lusardi and Alessie (2011), Christelis et al. (2013) and Arrondel et al. (2016).

Table 5 Median value of household assets in the 1st and 2nd wave of the HFCS

Value of assets	1st wave 2009 Median (in EUR)	2nd wave 2014 Median (in EUR)	Percentage changes (%)	t-stat of difference in medians
Total assets	117,461	73,420	-37.5	-8.4***
Total real assets	121,677	78,087	-35.8	-8.6***
Real estate property	127,795	80,203	- 37.2	-6.9***
Household main residence	106,340	69,834	-34.3	-12.7***
Other real estate property	65,900	49,167	- 25.2	-2.3**
Total financial assets	4,631	1,995	-56.9	-4.1***
Deposits	3,856	1,987	-48.5	-2.9***

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
***, **, * denote significance at 1%, 5% and 10%, respectively.

In Table 5 we observe that the median value of household assets decreased during the crisis from €117,461 in 2009 to €73,420 in 2014, i.e. down by 37.5%. This change is statistically significant at 1% (t-stat= -8.4). With respect to fixed assets, it is clear that the median value of real estate property shrank by 37%, from €127,795 in 2009 to €80,203 in 2014. This drop is statistically significant at 1% with t-stat= -8.6. In particular, the median value of households' main residence decreased during the crisis by 34%, from €106,340 in 2009 to €69,834 in 2014. This negative change is statistically significant at 1% (t-stat= -12.7). The median value of other real estate property declined by 24%. This change, in absolute terms, is statistically significant at 5% (t-stat= -2.3). The sharp drop in the value of real estate property is mainly due to the recessionary state of the economy, which is a result of the fiscal adjustment, as well as to higher taxation of real estate.[10] The decrease in the value of real estate property is reflected in the drop of the real estate price index, which is compiled by the Bank of Greece, from 97.9 in 2009 to 64.3 in 2014. Turning to household financial assets, Table 5 shows that the median value of financial assets decreased from €4,631 in 2009 to €1,995 in 2014. This change is statistically significant at 1% with t-stat= -4.1. We also observe that deposits, which are the major component of financial assets, dropped by 48.5%. In particular, the median value of deposits in 2009 was €3,856, whereas in 2014 the median value of deposits stood at €1,987. This drop in deposits is also statistically significant at 1% (t-stat= -2.9). This may be attributed mainly to the decrease in household income and the increase in taxation and social security contributions, as well as to the rise in unemployment during the crisis.

With regard to household debt, the HFCS data in 2014 showed that household debt was lower compared with the HFCS data in 2009. In particular, in 2014, 27.1% of households reported having an outstanding debt, whereas in 2009 the corresponding percentage was 36.6%. In Table 6 data on the outstanding balances of debt of Greek households in 2009 and 2014 are provided.

We observe that the median value of outstanding debt decreased during the crisis by 21.6%, from €15,425 in 2009 to €12,097 in 2014. As clearly seen, the change in the outstanding balance of debt is not statistically significant (t-stat= -1.3). The decrease in household debt is noticeable across all types of debt during the crisis period. The median value of the outstanding balance of mortgage debt

10 The study by Christelis (2015) is indicative of the effects on the real estate market from increased taxation during the crisis in Greece.

Table 6 Household debt by loan type in the 1st and 2nd wave of the HFCS

Household debt	1st wave 2009 Median (in EUR)	2nd wave 2014 Median (in EUR)	Percentage changes (%)	t-stat of difference in medians
Total debt	15,425	12,097	-21.6	-1.3
Mortgage debt	43,410	35,261	-18.8	-1.4
With mortgage on household main residence	41,902	34,619	-21.0	-1.2
With mortgage on other property	44,311	34,222	-22.8	-1.0
Non-mortgage debt	4,591	2,936	-36.0	-2.6***

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
***, **, * denote significance at 1%, 5% and 10%, respectively.

declined by 18.8%, from €43,410 in 2009 to €35,261 in 2014. However, this drop is not statistically significant as the t-stat is -1.4. The median value of the outstanding balance of non-mortgage debt decreased from €4,591 in 2009 to €2,936 in 2014, which is equivalent to a 36% drop over the crisis. This drop is statistically significant at 1%, with t-stat= -2.6. The decrease in household debt may reflect the subdued lending activity of the banking system, coupled with debt repayment during the crisis. Overall, the decrease in household net wealth is attributed primarily to the drop in the value of real estate and secondarily to the drop in deposits.

For a better evaluation of households' financial burden we compare some indicative financial burden ratios for indebted households of both waves of the HFCS, such as the debt-to-income ratio or the debt-to-assets ratio. As shown in Table 7, the median debt-to-income ratio rose in percentage terms from 47.1% in 2009 to 53.1% in 2014 and the median debt-to-assets ratio increased from 14.8% to 17.3%, respectively. The increase in both ratios is attributed to a great extent to the decline in income and the drop in the value of households' assets, as a result of the fiscal adjustment and the recession. For households that have mortgage debt on their main residence, we calculate the median loan-to-value ratio. According to Table 7, we can see that this ratio has increased during the crisis from 31.6% in 2009 to 42.4% in 2014, reflecting the sharp drop in the value of household main residence. However, it is worth mentioning that the variations in all three financial burden

Table 7 Household financial burden indicators of the 1st and 2nd wave of the HFCS

Financial burden indicators (%)	1st wave 2009 Median	2nd wave 2014 Median	t-stat of difference in ratios
Debt-to-income ratio	47.1	53.1	0.7
Debt-to-assets ratio	14.8	17.3	0.8
Loan-to-value ratio of household main residence	31.6	42.4	1.5
Debt service-to-income ratio	14.8	8.8	-4.9***
Mortgage debt service-to-income ratio	16.3	18.1	1.2

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
***, **, * denote significance at 1%, 5% and 10%, respectively

ratios are not statistically significant over the crisis period.

Furthermore, two additional financial burden indicators are presented, which are more directly associated with households' financial strain. The first is the debt service-to-income ratio, which is the median ratio of total monthly debt payments to household gross monthly income. This ratio decreased during the crisis from 14.8% in 2009 to 8.8% in 2014. This change is statistically significant at 1%, with t-stat= -4.9. Households seem to bear lower debt servicing costs during the crisis, possibly because they renegotiate their loans with better terms, such as lower or fixed interest rates or lower monthly debt payments. However, this is not the case for the second financial burden ratio, i.e. the mortgage debt service-to-income ratio, which is the median ratio of total monthly mortgage debt payments to household gross monthly income. We observe a slight increase in the mortgage debt service-to-income ratio during the crisis. In particular, the ratio rose from 16.3% in 2009 to 18.1% in 2014. This may be due to the significant decline in monthly household income during the crisis, which has a stronger impact on debt repayment for mortgage loans compared with non-mortgage loans. However, it is worth mentioning that the increase of the ratio is not statistically significant (t-stat= 1.2).[11]

4 HOUSEHOLD INCOME

The HFCS includes questions on the income of each household member and of the household as a whole. In particular, for each household member aged 16 plus, there was a question for employee income, self-employment income, pension income and unemployment benefits. Total gross household income is derived by adding labour income and non-labour income for all household members aged 16 plus. Labour income is the sum of employee income and self-employment income. Non-labour income is derived by adding pension income, income from social transfers, income from private transfers, rental income from real estate property, income from private business, and income from financial investments (dividends, interest on bonds, deposits, etc.).

11 Hintermeier and Koeniger (2011), Christelis et al. (2017) and Bover et al. (2016), among others, investigate household debt allocation across countries.

Table 8 Percentiles of annual gross household income in the 1st and 2nd wave of the HFCS

	1st wave 2009	2nd wave 2014		
Percentiles	Annual household income (in EUR)	Annual household income (in EUR)	Percentage changes (%)	t-stat of difference in percentiles
P_{10}	7,758	6,569	-15.3	-2.4**
P_{20}	11,729	9,924	-15.4	-6.7***
P_{30}	15,533	12,207	-21.4	-6.7***
P_{40}	19,179	15,003	-21.8	-7.0***
P_{50}	23,492	17,465	-25.7	-8.5***
P_{60}	28,453	20,312	-28.6	-8.6***
P_{70}	34,209	24,336	-28.9	-8.2***
P_{80}	42,259	30,454	-27.9	-8.0***
P_{90}	56,865	39,737	-30.1	-7.9***

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
Note: We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.
***, **, * denote significance at 1%, 5% and 10%, respectively.

To compare gross household income between 2014 and 2009, we will not only focus on median household income but we will also analyse the entire range of the income distribution providing data on the percentiles of the distribution. In Table 8 the percentiles of gross household income are presented, from the 10th percentile (P_{10}) to the 90th percentile (P_{90}) for the first and the second wave of the HFCS. We observe that there is a clear decline in income across the income distribution in 2014, compared with 2009. The drop in gross household income may be attributed to lower labour income, and lower employee income in particular, coupled with cuts in social benefits as a result of the fiscal adjustment effort in Greece during the crisis. Median household income (see 50th percentile) declined by 26% during the crisis period. In particular, in the first wave of the HFCS median household income amounted to €23,942, whereas in the second wave of the HFCS it came to €17,465. As shown in Table 8, the drop in median income during the crisis is statistically significant, with t-stat= -8.5.

At the lower tail of the distribution, i.e. the 10th percentile, income decreased by 15%, from €7,758 in 2009 to €6,569 in 2014. The drop is statistically significant at 5%, with t-stat= -2.4. At the upper tail of the distribution, i.e. the 90th percentile, income declined by 30% during the crisis (2009-2014). The 90th percentile in 2009 was €56,865, while in 2014 it was €39,737. The decline at the upper tail of the distribution is statistically significant at 1%, with t-stat= -7.9. Looking at the entire range of the household income distribution of both waves, we conclude that the decrease in income is statistically significant across all income percentiles. On the other hand, the magnitude of the income drop is greater in richer households than in poorer households, that is from the 60th percentile upwards.

5 HOUSEHOLD CONSUMPTION

The HFCS provides valuable information on household consumption. For the comparison of the two waves of the HFCS we will focus on

Table 9 Percentiles of household total annual food consumption (at home and outside) in the 1st and 2nd wave of the HFCS

	1st wave 2009	2nd wave 2014		
Percentiles	Annual food consumption (in EUR)	Annual food consumption (in EUR)	Percentage changes (%)	t-stat of difference in percentiles
P_{10}	3,144	2,223	-29.3	-5.5***
P_{20}	4,202	2,937	-30.1	-6.4***
P_{30}	5,089	3,567	-29.9	-16.3***
P_{40}	5,743	4,145	-27.8	-11.9***
P_{50}	6,520	4,764	-26.9	-7.3***
P_{60}	7,644	5,363	-29.8	-17.0***
P_{70}	8,865	5,958	-32.8	-9.8***
P_{80}	10,089	6,598	-34.6	-8.2***
P_{90}	12,700	8,144	-35.9	-10.2***

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
Note: We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.
***, **, * denote significance at 1%, 5% and 10%, respectively.

Table 10 Percentiles of household annual food consumption at home in the 1st and 2nd wave of the HFCS

Percentiles	1st wave 2009 Annual food consumption at home (in EUR)	2nd wave 2014 Annual food consumption at home (in EUR)	Percentage changes (%)	t-stat of difference in percentiles
P_{10}	3,144	2,223	-29.3	-5.5***
P_{20}	4,202	2,937	-30.1	-6.4***
P_{30}	5,089	3,567	-29.9	-16.3***
P_{40}	5,743	4,145	-27.8	-11.9***
P_{50}	6,520	4,764	-26.9	-7.3***
P_{60}	7,644	5,363	-29.8	-17.0***
P_{70}	8,865	5,958	-32.8	-9.8***
P_{80}	10,089	6,598	-34.6	-8.2***
P_{90}	12,700	8,144	-35.9	-10.2***

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
Note: We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.
***, **, * denote significance at 1%, 5% and 10%, respectively.

food consumption, as the questionnaire of the first wave did not include any questions on the consumption of goods and services and the amounts spent by the household on utilities. These data are available only for the second wave of the HFCS. Data on total annual food consumption at home and outside home for Greek households are presented in Table 9. Annual food consumption has significantly decreased during the crisis, mainly due to the decline in income and the rise in unemployment. In particular, median annual food consumption at home and outside home fell from €6,520 in 2009 to €4,764 in 2014, which corresponds to a drop of 27%. The decrease in Greek households' median food consumption is statistically significant, with t-stat= -7.3. At the 10th percentile of the distribution of annual food consumption, a decline of 29% can be observed. Specifically, annual food consumption decreased from €3,144 in 2009 to €2,223 in 2014 (i.e. a decrease of €921 in absolute terms). The decrease is statistically significant, with t-stat= -5.5. At the 90th percentile of the distribution, a 24% decrease is observed for the period 2009-2014. In particular, the change in consumption from €12,700 in 2009 to €8,144 in 2014, which accounts for a drop of €4,565 in absolute terms, is statistically significant, with t-stat= -10.2. The drop in total annual food consumption in 2014 compared with 2009 is statistically significant across all percentiles of the distribution.

Table 10 shows the entire range of distribution of Greek households' annual food consumption at home for both waves of the HFCS. We notice that the decline in annual food consumption at home during the crisis is statistically significant across the distribution range. Median food consumption at home dropped from €5,050 in 2009 to €3,565 in 2014. This negative change is statistically significant, with t-stat= -13.8. Comparing the 10th percentile between the two waves of the HFCS, there is a statistically significant drop in food consumption at home from €2,503 in 2009 to €1,731 in 2014, with t-stat= -3.5. Respectively, at the 90th percentile, there is a statistically significant decline in food consumption at home from €8,804 in 2009 to €5,963 in 2014. Similar to Table 9, relative to the 10th percentile, the drop in consumption is clearly stronger in

Table 11 Percentage of households reporting that their expenses are lower than their income in the 1st and 2nd wave of the HFCS

	1st wave 2009	2nd wave 2014
	%	%
Income percentiles		
P_1-P_{20}	9.3	7.2
P_{20}-P_{40}	17.5	8.5
P_{40}-P_{60}	19.7	10.0
P_{60}-P_{80}	22.6	16.1
P_{80}-P_{90}	32.4	22.0
P_{90}-P_{100}	48.5	29.3
Housing status		
Owners-outright	24.2	16.0
Owners with mortgage	19.0	8.5
Renters-others	18.3	10.1

Source: 1st and 2nd wave of the Greek HFCS, Bank of Greece.
Note: We define the P_k percentile as the value below which k% of observations and above which (100-k)% of observations can be found.

richer households that exhibit higher annual food consumption at home. This is in line with the fact that poorer households have a higher marginal propensity to consume, as the bulk of their consumption consists in relatively inelastic expenses.

The HFCS depicts the saving behaviour of households, providing information on the extent to which households' expenses were lower than their income in the past few years.[12] The percentage of Greek households reporting that their expenses were lower than their income in the first wave of the HFCS in 2009 was 21.9%. The corresponding percentage significantly decreased in 2014 to 13.5%. This decrease is statistically significant at 1%, with t-stat= -4.3.

Table 11 presents the share of households reporting that their expenses are lower than their income on the basis of income percentiles and housing status for both waves of the HFCS. We observe, as expected, that the propensity to save in both 2009 and 2014 increases with household income. As we move from lower to upper percentiles, the percentage of households reporting that their expenses are lower than their income increases in both waves. On the other hand, the percentage of households that save has declined visibly, relative to 2009, if the focus is on income percentiles. This is attributable to Greek households' significantly lower income and higher taxes during the crisis period, as a result of the fiscal adjustment. We also notice that the saving behaviour of Greek households varies with their housing status. As we would expect, households save more if they are outright owners, compared with those that have a mortgage loan on the household's main residence or compared with renters. However, the percentage of households that are outright owners reporting that their expenses are lower than their income decreased in 2014 compared with 2009, from 24.2% to 16%. The percentage of households that save is slightly higher for owners that have a mortgage loan than for renters in 2009. The saving behaviour of households that are homeowners with a mortgage

12 The saving behaviour of households receives extensive attention in the literature, such as Guiso et al. (1992), Chang (1994), Browning and Lusardi (1996), Kennickell and Lusardi (2005) and Bover et al. (2016).

has deteriorated in 2014. In particular, 8.5% of owners with a mortgage loan reported that they save, compared with 19% in 2009. The percentage of renters reporting that they save is 10.1%, which is significantly lower than the corresponding percentage in 2009, i.e. 18.3%.

6 CONCLUSIONS

This study examines whether and to what extent the crisis has affected the finances of Greek households, using data from the two waves of the HFCS, which were conducted in 2009 and 2014, respectively. The results show that the crisis had a strong negative impact on households' net wealth, assets, income and consumption. Median household net wealth declined during the crisis by 40% and this change is statistically significant. The decrease in the value of household net wealth in 2014 relative to 2009 is visible and statistically significant across the entire distribution. The drop in household net wealth is primarily attributed to the reduced value of their fixed assets, in particular real estate, and secondarily to the lower value of their financial assets. Furthermore, the study points to a decrease in the outstanding balance of total household debt and mortgage debt, but this variation is not statistically significant. On the other hand, a statistically significant decline in the outstanding balance of non-mortgage debt is observed.

Apart from household net wealth, median household income declined by 26% during the period 2009-2014. The decline is statistically significant across the income distribution. Reduced income and increased taxation had a detrimental effect on household consumption. Median annual food consumption at home and outside home declined by 27%. This drop is statistically significant across the distribution. Household saving shrank over the crisis period. The percentage of households reporting that their expenses are lower than their income fell from 21.9% in 2009 to 13.5% in 2014.

The third wave of the Greek HFCS will be conducted within 2017 and will include additional questions on households' liabilities. In particular, unlike the first and the second wave, the third wave will gather information not only on households' outstanding loans, but also on unpaid taxes, social security contributions or utility bills (electricity, water or phone bills), thereby providing valuable insight into overall household debt.

APPENDIX
SAMPLING ERROR ESTIMATION METHOD

The HFCS uses multiple imputation method for the estimation of missing values.[13] Using this method we can estimate the sampling error. The total variance T of the estimator for a parameter $\hat{Y}$ is given by:

$$T=W+\left(1+\frac{1}{m}\right)Q \qquad (1)$$

where W is the within variance, Q is the between variance and m is the number of implicates. The number of implicates m for the two waves of the HFCS is 5.

To estimate the change in the estimator of the parameter $\hat{Y}$ between the first wave of the HFCS in 2009 and the second wave of the HFCS in 2014, we use the following formula:

$$Var(\hat{D})=Var(\hat{Y}_{2009})+Var(\hat{Y}_{2014})-2Cov(\hat{Y}_{2009},\hat{Y}_{2014}) \qquad (2)$$

where $\hat{D}=\hat{Y}_{2014}-\hat{Y}_{2009}$, i.e. the change in the estimator of the parameter $\hat{Y}$ between the two waves, $Var(\hat{Y}_{2009})$ and $Var(\hat{Y}_{2014})$ are the variances of $\hat{Y}_{2009}$ and $\hat{Y}_{2014}$ respectively, and $Cov(\hat{Y}_{2009},\hat{Y}_{2014})$ is the covariance between $\hat{Y}_{2009}$ and $\hat{Y}_{2014}$. As already mentioned, in the case of Greece, both samples from the two waves of the HFCS do not use a panel component and hence they are statistically independent. Therefore, in our case $Cov(\hat{Y}_{2009},\hat{Y}_{2014})=0$. Therefore, (2) is converted as follows:

$$Var(\hat{D})=Var(\hat{Y}_{2009})+Var(\hat{Y}_{2014}) \qquad (3)$$

The t-statistic for the change in the estimator of the parameter $\hat{Y}$ between the two waves is given by the following formula:

$$t_{stat}=\frac{\hat{D}}{std\ err\ (\hat{D})} \qquad (4)$$

where $std\ err(\hat{D})=\sqrt{Var(\hat{D})}$

For the degrees of freedom (df) we use the following formula:

$$df_m=(m-1)\left[1+\frac{W(\hat{Y}_{2014})-W(\hat{Y}_{2009})}{(1+m)^{-1}(Q(\hat{Y}_{2014})-Q(\hat{Y}_{2009}))}\right]^2$$

where m is the number of implicates, $W(\hat{Y}_{2014})-W(\hat{Y}_{2009})$ is the change in the within variance of $\hat{Y}_{2009}$ and $\hat{Y}_{2014}$ and $Q(\hat{Y}_{2014})-Q(\hat{Y}_{2009})$ is the change in the between variance of $\hat{Y}_{2009}$ and $\hat{Y}_{2014}$.

13 For details on the multiple imputation method, see Christelis (2011).

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LABOUR MARKET ADJUSTMENT AND LABOUR MARKET REFORMS IN GREECE DURING THE CRISIS: FINDINGS FROM THE THIRD WAVE OF THE WAGE DYNAMICS SURVEY*

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1 INTRODUCTION

The recession that followed the global financial crisis and the sovereign debt crisis resulted in large falls in output (GDP) and rises in unemployment across Europe. The large rises in unemployment led many countries to proceed to significant labour market reforms. In this context, the European System of Central Banks (ESCB) conducted a third wave of the Wage Dynamics Network (WDN3) survey in 2014-2015.[1] The aim of the survey was to investigate how firms adjusted to the shocks affecting them and to what extent, according to their perceptions, labour market reforms made it easier for them to adjust labour input and wages.[2] In Greece, the third wave of the survey was conducted in the second half of 2014 and the beginning of 2015.

This paper summarises the main findings of the Greek WDN3 survey. The results show that the decline in economic activity, during the period 2010-2013, had a significant negative impact on firms' activity and firms reacted to the shocks affecting them by adjusting both labour input and wages. The share of firms adjusting wages in Greece is the highest among the countries participating in the WDN3 survey. Furthermore, reforms seem to have made it easier for firms to adjust to the shocks affecting them. A significant share of firms report that it is now easier for them to adjust labour input and wages and attribute this flexibility mainly to the reform of labour laws. Regarding remaining inflexibilities in the Greek labour market and other obstacles that would influence the hiring of new employees with contracts of indefinite length, the survey shows that Greek firms consider economic uncertainty to be comparatively the most binding obstacle to hiring, followed by high payroll taxes. The regulatory framework, which has been significantly reformed in the recent period, is not frequently considered as a relevant obstacle to hiring employees with contracts of indefinite length.

The rest of the paper is organised as follows: Section 2 provides a short description of the main labour market reforms that took place during recent years. Section 3 describes the main features of the survey and the Greek sample. Section 4 describes the main shocks affecting Greek firms. Section 5 discusses how Greek firms adjusted labour input and their wage bill. Section 6 analyses the flexibility provided to firms by the labour market reforms by focusing on firms' perceptions about the effectiveness of reforms. A final section concludes.

* We would like to thank Costas Kanellopoulos for his useful and constructive comments and suggestions during the initial phases of the preparation of this paper, as well as for his valuable help in the organisation and conduct of the survey. We would also like to thank Elli Nobeli for her excellent research assistance, as well as Konstantinos Kanellopoulos. Finally, we thank Juan Francisco Jimeno, Heather Gibson, Hiona Balfoussia and the participants in the Wage Dynamics Network meetings for their helpful remarks. The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank of Greece.

1 Denmark, Finland and Sweden are the only three EU countries which are not covered by the WDN3 survey.

2 This was a follow-up to the two previous WDN surveys carried out in 2007 and 2009. The first wave was carried out in order to collect information on wage-setting practices at the firm level and the second to assess how firms reacted in the aftermath of the financial crisis of 2007-2008. For a summary of the main findings of the first and second wave of the Wage Dynamics Network Survey, see Fabiani et al. (2010) and Fabiani et al. (2015), respectively.

2 DEVELOPMENTS IN THE GREEK LABOUR MARKET BETWEEN 2010 AND 2013

The sovereign debt crisis had a significant negative impact on the Greek economy, which registered a cumulative reduction in output of 21% in real terms over the period 2010-2013.[3] This led to an increase in the unemployment rate from 12.7% in 2010 to 27.5% in 2013, with the number of unemployed reaching 1.3 million in 2013 (from 639,400 in 2010). During the same period, employment declined from 4.4 million at the beginning of 2010 to 3.5 million at the end of 2013.[4] The fall in output and the increase in unemployment stand out when compared with the evolution of output and unemployment in the EU and in other southern European countries that were also much affected by the sovereign debt crisis (see Izquierdo et al. 2017). For instance, in Italy GDP fell by 9.4% in the period 2008-2014 and unemployment rose by 6 percentage points (see D' Amuri et al. 2015). In Spain, output fell by 8% between 2010 and 2013 and unemployment rose by 7 percentage points (see Izquierdo and Jimeno 2015 and Izquierdo et al. 2017).

The increase in unemployment and the need to deal with various structural inefficiencies of the Greek labour market led to the adoption of significant labour market reforms. Labour market reforms were aimed at reducing labour costs, as a key to boosting competitiveness, and at increasing the ability of firms to adjust to shocks.[5] The main reforms involved measures that made the wage bargaining system more decentralised and reduced employment protection for permanent employees by lowering firing costs. Also, the setting of the minimum wage was turned over to the government away from the social partners.

With respect to collective bargaining, to increase flexibility and firms' ability to adjust to the decline in economic activity, procedures for the conclusion of firm-level agreements were simplified and firm-level agreements can now allow for remuneration and working conditions that are less favourable than any sectoral/occupational agreement. Moreover, in an effort to reduce further the centralisation of wage bargaining, the extension of occupational and sectoral collective agreements to non-signatory parties was suspended.

Finally, recourse to arbitration to solve disputes is allowed only if both parties agree and it is limited to basic pay issues. The new framework for recourse to arbitration aimed at a faster conclusion of agreements.[6] As a result, the number of firm-level agreements has risen significantly. Firm-level agreements have allowed for wage freezes and the downward adjustment of wages of between 10% and 40% (see Bank of Greece 2014).

Regarding firing costs, there was a reduction in severance pay on dismissals without prior notice. The notice period for the termination of employment contracts was also reduced and the minimum threshold for activating rules on collective dismissals increased.[7]

Finally, in the area of the national minimum wage, a new system was introduced. Previously, the minimum wage was the outcome of a bargaining process between the social partners. Following the changes, the minimum wage is set by law after consultation with social partners and sub-minimum wages for workers under the age of 25 apply. Moreover, in 2012, in an attempt to reduce labour costs, a new national minimum wage was legislated, lower by 22% (and 32% for those under 25). This downward minimum wage adjustment along

3 National accounts, seasonally adjusted data (ELSTAT).
4 Labour Force Statistics (LFS) (ELSTAT).
5 For an extended discussion of labour market reforms during the period 2010-2013, see, among others, Bank of Greece, *Annual Report 2011*, *Annual Report 2012*, *Monetary Policy – Interim Report 2012*, as well as the European Commission's Labour Market Reforms Database (https://webgate.ec.europa.eu/labref/public/).
6 To further increase the ability of firms to adjust to shocks, some measures that made the adjustment of working hours easier were also introduced. For instance, firms were permitted to extend working hours per day in periods of high employment, on the condition that weekly working hours were reduced at another time (of low employment). Working time cannot, however, deviate from regular hours for more than six months in a period of twelve months.
7 For dismissals with prior notice the severance pay is half of that for dismissals without prior notice. The reduction in the notice period increases firms' flexibility and reduces firing costs.

with the abolition of various allowances (such as those for the use of computers or foreign language skills) is reflected in the evolution of wage costs, as the index of wages declined from 114.5 in 2009 to 89.9 in 2013.[8]

3 SURVEY DESIGN AND DESCRIPTION OF THE GREEK SAMPLE

In Greece, the third wave of the Wage Dynamics Network survey was conducted in the second half of 2014 and the beginning of 2015. The questionnaire was sent to firms with more than 20 employees in the manufacturing, trade and business services sectors.[9,10] The final sample includes 402 firms.

The questionnaire included a set of questions collecting information on:

a) the firm (i.e. ownership structure, number of employees, distribution of employees according to skills and type of employment contract, etc.);

b) the type of shocks affecting firms;

c) whether firms adjusted wages and employment and how this adjustment was achieved (i.e. whether firms had frozen and/or cut wages, flexible wage components, whether they adjusted employment by lay-offs, adjustment of hours, freeze of new hires, non-renewal of temporary contracts, etc.);

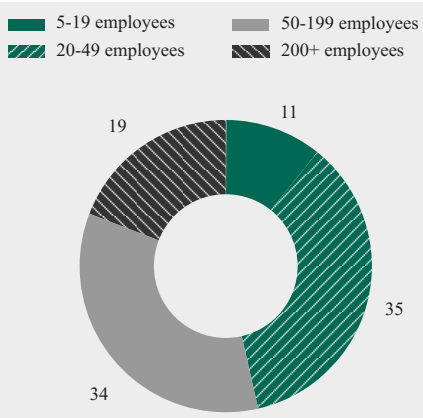
d) the effectiveness of reforms by asking firms whether they perceived it easier or more difficult to adjust employment and wages in 2013 compared to 2010;

e) firms' price-setting strategies and whether price-setting strategies changed during the crisis.

Looking at the composition of our sample, almost 70% of firms have between 20 and 200 employees. A significant share of firms though (19%) are firms with more than 200 employees (see Chart 1). As to the sectoral coverage, the sample is almost evenly split among manufac-

Chart 1 Distribution of sample by firm size

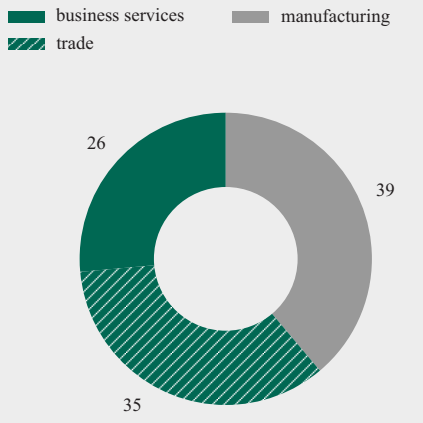
(%)



Source: Third wave of the WDN survey - Sample of Greek firms.

Chart 2 Distribution of sample by sector

(%)



Source: Third wave of the WDN survey - Sample of Greek firms.

8 ELSTAT, Index 2012=100.

9 As in the previous two waves, the countries conducting the survey used a harmonised questionnaire that contained a core set of questions asked in all countries and a set of non-core questions asked only in some of them. The harmonised design of the survey allows the creation of a cross-country dataset that provides comparable information on firms' adjustment during the crisis.

10 Since firms adjusted their labour input during the crisis, the sample also includes some firms with less than 20 employees. The sample does not include the financial sector. The survey was conducted by email and the response rate was 8%, which is comparable to the response rate of countries conducting the survey either by email or by traditional mail (see Izquierdo et al. 2017).

turing, trade and business services. Specifically, 39% of firms belong to the manufacturing sector, 35% to the trade sector and 26% to the business services sector (see Chart 2).

The majority of firms in the sample (75%) are mainly domestically owned, 66% represent the parent company and around half of them are multi-establishment firms. Interestingly, 77% of firms have some exporting activity and, on average, 30% of their revenues are generated in foreign markets. For 18% of firms, foreign markets are the main market (i.e. they generate more than 50% of revenues) and, on average, 79% of revenues are generated there. The significant share of multi-establishment and exporting firms in our sample is consistent with the size distribution of our sample. Bigger firms are more likely to have premises in more than one location and are also more likely to be able to bear the initial sunk costs that are related to selling products in foreign markets.

4 MAIN SHOCKS AS PERCEIVED BY FIRMS

In this section we analyse the main shocks affecting Greek firms in the period 2010-2013. Firms were asked to assess the impact and expected duration of the various shocks affecting their activities in the period 2010-2013. In particular, they were asked to provide answers regarding the impact of the following factors: (a) changes in demand; (b) volatility of demand; (c) access to external finance; (d) customers' ability to pay; and (e) availability of supplies from the usual suppliers. Answers on the impact were provided for each factor on a 5-point scale (1= strong negative impact, 2= moderate negative impact, 3= no impact, 4= moderate positive impact, 5= strong positive impact).

Tables 1a and 1b provide information regarding the impact of changes in demand. As expected, given the general macroeconomic picture of the Greek economy, 71% of firms reported that demand negatively affected their activities (40% noted that the negative impact was very strong).[11] It appears that the evolution of domestic demand exerted the strongest

11 The survey covers firms that survived the crisis, at least until the end of 2014 and early 2015, the period in which the survey was conducted. Therefore, the current survey is likely to underestimate the overall impact of the economic downturn on firms' activities, as it is not able to account for firm closures.

Table 1a Impact of changes in demand in the period 2010-2013 (% of firms)

(%)

	Strong negative impact	Moderate negative impact	No impact	Moderate positive impact	Strong positive impact
Demand	40	31	4	17	8

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response. The employment-adjusted weights account for the unequal probabilities of receiving and responding to the questionnaire across strata as well as for the average firm size (measured on the basis of the number of employees) in the population in each stratum. For a brief description of how these weights are calculated, see Babecký et al. (2010).

Table 1b Evolution of demand for the main product (% of firms)

(%)

	Strong decrease	Moderate decrease	Unchanged	Moderate increase	Strong increase
Domestic demand	41	34	3	18	4
Foreign demand	9	18	43	24	6

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

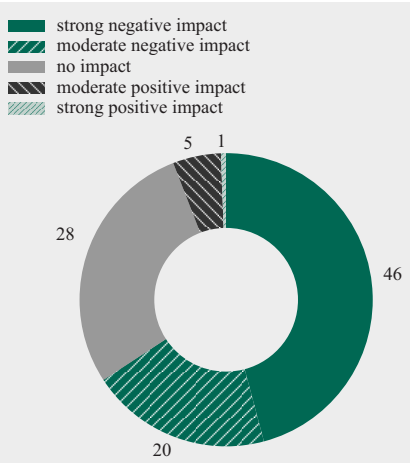
pressure on firms, with 75% of firms reporting that domestic demand decreased. By contrast, foreign demand appears to have supported firms' activities since most firms (73%) noted that foreign demand was either unchanged or positive. The share of firms reporting a decrease in foreign demand is comparatively lower (27%).

Credit constraints were also prevalent in Greece in 2010-2013 and this is confirmed by firms' replies in the survey.[12] In particular, regarding the impact of access to external financing, the majority of firms (66%) report a negative impact on their activities, with 46% reporting a strong negative impact (see Chart 3). Regarding the source of financial constraints, firms reported that both cost and quantity constraints were important (see Table 2). Cost and quantity constraints relating to working capital financing are considered as relevant or very relevant by half of the firms.[13] Cost and quantity constraints relating to investment financing and debt refinancing are also important as they are considered to be relevant or very relevant by over 40% of firms. Constraints relating to working capital appear, however, to be slightly more binding compared to the other options.

Concerning other shocks, 78% of firms report that they were negatively affected (strongly or moderately) by the volatility of demand and 61% that they were negatively affected by the availability of supplies from the usual suppliers. Interestingly, 85% of firms report a negative impact of customers' ability to pay. Customers' ability to pay could be considered as a factor influencing firms' liquidity. Considering that constraints in accessing external finance were also prevalent, the survey shows that financial pressures have had a negative impact on the activities of a significant share of firms during the survey reference period.

Chart 3 Impact of changes in access to finance in the period 2010-2013 (% of firms)

(%)



Source: Third wave of the WDN survey - Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

12 The growth of bank credit to non-financial corporations declined from 4.3% year-on-year in January 2010 to -5% year-on-year in December 2013 (Source: Bank of Greece).
13 Firms were asked to rank each option in terms of relevance (1= not relevant, 2= of little relevance, 3= relevant, 4= very relevant).

Table 2 Difficulties in access to finance in the period 2010-2013 (% of firms replying that restrictions are relevant or very relevant)

(%)

Credit was not available to (quantity restrictions)		Credit was available but conditions were too onerous to (cost restrictions)	
Finance working capital	53	Finance working capital	54
Finance investment	49	Finance investment	45
Refinance debt	43	Refinance debt	45

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

There appear to be no significant differences in the impact of the various shocks across different sectors and size classes. Size and sector dummies are insignificant in a simple probit regression where the incidence of negative shocks is the dependent variable and size and sector dummies the independent variables (see Table A1 in the Appendix). It appears that since the shocks that hit Greece were so pervasive, they influenced firms in all sectors alike. Interestingly enough, firms that are mainly foreign-owned are less likely to have been negatively affected by credit constraints and the availability of supplies. Therefore, domestic credit conditions and the availability of supplies do not seem to constitute a significant problem for foreign firms that most probably rely on their parent companies for funding and supplies.

Regarding the duration of shocks, firms were asked for each shock to indicate whether they considered it to be transitory, partly persistent or long-lasting. 71% of the firms reporting a negative impact of demand perceive that the shock to demand is partly persistent. The corresponding share is 74% for the volatility of demand, 71% for the access to external finance, 72% for customers' ability to pay and 59% for the availability of supplies from the usual suppliers. Therefore, the majority of firms reporting a negative impact of the shocks on their activity consider the shocks to be partly persistent.

5 MAIN CHANNELS OF FIRM ADJUSTMENT DURING THE CRISIS

The survey provides detailed information on the evolution of the various components of firms' costs, allowing the extent to which Greek firms reacted to the various shocks affecting their activity by adjusting labour input and wages to be explored. We start by analysing the evolution of total costs so as to assess overall cost developments and then we advance to a detailed analysis of the various cost categories.

Regarding total costs, firms were asked to indicate how total costs and their main components evolved during the period 2010-2013.[14]

Table 3 shows that 60% of firms reported that their total costs decreased (moderately or strongly). With respect to cost components, 68% of firms indicated that they experienced a decrease in labour costs, while the share of firms indicating a decrease in other cost components is much lower. In particular, only 16% of firms indicated that they experienced a decline in financing costs and 32% a decline in the cost of supplies. By contrast, a significant share of firms (57%) indicated that they actually experienced an increase in financing costs, an answer consistent with the analysis of credit constraints in the previous section.

The high share of firms indicating a decline in labour costs is also consistent with the labour market reforms that took place and made it easier for firms to adjust both wages and labour input. Interestingly, in other southern European countries, also affected by the crisis and taking steps towards reforming their labour markets, the share of firms experiencing a decline in labour costs is comparatively lower, i.e. 29% in Spain and 23% in Italy. The low response of labour costs in these two countries can be attributed to the moderate response of wages, since a significant share of firms in these two countries seem to have adjusted their labour input instead (see D' Amuri et al. 2015 and Izquierdo and Jimeno 2015).

The analysis so far has revealed that a significant share of firms experienced a decline in demand and total costs. It is therefore interesting to see whether prices followed a similar path. Firms were asked to indicate how their prices in the foreign and domestic markets evolved during the period 2010-2013.

Table 4 shows that 66% of firms experienced a decline in domestic prices (27% of which

14 Firms were asked to indicate whether their costs: 1= decreased strongly, 2=decreased moderately, 3= remained unchanged, 4= increased moderately, 5= increased strongly.

Table 3 Evolution of firms' costs in the period 2010-2013 (% of firms)

(%)

	Strong decrease	Moderate decrease	Unchanged	Moderate increase	Strong increase
Total cost	12	48	8	24	8
Labour cost	20	48	15	15	2
Financing cost	3	13	27	27	30
Cost of supplies	6	26	25	37	6

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

Table 4 Evolution of prices during the period 2010-2013 (% of firms)

(%)

	Strong decrease	Moderate decrease	Unchanged	Moderate increase	Strong increase
Domestic prices	27	39	23	10	1
Foreign prices	6	30	52	11	1

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

report a strong decline). The share of firms indicating that prices increased is comparatively lower (11%). Regarding foreign prices, 52% of firms indicate that prices remained unchanged and 36% report that foreign prices declined. The evolution of domestic prices seems to be consistent with the intensity of the demand shock and the decline in costs. In foreign markets, Greek firms did not experience, as noted in the previous section, a comparable decline in demand. The evolution of foreign prices is therefore consistent with the evolution of foreign demand. Further, Greece is a small country and may in some markets be a price-taker.

5.1 ADJUSTMENT OF EMPLOYMENT

The decline in labour costs reported by many of the surveyed firms can be achieved by changing either labour input and/or wages. Next, we provide a detailed analysis of the evolution of labour cost components and start by analysing the extent to which firms adjusted labour input and the margins they used for this adjustment.

In particular, firms were asked to indicate whether during the period 2010-2013 they needed to significantly reduce labour input or alter its composition. Firms which answered that they did were then prompted to indicate to what extent they had altered their labour input through layoffs (collective, individual, temporary), subsidised reduction of working hours, non-subsidised reduction of working hours, non-renewal of temporary contracts at expiration, early retirement schemes, a freeze or reduction of new hires, a reduction of agency workers, external consultants and others. They were asked to indicate the use of each of the above margins on a 4-point scale (1= not at all, 2= marginally, 3= moderately, 4= strongly).

Interestingly, 55% of firms indicated that they needed to significantly reduce their labour input or alter its composition. The share is higher among firms experiencing one or more shocks. For instance, 67% of firms experiencing a demand shock said that they needed to adjust their labour input. The share is even higher among firms experiencing a demand

Table 5 Labour input adjustment (% of firms)

(%)

	Not at all	Marginally	Moderately	Strongly
Collective layoffs	87	9	1	3
Individual layoffs	24	42	24	9
Temporary layoffs	94	3	2	0
Subsidised reduction of working hours	95	3	1	1
Non-subsidised reduction of working hours	42	26	22	10
Non-renewal of temporary contracts	61	20	14	5
Early retirement schemes	80	14	4	3
Freeze or reduction of new hires	19	21	24	36
Reduction of agency workers and others	56	18	17	10

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

shock and financial constraints, i.e. 71%.[15] Table 5 shows the margins these firms used in order to achieve the required adjustment of their labour input. Specifically, the margin used significantly (moderately/strongly) by more than half of the firms is a freeze or reduction of new hires. A non-subsidised reduction of working hours, individual layoffs, a reduction in the employment of agency workers and others, and the non-renewal of temporary contracts were also used to a large extent by firms to adjust their labour input. By contrast, collective layoffs and early retirement schemes were not used much.[16]

The question analysed in Table 5 focuses on the intensity of use of the various margins firms used to adjust labour input. Another question allows us to quantify the actual adjustment of employment and hours and to link the use of these margins to the adjustment of permanent and temporary employment as well as hours.[17] Particularly, firms were asked to indicate how permanent and temporary employment, as well as hours, have evolved.[18] The share of firms reporting a decrease (moderate or strong) in the employment of permanent workers is 47%; the share of firms reporting a decline in the employment of temporary workers is 23%; and the share of firms reporting a decline in hours per employee is 18%.

Therefore, during the period under investigation, more than half of the firms surveyed needed to adjust their labour input or change its composition. Firms used a combination of measures in order to make the necessary adjustments and these led to a decrease in both permanent and temporary employment as well as a reduction in hours per employee. Employment adjustment seems however to have been higher than hours adjustment.

5.2 ADJUSTMENT OF WAGES

Prior to the global financial crisis wage cuts in Europe were very rare and firms, when faced with shocks, adjusted the wage bill by using other measures of labour cost adjustment such as pay and non-pay benefits, promotion

15 Firms experiencing a demand shock are those reporting a (strong or moderate) negative impact of demand on their activities. Firms experiencing a demand shock and financial constraints are those reporting a (strong or moderate) negative impact of demand and access to external finance on their activities.

16 There is a higher intensity of use of most measures of labour input adjustment across firms experiencing a demand shock or a demand shock and financial constraints. The ranking of measures, however, in terms of intensity of use does not change.

17 The question on the evolution of permanent employment, temporary employment and hours is asked independently and is not directly linked to the question analysed in Table 5. The joint analysis of both questions could, however, provide an indication of the impact of the use of these margins on the actual evolution of employment and hours.

18 They were asked to indicate whether temporary employment, permanent employment and hours have: 1= decreased strongly, 2= decreased moderately, 3= remained unchanged, 4= increased moderately, 5= increased strongly.

Table 6 Share of firms having cut/frozen wages

(%)

	Wage cuts	Wage freezes
2010	8	51
2011	18	46
2012	35	42
2013	28	43

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

freezes, etc. (see Babecký et al. 2012). The rarity of wage cuts is well documented in the literature and is attributed mainly to concerns about the retention of productive staff and the impact of wage cuts on workers' effort and morale (see Bewley 1995 and Campbell and Kamlani 1997). However, in 2010-2013 the intensity and duration of shocks were strong and extended. As noted in the previous section, 71% of Greek firms reported that the evolution of demand had a negative impact on their activities. It remains interesting therefore to examine whether during the recent recession Greek firms adjusted their wage bill by a downward adjustment of wages.

The WDN3 survey allows us to investigate this question as it asked firms to indicate whether they froze and/or cut base wages in each of the years 2010, 2011, 2012 and 2013. 63% of firms indicated that they kept wages constant at least once in the period 2010-2013. As regards the timing of wage freezes, Table 6 shows that 51% of firms indicated that they froze wages in 2010, 46% in 2011, 42% in 2012 and 43% in 2013. Concerning wage cuts, 55% of firms stated that they cut wages at least once.[19] As to the timing, the share of firms cutting wages was low in the initial phase of the crisis, 8% in 2010, and gradually increased to 18% in 2011 and 35% in 2012, before falling to 28% in 2013. The timing is consistent with the time pattern of reforms. Most reforms that allowed firms to adjust labour costs took place in 2011-2012, i.e. the possibility for firm-level agreements to undercut sectoral/occupational agreements, the suspension of the extension of occupational and sectoral collective agreements to non-signatory parties and the reduction in the minimum wage.

The fact that downward wage flexibility is associated with the labour market reforms implemented during recent years is also confirmed by the probit regression results presented in Table A2 in the Appendix. For instance, firms applying firm-level agreements are less likely to keep wages constant. By contrast, firms applying firm-level agreements are more likely to cut wages. Another interesting result that emerges from the regression analysis is that foreign-owned firms are less likely to cut wages. This may be related to the skill mix of these firms as well as to their different wage policies.

If one looks at the timing of freezes and cuts, one observes that in the first years of the crisis the share of firms freezing wages was significantly higher than that of firms cutting wages. As the crisis progresses, the difference between the two shares is reduced. Of course, the timing of reforms is important. However, firms being aware of the negative impact of wage cuts on employees' morale appear to have exhausted all alternatives before cutting wages. As unemployment increased and options for switching jobs decreased, employees may have become less reluctant to accept wage cuts if this were to secure their jobs.

19 The share of firms cutting wages is higher among firms experiencing a demand shock and firms experiencing a demand shock and credit constraints, i.e. 62% and 71%, respectively.

As mentioned earlier, prior to the crisis the adjustment of base and non-base wage components were substitutes. Firms did not cut wages but adjusted pay and non-pay benefits instead. During the current crisis, along with base wage cuts, Greek firms adjusted flexible wage components as well.[20] Therefore, in the current crisis in Greece the adjustment of base and non-base wage components were complements and this is confirmed by the positive correlation of the variable measuring wage cuts and that measuring the decrease in flexible wage components (0.3280).

In conclusion, in Greece, between 2010 and 2013 there appear to be no rigidities regarding wage and labour input adjustment. A significant share of firms adjusted both. Labour input adjustment (hours and employment) was still the main adjustment channel in many EU countries, but wage cuts appear to have been more frequently used in the EU in this recession. Yet, the share of firms adjusting wages in other countries is comparatively lower, i.e. 37% in Cyprus, 25% in Croatia, 23% in Ireland, 12% in Estonia, 16% in Latvia (see Izquierdo et al. 2017).

6 THE IMPACT OF REFORMS – CHANGES IN THE INSTITUTIONAL FRAMEWORK

As discussed earlier, during the period 2010-2013, wide-ranging reforms took place in Greece that made it easier for firms to adjust their labour input and wages and, indeed, many of the firms surveyed indicated that they adjusted both. The share of firms adjusting labour input and wages is, however, only partially informative about the flexibility provided to firms by labour market reforms. The WDN3 survey enables us to directly assess the flexibility provided to firms by asking them to indicate whether they found it easier or more difficult to perform a set of actions in 2013 compared to 2010. This is a potentially useful alternative source of information, as it is based on the perceptions and actual experience of firms and can supplement more objective indicators

Table 7 Share of firms indicating that it has become less difficult/much less difficult to perform the following actions relative to 2010

(%)

Lay off employees collectively	43
Lay off employees individually	53
Lay off employees for disciplinary reasons	24
Lay off employees temporarily	34
Hire employees	54
Adjust hours	53
Move employees to other locations	34
Move employees to other positions	43
Adjust the wage of incumbents	63
Offer new hires a lower wage	80

Source: Third wave of the WDN survey – Sample of Greek firms.
Note: Figures are weighted to reflect overall employment and rescaled to exclude non-response.

(i.e. the OECD Employment Protection Legislation index) that are created by classifying the changes in the underlying legislation.

Specifically, firms were asked to indicate whether it has become easier or more difficult to:

- lay off employees (collectively, individually, temporarily and for disciplinary reasons);
- adjust working hours;
- hire employees;
- move employees to other job positions or locations;
- lower the wages of incumbent workers and offer new hires a lower wage.

Firms were asked to provide a response on a 5-point scale: 1= much less difficult, 2= less difficult, 3= unchanged, 4= more difficult, 5= much more difficult.

20 Firms were asked to indicate whether flexible wage components have: 1= decreased strongly, 2= decreased moderately, 3= remained unchanged, 4= increased moderately, 5= increased strongly.

As Table 7 shows, a significant number of firms indicate that they find it less difficult or much less difficult to adjust labour input and wages. In particular, 63% of firms report that it became easier to lower the wage of incumbents and 80% of firms report that it became easier to offer new workers lower wages. Regarding labour input adjustment, half of the firms indicate that it became easier to lay off employees individually and to adjust working hours as well as to hire employees.

Firms were also asked to indicate the factors making it easier or more difficult for them to adjust. They were prompted to indicate whether their answer to the above question was due to: (a) reform of labour laws; (b) law enforcement; (c) a change in the behaviour of trade unions; and (d) a change in the behaviour of the individuals. Table 8 shows the most frequently cited reason indicated by firms for each margin of labour cost adjustment. For firms reporting that it has become easier to adjust labour input and wages, the reform of labour laws is the most frequently cited reason in all cases except for the easiness to move employees to other locations and positions. In these two cases, the most frequently cited reason is changes in individual behaviour.

Finally, the survey allows us to assess the impact of reforms on the structure of the bargaining system, as many of the measures taken involved changes in this direction. The survey shows that there is a trend towards lower centralisation of wage bargaining, as the share of firms applying agreements concluded outside the firm declined, while the share of firms applying firm-level agreements increased. Indeed, the share of firms with agreements signed outside the firm stood at 43% in 2013, compared to 86% in 2007, while the share of firms applying firm-level agreements increased from 21% in 2007 to 26% in 2013. Accordingly, the share of workers covered by a collective pay agreement declined to 71% in 2013 from 91% in 2007 (see Izquierdo et al. 2017).

We have seen so far that, following the significant labour market reforms that took place, a substantial share of Greek firms find it easier to adjust both their labour input and the wage bill. However, it is also crucial to gauge how employment is likely to evolve as the country comes out of the crisis. The WDN3 questionnaire asked firms about their perceptions regarding obstacles to hiring employees with contracts of indefinite length, in an attempt to evaluate the relative importance of impediments emanating from the regulatory frame-

Table 8 Most frequently cited reason why it has become easier to perform the following action (modal answer)

Lay off employees collectively	Reform of labour laws
Lay off employees individually	Reform of labour laws
Lay off employees for disciplinary reasons	Reform of labour laws
Lay off employees temporarily	Reform of labour laws
Hire employees	Reform of labour laws
Adjust hours	Reform of labour laws
Move employees to other locations	Changes in the behaviour of individuals
Move employees to other positions	Changes in the behaviour of individuals
Adjust the wage of incumbents	Reform of labour laws
Offer new hires a lower wage	Reform of labour laws

Source: Third wave of the WDN survey – Sample of Greek firms.

Table 9 Obstacles to hiring: most frequent ranking of reasons (modal answer)

Economic uncertainty	Very relevant
Insufficient availability of required skills	Not relevant
Access to finance	Not relevant
Cost of other inputs	Of little relevance
Firing costs	Of little relevance
Hiring costs	Not relevant
High payroll taxes	Relevant
High wages	Not relevant
Risk that legal framework will change	Not relevant

Source: Third wave of the WDN survey – Sample of Greek firms.

work (i.e. payroll taxes, hiring and firing costs) and the environment in which firms operate (i.e. uncertainty, skill shortages, etc.).

In particular, firms were asked to rank in terms of relevance (i.e. not relevant, of little relevance, relevant, very relevant) the following nine factors: (a) uncertainty about economic conditions; (b) insufficient availability of workers with the required skills; (c) access to finance; (d) firing costs; (e) hiring costs; (f) high payroll taxes; (g) high wages; (h) risks that labour laws will change; and (i) costs of other inputs complementary to labour.

Table 9 shows that economic uncertainty is the only reason cited most frequently as very relevant by Greek firms. The other impediment that is most frequently ranked as relevant is the high payroll taxes. The remaining obstacles presented in Table 9 are most frequently considered by Greek firms as not relevant or of little relevance. Interestingly, high wages as well as hiring and firing costs are most frequently considered to be obstacles of no or little relevance, which is consistent with the fact that firms find it easier now to adjust labour input and wages. Thus, for Greek firms, the most binding obstacle to hiring employees with contracts of indefinite length appears to be economic uncertainty and, to a lesser extent, payroll taxes rather than the regulatory framework, which in any case has been significantly reformed in the recent period.

7 CONCLUSIONS

This paper summarises the main findings of the third wave of the WDN survey in Greece. The survey has allowed us to investigate how firms have adjusted to shocks and, to what extent, according to their perceptions, labour market reforms have made it easier for them to adjust labour input and wages.

The survey shows that the decline in economic activity, during the period 2010-2013, had a significant negative impact on firms' activity. Firms reacted to shocks by adjusting both labour input and the wage bill. Interestingly, the share of firms adjusting wages in Greece is the highest among the countries participating in the WDN3 survey.

Furthermore, reforms seem to have made it easier for firms to adjust to shocks. A significant number of firms report that it was easier for them to adjust labour input and wages in 2013, compared to 2010. Firms attribute this flexibility mainly to the reform of labour laws.

The survey shows that Greek firms consider economic uncertainty to be the most binding obstacle to hiring new employees with contracts of indefinite length. By contrast, the regulatory framework, which has been significantly reformed in the recent period, is not frequently considered a relevant obstacle to hiring permanent employees.

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APPENDIX

Table A1 Probit estimate (marginal effects) – Probability of a negative impact (strong or moderate) of shocks

	Demand	Access to finance	Volatility of demand	Customers' ability to pay	Availability of suppliers
Reference category: 200+ employees					
5-19 employees	0.05100 (0.09454)	0.12002 (0.09416)	-0.04892 (0.09034)	-0.03427 (0.06672)	0.14408 (0.09685)
20-49 employees	-0.00401 (0.07232)	-0.01544 (0.08339)	-0.00203 (0.06176)	0.06597 (0.04152)	0.00277 (0.08187)
50-199 employees	-0.03984 (0.07227)	-0.13096 (0.08379)	-0.07126 (0.06507)	0.02043 (0.04321)	0.03708 (0.07939)
Reference category: Manufacturing					
Trade	0.08192 (0.05838)	0.03637 (0.06892)	0.10202** (0.04754)	0.04224 (0.04010)	-0.05330 (0.07154)
Business services	-0.01985 (0.06460)	-0.00574 (0.07215)	-0.02981 (0.05314)	-0.04787 (0.04530)	-0.06486 (0.07528)
Foreign-owned	-0.01263 (0.06060)	-0.46379*** (0.06695)	-0.07069 (0.05337)	-0.02302 (0.04234)	-0.34194*** (0.06993)
Observations	***333***	***304***	***348***	***367***	***297***

Source: Third wave of the WDN survey – Sample of Greek firms.
Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A2 Probit estimates (marginal effects) – Probability of having frozen or cut wages

	Have frozen wages at least once	Have cut wages at least once	Have cut wages at least once
Reference category: 200+ employees			
5-19 employees	-0.24684 (0.16496)	-0.19793 (0.17025)	-0.05819 (0.18936)
20-49 employees	-0.04495 (0.10278)	0.01973 (0.12680)	0.00584 (0.13390)
50-199 employees	-0.03391 (0.10309)	0.11612 (0.12571)	0.06725 (0.13520)
Reference category: Manufacturing			
Trade	-0.04277 (0.07772)	-0.15065 (0.09297)	-0.08319 (0.10254)
Business services	-0.09024 (0.09387)	0.07224 (0.10382)	0.12235 (0.10554)
Credit constraints	0.25986*** (0.07627)	0.34349*** (0.08042)	0.26974*** (0.09168)
Demand shock	0.07595 (0.08054)	0.29999*** (0.08753)	0.34013*** (0.08744)
Firm-level agreement	-0.21478** (0.09534)	0.29789*** (0.08946)	0.31182*** (0.09354)
Foreign-owned			-0.26566*** (0.10078)
Observations	***199***	***199***	***193***

Source: Third wave of the WDN survey – Sample of Greek firms.
Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

THE VALUATION OF ASSETS AND LIABILITIES OF (RE)INSURANCE UNDERTAKINGS UNDER SOLVENCY II

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A. INTRODUCTION

The core business of (re)insurance undertakings is to pool funds from policyholders and channel them to financial markets. More specifically, the funds are pooled from policyholders in exchange for the insurer's promise of refund if a loss or any other contractually determined event occurs, while investments take the form of debt securities, shares or other equity. In this context, the assessment of the financial condition and the overall solvency of these undertakings is directly associated with the level of assets held to fulfil their promises, as well as with the level of those promises. The pricing of each asset held and of each promise assumed is called valuation. Valuations are performed by a (re)insurance undertaking for several purposes, e.g. to inform shareholders about the undertaking's ability to generate profits (accounting valuation) or to calculate tax payable (tax valuation). The present paper focuses on valuation for supervisory purposes, which is aimed at revealing the solvency position of the undertaking.

In the European Union, the applicable supervisory framework for insurance and reinsurance undertakings, effective from 1 January 2016, is known as Solvency II. Issue 44 of the Bank of Greece's *Economic Bulletin* comprises an introduction to Solvency II and its core principles. The valuation of assets and liabilities of (re)insurance undertakings, which are presented in the so-called *Solvency II balance sheet*, is at the heart of this framework.[1]

In general, there are two main methodologies for the valuation of any item (either asset or liability). The first approach is based on estimates of the level of the value that the item under valuation has for its holder, e.g. sentimental value, acquisition value, etc. Typical examples of such methodologies were the methods used for valuing insurance liabilities (which were called *technical reserves*) and the method used for valuing property under the former supervisory framework.[2] In the case of technical reserves, the actuary, who was mainly responsible for their valuation, had to estimate their possible level on the basis of conservative (rather than realistic) assumptions and scenarios, whereas in the case of real estate properties used to cover technical reserves, the applicable law determined their valuation at their tax value plus 30%. The ensuing value had no relation to or connection with the values that others attributed to similar items.

The second methodology focuses on the concepts of "substitution" and "price". If two items are identical and (to a great extent) substitutable, it can be expected that their market prices[3] would also be similar. Thus, if there is evidence of the price that the market attributes to one of those two items, it is easy to deduce the market price of the second item. It is evident that, in this case, valuation methods are not aimed at approximating to the internal value of the item under valuation but, rather, to its price relative to other (similar) items which are traded on the market. In other words, they provide a "relative valuation" (estimation of the price of an item "relative to" the price of similar items). Such methodologies are defined as *market consistent valuation methods* and are the only methods which are allowed under Solvency II.

The objective of this paper is to instruct in and discuss the underlying principles and assumptions of valuation under Solvency II. Section B provides an introduction to and a presen-

1 Under Article 1(2) of Bank of Greece Executive Committee Act 62/2016, "Solvency II valuation or balance sheet" refers to the valuation of total assets and liabilities in accordance with the methodologies specified in Law 4364/2016, Regulation (EU) 2015/35, as well any other relevant provisions at the national or the EU level.
2 The former supervisory framework was known as Solvency I and was effective up until 31 December 2015.
3 I.e. the amount to be paid to a seller for their purchase.

tation of the core principles and main assumptions underlying the valuation of assets and liabilities in line with Solvency II. Section C describes the application of the above principles and assumptions in the recognition and valuation of specific assets and liabilities (contingent liabilities, goodwill and intangible assets, related undertakings, financial liabilities, property, and deferred taxes) and analyses the envisaged risk-adjustment methods. In Section D the underlying principles of valuation for obligations vis-à-vis policyholders (i.e. technical provisions) are outlined, the calculation of such obligations is shown to be inferred by the price they would take in the context of a hypothetical transfer, and a breakdown in their key components is provided. Furthermore, this section analyses the concepts of the best estimate and the cost-of-capital risk margin, while at the same time it discusses the concepts which are instrumental in the calculation thereof, such as reference undertaking, hedgeable and non-hedgeable risks, market value of risk, and expected and unexpected loss. Finally, Section E sets forth the main conclusions of the analysis.

B. VALUATION UNDER SOLVENCY II

B.1 VALUATION ASSUMPTIONS

For the valuation of assets and liabilities, Solvency II is based on three assumptions-approaches:

– the going concern assumption[4];

– the total balance sheet approach[5]; and

– the decoupling of the solvency assessment from the accounting system applicable.

The going concern assumption, albeit widespread in several accounting systems, is neither self-evident nor commonplace in supervisory frameworks, according to the practice followed so far.[6] The most important consequence of this assumption is that the concept of certain assets "admissible" for supervisory purposes is no longer valid. As a result, all assets held by an undertaking may be acceptable for the needs of supervision, so long as the undertaking is able to properly identify, measure and monitor the risks ensuing from those assets.[7]

The total balance sheet approach is associated with the fact that financial soundness for solvency purposes is determined on the basis of an undertaking's balance sheet items on an integrated basis, where assets and liabilities are valued consistently, in line with market values, and not in a conservative way.

According to the total balance sheet approach, the valuation of assets and liabilities is performed on the basis of the mark-to-market method, which uses current market prices from active markets for the same assets and liabilities. In the event that the above method is not employable, either because some assets are not traded in a market or because they are only traded in markets which cannot be deemed active, the mark-to-model valuation method is used, which however uses the maximum possible information from respective markets and is based as little as possible to data from the undertaking concerned.

The mark-to-market method is not limited to the valuation of assets, but it is also used for the valuation of liabilities. More specifically, with regard to insurance obligations, undertaking-specific data can be used only to the extent that these best reflect the characteristics of the insurance portfolio.[8] Besides, the rules for the valuation of assets and liabilities are only intended for solvency purposes and not for accounting purposes. In other words,

4 Article 7 of Delegated Regulation (EU) 2015/35.
5 Proposal for a Directive of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance - Solvency II, COM/2007/0361 final, on the basis of which Directive 2009/138/EC was issued.
6 For instance, the going concern assumption was not adopted, at least consistently, under the Solvency I framework.
7 The most illustrative examples of such assets, which were not taken into account under Solvency I but are recognised by Solvency II, are intangible assets, investments in financial derivatives, claims by reinsurers above a specified amount, etc.
8 In all other cases, market-based information is used.

undertakings apply two different valuation systems: a valuation system for solvency purposes, the results of which are taken into account by supervisory authorities, and another one for accounting purposes, upon which rests the preparation of their financial statements.

Although, as mentioned above, Solvency II in principle distinguishes between supervisory valuation (solvency balance sheet) and accounting valuation (balance sheet addressed to shareholders), the above two valuation methods may not be so different after all, for some items. This is due to the fact that Solvency II is based on International Accounting Standards, which Greek insurance undertakings are required to adopt for preparing their financial statements, and only if some method deviates from the mark-to-market method, within the meaning of Solvency II, a different valuation method is determined.[9]

For solvency purposes, assets are valued at the amount for which they could be exchanged between knowledgeable and willing parties in an arm's length transaction. A similar definition is provided for the valuation of liabilities, as these are valued at the amount for which they could be transferred or settled between knowledgeable and willing parties in an arm's length transaction.[10,11]

Finally, it is stated that when valuing liabilities, no adjustment to take account of the own credit standing of the insurance or reinsurance undertaking is made.

In particular for insurance obligations, i.e. technical provisions, their value corresponds to the current amount insurance and reinsurance undertakings would have to pay if they were to transfer these obligations immediately to another insurance or reinsurance undertaking.

While the definition for the valuation of obligations seemingly refers to two different values —value of transfer and value of settlement— these two values should not be divergent, at least in the context of an information-wise efficient market and under specific circumstances.

B.2 THE VALUATION HIERARCHY

Solvency II[12] introduces a hierarchy in valuation methods, i.e. a determined sequence of methodologies that is to be followed when valuing assets and liabilities. The feasibility of the methodology which is at the top of the hierarchy is first explored and only where its use is not possible, the second-in-hierarchy methodology is applied. The valuation hierarchy under Solvency II is as follows:

– Quoted market prices, where available, are used.

– If quoted market prices are not available for the same assets or liabilities, then quoted market prices for similar assets or liabilities are used, with adjustments to reflect differences.

– If neither quoted market prices nor inputs on similar assets or liabilities are available, alternative valuation methods are used.

In more detail:

Hierarchically 1st method (default): quoted market prices

The default valuation method for assets and liabilities uses quoted market prices in active markets for identical assets or liabilities. For this method to be applicable, there must be marketable shares or other equity which can accurately replicate all possible future cash flows relating to the asset or liability under valuation, taking account of the uncertainty surrounding their amount and timing.

9 Article 9 of Regulation (EU) 2015/35.
10 Article 50 of Law 4364/2016.
11 Although the above definitions allude to respective definitions of the fair price or fair value, valuation under Solvency II may not be so fair in some cases. The reasons and the differences are discussed further below on a case-by-case basis.
12 Article 10 of Regulation (EU) 2015/35.

The definition of active markets is pivotal in the default method, as prices based on those markets can only be used when markets are deemed active. A market is deemed[13] active so long as transactions in securities have sufficient frequency and volume to provide information about prices on a constant basis.

Hierarchically 2nd method: prices of similar assets or liabilities

Where the use of quoted market prices in active markets for the same assets or liabilities is not possible, (re)insurance undertakings value assets and liabilities using quoted market prices in active markets for similar assets or liabilities.[14]

For such items it is possible to create a portfolio with tradable securities in an active market, which has similar behaviour and similar risk as the items under valuation. That is, a portfolio which broadly replicates future cash flows relating to those items under valuation (the basis risk is not significant) can be constructed. In such cases, the price of the above portfolio can be used as a logical approximation of the value of the assets or liabilities under valuation.

Since the assets or liabilities for which there are available quoted market prices are not the same as but similar to the assets or liabilities under valuation, adjustments are needed to reflect any differences. The necessary adjustments depend on the reasons for which the use of quoted market prices for identical assets or liabilities is not possible. There are mainly two reasons:[15] either there are no identical items traded in a market or there may exist similar items in a market, but the quoted market price in that market is not suitable.

In the first case, there may be some restrictions as to the tradable assets, thereby making impossible the conclusion of an arm's length transaction. Such an example reflects recoverables from reinsurance contracts. By way of illustration, an insurance undertaking cannot transfer[16] to another entity any claims against its reinsurers, and therefore there are no identical assets (i.e. the same recoverables from reinsurance contracts) tradable in a market. Notwithstanding, the reinsurance undertaking which has assumed the risk can securitise part of its reinsurance obligations; the ensuing securities could then be traded in an active market and their prices could serve as a guide to valuation.

In the second case, special conditions are likely to prevail either in the market (there is little trading activity for the assets or liabilities under review or the frequency of transactions is quite low, which makes the ensuing quoted market prices very sensitive to daily movements in supply and demand and thus inconsistent with long-term market conditions) or in terms of the valued asset or liability itself (e.g. special conditions related to its condition or location).

The above suggest that the required adjustments can take the following three forms:[17]

– adjustments for the condition or location of the asset or liability relative to items which are traded in an active market;

– adjustments for the extent to which inputs relate to items that are comparable to the asset or liability; and

– adjustments for the volume or level of trading activity in the markets within which the inputs are observed.

Hierarchically 3rd method: use of alternative valuation methods

In the event that the use of quoted market prices in active markets is not possible even for

13 Article 10(4) of Regulation (EU) 2015/35 regarding the definition of an active market makes reference to Regulation (EC) 1606/2002, by virtue of which international accounting standards were adopted.
14 Article 10(3) of Regulation (EU) 2015/35.
15 *Public Policy Monograph*, "Fair valuation of insurance liabilities: principles and methods", American Academy of Actuaries, September 2002.
16 At least immediately.
17 Article 10(3) of Regulation (EU) 2015/35.

similar assets or liabilities, alternative valuation methods are used.[18]

Alternative valuation techniques may adopt any of the following approaches:[19]

– The market approach: prices and other relevant information generated by market transactions are used. Valuation techniques consistent with the market approach include, indicatively, matrix pricing.[20]

– The income approach: it involves an estimate of future cash flows (inflows and outflows) relating to the asset or liability and the discounting thereof using an appropriate interest rate. The outcome must then be risk-adjusted (using either an appropriate conversion of future cash flows or the discount rate).

– The cost approach: also known as "current replacement cost approach". This approach reflects the amount that would be required currently to replace the service capacity of an asset or liability. From the perspective of a market participant seller, the price that would be received for the asset or liability is based on the cost to a market participant buyer to acquire or construct a substitute asset or liability of comparable quality adjusted for obsolescence.

In all three approaches, the valuation of assets or liabilities must rely as little as possible on undertaking-specific inputs and make maximum use of relevant market inputs, while the results from the application of valuation techniques to measure fair value must take into account the risk inherent in the specific valuation technique and the risk inherent in the inputs of that valuation technique.[21]

B.3 INCOME APPROACH: RISK ADJUSTMENT

The income approach, as already mentioned, involves the estimate of future cash flows (inflows and outflows) relating to the asset or liability and the discounting thereof using an appropriate interest rate. The ensuing amount must be risk-adjusted.[22] Valuation techniques consistent with the income approach are the most commonly used and form the basis for the valuation of the technical provisions of (re)insurance undertakings, where there are no available quoted market prices. Such techniques include:

– present value techniques;

– option pricing models; and

– multi-period excess earnings methods.

Those three techniques are best illustrated by the following example, which applies a one-period binomial model (although the findings are not differentiated in more realistic and at the same time more complex models, this model enables us to focus on the substance of the issue).[23]

Consider a security with price S that will pay either S_u or S_d in one year $t = 1$. The true probability of payoff S_u was estimated, in some way, at a percentage p, thus the true probability of payoff S_d is estimated at $1–p$.

Using the present value technique, for the valuation of the security in time $t = 0$, future cash flows are first estimated and subsequently their expected price is calculated. In our case however, the expected price of future cash flows is equal to:

$$p \times S_u + (1 - p) \times S_d$$

The expected price of future cash flows is discounted using a risk-adjusted discount rate.

18 Article 10(5) of Regulation (EU) 2015/35.
19 Article 10(7) of Regulation (EU) 2015/35.
20 Matrix pricing refers to the practice of interpolation among values for similar instruments arranged in a matrix format (hence the name of the technique). The matrix can include quoted prices and/or bond yields that are categorised e.g. by type or issuer, credit rating, coupon, maturity, etc. In this way, the approximate price of a non-tradable bond can be calculated by interpolation among the prices or yields of bonds with similar characteristics.
21 Article 10(6) of Regulation (EU) 2015/35.
22 Article 10(6) of Regulation (EU) 2015/35.
23 D. Babbel et al., "Fair Value of Liabilities: The financial economics perspective", *North American Actuarial Journal*, January 2002.

The risk-adjusted discount rate is the sum of the risk-free rate r and the quantity $\lambda \times \sigma_S$, where λ is the market price of risk associated with the risk inherent in the security and σ_S is the standard deviation of future cash flows.[24]

If S is the present value of the security, then:

$$S = \frac{p \times S_u + (1-p) \times S_d}{1 + r + \lambda \sigma_S}$$

The option pricing model is similar to the present value technique, except that risk is not adjusted using the discount rate, which is the risk-free rate, but using the probabilities for the calculation of the expected price of future cash flows.

In the above example, if the probabilities on which the average price in the numerator is calculated are slightly "distorted" and instead of the true probabilities, i.e. instead of p and $1 - p$, π and $1 - \pi$ are used, where π is a quantity that is calculated as follows:

$$\pi = p - \lambda \sqrt{p(1-p)}$$

then the value of the security S is equal to:

$$S = \frac{\pi \times S_u + (1-\pi) \times S_d}{1 + r}$$

π is called the risk-neutral or martingale measure.

Lastly, the multi-period excess earnings method refers to the discounting of expected cash flows to account for the return on the security sought by its holders.[25] If applied over a one-year period and if Z is the return on the security sought by its holders, then:

$$S = \frac{p \times S_u + (1-p) \times S_d + Z}{1 + r}$$

where Z is equal to:

$$Z = -EC \times (ROE - r)$$

where EC is the economic capital covering the risks of the security, ROE is the return on equity sought and r is the risk-free rate. Actually, the numerator reflects the expected additional income relative to the return sought by the holder of the security. The discounting is made using the risk-free rate. The demonstration of the calculation method for Z is beyond the scope of the present paper; readers interested in this demonstration may consult any corporate finance textbook.

For example, if $S_u = 110$ and $S_d = 90$ and $p = 60\%$, then $1 - p = 40\%$. Thus, by applying the first formula, we have:

$$p \times S_u + (1-p) \times S_d$$

$$= 60\% \times 110 + 40\% \times 90 = 102$$

Besides, if $r = 5\%$, $\lambda = -0.1$ and $\sigma_S = 10\%$, then the present value of the security S is equal to:

$$S = \frac{p \times S_u + (1-p) \times S_d}{1 + r + \lambda \sigma_S} =$$

$$= \frac{102}{1 + 5\% - 0.1 \times 10\%} = \frac{102}{1.04} = 98.08$$

Under the option pricing model, we calculate

$$\pi = p - \lambda \sqrt{p(1-p)} =$$

$$= 60\% - (-0.1) \times \sqrt{60\% \times 40\%} = 64.9\%$$

Then the value of the security S is equal to:

$$S = \frac{\pi \times S_u + (1-\pi) \times S_d}{1 + r} =$$

$$= \frac{64.9\% \times 110 + 35.1\% \times 90}{1 + 5\%} = 98.08$$

Finally, under the multi-period excess earnings method, we need Z. Consider that, in applying the Z equation using specific values for return

24 It can be demonstrated that, if the distribution of cash flows is binomial, the standard deviation of cash flows is equal to

$$\sigma_S = \left[\frac{S_u - S_d}{S}\right]^2 p(1-p)$$

25 This is actually the Economic Value Added (EVA) method, which has been applied in multi-period variations. EVA is an estimation of economic profit, i.e. the value generated by the amounts of profit to the extent that these exceed shareholders' return expectations.

and equity, then $Z = 0.9798$. As a result, the security amounts to:

$$S = \frac{p \times S_u + (1-p) \times S_d + Z}{1+r} =$$

$$= \frac{102 + 0.9798}{1 + 5\%} = 98.08$$

Thus the resulting value of the security S is, according to all three techniques, 98.08.

Last but not least, it should be noted that λ is positive and Z is negative for the valuation of assets, whereas for the valuation of liabilities λ is positive and Z is negative (leading to the conclusion that the security S under the aforementioned example is in fact a liability). The above observation suggests that risk adjustment decreases the value of S relative to the present value (using the risk-free rate) of expected cash flows where S is an asset, while it increases the value of S where S is a liability. That is, in any event risk adjustment brings about a more conservative valuation.

This example shows that, although the above three techniques may appear to be different at first glance, they generate exactly the same results on the basis of consistent assumptions.

C. RECOGNITION AND VALUATION METHODS FOR SPECIFIC ASSETS AND LIABILITIES

Solvency II, apart from the aforementioned valuation hierarchy for assets and liabilities, envisages particular recognition and valuation methods for specific items. Such items are contingent liabilities, goodwill and intangible assets, related undertakings, specific liabilities, property valuation, and deferred taxes. Furthermore, it determines concrete valuation methods not to be used in any event (exclusion of valuation methods).

C.1 RECOGNITION OF CONTINGENT LIABILITIES

In accordance with the International Accounting Standard (IAS) 37, a contingent liability is defined as:

(a) a possible obligation that arises from past events and whose existence will be confirmed only by the occurrence or non-occurrence of one or more uncertain future events not wholly within the control of the entity, or

(b) a present obligation that arises from past events, but is not recognised because:

i) it is not probable that an outflow of resources embodying economic benefits will be required to settle the obligation or

ii) the amount of the obligation cannot be measured with sufficient reliability.

With regard to contingent liabilities, Solvency II deviates from the respective requirements of international accounting standards. While under IAS 37 a contingent liability should not be recognised but merely disclosed, under Solvency II[26] (re)insurance undertakings must recognise all contingent liabilities that are material[27] as liabilities.

The value of contingent liabilities[28] is equal to the expected present value of future cash flows required to settle the contingent liability over the lifetime thereof, using the basic risk-free interest rate term structure.

C.2 RECOGNITION OF GOODWILL AND INTANGIBLE ASSETS

Under Solvency II, goodwill and any other intangible assets held by a (re)insurance undertaking are not recognised (or are valued at zero).[29]

The only exception to the above rule is where the intangible asset can be sold separately and the (re)insurance undertaking can demonstrate that there are quoted market prices in active

26 Article 11 of Regulation (EU) 2015/35.
27 Contingent liabilities are deemed material where information about the current or potential size or nature of those liabilities could influence the decision-making or judgement of the intended user of that information, including the supervisory authorities.
28 Article 14(2) of Regulation (EU) 2015/35.
29 Article 12 of Regulation (EU) 2015/35.

markets for the same or similar assets.[30] In this case, that intangible asset is valued in accordance with the general valuation principles.

C.3 VALUATION OF RELATED UNDERTAKINGS

If a (re)insurance undertaking holds participations in related undertakings, those are valued in accordance with the following hierarchy of methods:[31]

– Using quoted market prices, where available.

– Where quoted market prices are not available for the same undertakings, using the adjusted equity method.

– Where neither valuation using the default method nor the adjusted equity method is possible, using

  ○ either quoted market prices in active markets for similar assets and liabilities, with adjustments to reflect differences from the related undertaking,

  ○ or alternative valuation methods.

The default valuation method uses quoted market prices in active markets for identical assets or liabilities. Where the default method is not available, the adjusted equity method is used.

According to the adjusted equity method, the valuation of the related undertaking is equal to the product of the percentage of ownership multiplied by the excess of assets over liabilities of the related undertaking. The excess of assets over liabilities of the related undertaking is calculated as assets minus liabilities,[32] where its assets and liabilities are valued in accordance with Solvency II methods. In this regard, it should be stressed that the related undertaking values its assets and liabilities and prepares its financial statements in accordance with the accounting system applicable. However, those valuations are not taken into account and must, for supervisory reasons, be re-determined in accordance with the Solvency II principles[33] or, in other words, they are only taken into account to the extent that they are consistent with the principles of Solvency II. This is done with a view to averting any supervisory arbitrage; otherwise, it would be possible for a (re)insurance undertaking to establish a subsidiary undertaking and exchange assets with it, taking advantage of the possible ensuing highest valuations.

In many cases, the related undertaking is not a subsidiary of the (re)insurance undertaking. In those cases, the (re)insurance undertaking may not have access to all of the appropriate information in order to re-determine the value of the assets and liabilities of the related undertaking. If the related undertaking follows the International Financial Reporting Standards (IFRS) and is not a (re)insurance undertaking itself, valuations using the IFRS, in this very special case alone, may be deemed satisfactory, requiring only an adjustment to reflect that the related undertaking's goodwill and other intangible assets are valued at zero.[34] If the related undertaking follows accounting standards other than the IFRS, then all necessary adjustments must be made for the recognition and valuation of its assets and liabilities in accordance with the IFRS.[35]

Finally, if this method is also not practicable, other acceptable valuation methods are used, i.e. quoted market prices for similar assets and liabilities or alternative valuation methods, in accordance with the terms and conditions that were mentioned above regarding the valuation hierarchy.

C.4 VALUATION OF FINANCIAL LIABILITIES

What is central to the valuation of financial liabilities is the Solvency II requirement[36] that no subsequent adjustments to take account of the

30 Article 12(2) of Regulation (EU) 2015/35.
31 Article 13(1) of Regulation (EU) 2015/35.
32 Article 13(3) of Regulation (EU) 2015/35.
33 Article 13(4) of Regulation (EU) 2015/35.
34 Article 13(5) of Regulation (EU) 2015/35.
35 Article 7(1) of Bank of Greece Executive Committee Act 62/2016.
36 Article 50 of Law 4364/2016.

own credit standing of the insurance or reinsurance undertaking will be made. Against this backdrop, there are two stages when valuing financial liabilities: the first stage involves the initial valuation and the second stage involves any subsequent valuation.

Initial valuation is consistent with the principles of the IFRS[37] and the valuation techniques used determine the amount for which liabilities could be transferred or settled between knowledgeable and willing parties in an arm's length transaction, i.e. the market value. Furthermore, IFRS 13 describes all necessary data that should be taken into account when determining the market value, such as the characteristics of the liability, the transaction type, market participants, etc.

Financial liabilities of (re)insurance undertakings which are traded in the stock market have a directly observable quoted price. However, for financial liabilities which are not traded in the stock market, a value consistent with the market value can be determined, in line with IFRS valuation techniques. In any event, it should be pointed out that the above market value reflects investors' expectations about the credit standing of the issuer's liabilities, i.e. of the (re)insurance undertaking.

Yet, for any subsequent valuation, the Solvency II methodology deviates from that of the IFRS and from the market value. In this case, the valuation techniques used determine the amount for which liabilities could be transferred or settled between knowledgeable and willing parties in an arm's length transaction, excluding any subsequent adjustment to take account of the change in the own credit standing of the undertaking after initial recognition.[38]

As a result, for the valuation of those liabilities, after initial recognition, to be in line with the Solvency II requirements, valuation should rely on the market value of liabilities, but also make the necessary adjustments to take account only of the initial, upon initial recognition, own credit standing of the undertaking, which is deemed unchanged thereafter, despite any subsequent changes. As the credit rating of an issuer is mirrored, in terms of its liabilities, in the credit spread by which its liabilities are discounted, the adjustment refers to the discount rate of future cash flows that are associated with the valued liability. The employable adjustment techniques can follow two approaches:[39]

– a "bottom-up" approach or

– a "top-down" approach.

The bottom-up approach moves along the following steps:[40] the yield on each liability is calculated upon initial recognition (such liabilities have mostly the form of a bond). This yield can be broken down in a risk-free interest rate (cost of money) and a credit spread. In any subsequent valuation of the liability, the current risk-free interest rate is derived from the market and the initially calculated credit spread is then added. The value of the liability under Solvency II is equal to the present value of future cash flows, taking account of the risk-free interest rate and the aforementioned adjustment.

The top-down approach moves along the following steps:[41] the market value of each liability is calculated upon initial recognition. In the first valuation that follows, the market value of the liability is calculated, which is then compared to the value of the former (initial) valuation, and their differential is measured. This change in the value between those two time periods is due to three factors: a change in the future cash flows of the liability, part of which has already been repaid; a change in the risk-free interest rate; and a change in the credit spread. That part of the change in the value reflecting a change in the credit spread is calculated and deducted from the market

37 Article 14 of Regulation (EU) 2015/35.
38 Article 6 of Bank of Greece Executive Committee Act 62/2016.
39 Article 6(1) of Bank of Greece Executive Committee Act 62/2016.
40 Articles 6(2) and 6(3) of Bank of Greece Executive Committee Act 62/2016.
41 Article 6(4) of Bank of Greece Executive Committee Act 62/2016.

value, thereby resulting in the Solvency II value of the liability.

In each subsequent valuation the same process is followed, i.e. the market value of the liability is calculated, which is then compared to the Solvency II value that resulted from the previous valuation, and the change is measured. That part of the change in the value reflecting a change in the credit spread is calculated and deducted from the market value, and so on.

C.5 PROPERTY VALUATION

In most cases, the assets of (re)insurance undertakings include real estate. Owning a property can serve investment purposes or could be intended for own use. In the first case, the undertaking owns the property in search for profit from its lease and/or its future sale. In the second case, it has purchased the property in order to house its business and does not seek any returns other than the obvious benefits from its use.

In both cases, irrespective of the reasons of ownership, a property is valued in accordance with the aforementioned valuation hierarchy, under the assumption[42] that the (re)insurance undertaking is able to generate economic benefits either making itself maximum and optimal use of the property or reselling it to others who would make maximum and optimal use of the property themselves.

As it is difficult to obtain quoted market prices for identical or similar properties, it is common practice to apply alternative valuation methods. In such an event, between two alternative methods, the method which is preferred is the one that provides the most representative estimate of the amount for which the property could be transferred between knowledgeable and willing parties in an arm's length transaction.[43] Whichever method may be opted for, it should rely as little as possible on undertaking-specific inputs and make maximum use of relevant market inputs[44], including the following:

– current prices in an active market for properties of different nature, condition or location, or subject to different leases or other contractual terms, with adjustments to reflect those differences;

– recent prices in less active markets for similar properties, with adjustments to reflect any change in general economic conditions relative to the relevant transaction date; and

– projections of discounted cash flows.

It is not uncommon for the above methods to generate different valuations for the same property. In this case, the factors behind those discrepancies are examined and the most representative value within the range of valuations is determined.[45]

When the method applied is based on projections of discounted cash flows, then:

– The estimation of future cash flows takes account of any existing lease or other relevant contracts and, where possible, market-corroborated inputs, such as current market rents for similar properties in the same location and condition.

– The discounting uses interest rates which reflect current market expectations about the uncertainty surrounding the level and the timing of cash flows (i.e. risk-adjusted interest rates).

C.6 EXCLUSION OF VALUATION METHODS

In several instances, the methods described in Solvency II for the valuation of assets and liabilities allude to the respective methodologies of the International Financial Reporting Standards (IFRS). Nevertheless, Solvency II excludes certain methodologies (as not applicable), even though these are envisaged in the

42 Article 4(4) of Bank of Greece Executive Committee Act 62/2016.
43 Article 4(1) of Bank of Greece Executive Committee Act 62/2016.
44 Article 4(2) of Bank of Greece Executive Committee Act 62/2016.
45 Article 4(3) of Bank of Greece Executive Committee Act 62/2016.

IFRS. In this context, the following methods are excluded:

– methods that value financial assets or financial liabilities at cost or amortised cost;[46]

– valuation models that value at the lower of the carrying amount and fair value less costs to sell;[47]

– methods that value property, investment property, plant and equipment with cost models where the asset value is determined as cost less depreciation and impairment;[48]

– methods that value financial leases at depreciated cost;[49]

– methods that value inventories at cost;[50]

– valuation of non-monetary grants at a nominal amount.[51]

C.7 DEFERRED TAXES

Insurance and reinsurance undertakings recognise and value deferred tax assets and liabilities in accordance with the valuation hierarchy. In this context, deferred taxes arise from the different values ascribed to assets and liabilities as valued and recognised under Solvency II on the one hand and for tax purposes on the other. While a deferred tax liability is directly recognised, a deferred tax asset is only recognised to the extent that it is probable that future taxable profit will be available against which the deferred tax asset can be utilised, taking into account any legal or regulatory requirements on the time limits relating to the carryforward of unused tax losses or the carryforward of unused tax credits.[52] The exercise which provides a projection of future tax profits and examines whether these are sufficient to cover any deferred tax assets is typically called a recoverability test. In the event that both deferred tax assets and liabilities arise, these cannot be offset and thus the recoverability test refers to the total amount of deferred tax assets rather than a reduced amount after offset. The only case[53] in which those amounts can be offset is where:

– the entity has the legal right to settle current tax amounts on a net basis and

– the deferred tax amounts are levied by the same taxing authority on the same entity.

In addition, in accordance with the Solvency II methodology, deferred tax assets and liabilities cannot be discounted.[54]

D. PRINCIPLES UNDERLYING THE VALUATION OF TECHNICAL RPOVISIONS

Each insurance and reinsurance undertaking establishes technical provisions on a continuous basis with respect to all of its insurance and reinsurance obligations against policyholders and beneficiaries; the value of technical provisions corresponds to the current amount an insurance or reinsurance undertaking would have to pay if it transferred its contractual rights and obligations immediately to another undertaking.[55] The calculation of technical provisions makes use of and is consistent with information provided by the financial markets as well as generally available data on underwriting risks (market consistency).

In the light of the above, the value of technical provisions (a) is associated with a transfer of insurance and reinsurance obligations and its ensuing cost, and (b) is measured in line with market prices. Putting aside the concept of transfer for the time being, let us attempt to shed light on the concept of market consistency. The clarification sought is provided by Solvency II itself, namely in Article 22 of Regulation (EU) 2015/35. This article specifies that:

46 Article 16(1) of Regulation (EU) 2015/35.
47 Article 16(2) of Regulation (EU) 2015/35.
48 Article 16(3) of Regulation (EU) 2015/35.
49 Article 16(4) of Regulation (EU) 2015/35.
50 Article 16(5) of Regulation (EU) 2015/35.
51 Article 16(6) of Regulation (EU) 2015/35.
52 Article 15 of Regulation (EU) 2015/35.
53 Article 10(2) of Bank of Greece Executive Committee Act 62/2016.
54 Article 10(1) of Bank of Greece Executive Committee Act 62/2016.
55 Article 51 of Law 4364/2016.

– the assumptions used for the calculation of technical provisions are based on the characteristics of the portfolio of insurance and reinsurance obligations, where possible regardless of the insurance or reinsurance undertaking holding the portfolio;

– where insurance and reinsurance undertakings use a model to produce projections of future financial market parameters,[56] it complies with all of the following requirements:

a) it generates asset prices that are consistent with those observed in financial markets;

b) it assumes no arbitrage opportunity;

c) the calibration of the parameters and scenarios is consistent with the relevant risk-free interest rate term structure used to calculate the best estimate.

In other words: under requirement (a) the valuation should replicate market prices (whether a closed-form expression or a stochastic methodology is used); under requirement (b) the valuation should be based on the assumption that the financial environment is arbitrage-free; and under requirement (c) the valuation should be based on a model which assumes that all assets and liabilities have a risk-free return (risk-neutral valuation). In sum, we arrive at three main conditions that valuation models should meet so as to be market consistent. They should:

– replicate market prices,

– be arbitrage-free, and

– use the risk-neutral measure.

D.1 PRINCIPLES UNDERLYING THE CALCULATION OF TECHNICAL PROVISIONS

Technical provisions are included in the liabilities of insurance undertakings, while their calculation, as mentioned above, is based on the amount an insurance or reinsurance undertaking would have to pay if it transferred its contractual obligations to another (re)insurance undertaking. This principle in a strand of the literature is called "current exit value". As evidenced by this definition of technical provisions, the emphasis, in contrast with Solvency I, is on the amount that a theoretical transfer of obligations would be worth, although such a transfer may not necessarily be carried out in practice and a potential buyer may not be found in reality.

A theoretical buyer, who would be willing to assume (by transfer) some insurance obligations, would by all means expect in exchange an amount of money (or assets) which would ensure that he/she would be able either to settle on his/her own the insurance obligations towards beneficiaries or to transfer those obligations to a third (re)insurance undertaking. To achieve such a thing, he/she would definitely expect that the assets received are sufficient to cover the obligations on average. This amount is called best estimate. But as he/she would also like to make profit —otherwise why should he/she get involved in the transaction in the first place?— then he/she would have to receive an additional amount of assets, on top of what would be used to cover, on average, the obligations assumed. This additional sum (the profit) is called in the Solvency II context a "risk margin".

In this regard, it should be noted that insurance obligations are priced by the original insurer so as to generate, in certain conditions, a specific level of annual profits. If the future profits which are priced in technical provisions fall short of the profits that the potential hypothetical buyer seeks, the original insurer must make up for the shortfall in technical provisions in order for the transfer to be concluded;

56 This is required where the undertaking has assumed any financial guarantees or other contractual options. Under Article 55 of Bank of Greece Executive Committee Act 81/2016, insurance and reinsurance undertakings, when valuing financial guarantees and any contractual options, adopt one of the following two methodologies:
- use of a closed-form mathematical expression
- use of a stochastic methodology, including an economic scenario generator.

namely, he must increase the assets of the (theoretical) transfer by an equal amount.

If however insurance obligations are priced by the original insurer in such a way as to generate higher future profits than those sought by the potential buyer, then excess profit will be held by the original insurer through a tantamount reduction in technical provisions and thus the (theoretically) transferred assets will decrease; in any event, the hypothetical buyer will receive only the agreed profits.

At this point, the above methodology needs to be further analysed. Under Solvency I, the task of the actuary was to project the future benefits arising from each insurance contract. If one wished to assess how effective the actuary was in fulfilling his task, only time would tell to what extent his projections matched reality. Conversely, under Solvency II, the actuary's task is utterly different, even though calculations are similar. He aspires to predict the actual price of a theoretical transfer. Interestingly enough, once the theoretical price has been estimated, it is impossible to check whether the actuary was right in his projections or not. Once this price becomes a fact of the past, every transfer that follows will take a different price, as economic conditions will have changed in the meantime. In the first case —under Solvency I— the actuary attempts to predict a future which gradually becomes known, while in the second case —under Solvency II— the actuary tries to predict an unknown present, relying exclusively on generally available market inputs. Undertaking-specific inputs can be used in the calculation of technical provisions only to the extent that these reflect more accurately the characteristics of the insurance portfolio.

As a consequence of the above analysis, the undertaking directly recognises in its supervisory own funds, at the time of the valuation of technical provisions, all excess future profits which have been priced-in in insurance contracts, are embedded in future insurance premiums and are higher than the corresponding amount of profits sought by the potential buyer. Therefore, with the methodology introduced by Solvency II, the undertaking, when valuing technical provisions, now recognises in its supervisory statements —and therefore as an integral part of its solvency— all excess profits that are expected to be received in the future from existing contracts. The risk that all expected, yet uncertain, future profits may not be generated is taken into account and addressed in the calculation of the undertaking's own funds. This figure, under Solvency II, is known as "expected profits included in future premiums" (EPIFP) and is disclosed on a yearly basis as a component of liquidity risk.

D.2 HYPOTHETICAL BUYER – REFERENCE UNDERTAKING

Of course, the amount of the theoretical transfer is neither fixed nor predetermined, but varies depending on what the hypothetical buyer will request. Therefore, for the actuary of the (re)insurance undertaking valuing its technical provisions to be able to estimate the amount which would seal the theoretical transfer, he must be informed of all those parameters that a hypothetical buyer of the insurance or reinsurance portfolio would take into consideration. Such parameters refer to information about the transferred portfolio and the theoretical transfer agreement as well as the characteristics of the hypothetical buyer (its type and size, its investment strategy, its risk and capital management, other operations and administration actions, etc.). In other words, the actuary of the undertaking under valuation must have knowledge of all the parameters taken into consideration by the actuary of the hypothetical buyer who would be invited to estimate the amount that the hypothetical buyer would seek to receive in order to assume this portfolio.

Under Solvency II,[57] all of the above information is specified. In greater detail:

57 Article 38 of Regulation (EU) 2015/35.

– **Information about the transferred portfolio:** the transfer involves either a life insurance or a non-life insurance portfolio[58] and it is assumed that, along with the (re)insurance obligations, all reinsurance contracts and arrangements relating to those obligations are transferred.

– **Information about the type and size of the hypothetical buyer:** the hypothetical buyer does not have any other insurance or reinsurance obligations or own funds before the transfer takes place and shall not assume any new insurance or reinsurance obligations after the transfer.

– **Information about the capital management of the hypothetical buyer:** after the transfer, the hypothetical buyer shall raise eligible own funds equal to the Solvency Capital Requirement to support the insurance and reinsurance obligations over the lifetime thereof.

– **Information about the investment strategy of the hypothetical buyer:** the hypothetical buyer holds assets which amount to the sum of its Solvency Capital Requirement and of the technical provisions net of the amounts recoverable from reinsurance contracts and which are selected in such a way that they minimise the Solvency Capital Requirement for the market risk to which the hypothetical buyer is exposed.

– **Information about the risk management of the hypothetical buyer:** the hypothetical buyer shall assume all of the following risks:

  ○ underwriting risk with respect to the theoretically transferred business;

  ○ market risk, where material, other than interest rate risk;

  ○ credit risk with respect to reinsurance contracts, arrangements with special purpose vehicles, intermediaries, policyholders and any other material exposures which are closely related to the insurance and reinsurance obligations;

  ○ operational risk.

– **Information about the tax regime of the hypothetical buyer:** the hypothetical buyer operates under a tax regime where there is no loss-absorbing capacity of deferred taxes.

– **Information about the administration of the hypothetical buyer:** the hypothetical buyer will adopt future management actions that are consistent with the assumed future management actions of the original undertaking.

The hypothetical buyer that meets all of the above characteristics is called **reference undertaking**.

All of the above information has an impact on the valuation of technical provisions, mainly in terms of the amount of profits sought by the hypothetical buyer to conclude this theoretical transfer, i.e. on the calculation of the risk margin.

D.3 CREDIT STANDING AND TECHNICAL PROVISIONS

Key to the calculation of technical provisions is whether the own credit standing of the undertaking is taken into account. Before examining the stance of Solvency on that matter, let us elaborate on what it actually means.

The liabilities assumed by an undertaking (seller) are the assets of another entity (another undertaking or another natural person) called the buyer. From the buyer's perspective, the fair value of an asset decreases as the default risk of the seller increases. Therefore, the credit rating of the seller is taken into account in the valuation of its liabilities performed by the buyer. For example, the credit rating of a country is taken into account in the valuation of its government bonds. The lower the credit standing of the seller, the larger the decline in the value of its liabilities. If however

58 That is, it is assumed that life and non-life insurance obligations combined cannot be transferred to the same hypothetical buyer.

the seller can write off (purchase) its liabilities by paying an amount to the buyer, this amount does not correspond to the face value of the liabilities, but is equal to the amount that any third party would be willing to pay to purchase the liabilities. But this third party would only agree to purchase the liabilities by paying an amount that would reflect the credit standing of the seller. Against this background, the seller should also value its liabilities, albeit not at the face value thereof, but at a value that reflects its own credit standing.

The above reasoning is not questioned where liabilities have the form of bonds tradable in stock markets. In this event, there is a readily available quoted market price for bonds, which factors in market perceptions of the issuer's credit rating, and both the seller and the buyer value the bonds at their market value. The following question now arises: why should this rationale not apply to other —non-tradable in stock markets— liabilities, including technical provisions? If the fair value of an undertaking in the form of a société anonyme, from the shareholders-investors' perspective, reflects the fact that shareholders may suffer losses amounting, at the most, to the value of the funds they have contributed (the price of a société anonyme's stock cannot be negative), then the fair value of shareholders' liabilities can by no means be higher than the value of their assets held. It is therefore imperative that the fair value of liabilities reflects the own credit standing of the undertaking.

The implications of the above reasoning are more apparent in the case of an insurance obligation. If two insurance undertakings, of which one holds assets worth 100 and the other holds assets worth 10, have assumed e.g. the insurance coverage of an asset against earthquakes, at an expected cost of 80, then the first undertaking will value its obligation at the level of 80 (as it holds sufficient assets to cover the cost of the risk), while the second undertaking will value the obligation at the level of just 10, as, if the risk materialises, the undertaking will default and, as a result of the winding-up, the policyholder will receive the total of its assets, i.e. a mere 10.

The disadvantages of the above reasoning are several and have to do with the fact that the valuation of technical provisions, which are not traded in a stock market, is bound to vary depending on the undertaking that has assumed the obligation. Undertakings with sufficient assets perform increased valuations of their technical provisions, which reflect their ability to meet the benefits promised. By contrast, undertakings with lower assets, and possibly of a lower credit standing, perform reduced valuations of their technical provisions, reflecting a high likelihood of not being able to meet the benefits promised.

Solvency II stipulates that during the valuation of assets and liabilities and hence of technical provisions, no adjustment is made to take account of the own credit standing of the undertaking. This has two direct consequences, on the one hand for other liabilities (excluding technical provisions) of undertakings, as discussed in Section C.4 above, and on the other hand for insurance obligations, i.e. technical provisions.

With regard to the valuation of technical provisions, a distinction should be made as to whether the assets vis-à-vis their corresponding liabilities are matched in level, time and risk and whether the undertaking manages those assets separately from the remainder of its assets. If yes, then the respective technical provisions may be valued at prices that reflect, at least in part and up to a certain degree, the own credit standing of their corresponding assets. If not, technical provisions may not be valued at prices that reflect the own credit standing of the undertaking.

The mechanism used for the introduction or not of the own credit standing is the discount rate on future cash flows which make up technical provisions. Discounting, which does not include adjustment for own credit standing, takes account of the basic term structure of

risk-free interest rates, whereas adjustment for own credit rating is performed using two alternative spreads above the risk-free interest rate, i.e. volatility adjustment and matching adjustment.

D.4 CALCULATION OF TECHNICAL PROVISIONS

A first step in the calculation of technical provisions is to determine the cash flows which are associated with insurance and reinsurance obligations.

The next step is the segregation of those cash flows in two categories:

– cash flows which can be reliably replicated using financial instruments for which a reliable market value is observable – these are typically cash flows relating to interest rate risk and other market risks, if relevant, and

– other cash flows, which are normally cash flows relating to biometric risks, expense risks and lapse risks.

The first cash flows are associated with hedgeable risks, whereas the latter are associated with non-hedgeable risks.

The value of technical provisions is equal to the sum of the best estimate and the risk margin.[59] The best estimate corresponds to the probability-weighted average of future cash flows, taking account of the time value of money (expected present value of future cash flows), using the relevant risk-free interest rate term structure.[60] The calculation of the risk margin shall be such as to ensure that the value of the technical provisions is equivalent to the amount that insurance and reinsurance undertakings would be expected to require in order to take over and meet the insurance and reinsurance obligations.[61]

For cash flows with hedgeable risks, the best estimate and the risk margin are not calculated separately and in this case, the value of technical provisions relating to such future cash flows is determined on the basis of the market value of those financial instruments.[62] I.e. the value of hedgeable cash flows is derived from the market price of the risk inherent in the respective portfolio. Separate calculations of the best estimate and the risk margin are not possible, as market prices already include a risk margin (the market value of risk λ); therefore, the calculation of an additional risk margin, beyond that included in the above calculations, is not required. The aforementioned methods are summed up in the use of the risk-neutral measure as a probability measure for calculating the expected value of future cash flows.

For cash flows with non-hedgeable risks, the best estimate and the risk margin are calculated separately.[63] In this case, the risk margin is calculated on the basis of the cost of the hypothetical transfer of those cash flows to the reference undertaking and corresponds to the cost of providing an amount of eligible own funds equal to the Solvency Capital Requirement necessary to support the insurance and reinsurance obligations over the lifetime thereof. For a better understanding of the above definitions, let us examine, for example, a traditional insurance policy, e.g. death insurance.[64] If as $X_T(r,y)$ we define the cash flows that are conditional upon market risks, which in such an insurance policy mainly involve interest rate risk and which are expressed as r, as well as upon the level of other risks, which in such an insurance policy mainly involve underwriting risk and which are expressed as y, using an arbitrage pricing model, technical provisions are equal to:

$$TP = E^{Q}_{y,r}\left[\frac{X_T(r,y)}{(1+r_f)^T}\right] \quad (1)$$

Subscripts r, y for the average price E are used in order to show that the average price is cal-

59 Article 52(1) of Law 4364/2016.
60 Article 52(2) of Law 4364/2016.
61 Article 52(3) of Law 4364/2016.
62 Article 52(4) of Law 4364/2016.
63 Article 52(5) of Law 4364/2016.
64 The type of insurance used in our example is not relevant, as the formulas are quite generic and applicable to all insurance policies.

culated for all possible combined likelihoods of risks *r, y,* while superscript *Q* denotes that the average price is calculated on the basis of the risk-neutral measure. According to the total probability theorem, the above average price is equal to:

$$TP = E_r^Q \left\{ E_{y|r}^Q \left[\frac{X_T(r,y)}{(1+r_f)^T} \right] \right\} \quad (2)$$

where the first average price (internal) is a dependent average and applies to all likelihoods of risks *y*, given a specific *r*, whereas the second average price (external) applies to all likelihoods of market risks *r*.

If the risks *y* are now broken down, on the one hand, in orthogonal risks (i.e. independent or non-hedgeable) relative to market risks, assuming y_O (e.g. mortality risks, expense risks, that part of lapse risk that is not market-related), and on the other hand, in non-orthogonal risks (i.e. dependent or hedgeable) relative to market risks, assuming y_{NO} (e.g. that part of surrender risk that is market-related), then, since $y = y_O + y_{NO}$:

$$TP = E_r^Q \left\{ E_{y_O|r}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] + E_{y_{NO}|r}^Q \left[\frac{X_T(r,y_{NO})}{(1+r_f)^T} \right] \right\} \Rightarrow$$

$$TP = E_r^Q \left\{ E_{y_O|r}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] \right\} + E_r^Q \left\{ E_{y_{NO}|r}^Q \left[\frac{X_T(r,y_{NO})}{(1+r_f)^T} \right] \right\} \quad (3)$$

But as the risk y_O is not related with the market *r*, then

$$E_{y_O|r}^Q = E_{y_O}^Q \quad \text{and} \quad E_{y_O|r}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] = E_{y_O}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right]$$

Thus, the first part of equation (3)

$$E_r^Q \left\{ E_{y_O|r}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] \right\} \text{ is equal to } E_r^Q \left\{ E_{y_O}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] \right\}$$

Making the relevant replacement, equation (3) can also be expressed in the following equivalent form:

$$TP = E_r^Q \left\{ E_{y_O}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] \right\} + E_r^Q \left\{ E_{y_{NO}|r}^Q \left[\frac{X_T(r,y_{NO})}{(1+r_f)^T} \right] \right\} \quad (4)$$

The first part of the sum in equation (4) of the internal average price refers to the value of cash flows to the extent that these are conditional only upon non-hedgeable, i.e. non-market-related, risks. For this reason, instead of a risk adjustment using the risk-neutral measure, we use an equivalent method of cash-flow adjustment:

$$E_{y_O}^Q \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] = E_{y_O}^P \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] + \frac{Z}{(1+r_f)^T} \quad (5)$$

Thus (with a rearrangement of the terms) taking into account that

$$E_r^Q \left\{ \frac{Z}{(1+r_f)^T} \right\} = \frac{Z}{(1+r_f)^T}$$

$$TP = E_r^Q \left\{ E_{y_O}^P \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] + E_{y_{NO}|r}^Q \left[\frac{X_T(r,y_{NO})}{(1+r_f)^T} \right] \right\} + \frac{Z}{(1+r_f)^T} \quad (6)$$

The first part of equation (6) represents the expected present value of future cash flows, according to the real-world measure, discounting at an interest rate *r* plus the cost of financial guarantees and any contractual options included in insurance products, while the second part represents the separately calculated risk margin that corresponds to non-hedgeable risks.

In relation to equation (6), the best estimate is equal to the first term, while the risk margin to the second term. Thus:

$$TP = BE + RM$$

$$BE = E_r^Q \left\{ E_{y_O}^P \left[\frac{X_T(r,y_O)}{(1+r_f)^T} \right] + E_{y_{NO}|r}^Q \left[\frac{X_T(r,y_{NO})}{(1+r_f)^T} \right] \right\}$$

$$RM = \frac{Z}{(1+r_f)^T}$$

where *BE* denotes the best estimate and *RM* the risk margin.

D.5 BEST ESTIMATE

The best estimate corresponds to the probability-weighted average of future cash flows, taking

account of the time value of money. If instead of a cash flow, we have cash flows each year from time *0* to *n* and instead of a risk-free interest rate r_f we use the interest-rate term structure, then the best estimate (*BE*) is equal to:

$$BE = E_r^Q \left\{ E_{y_0}^P \left[\sum_{t=0}^{n} \frac{X_t(r, y_0)}{(1 + r_{f_t})^t} \right] + E_{y_{N0}|r}^Q \left[\sum_{t=0}^{n} \frac{X_t(r, y_{N0})}{(1 + r_{f_t})^t} \right] \right\}$$

The calculation of the best estimate reflects an unbiased expectation and is forward-looking. It becomes clear that the definition of the best estimate does not in the least imply a simple application of recent historical or current parameters nor does it aspire to a future replication of the recent experience. The assets used to cover the liabilities do not affect the level of the best estimate, unless the liabilities for which it is calculated change as a result of the assets held.

The definition of the best estimate as a probability-weighted average price directly refers to stochastic valuation models, in the sense that the calculation of the best estimate must consider all possible future inflow and outflow scenarios which could materialise until the end of each contract and the settlement of each claim. Furthermore, under scenarios about non-market-related (non-hedgeable) risks, probabilities of realisation are those derived from the risk-neutral measure, while under scenarios about market-related (hedgeable) risks, probabilities of realisation are those derived from the real-world measure. Of course, although all possible future scenarios must be considered, not all possible scenarios should be incorporated in the calculation, nor should theoretical probability distributions be developed in all cases. Finally, future scenarios should not take into account the probability of default of an insurance undertaking and thus not assume that there are cases in which the undertaking will fail to meet its insurance obligations.

The best estimate takes account of all cash inflows and outflows needed for the settlement of insurance and reinsurance obligations over the lifetime thereof,[65] all expenses that are incurred in servicing obligations, inflation, including expenses and claims inflation, and all payments to policyholders and beneficiaries, including future discretionary bonuses, which insurance and reinsurance undertakings expect to make, whether or not those payments are contractually guaranteed.[66]

As future outflows and inflows are directly related to undertaking-specific management practices, it is important that the best estimate take accounts of future management actions. It is only reasonable that such future management actions are to be expected by the management of each undertaking in the event of realisation of an adverse scenario. Such actions include premium increases, reductions in discretionary benefits, actions to cut down the cost of business operations, etc. and, in order to be taken into account in the calculation, they must be recorded, adopted according to a comprehensive plan, explicitly determined for every possible adverse event and implemented in practice.[67]

As the best estimate includes the valuation of financial guarantees and contractual options in insurance or reinsurance policies, its calculation takes account of policyholders' behaviour with respect to the exercise of those options.[68]

Besides, it includes all future administrative, investment and management expenses which are expected to be incurred in servicing insurance contracts. Lastly, it is important that it takes account of all expected future developments in the external environment, which are summarised in social, technological, economic, environmental, (legal), and political developments.[69]

65 Article 52(2) of Law 4364/2016.
66 Article 59 of Law 4364/2016.
67 Article 23 of Regulation (EU) 2015/35.
68 Article 60 of Law 4364/2016.
69 Hence the acronym STEEP.

D.6 RISK MARGIN

D.6.1 Orthogonal risks and CAPM

In order to move forward and explain what the risk margin should be, it is necessary to analyse dependent and independent risks. Two risks can be defined as independent (orthogonal) if the materialisation or the outcome of one risk is not affected by the other; otherwise, they are defined as dependent.[70]

The measures of risk dependency are several. One of them is the coefficient of correlation ϱ, with values ranging from -1 to 1. Close-to-1 values of ϱ suggest a strong positive correlation of risks, while ϱ values which are close to -1 denote a strong negative correlation of risks. Uncorrelated risks give a value of $\varrho = 0$. Another measure of risks, which is used in market analysis and will be of relevance for the analysis of the concepts in this chapter, is the beta coefficient. From a mathematical perspective, the beta of a risk S_j is defined as:

$$\beta_{s,m} = \frac{Cov(S_j, m)}{Var(m)}$$

where m expresses total market risk, $Cov(S_j,m)$ is the covariance of risk S_j with total market risk and $Var(m)$ is market risk variance. The beta of a risk has been introduced as a concept in economic theory with the CAPM (Capital Asset Pricing Model), an economic model for situations of economic equilibrium.[71] Although the objective of this section is not a detailed presentation of the above model, its key ideas and underlying assumptions will be described herein. The CAPM distinguishes between orthogonal and non-orthogonal risks. Orthogonal risks have beta equal to zero (0) —i.e. they are uncorrelated with total market— and are called idiosyncratic or non-systematic or diversifiable, while non-orthogonal risks, with beta other than zero, are correlated with total market and are called systematic or non-diversifiable.

The main assumption on which the CAPM is based[72] is that all investors are rational, small and identical to the extent possible, yet with differences in their original wealth and risk aversion, as well as that they all share the same information about the market. On the basis of this assumption, conditions of perfect competition in the market are ensured (as investors are small and thus cannot influence the market), and investors have uniform expectations (as they are identical and share the same information) and seek to maximise their wealth with the minimum possible risk (as they are rational). A direct outcome of the assumptions is that all investors invest part of their wealth in risk-free investments (e.g. highly rated government bonds) and the remainder of their wealth is invested in exactly the same investment portfolio, with the maximum possible diversification and the same composition of securities, which is called "total market" or "market portfolio".[73] Total market (the market portfolio) consists of all available securities. In other words, while all existing securities should be included in the market portfolio, the only question that arises is the price thereof.

A key conclusion of the CAPM, as well as of most economic equilibrium models, is that orthogonal risks do not entail a market premium, whereas systematic risks price in an excess return (risk premium) as valued by the market.[74]

The CAPM generates the following equation about the one-period return of a risk:

$$E(r_j) = r_f + \beta_{S_j,m}\,(E(r_m) - r_f)$$

70 D. Babbel et al., "Fair Value of Liabilities: The financial economics perspective", *North American Actuarial Journal*, January 2002.
71 This model was developed by William Sharpe in 1964. For that paper he received the Nobel prize in economics.
72 Zvi Bodie et al. (2008), *Investments*, ed. 7, Chapter 9.
73 The only thing that differentiates investors among them, apart from the size of their wealth, is the part that they invest in risk-free returns and the part that they invest in the market portfolio. The distribution of their wealth hinges upon their risk aversion. The more risk averse an investor is, the larger part of his/her wealth he/she invests in risk-free returns.
74 The concept of excess return (risk premium) during the valuation of a risk by the market is associated with the fact that the price of risk in the market is higher than its respective price had risk been valued at the present value of the average price of the corresponding random variable, where the present value is calculated on the basis of the risk-free interest rate.

where r_j and r_m represent, as random variables, the returns on risk S_j and on total market risk, respectively, $E(r_j)$ and $E(r_m)$ represent the expected returns on the above random variables r_j and r_m respectively, while r_f expresses the risk-free return.

The term $\beta_{Sj,m}\,(E(r_m) - r_f)$ is the excess return (risk premium) —incremental to the risk-free return— on total market risk. The quantity $(E(r_m) - r_f)$ is usually positive, as investors are considered to be risk-averse and prefer a safe return over a risky return of a lower or equivalent average price.

As already mentioned, $\beta_{Sj,m}$ is a measure of dependence of risk S_j on total market risk. A positive value of beta denotes a positive dependence of risk on total market risk —the price of the corresponding security co-moves with total market— and suggests that the expected return on risk is higher than the risk-free return. Conversely, a negative value of beta denotes a negative dependence of risk on total market risk —the price of the corresponding security moves in the opposite direction from total market— and suggests that the expected return on risk is lower than the risk-free return. Such securities yield higher returns when the market is undervalued. It is interesting to look into the case where there is no correlation between a risk and total market risk – i.e. where beta equals zero. According to the CAPM, securities with zero beta do not entail any systematic risk and therefore do not price in (or, rather, should not price in) any incremental return (risk premium) to the risk-free return during their market valuation. Under the CAPM, only orthogonal (or non-systematic or idiosyncratic) risks are inherent in debt securities with zero beta. In other words, always according to the CAPM, "the market does not reward for non-systematic (idiosyncratic) risks".

The rationale behind such a statement is associated with the fact that risk-averse investors do not value securities on the basis of their security-specific risk and return, but rather on the basis of the contribution of those debt securities to the risk and return of their total portfolio – i.e. the market portfolio. The inclusion of a security with zero beta in a portfolio can diversify the ex post returns on the final portfolio (as a result of the debt security's idiosyncratic returns) but cannot diversify the ex ante distribution of expected returns on adequately diversified portfolios.

The review of securities with zero beta (orthogonal risks) is of particular relevance. The most simple example of a security with zero beta is a one-period bond without coupons and without issuer default risk. As the yield on that bond is not surrounded by any uncertainties, it is independent from market developments and therefore has zero beta. Naturally, since it has zero beta, its respective yield (in accordance with the equation of the CAPM) is risk-free.

Another typical example of a risk-free security would also be an insurance contract, e.g. earthquake insurance, for a residential property. The insurance contract, after its conclusion, is included in the total market portfolio. Furthermore, the condition of this residential property after an earthquake is not related to the condition of the total market. This independence is more visible if compared with the price of a share, which is positively correlated with the market. If after one year of seclusion one gets briefed on the performance of the Athens Exchange, one would also be able to draw an estimation about the performance of that share. However, such an estimation is not possible with respect to the condition of a house. Perhaps an earthquake has occurred, perhaps not.

In this context, assuming that insurance contracts have zero beta, it is only natural to accept that insurance undertakings' return on equity will be equal to the risk-free return.

In other words, if we accept the above analysis, then we must also accept that for the calculation of technical provisions future cash flows can be discounted at the risk-free interest rate, using the real-world measure, as no

reference has been previously made to risk-neutral valuation or other risk adjustment. Of course, this is contrary to the analysis and all previous conclusions, being in conflict with the fact that technical provisions should include a risk adjustment for non-hedgeable risks, i.e. a risk margin, either in the form of a discount rate or in the form of modified cash flows.

So be it, if we adopt the above example about the perspective of the insurance undertaking that offers the insurance contract, underwriting or even operational risks, being orthogonal with the market, should not price in any excess return (risk premium) incremental to the risk-free return. By contrast, only non-orthogonal risks of an insurance undertaking (e.g. market risks) should price in an excess return (risk premium) on top of the risk-free return.

The questions that arise and beg for an answer are the following: (a) is it right that underwriting risks, albeit orthogonal, are priced exclusively in line with the risk-free return without any risk premium? If the answer is affirmative, then we should re-examine why an investor should in the first place invest in an insurance undertaking, while if the answer is negative, then we should explore what in the above assumption is not akin to underwriting risks, which would then require the pricing-in of a risk premium, and, in which case, what would be the appropriate excess return (risk premium) above the risk-free return for the orthogonal risks of an insurance undertaking; and (b) what is the appropriate risk premium in excess of the risk-free return for the non-orthogonal risks of an insurance undertaking?

In order to answer the first question, we should resort to current practices. The reasoning that was developed above, albeit plausible, tends to overlook some very important aspects of insurance. The first aspect is that all interested parties, such as investors who provide funds to insurance undertakings, supervisory authorities and policyholders, do not perceive underwriting risks as orthogonal with the market, but believe that they have a negative correlation with it, i.e. underwriting risks have negative beta.[75] All stakeholders somehow believe that insurance events (major ones in particular) can influence the markets. For instance, large-scale flooding may lead to a slowdown in the local economy.

It is only natural that after the conclusion of an insurance contract the beta of the insurance undertaking will be affected – the policyholder's beta declines as the insurance undertaking's beta increases. The shareholders of the insurance undertaking are thus justified to ask for extra profits in order to cover the increased systematic risk. Against this backdrop, it is reasonable for them to request that those extra profits result from an excess return (risk premium) which is embedded in the insurance premium.

The second aspect that is usually overlooked involves the assumptions of the CAPM used as a basis for our analysis. The basic assumption of the CAPM, as already mentioned above, suggests that all investors, being rational and well-informed, carry out an investment analysis, as described in academic textbooks, and invest their wealth in adequately diversified portfolios, if not in the market portfolio, then at least in portfolios that comprise a wide range of securities so as to simulate the market portfolio. In this context alone, it is meaningful that the shareholders of insurance undertakings value their investment in insurance stocks in relation to its contribution to the risk and return of the total portfolio. Yet, insurance policies are characterised by great complexity, are not familiar to most investors and are opaque, as they are affected by information asymmetries between the insurance undertaking and the policyholder. Thus the shareholders of insurance undertakings typically have an expertise in insurance stock investment and as a result, are not limited in investing in ade-

75 The fact that shareholders, supervisory authorities and policyholders agree that underwriting risks have negative beta is reflected in their insistence, as explained further below, on insurance undertaking establishing adequate technical provisions, including a safety buffer.

quately diversified portfolios —which also comprise insurance stocks— but mainly make individual investments in insurance undertakings. It is clear that the shareholders of insurance undertakings, in order to continue investing their wealth in insurance undertakings, should also be compensated for the idiosyncratic (orthogonal) risks of the undertakings.[76]

Lastly, there are specific risks, such as catastrophe risks, to which the law of large numbers does not apply. Either such risks will never materialise or, if they do, losses will be so extensive that no risk pooling mechanism will be able to effectively cope with them, unless an adequate insurance premium has been received in advance, which will include, apart from the simple average price of the risks discounted at the risk-free interest rate, a sufficient risk margin.

Concluding, it can be argued that both the non-orthogonal risks (i.e. the risks ensuing from the market exposure of the undertaking) and the orthogonal risks of an insurance undertaking (e.g. underwriting and operational risks) must price in an excess return (risk premium) on top of the risk-free return, as well as that the incremental return for market risks is determined by the market itself and is called market price of risk, while the incremental return for the remaining, non-systematic risks is determined using methods which seek to replicate the excess return that the market would determine for those risks, should such a market exist (mark-to-model price of risk). It appears that, if at some point a (secondary) market for underwriting and operational risks were to be established, those risks would be included in the market portfolio (and they would thus turn into systematic/non-orthogonal), in which case the excess return would be determined by the market itself (mark-to-market).

D.6.2 Expected and unexpected losses

As mentioned above, the risk margin for hedgeable risks under Solvency II is calculated on the basis of the cost of capital. For a deeper understanding of the concept of risk margin, in particular the cost-of-capital risk margin, it is necessary to explore the concepts of economic capital and, even before that, to make a distinction between expected and unexpected loss over a given reference period (of one year in our case, where an assurance is sought that the insurance undertaking will be able to cover the losses it may sustain in the following year).

Each insurance undertaking has at the beginning of each reference period[77] a given amount of liabilities, L_0, which is assumed to be known by the undertaking. L_1 represents the value of the undertaking's liabilities at the end of the reference period (where 1 in subscript denotes either one year or the time at which its insurance portfolio will have been settled). It should be noted that the level of L_1 is not known beforehand at time $t=0$, but is determined by random events that may occur over the reference period. Thus L_1 is a random variable and we have

$$L_1 = L_0 (1+R_L)$$

where R_L is the growth rate of the undertaking's liabilities over the reference period and is a random variable, with average price and variance:

$$\mathrm{E}(R_L) = \overline{R_L}$$

$$VAR(R_L) = \sigma^2_{R_L}$$

As a result, the average price and variance of L_1 using the real-world probability measure will be:

$$\mathrm{E}(L_1) = L_0(1+\overline{R_L})$$

$$VAR(L_1) = \sigma^2_{L_1} = L^2_0\sigma^2_{R_L}$$

A solvent insurance undertaking holds assets to support both its obligations and its own

76 I.e. for the shareholders of insurance undertakings the ultimate measure of risk is usually not the beta of their investment but its dispersion.

77 "Specialty Guide on Economic Capital", Society of Actuaries (SOA), Version 1.5, March 2004.

funds. At the start of the reference period the total level of assets is symbolised by A_0 and it is assumed that this figure is also known by the undertaking. It is assumed that A_1 is the value of the above assets at the end of the reference period.

Likewise, in the case of assets, the level of A_1 is not known beforehand at the start of the reference period, but is determined by random events that may occur over that period. Thus A_1 is a random variable and we have:

$$A_1 = A_0 (1+R_A)$$

where R_A is the growth rate of the undertaking's assets over the reference period and is a random variable, with average price and variance:

$$\mathrm{E}(R_A) = \overline{R_A}$$

$$VAR(R_A) = \sigma^2_{R_A}$$

As a result, the average price and variance of A_1, using the real-world measure, will be:

$$\mathrm{E}(A_1) = A_0(1+\overline{R_A})$$

$$VAR(A_1) = \sigma^2_{A_1} = A^2_0\sigma^2_{R_A}$$

In most cases, liabilities co-move with return on assets, but between liabilities and assets there is a correlation with a respective coefficient

$$\varrho_{R_L,R_A} = \frac{\sigma_{R_L,R_A}}{\sigma_{RL}\sigma_{RA}}$$

Thus the covariance of A_1 and L_1 is:

$$Cov(A_1,L_1) = A_0L_0\sigma_{R_L,R_A} = A_0L_0\varrho_{R_L,R_A}\sigma_{R_L}\sigma_{R_A}$$

Each insurance undertaking holds at the beginning of each reference period a specific level of capital, K_0, which is measured as the value of assets A_0 minus the value of liabilities L_0, namely:

$$K_0 = A_0 - L_0$$

Based on the assumption that each insurance undertaking knows with certainty the levels of A_0 and L_0, it is reasonable to assume that it also knows K_0 with the same certainty.

However, the level of capital K_1 at the end of the reference period is a random variable and is measured as

$$K_1 = A_1 - L_1$$

For the insurance undertaking to be solvent at the beginning of the reference period, K_0 must be higher than or equal to zero, i.e.

$$K_0 \geq 0$$

In other words, the undertaking must hold adequate assets to at least meet the obligations assumed.

Still, this is not enough. The insurance undertaking should maintain a higher level of capital K_0, so as to be sure, at the start of the reference period, that K_1 will also be positive. Thus, the amount of capital K_0 that an undertaking should hold must be higher than a specific minimum to ensure that:

$$Pr(K_1 \geq k) \geq 1 - \alpha$$

The minimum amount of capital ensuring the above equation is called "economic capital".

In the above equation, $1 - \alpha$ is called confidence level and α is called risk tolerance level. k is a figure that is determined by the insurance undertaking and describes the minimum level of capital which makes it feel comfortable (comfort level). k can be expressed in several forms: as an absolute amount, or as a percentage of liabilities, or as a function of the maximum given loss that the undertaking can tolerate. The combination of figures (k, α) is called risk appetite.

Where an undertaking has chosen k as the zero value (0), the undertaking merely seeks to be able to fulfil its total obligations at the end of

the reference period. Nevertheless, this may not be the only aspiration of an undertaking; it is likely that an undertaking seeks to optimise the level of its capital, thereby determining k as a function of its optimal level.

Summing up the economic capital issue, an insurance undertaking for a given portfolio of liabilities with financial value L_0, expected end-of-period value $E(L_1)$ and standard deviation σ_{L_1} should hold a portfolio of assets with market value A_0, expected end-of-period value $E(A_1)$, standard deviation σ_{A_1} and covariance with the portfolio of liabilities $Cov(A_1,L_1) = A_0L_0\varrho_{R_L,R_A}\sigma_{R_L}\sigma_{R_A}$, so as to ensure that

$$Pr(A_1 - (1+\mathrm{k})L_1 \geq 0) = 1 - \alpha$$

The above equation has nine parameters $L_0,E(L_1),\sigma_{L_1},A_0,E(A_1),\sigma_{A_1},\varrho_{R_L,R_A},k,\alpha$. If we know the values of the eight parameters, as well as their correlations, we can solve the above equation in terms of the other parameters. If we know the values of $L_0,E(L_1),\sigma_{L_1},E(A_1),\sigma_{A_1},\varrho_{R_L,R_A},k,\alpha$, we can calculate the value of $A_0^{(opt)}$, and in turn we can calculate the value of $K_0^{(opt)}$ as $K_0^{(opt)} = A_0^{(opt)} - L_0$.

The above process ensures that the optimal level of the undertaking's assets at a given time $A_0^{(opt)}$ covers both liabilities L_0 (technical provisions) and capital needs $K_0^{(opt)}$, which are capable to ensure, at a specific confidence level, that the undertaking will be solvent at the end of the year. L_0 corresponds to the average value of all future outflows of the undertaking (e.g. death or disability or longevity (retirement) benefits, or loss coverage against earthquake, car accident, catastrophes, etc., payments of insurance contract expenses or operating expenses, etc.), taking account of the cost of money. In other words, it corresponds to the level of the present value of the undertaking's expected future losses, which arise from existing commitments. Expected losses,[78] due to the fact that they are anticipated by the undertaking in the course of its business activity, do not constitute a risk, but reflect the cost of doing business. This figure must be recorded in the balance sheet (on the liabilities side) of the undertaking and it should be ensured, using appropriate valuation techniques for insurance products, that the insurance premiums charged on policyholders cover at least expected losses.

$K_0^{(opt)}$ is a quantity other than expected liabilities (technical provisions) of the undertaking and reflects to what degree the actual value and the actual profits of the undertaking are different from the expected ones. In other words, it reflects the degree of deviation from the average. In contrast with expected losses, unexpected losses[79] constitute the risk, rather than the cost, of doing business. But whereas insurance premiums must be sufficient so as to meet expected losses, the same does not apply for unexpected losses. Unexpected losses are not a cost for the undertaking, but reflect the risk assumed as a result of insurance operations. In order to meet unexpected losses, undertakings provide their economic capital. But the capital has its own cost – the cost of capital. Thus the insurance premiums charged on policyholders must cover, beyond and above the cost of doing business, the cost of the funds that they attract.

D.6.3 The concept of the cost-of-capital risk margin

To analyse the reasons for which it is imperative that insurance premiums cover the cost of capital, on top of the cost of doing business, one must first look into the value of capital, i.e. its ability to generate profit. So long as corporate profits from an investment satisfy the investors who provide their funds, relative to the profits that they would have received if they had invested in alternative investment opportunities of similar risk, investors continue to financially back their investment, which is in turn deemed capable of attracting new funds raising the value thereof. However, if the prof-

78 C.W. Smithson (2003), *Credit Portfolio Management*, John Wiley & Sons Inc-Books, Ch. 1 "The Revolution in Credit – Capital is the key".
79 C.W. Smithson, op. cit.

its generated cease to satisfy investors relative to alternative investment opportunities of similar risk, investors see their funds diminishing in value and, as expected, they choose to withdraw their funds to invest them in new investment opportunities.

In the context of insurance undertakings, this is a critical decision which has a direct impact on the level of policyholders' protection – it should not be ignored that in insurance undertakings the funds are used for the absorption of unexpected losses, which would otherwise burden policyholders as a whole through commensurate declines in their expectations. Competition among undertakings in attracting funds relies on their ability to maximise the value of the capital invested in them, taking into account the maturity of an insurance policy and the fact that policyholders seek protection throughout the lifetime of their insurance contracts rather than just over a limited period of time. In this regard, a distinction should be made between the time period during which losses must be covered by the economic capital, which is normally one year, and the time period that corresponds to the lifetime of insurance liabilities assumed by the insurance undertaking, which as a rule lasts more than a year (e.g. in the case of retirement schemes or whole life policies which may provide coverage for up to 70 or 80 years).

So, how can those two time periods be reconciled? The question is crucial, as it lies at the heart of every successful effort to attract funds. First of all, this reconciliation should be made for each individual insurance liability separately. The insurance undertaking for each insurance liability assumed must estimate its lifetime, i.e. for how long this liability is estimated to remain on its balance sheet and therefore may cause unexpected losses on the undertaking. Then, the level of unexpected losses that the liability may cause on an annual basis over its lifetime must be estimated and converted into economic capital terms $K_0^{(opt)}, K_1^{(opt)}, K_2^{(opt)}, \ldots$ and so on.

Against this backdrop, for an insurance undertaking to successfully overcome competition in attracting funds, it must seek to maximise the value of total future capital needs for servicing its insurance obligations $K_0^{(opt)}, K_1^{(opt)}, K_2^{(opt)}, \ldots$ rather than just the value of the existing capital $K_0^{(opt)}$. Investors seek profit not merely for one year, but for each year in which they contribute funds to the insurance undertaking. Furthermore, the cost of future capital needs (which corresponds to total future profits to be allocated to investors) should be calculated in a transparent manner, already known by investors, to enable them to assess the value or the feasibility of their investment. Lastly, as the projected profits to be allocated to investors should be distributed gradually in proportion to the use of the funds they have provided, the undistributed amount must be held separately in the financial statements of the undertaking. This holding on the balance sheet is typically secured using a capital charge on technical provisions, which is called "cost-of-capital risk margin".

This capital charge, although its name encompasses the term "risk margin", is not aimed at achieving technical provision adequacy. It is merely the amount of investors' undistributed future profit that will be allocated to them in proportion to the use of their funds.

For reasons of consistency with the economic approach, the level of the risk margin must be determined in line with the terms of economic theory. Those terms were determined by Modigliani and Miller.[80] In this context, the assets of insurance undertakings must be equal to their liabilities plus their capital base, i.e. $A_0 = K_0 + L_0$. After one year, assets will average (using the real-world probability measure to reflect reality) $E(A_1) = A_0(1 + \overline{R_A})$ and $E(L_1) = L_0(1 + \overline{R_L})$. At the same time, shareholders demand that their capital grows, on average, at the same rate as the cost of capital

80 Modigliani, F. and M.H. Miller (1958), "The Cost of Capital, Corporation Finance, and the Theory of Investment", *American Economic Review*, Vol. 48.

$\overline{R_E}$. $\overline{R_A}$, $\overline{R_L}$ and $\overline{R_E}$ must be such so that after one year assets are equal to liabilities plus the capital base as at the end of the year, i.e.:

$$A_1 = K_1 + L_1 \Rightarrow A_0(1+\overline{R_A}) = K_0(1+\overline{R_E}) + L_0(1+\overline{R_L})$$

Solving the above equation in terms of $\overline{R_L}$ it follows that:

$$\overline{R_L} = \overline{R_L} - \frac{K_0}{L_0}(\overline{R_L} - \overline{R_L})$$

Adding and deducting the risk-free interest rate and rearranging the terms of the equation, we arrive at the following equation:

$$\overline{R_L} = r_f - \frac{K_0}{L_0}(\overline{R_E} - r_f) + (\overline{R_A} - r_f)(1 + \frac{K_0}{L_0}) \qquad (7)$$

How can equation (7) be interpreted? The growth rate of liabilities,[81] i.e. the interest rate used to discount liabilities, since the real-world measure has been applied, is equal to the sum of all three parts: (a) the first part is the risk-free return; (b) the second part is the risk adjustment for the uncertainty of liabilities as perceived by shareholders; and (c) the third part reflects the risk assumed by the insurance undertaking via its investments, which is not correlated with liabilities (e.g. credit risk and spread risk).

Turning to part (c) it should be noted that in some cases and under strict conditions and to the extent that the assets and their corresponding liabilities are matched in level, time and risk, and managed separately from the remainder of the undertaking's assets, that part could be a positive quantity (see Section D.3 on volatility adjustment).

If however it is assumed that the additional risk ensuing from investments should not, save in exceptional cases, be reflected in technical provisions, then the third part of the above equation should be zero (0).[82] Hence:

$$\overline{R_L} = r_f - \frac{K_0}{L_0}(\overline{R_E} - r_f)$$

At this point, a further clarification is warranted: in the above equation, K_0 does not correspond to the insurer's own funds, which should amount to its total economic capital. It should be recalled that the issue is addressed from the point of view of the reference undertaking that would purchase the portfolio. Thus, even if the original undertaking holds a higher capital than the economic capital that the reference undertaking would hold, the latter is not obliged to maintain it, as it is expected that the reference undertaking will indeed hedge all hedgeable risks and adopt all necessary actions, as determined. Thus, K_0 should be equal to the part of $K_0^{(opt)}$ which corresponds to the economic capital used to cover the risks of the reference undertaking.

Therefore, we re-calculate $K_0^{(opt)}$ from the perspective of the reference undertaking, using SCR_{RU} to represent it. Then

$$\overline{R_L} = r_f - \frac{SCR_{RU}}{L_0}(\overline{R_E} - r_f)$$

If instead of modifying the interest rate, we wish to modify cash flows in an equivalent manner, we have:

$$BE + RM = \frac{E^P(X(\omega))}{1+\overline{R_L}}$$

Replacing BE (for reasons of simplification we assume that the cost of contractual options and financial guarantees is zero), then:

$$\frac{E^P(X(\omega))}{1+r_f} + RM = \frac{E^P(X(\omega))}{1+\overline{R_L}}$$

Solving the equation, we take

$$RM = SCR_{RU}\frac{(\overline{R_L} - r_f)}{1+r_f}$$

and given $RM = \frac{Z}{(1+r_f)}$, we have

$$Z = SCR_{RU}(\overline{R_E} - r_f)$$

81 Over a time horizon of one year.
82 This assumption is directly associated with who we want to bear the cost of a possible materialisation of asset risks that are not related to liabilities.

Of course, the above equation can be expanded to cash flows over a time horizon of more than a year, as follows:

$$RM=\sum_{t=0}^{n} SCR_{RU_{t+1}} \frac{(\overline{R_E}-r_{f_t})}{(1+r_{ft})^t}$$

The quantity $(\overline{R_E}-r_{f_t})$ reflects the cost-of-capital rate (over risk-free) and is represented as *CoC*. Thus:[83]

$$RM=CoC\sum_{t=0}^{n} \frac{SCR_{RU_{t+1}}}{(1+r_{f_t})^t}$$

Finally, as under Solvency II the CoC of the reference undertaking is determined at a level equal[84] to 6%, it follows that:

$$RM=6\%\sum_{t=0}^{n} \frac{SCR_{RU_{t+1}}}{(1+r_{f_t})^t}$$

E. CONCLUDING REMARKS

Having reached the end of the presentation of the economic valuation theory and its association with the respective requirements of Solvency II, a number of conclusions can be drawn.

A first, immediate conclusion is that, in contrast with Solvency I, valuation methodologies under Solvency II are far more complex. However, this is warranted to the extent that (re)insurance undertakings are now more free to channel their funds into investments of their choice, enjoying greater flexibility. As the freedom to invest has increased, it is no longer easy for legislation to establish concrete, straightforward rules of valuation, as was the practice under Solvency I.[85]

Another takeaway that is brought to the fore by the nature of the Solvency II methodologies (option pricing, arbitrage pricing) is that valuations are characterised by strong procyclicality, suggesting that valuations are positively correlated with the business cycles of the markets,[86] as valuation models rely on market prices and adjust their estimations so as to be in line with the market.[87]

This increases the volatility of the supervisory balance sheets of (re)insurance undertakings and thus the volatility of their supervisory own funds, with two direct consequences: (a) to the extent that own funds determine the solvency of a (re)insurance undertaking, the solvency (or insolvency) of (re)insurance undertakings is procyclical (at least to a greater degree than under Solvency I) and (b) it is imperative for (re)insurance undertakings to implement asset-liability management (ALM) practices, with a view to reducing volatility.

Furthermore, it is now more clear than ever that the rationale itself behind the valuation of obligations towards policyholders, i.e. technical provisions, is shifting. Under Solvency I, the actuary worked on the projection of future benefits from each insurance contract. If one wished to assess how effective the actuary was in his task, one would only have to patiently wait and see whether his projections checked out or not. By contrast, under Solvency II, the actuary's task is utterly different, even though calculations are indeed similar: he tries to predict the price at which a theoretical transfer would be carried out. Interestingly enough, once the theoretical price has been estimated, it is impossible to check whether the actuary was right in his projections or not. Once this price becomes a fact of the past, every transfer that follows will take a different price, as economic conditions will have changed in the meantime. In the first case —Solvency I— the actuary attempts to predict a future which becomes gradually known, whereas in the second case —Solvency II— the actuary tries to foresee an unknown present, exclusively relying on generally available market inputs.[88]

83 The following equation is laid down in Article 37 of Regulation (EU) 2015/35.
84 Article 39 of Regulation (EU) 2015/35.
85 The approach under Solvency I was as plain as that: the asset or liability has a market value, which in this case is used, or its valuation is based on a simple formula (e.g. for properties, the objective value plus 30% is employed), or its holding is subject to approval by the supervisory authority, which is the one that determines the valuation method to be applied.
86 Besides, this fully justifies the term "market consistent valuation".
87 It is of utmost importance to understand that such models merely provide a pricing system which relies on existing market prices using an equation that correlates all those prices.
88 Undertaking-specific inputs can be used in the calculation of technical provisions only to the extent that these reflect more accurately the characteristics of the insurance portfolio.

Last but not least, it is important to understand how Solvency II perceives the protection of policyholders. The best estimate of insurance obligations is equal to their average level. If the level of obligations is based on a symmetrical distribution, there is a 50% probability that the best estimate is sufficient or, vice versa, there is a 50% probability that the best estimate is insufficient. Given that the likelihood of an insufficient best estimate is overly high, Solvency II requires that the undertaking holds adequate capital to cover both expected (i.e. the best estimate) and unexpected liabilities (the so-called Solvency Capital Requirement[89]). While the financing of the best estimate typically hinges upon policyholders, by way of insurance premiums, the financing of the Solvency Capital Requirements is ensured by shareholders in the form of equity or other capital. But why should shareholders provide their funds? To make profit of course. And where would this profit come from? As discussed above, from the cost-of-capital risk margin, which corresponds to the level of shareholders' future profit.

For example, it is assumed that for one year the level of insurance obligations of an insurance undertaking is higher than the best estimate.[90] Policyholders do not incur any losses, to the extent that they were indemnified with money coming from the undertaking's own funds (since the best estimate was not sufficient). As a result, this pattern was effective for one year: policyholders were indeed protected (they did not incur any losses). However, the capital base of the undertaking has eroded and needs to be replenished by shareholders; otherwise, the undertaking is deemed insolvent. Let us look at the following conversation between the management of an insurance undertaking and its shareholder:[91]

Management: I have some good news and some bad news. The bad news is that the best estimate, as calculated by our actuaries, proved to be insufficient and as a result, the company made losses this year and your capital is gone, as we made it available to our policyholders. The good news is that there are still sufficient loadings that you can expect a reasonable return on your investment, if you replace the lost capital now.

Shareholder: How can I be confident this won't happen again?

Management: You can't. Insurance is a risk business. Although the company's actuaries have followed the best professional methodologies and practices, it is possible that we could have another bad, unprofitable year before all policyholders have been fully indemnified. If you are uncomfortable with that, we must either find another shareholder to assume your business and make the required contribution or try to transfer the insurance portfolio to another insurance undertaking, the shareholder of which wishes to make such an investment.

Against this background, it is clear that Solvency II ensures that (a) on the one hand, the insurance undertaking can withstand severe losses for one year and (b) on the other hand, it possesses the safeguards to recapitalise the insurance portfolio, either directly to continue as a going concern or indirectly by transferring the insurance portfolio to another insurance undertaking.

While the requirement that own funds should at least be equal to the Solvency Capital Requirement ensures a high degree of loss-absorbency over one year, it is the risk margin encompassing shareholders' future profits, as shown above, that safeguards recapitalisation.

89 The Solvency Capital Requirement is equal to the economic capital, as defined in Section D.2 above, over a time horizon of 1 year and with a 99.5% confidence interval.
90 In other words, in that year, the insurance undertaking made losses.
91 J. Manistre (2014), "Down but not out: A cost of capital approach to fair value risk margins", condensed version presented to 2014 ERM Symposium.

WORKING PAPERS (JANUARY – JUNE 2017)

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On the determinants of NPLs: lessons from Greece

Working Paper No. 220
Evangelos Charalambakis, Yiannis Dendramis and Elias Tzavalis

The paper investigates the relationship between non-performing loans (NPLs) and their fundamentals, mainly bank and macroeconomic variables. This is done based on aggregate portfolio loans in the Greek economy. Greece constitutes an interesting case to study the factors determining NPLs, given the pervasive recessionary conditions that have characterised it since the outbreak of its sovereign debt crisis in 2010. We suggest a new econometric framework to study the above relationship which extends the SUR (seemingly unrelated regressions) framework to allow for a common break in its slope coefficient of unknown date. We show that the deterioration in the macroeconomic conditions (captured by very high rates of unemployment) and political uncertainty constitute key factors explaining the sharp rise of NPLs in the Greek banking sector after the first quarter of 2012. With the exception of bank profitability, we find that bank-specific variables associated with bank capitalisation and liquidity risk seem to determine NPLs only under normal economic conditions.

Markups and fiscal policy: analytical framework and an empirical investigation

Working Paper No. 221
Georgios Christou and Panagiotis Chronis

The paper focuses on the effects of fiscal policy on industry-specific profit margins in a sector of an economy (in manufacturing), rather than on the profit margin for the economy as a whole, which is the usual approach followed in the literature. In this study, the price-cost margin at the industry level is expressed as a function of the fiscal balance and other market variables, such as industry share and price which are usually absent in a macro-analysis environment. Using a panel of ten European Union member countries for the period 1988-2005, we obtain the statistical results that support the existence of a non-trivial relationship between price-cost margin and fiscal policy, as expressed by the fiscal balance of a country. There are differences, however, between countries as well as across industries, reflecting different production and labour market conditions. As a general conclusion, it is found that there is a negative relationship between profit margins and the impact of fiscal policy: investigating this relationship for the ten EU member countries sample, the paper indicates that an increase in the surplus/a decrease in the deficit causes the price-cost margin to fall. The same relationship is also confirmed in most industries of manufacturing, although it is not statistically significant across industries.

A ternary-state early warning system for the European Union

Working Paper No. 222
Savas Papadopoulos, Pantelis Stavroulias, Thomas Sager and Etti Baranoff

The global financial crisis of 2007-2008 focused the attention of financial authorities on developing methods to forecast and avoid future financial crises of similar magnitude. We contribute to the literature on crisis prediction in several important ways. First, we

develop an early warning system (EWS) that provides 7-12 quarters advance warning with high accuracy in out-of-sample testing. Second, the EWS applies region-wide to the leading economies in the European Union. Third, the methodology is transparent – utilising only publicly available macro-level data and standard statistical classification methodology (multinomial logistic regression, discriminant analysis, and neural networks). Fourth, we employ two relatively novel methodological innovations in EWS modelling: ternary-state classification to guarantee a minimum advance warning period, and a goodness-of-fit measure (the total harmonic mean) that prioritises avoiding classification errors for the relatively infrequent events of most interest. As a consequence, a policymaker who uses these methods will enjoy a high probability that future crises will be signalled well in advance and that warnings of crisis will not be false alarms.

Is there a case for intergenerational transmission of female labour force participation and educational attainment? Evidence from Greece during the crisis

Working Paper No. 223
Evangelia Papapetrou and Pinelopi Tsalaporta

Using logit regression techniques for binary response models, fit by maximum likelihood with robust standard errors, the analysis investigates the intergenerational transmission of female labour force participation and the intergenerational transmission of educational outcomes in Greece. To conduct this study, we pioneer in the utilisation of a unique dataset, the European Union Statistics on Income and Living Conditions (EU-SILC) for Greece. Data refer to 2011 when the first elements of the economic adjustment programme were being put into place. Most importantly, the EU-SILC 2011 wave is the latest one to include an ad hoc module on the intergenerational transmission of disadvantages. Results show that a wife's labour force participation decision is related to her husband's mother's and mother's participation, and even more strongly related to her own level of educational achievement along with the number of children in the household. The labour force participation of the mother of the husband is more important than that of the woman's own mother, indicating a strong transmission of the husband's cultural model. Concerning educational attainment, parental educational background, and especially maternal, is identified as a key determinant of women's high level of educational achievement.

Fiscal policy effects on non-performing loan formation

Working Paper No. 224
Vasilis Siakoulis

The fiscal situation in an economy may have a significant impact on the evolution of non-performing loans (NPLs), as austerity measures limit the loan servicing capacity of households and businesses (Perotti 1996). We empirically approach the effects of fiscal policy on NPLs employing a global dataset for 31 countries covering a 15-year period. We control also for other macroeconomic factors so as to quantify effects stemming from fiscal policy measures. We employ panel data methodologies, since they provide us with the means to deal with unobserved country heterogeneity when examining the determinants of asset quality. We also examine the one period ahead forecasting performance of our

models in line with the cross sample panel data validating suggestions by Granger and Huang (1997). Our findings imply that, on a global level, when accounting for variables linked to macroeconomic performance such as GDP growth and the unemployment rate, fiscal pressure imposed on the economy, as measured by changes in the cyclically adjusted primary surplus, constitute important determinants of non-performing loan formation. Our analysis could be of great interest to policymakers since the assessment of credit risk in the banking sector is a crucial element of macro-prudential policy.

The effect of card payments on VAT revenue in Greece

Working Paper No. 225
George Hondroyiannis and Dimitrios Papaoikonomou

The strong performance of VAT revenue in Greece since end-2015 has been without precedent during the crisis and presents a puzzle, as it is difficult to reconcile with developments in the tax base and the tax rates. Identifying the drivers behind the recent pick-up has important policy implications, particularly with regard to the fiscal requirements of the ESM financial assistance programme, as it can inform policymakers on the extent to which the recent revenue performance can be expected to continue, or whether it represents a temporary windfall. Applying time-varying coefficient methods on quarterly data during 2002q1-2016q2, we find that the accelerated growth in VAT revenue is explained by improved tax compliance, which has been positively affected by the increased use of card payments following the imposition of restrictions on cash withdrawals in July 2015. The analysis indicates that (i) a 1pp increase in the share of card payments in private consumption results in approximately 1% higher revenue through increased compliance; (ii) lowering the VAT rate can generate revenue gains; and (iii) card transactions may facilitate tax buoyancy. It is argued that stronger incentives for using card payments in tax evading industries can help lock-in the recent strong revenue performance when cash restrictions are lifted.

The interplay between quantitative easing and risk: the case of the Japanese banking

Working Paper No. 226
Emmanuel C. Mamatzakis and Anh N. Vu

The Japanese banking industry is an interesting one, given chronic problems related to notorious non-performing loans, originated back in the 1990s, but also due to an unprecedented monetary expansion. In this paper, we focus on the impact of quantitative easing on bank-level risk, while controlling for bank competition. We opt for a measure of bank-specific risk-taking, based on a new dataset of bankrupt and restructured loans. Given issues related to endogeneity among the main variables, we adopt dynamic panel threshold and panel vector autoregression analyses that address such criticism. Results demonstrate that quantitative easing reduces bankrupt and restructured loan ratios, although we do not observe a similar impact on bank stability. Given the adoption of negative rates in January 2016 by the Bank of Japan, our study comes in timely and provides insightful implications for future research.

Labour market adjustment and labour market reforms in Greece during the crisis: microeconomic evidence from the third wave of the Wage Dynamics Survey

Working Paper No. 227
Theodora Kosma, Evangelia Papapetrou, Georgia Pavlou, Christina Tsochatzi and Pinelopi Zioutou

The recession that followed the global financial crisis and the sovereign debt crisis resulted in large falls in output and rises in unemployment across Europe. In this context, many countries implemented significant reforms of their labour market. In order to analyse the impact of labour market reforms and, in particular, to investigate how firms adjusted to the shocks affecting them, the European System of Central Banks (ESCB) conducted a third wave of the Wage Dynamics Network (WDN3) survey in 2014-2015. This paper describes the main findings of the Greek WDN3 survey. The results show that the decline in economic activity, during the period 2010-2013, had a significant negative impact on Greek firms' activity. Greek firms reacted to the shocks affecting them by adjusting both labour input and wages, and reforms seem to have made it easier for this adjustment to take place. Regarding remaining rigidities in the Greek labour market and other obstacles that would influence the hiring of new employees with contracts of indefinite length, the survey shows that Greek firms consider economic uncertainty to be comparatively the most binding obstacle to hiring, followed by high payroll taxes. The regulatory framework, which has been significantly reformed in the recent period, is not frequently considered a relevant obstacle to hiring employees with contracts of indefinite length.

Exporting and performance: evidence from Greek firms

Working Paper No. 228
Heather D. Gibson and Georgia Pavlou

An extensive literature exists exploring differences in performance between firms that export and those that do not. With only a few exceptions, exporters have characteristics which suggest "better" performance than non-exporters, controlling for observed and unobserved heterogeneity. In most empirical studies it is found that exporters are larger, more productive and more capital intensive. Findings also suggest that it is the most productive firms that usually begin exporting and that there is little evidence to support the view that exporting, through learning-by-doing, brings higher productivity. However, the transition of firms from producing solely for the domestic market to selling abroad involves rapid employment and output and higher productivity growth. Conversely, exiting firms experience sharp declines in output and employment. Other potential benefits of exporting firms may be located in terms of the number of jobs and, through higher plant survival rates, the stability of those jobs.

This paper aims to provide evidence on the differences between exporters and non-exporters in terms of labour productivity and profitability across time, different sectors of economic activity and different size groups, using data from exporting and non-exporting firms incorporated in Greece for the period 2006-2014. The results suggest that the exporter productivity premium is around 14% for the whole sample, pointing to a significant productivity advantage for exporting firms which is even stronger in certain sectors of economic activity. There is also evidence in favour of higher

productivity growth for always exporting firms and starters, while there is a negative, though insignificant, effect for stoppers. The relationship between exporting activity and labour productivity growth weakens as we move up the firm size band. The results point to higher productivity growth for exporting SMEs – and in particular for micro SMEs.

The exporter profitability premium, when profitability is proxied by return-on-assets (RoA), is estimated at 2.8% for the whole sample in the reviewed period, and even higher in some sectors of economic activity, lending some support to the hypothesis that exporters can be more profitable than companies serving only their home market.

A new approach to governance and integration in EMU for an optimal use of economic policy framework – Priority to financial union

Working Paper No. 229
Theodoros S. Papaspyrou

This paper proposes a new approach to EMU governance and integration consisting of the following elements: (i) An optimal use of the existing EU institutional framework for economic, fiscal and financial policies is necessary and possible at each level of EMU integration that is politically feasible, in order to strengthen synergies between stability and growth policies, complete the single market, support public and private investment, and improve macroeconomic and fiscal coordination and surveillance. (ii) Priority should be given to financial union, which would facilitate the smooth transmission of monetary policy, enhance financial stability and economic growth and contribute to macroeconomic stabilisation through private risk sharing. (iii) The drive to fiscal union should be focused on the creation of fiscal backstops to banking union, enhancing its solidity and credibility. (iv) Initiatives towards deeper EMU integration should be undertaken where there is strong evidence, within the EU and beyond, of their usefulness and for which widespread political support exists, maximising benefits and avoiding controversial proposals. (v) Institutional strengthening and democratic accountability are indispensable elements for a successful EMU and should be pursued by following the "Community approach", based on the Treaties, in contrast to the "intergovernmental approach" increasingly used in recent years.

Is there accuracy of forward freight agreements in forecasting future freight rates? An empirical investigation

Working Paper No. 230
Evangelia Kasimati and Nikolaos Veraros

Participants in the maritime industry place much interest in the Forward Freight Agreements (FFA/FFAs), being an indispensable tool for hedging shipping freight risk. Our paper innovates by directly comparing the FFA predictions with their actual future settlement prices, as well as by examining contracts going forward as far as next calendar year. We combine straightforward comparison measurements with cointegration analysis to test for the accuracy and efficiency of the FFA projections. We find that FFAs display limited usefulness in pre-

dicting future freights, only slightly superior to simple naïve models. The shorter the contract period and the smaller the vessel, the better the forecast. We also find FFAs being relatively good predictors of future market direction but missing the turning points of the market cycles.

The effectiveness of unconventional monetary policy on risk aversion and uncertainty

Working Paper No. 231
Leonidas S. Robolis

In the wake of the global financial crisis, central banks throughout the world embarked on unconventional monetary policy measures in order to counter the risks to macroeconomic and financial stability. In the same vein, the European Central Bank (ECB) reacted with a basket of non-standard monetary policy measures, expanding its balance sheet to provide banks with liquidity and to improve bank lending to the real economy. The existing literature mostly focuses on the effect of unconventional monetary policy measures on government bond markets and key macroeconomic variables. The impact of such measures measures, however, on the volatility of equity markets and the risk-bearing capacity of investors is still to be explored. The paper aims to fill this gap in the literature by examining the effect of the ECB's balance sheet expansion on euro area equity market uncertainty and investors' risk aversion within a structural VAR framework. An expansionary balance sheet shock decreases both risk aversion and uncertainty at least in the medium run. A negative shock on policy rates has also a negative impact on risk aversion and uncertainty. These results are generally robust to different specifications of the VAR model, estimation procedures and identification schemes. Conversely, periods of high uncertainty are followed by a looser conventional monetary policy. The effect of uncertainty on the ECB's total assets and of risk aversion on conventional or unconventional monetary policy is not always statistically significant.

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