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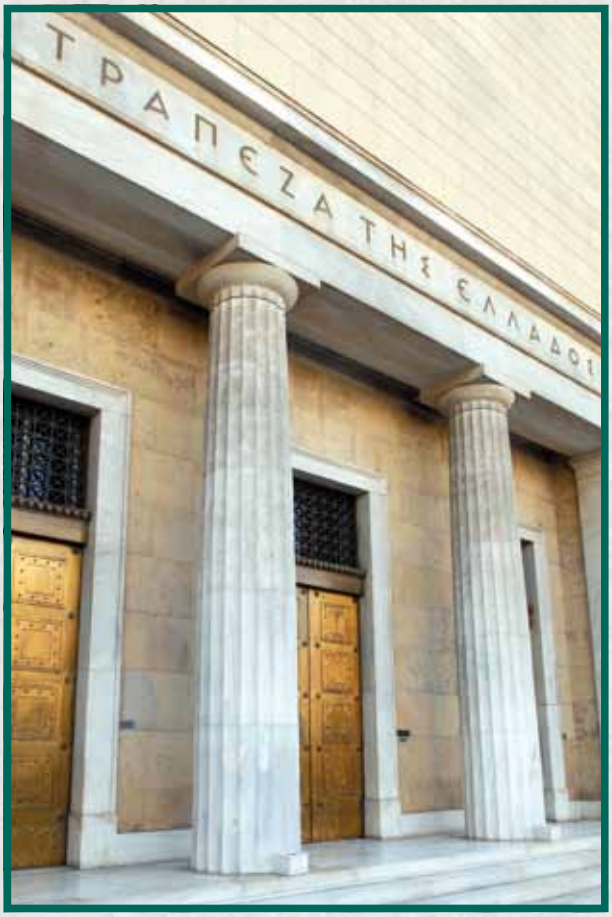

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FINANCING CONSTRAINTS AND FIRM CHARACTERISTICS: EVIDENCE FROM GREEK SMEs

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ABSTRACT

The paper analyses financing constraints faced by Greek SMEs in 2014-2017, exploiting the micro dataset of Greek SMEs provided by the Survey on the Access to Finance of Enterprises in the euro area (SAFE). More specifically, at the firm level, we examine whether certain characteristics of Greek firms such as firm size, age, exporting activity or performance were related to their access to bank credit and trade credit, while also examining complementarily the impact of the overall conditions in the economy and the banking sector. Overall, we find that firm size and performance were important limiting factors in firms' access to credit, while exporting companies have been more active in requesting financing. In addition, when borrowers' discouragement is taken into account, highly exporting firms and, in the case of bank financing, relatively younger firms too seem to be overall less likely to report constraints. Our evidence also corroborates the importance of domestic macroeconomic conditions and bank balance sheet strength for the severity of constraints encountered by SMEs.

Keywords: Financing constraints, bank credit, trade credit, small and medium-sized enterprises

JEL classification: E44, E51, G21, L25

ΠΕΡΙΟΡΙΣΜΟΙ ΣΤΗ ΧΡΗΜΑΤΟΔΟΤΗΣΗ ΚΑΙ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΤΩΝ ΜΙΚΡΟΜΕΣΑΙΩΝ ΕΠΙΧΕΙΡΗΣΕΩΝ ΣΤΗΝ ΕΛΛΑΔΑ

Ευαγγελία Γεωργίου
Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

ΠΕΡΙΛΗΨΗ

Η μελέτη εξετάζει τους περιορισμούς στην εξωτερική χρηματοδότηση που αντιμετώπισαν οι ελληνικές μικρομεσαίες επιχειρήσεις (ΜΜΕ) την περίοδο 2014-2017, αξιοποιώντας τα μικροδεδομένα του δείγματος ελληνικών επιχειρήσεων που περιλαμβάνονται στην έρευνα για την πρόσβαση σε χρηματοδότηση των επιχειρήσεων στη ζώνη του ευρώ (SAFE). Ειδικότερα, εξετάζεται κατά πόσον ορισμένα χαρακτηριστικά των μικρομεσαίων επιχειρήσεων όπως το μέγεθος, η ηλικία, η εξαγωγική δραστηριότητα και η οικονομική επίδοση συνδέονται με τους χρηματοδοτικούς περιορισμούς σε σχέση με την τραπεζική χρηματοδότηση και τις εμπορικές πιστώσεις, ενώ συμπληρωματικά εξετάζεται η επίδραση των γενικότερων συνθηκών που επικράτησαν στην οικονομία και τον τραπεζικό κλάδο. Τα αποτελέσματα των εκτιμήσεων παρέχουν ενδείξεις ότι οι επιχειρήσεις μικρότερου μεγέθους και με πιο αδύναμες οικονομικές επιδόσεις ανέφεραν συχνότερα χρηματοδοτικούς περιορισμούς. Οι εξαγωγικές επιχειρήσεις εκτιμάται ότι εκδήλωσαν υψηλότερη ζήτηση για χρηματοδότηση, ενώ, εφόσον ληφθεί υπόψη και η αποθάρρυνση των επι-

χειρήσεων από το να υποβάλλουν αίτημα δανείου, οι επιχειρήσεις με έντονα εξαγωγικό προσανατολισμό και, στην περίπτωση της τραπεζικής χρηματοδότησης, και οι σχετικά νεότερες επιχειρήσεις ήταν συνολικά λιγότερο πιθανόν να αναφέρουν χρηματοδοτικούς περιορισμούς. Επιπρόσθετα, επισημαίνεται η σημασία των εγχώριων μακροοικονομικών συνθηκών και της ευρωστίας των τραπεζικών ισολογισμών για τους περιορισμούς που αντιμετώπισαν οι ΜΜΕ.

FINANCING CONSTRAINTS AND FIRM CHARACTERISTICS: EVIDENCE FROM GREEK SMEs[1]

Evangelia Georgiou
Economic Analysis and Research Department

1 INTRODUCTION

One of the most prominent issues for policy makers in the context of the recent economic and financial crisis has been the restoration of credit growth to enterprises so as to support economic recovery and strengthen the dynamics of growth. This issue becomes even more relevant for small and medium-sized enterprises (SMEs), which have traditionally played a central role in value added, job creation and, more generally, the dynamism of the European and the Greek economy. However, conventional wisdom suggests that, despite their key role in the economy, firms which are smaller in size or present certain structural characteristics may be more exposed to credit constraints due to existing information asymmetries in credit markets.

During the past decade, the Greek economy experienced a protracted economic and financial crisis with severe negative implications for economic activity and overall credit conditions. On the one hand, credit supply was squeezed as a result of adverse bank capital and liquidity conditions and of a pronounced deterioration in the credit quality of bank loan portfolios, which was particularly evident in loans to SMEs.[2] On the other hand, the economic recession also brought about a marked decline in credit demand, as corporate balance sheets deteriorated significantly and many borrowers cut down their spending, were discouraged from applying for financing due to tight credit conditions or increasingly resorted to using internal cash flows.

Against this backdrop, the purpose of the present paper is to provide some insight into the factors relating to the credit constraints faced by Greek SMEs and to contribute to the dialogue regarding appropriate policies that can assist in easing such constraints in the future. To this end, we employ probit regression analysis based on the dataset of Greek SMEs provided by the Survey on the Access to Finance of Enterprises in the euro area (SAFE) for the 8 waves conducted during the period 2014-2017. The survey provides comprehensive information on the access to finance for a rich dataset of euro area/EU enterprises allowing for a separation between the supply-side and demand-side, as well as between perceived and experienced aspects of credit constraints. More specifically, at the firm level, we examine whether certain firm characteristics such as firm size, age, exporting activity or performance were related to firms' access to credit, while also examining, on a complementary basis, the impact of a number of macro-financial variables capturing the broader conditions prevailing in the economy during that period. Overall, we find that firm size and performance were important limiting factors in firms' access to credit, while exporting companies have been more active in requesting financing. In addition, when borrowers' discouragement is taken into account, highly exporting firms and, in the case of bank credit, relatively younger firms too were overall less likely to report constraints.

The contribution of this paper can be summarised as follows: (i) it employs a broad range of measures of credit constraints from the SAFE, capturing perceptions and actual experiences as well as demand and supply aspects of SME financing; (ii) these measures are constructed not only for bank credit but also for trade credit, i.e. for the two most important sources of financing for Greek SMEs; and (iii) apart from firm size, age and performance, this paper analytically exploits the export dimension from the SAFE dataset in empirical esti-

1 The views expressed in this article are those of the author and do not necessarily reflect those of the Bank of Greece. The author would like to thank Heather Gibson, Hercules Voridis, Hiona Balfoussia and Dora Kosma for very helpful comments and suggestions.

2 Specifically, in 2017, corporate non-performing exposures of banks represented 42% of total exposures, while the respective share within the group of very small enterprises was 65%.

mations. The remainder of the paper is organised as follows: Section 2 reviews the relevant literature on credit constraints and firm characteristics. Section 3 describes our empirical approach in terms of the data source and the methodology used. Section 4 summarises the empirical results, and Section 5 concludes.

2 RELEVANT LITERATURE

As proposed by the Modigliani-Miller theorem (1958), under the assumption of perfect and fully efficient capital markets, a firm's real economic decisions are independent of its financing structure. In this context, internal and external financing sources are considered as perfect substitutes, and financial factors such as a firm's internal funds, dividend behaviour or leverage are not relevant for the firm's investment decisions. However, once asymmetric information and other frictions in financial markets are taken into consideration, internal and external funds become imperfect substitutes, giving rise to an external finance premium for firms and thus to the emergence of financial constraints (Stiglitz and Weiss 1981).

These propositions have important implications for the transmission of monetary policy to the real economy and are embedded in the credit channel theory of monetary policy. According to this theory, the way monetary policy affects the external finance premium is further described by two distinct theoretical mechanisms: the balance sheet channel and the bank lending channel. The balance sheet channel suggests that the external finance premium faced by borrowers should depend on their financial position, i.e. fluctuations in the quality of borrowers' balance sheets affect the external finance premium, the overall terms of credit that they face and ultimately their investment and spending decisions (Bernanke and Gertler 1995). The bank lending channel relies on the special role that banks play in overcoming asymmetric information in financial markets and underlines how monetary policy may affect the external finance premium by changing bank balance sheet conditions and the supply of bank credit (Bernanke and Blinder 1988).

The role of asymmetric information in credit markets has been extensively discussed in the literature. It may arise due to the fact that firms have better information on their projects than the lenders. Insofar as the risk of a project is largely unknown to lenders, they cannot effectively discriminate between good and bad borrowers by using the interest rate. This may lead to adverse selection effects, lowering the general quality of borrowers, increasing lending to riskier borrowers or decreasing it for safer ones. It may also lead to moral hazard problems in the lender-borrower relationship, as firms may be induced to adopt a risky behaviour or act in a way that is not in the lender's interest (Stiglitz and Weiss 1981).

Such problems are thought to have exacerbated for some groups of firms with certain characteristics. For example, firms smaller in size are more likely to be financially constrained, if one assumes that size is highly correlated with the fundamental factors that determine the probability of being constrained (Schiantarelli 1996). This may be because smaller firms are thought to be more opaque than larger firms in terms of the provided quality and quantity of information, thus entailing higher monitoring costs for the undertaken projects. They may also not be able to offer adequate collateral relative to their debt liabilities or may be highly bank-dependent so that they cannot easily substitute bank loans with alternative (e.g. market-based) sources of financing. Also, younger firms may have not yet developed adequate credit track records, a high reputation or long-term relationships with lenders that could mitigate the information asymmetries they face.

Another important implication of asymmetric information discussed in the literature is the existence of discouraged borrowers, i.e. those borrowers who are in need of financing but refrain from even applying for fear of rejection. Discouragement may arise when banks cannot adequately screen prospective bor-

rowers, or when there are high bank interest rates or high application costs for firms. Understanding the behaviour of discouraged borrowers may be particularly indicative of firm behaviour and its effects on the real economy (Kon and Storey 2003; Canton et al. 2013; Ferrando and Mulier 2015).

The above theoretical arguments have led to the development of a substantial body of empirical literature which is based on the assumption of asymmetric information inducing financing constraints on firms and explores the determinants of such constraints, often considering not only bank loans but also other sources of financing (Bougheas et al. 2006). These determinants may refer to firm-specific characteristics as well as to broader economic, financial and institutional or country-specific characteristics.

On the basis of how credit constraints are measured in practice, this empirical micro-econometric literature may be split into two main categories: the first one employs firms' financial statement data, while the second one uses more direct measures of financial constraints involving direct firm self-assessment. Within the former category and following the seminal contribution of Fazzari et al. (1988), several papers tried to identify financially constrained firms in terms of the sensitivity of a firm's investment or growth to its cash flow across sub-groups of firms which are defined a priori according to criteria considered important determinants of access to finance (e.g. dividend payout rates, size, age, association with business groups or banks, corporate bond ratings, etc. – see Schiantarelli 1996).

However, the limitations that have been put forward regarding traditional measures of financing constraints based on financial statement data have led to the development of more direct approaches to measuring financing constraints by exploiting survey data that record firms' own perceptions or experiences of credit constraints and access to finance. For example, Beck et al. (2006) used a unique firm-level database of over 10,000 firms in 80 countries from the World Business Environment Survey (WBES), in order to investigate whether previously used a priori groupings of firms are indeed effective in identifying financially constrained firms as well as other country characteristics as determinants of firms' financing obstacles. Their results indicate that certain grouping criteria, specifically age, size and ownership structure of firms, are more effective in studying financing constraints, while a country's institutional development seems to be the most important characteristic explaining cross-country variation in firms' financing constraints. Canton et al. (2013) use survey data for 2005 and 2006 and for 3,500 SMEs from the Eurobarometer dataset of the European Commission to study the determinants of perceived bank loan accessibility at the firm and the country level. Their results show that the youngest and the smallest SMEs have the worst perception of access to bank loans and that SMEs in countries with concentrated banking sectors are more positive about loan accessibility than those in countries with less concentrated banking sectors. Kuntchev et al. (2014) use comparable data from the Enterprise Surveys for 119 countries to study the effect of firm size on credit constraints. They find that SMEs are more likely to be credit constrained than large firms, while firms which perform better in terms of labour productivity are less likely to be credit constrained. Kumar and Francisco (2005) also studied the role of firm size, firm performance, industry, ownership, region and other factors with respect to access to credit, based on an Investment Climate Survey of 1,642 firms in Brazil, finding that size is strongly related to access to credit and that this effect is stronger for longer-term loans.

A growing and constantly evolving part of the literature exploits the SAFE dataset to study the access to finance among euro area/EU firms. The survey, conducted bi-annually since 2009 in an increasing number of European countries, offers a rich, multi-dimensional database that enables to study financing patterns and constraints across European coun-

tries. The period since the start of the survey broadly coincides with the unfolding and the aftermath of the recent financial crisis.[3]

Some of the first papers to use the SAFE dataset provide evidence that firm characteristics such as age and ownership (Ferrando and Griesshaber 2011) or size and age (Artola and Genre 2011) relate to the probability of perceiving or actually experiencing financing constraints. To investigate further the role of firm characteristics, Ferrando and Mulier (2013) matched firms' responses to the SAFE with balance sheet information of comparable firms and distinguished between perceived and actual financing constraints. They find that age is important in explaining both perceived and actual financing constraints and that more profitable firms are less likely to face actual financing constraints. Drakos (2013) also points out that profitability and firms' net interest expenses are important determinants in explaining the cross-sectional variation in the terms and conditions of bank loans for euro area SMEs. Casey and O'Toole (2014) find that SMEs which are bank credit constrained are more likely to resort to trade credit (this effect increases with firm size), as well as to informal lending, loans from other companies or inter-company loans, but find no evidence of market finance. In a similar vein, Leitner and Stehrer (2015) identify firm-specific characteristics that determine the ease of access to both bank credit and trade credit. Their results corroborate that smaller, younger and innovating firms are more likely to face financing constraints, while they emphasise the significance of a credit record and of the financial position of firms. Andrieu et al. (2018) examine differences in obtaining bank loans and trade credit across firms, industries and countries. They show that firm age and firm size are positively linked to SMEs' access to bank loans, but only firm size is positively related to the provision of trade credit. Holton et al. (2014) use SAFE data to analyse the effects of the recent economic, financial and private debt crisis on the supply and demand for bank loans in euro area countries. Their results show that larger and older firms face the lowest risk of experiencing an actual loan rejection, but size and age are less important for firms' perceived loan availability. Reported deterioration in profits or negative firm prospects seem to matter for explaining perceived credit availability constraints. Öztürk and Mrkaic (2014) found that access to finance is positively related to firm size and age, and that increases in bank funding costs and borrowers' debt-to-asset ratios are negatively associated with it. Ferrando and Mulier (2015) also exploited the SAFE dataset to explain the characteristics and behaviour of discouraged borrowers in the euro area. They show that discouragement has strong negative real effects to the extent that it reflects lack of access to finance. Additionally, they find that the majority of discouraged borrowers are relatively risky firms that would be unable to get a loan if they had applied. In another paper, Ferrando et al. (2015) show that the improvement in credit supply arising from the ECB's unconventional monetary policy measures was particularly evident for the more creditworthy firms, while Russo and Parlapiano (2018) supported the view that declines in the cost of credit in Italy and other vulnerable countries were largely associated with the improvement in the financial situation of firms.

3 EMPIRICAL ANALYSIS: DATA SOURCE AND METHODOLOGICAL APPROACH

3.1 THE SAFE DATASET AND THE SAMPLE OF GREEK SMES

Our analysis is based on the dataset provided by the Survey on the Access to Finance of Enterprises (SAFE). The survey, which has been conducted bi-annually since 2009 by the European Central Bank (ECB) and the European Commission (EC),[4] focuses on a wide

3 The following survey of papers is by no means exhaustive.
4 Specifically, the SAFE is conducted every six months in 12 euro area countries (France, Germany, Italy, Spain, Belgium, Ireland, Greece, the Netherlands, Austria, Portugal, Finland and Slovakia) by the ECB (ECB round, October-March round), while a more comprehensive survey covering all EU and some neighbouring countries is run once a year in cooperation with the European Commission (Common round, April-September round).

sample of non-financial euro area SMEs, providing evidence of changes in their financial situation, financing needs and the availability and market conditions of external finance; complementarily and for comparison purposes, a sample of large enterprises is also included in the survey.[5] The SAFE dataset contains information on structural firm characteristics such as size, sector, age, ownership structure and export orientation and, apart from bank credit products (credit lines and term loans), also covers a number of alternative sources of financing such as trade credit from suppliers, other loans, leasing, factoring, equity capital, grants or subsidised bank loans, equity capital, debt securities, etc.

As already mentioned, our empirical analysis concentrates on the sub-sample of Greek SMEs participating in the SAFE, in order to gain a deeper insight into the particular financing problems and conditions that firms in Greece faced in the recent economic and financial crisis. We focus on the SAFE dataset from 2014 onwards (8 waves, rounds 11 to 18, from April-September 2014 to October 2017-March 2018) because that year saw revisions in various components of the survey, the composition of the sample (to ensure that it better reflects employment conditions in the euro area) and the questionnaire, with the addition of some key variables which are thus only available from that time on.

The sample of Greek SMEs included in the survey initially comprised about 200 SMEs; since the 2010H1 round, it has been expanded to almost 500 enterprises, thereby improving the information provided for the country. Moreover, since the 2014H2 round, the number of Greek enterprises included once a year in the ECB round has been further increased to around 800 enterprises.[6] Overall, for the 8 waves conducted in the period 2014-2017, the SAFE dataset of Greek SMEs consists of 5,024 observations.

Chart 1 shows the average unweighted breakdown of the sample of Greek SMEs by size, age, sector, ownership and export orientation across the 8 waves of the survey. In terms of size (based on the number of employees), almost two thirds of participating firms are micro firms, one quarter is classified as small firms and the remaining 15% as medium-sized firms. Regarding age, 80% can be characterised as older firms with 10 years or more since their establishment, while the rest 20% accounts for younger firms with less than 10 years since establishment. Regarding their ownership structure, almost two thirds of firms are owned by family or entrepreneurs, one quarter belongs to only one owner and the remaining 7% is owned by other enterprises, business associates or public shareholders. As far as their exporting activity is concerned, more than half of firms in the sample have no export activity, approximately one third export up to 50% of total turnover and 12% are mainly exporting firms. Lastly, in terms of sector of activity, almost half of the sample firms are classified as trade firms, approximately one third operates in the services sector and almost one quarter in manufacturing and construction.

As a starting point of our analysis, we review the overall financing sources for Greek SMEs, based on survey data on the financing sources which are either relevant to these firms in general or have actually been used during the reference six-month period of each survey round. Chart 2 summarises firms' responses for the period 2014-2017. In terms of relevance, i.e. whether a particular financing source has ever been used by, or is relevant to, the firm, trade credit, grants or subsidised bank loans and bank credit have been reported by more or less 50% of respondents. Leasing and equity capital have been relevant to around one quarter of firms, while retained earnings, other loans, factoring and other sources of financing seem

5 The SAFE sample of firms includes a rotating panel of enterprises so as to obtain more accurate information on changes between subsequent rounds of the survey. A company is classified as a panel if it participated in the survey at least twice, though not necessarily in consecutive waves.

6 The Greek sample of SAFE also includes a number of large enterprises. However, due to the different nature of the financing of large enterprises, our analysis focuses exclusively on the Greek SMEs dataset.

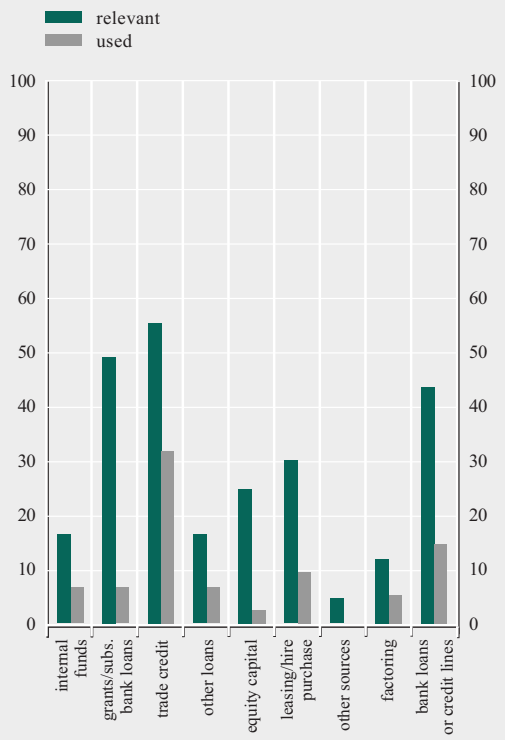
Chart 1 Breakdown of the sample of Greek SMEs by firm characteristic (2014-2017)

(unweighted percentages)

Source: EC/ECB, Survey on the access to finance of enterprises in the euro area.

Chart 2 Relevance or use of alternative sources of financing to SMEs in Greece (2014-2017)

(average percentage of respondent firms)



Source: EC/ECB, Survey on the access to finance of enterprises in the euro area.
Survey question: *Are the following sources of financing relevant to your enterprise, that is have you used them in the past or considered using them in the future? If relevant, have you used this financing source in the past six months?*

to be less relevant. As far as recent actual use (i.e. in the past six months) is concerned, trade credit is the most frequently reported financing source (almost 30% of firms), followed by bank credit (15%), leasing (9%) and other financing sources (less than 7%). On the basis of this evidence, the remainder of our analysis will focus on bank credit and trade credit,[7] as these two financing sources come up as the two most commonly used types of financing for SMEs in Greece.

Another important feature of the SAFE is that it explicitly attributes a separate role to supply-side and demand-side effects on access to credit, which is a crucial issue in analysing credit developments. For example, a monetary policy tightening or a deterioration in bank balance sheets may result in increasing supply-side credit constraints for smaller firms; on the other hand, during recessions, smaller firms may not perform well or may perform worse than larger firms, thus cutting down more on their investment projects or operations, hence reducing their demand for external finance (Kashyap et al. 1996). Furthermore, the survey enables to distinguish between perceived and actual financing constraints (Holton et al. 2014). Perceived financing constraints may embed objective information, i.e. firms' experiences of actual credit applications, but may also reflect overly pessimistic/optimistic views of firms. They may also include the effect of discouraged borrowers who do not apply for credit for fear of rejection. Discouraged borrowers seem to have been particularly relevant in the case of Greece: according to SAFE results, their proportion is relatively high compared with the euro area, ranging from 33% in 2014 to 23% in 2017 for bank credit and from 18% to 11%, respectively, for trade credit. Measures based both on firms' perceptions as well as on actual experiences in obtaining credit are considered in this analysis.

3.2 THE METHODOLOGICAL APPROACH

Our dependent variables measuring financing constraints are expressed as binary variables constructed on the basis of firms' responses to relevant survey questions. Financing constraints are examined with reference not only to bank credit (comprising credit lines, overdrafts and term loans) but also to trade credit. Table 1 summarises descriptive statistics on these variables. In more detail, we use the following dependent variables:

Dependent variables

(1) Perceived availability of credit decreased compared with the previous six months.

7 Bank credit comprises credit lines, overdrafts and term loans, while trade credit may be of a more short-term nature than a typical bank loan entailing a delay between the provision of goods or services from suppliers and their actual payment by the firm.

Table 1 Descriptive statistics for dependent and economic/financial variables

Variable	Mean	SD	Min	Max
Bank financing				
Availability decreased	0.35	0.48	0	1
Needs increased	0.62	0.48	0	1
Applied	0.25	0.43	0	1
Quantity constrained	0.37	0.48	0	1
Financially constrained	0.37	0.48	0	1
Interest rate increased	0.27	0.44	0	1
Collateral increased	0.44	0.50	0	1
Trade credit				
Availability decreased	0.28	0.45	0	1
Needs increased	0.40	0.49	0	1
Applied	0.30	0.46	0	1
Quantity constrained	0.47	0.50	0	1
Financially constrained	0.24	0.43	0	1
Economic/financial variables				
GDP growth (%)	0.29	0.70	-0.55	1.32
Bank capital adequacy ratio (%)	15.74	2.46	10.30	17.80
Bank deposit growth (%)	-2.18	7.63	-16.55	3.25
Composite bank funding cost (%)	0.75	0.29	0.40	1.22
10-year government bond yield (%)	7.67	2.07	4.89	11.67

This variable is expected to capture the perceived supply of credit. It takes a value of 1 if firms report that availability decreased and a value of 0 otherwise (availability increased or remained unchanged).

(2) Perceived needs for credit increased relative to the previous six-month period. This variable is thought to be indicative of the perceived or potential demand for credit. It takes a value of 1 for firms reporting that credit needs decreased and 0 for firms reporting that these needs either increased or remained unchanged.

(3) Actual application for credit was submitted. This variable is expected to measure actual credit demand. It takes a value of 1 for firms reporting that they actually applied for credit during the past six months and 0 for firms that did not apply.

(4) The firm experienced quantity constraints (quantity constrained). This variable measures the extent to which firms, within the sub-sample of firms that applied for bank credit, experienced financing constraints in their credit application process. It takes a value of 1 for firms that received less than 75% of the amount of financing they requested, as well as for firms which were fully rejected or refused to proceed because the cost was too high, and 0 for firms which received all or more than 75% of the amount requested.

(5) The firm experienced financing constraints in a broader sense (financially con-

strained). This variable considers, apart from firms which experienced quantity constraints in their credit application, also those firms which did not apply because of a high perceived probability of rejection (discouraged borrowers), thus combining elements from the supply and the demand side of credit. It takes a value of 1 for firms that received less than 75% of the requested financing, were overall rejected, refused to proceed because of high cost of credit or did not apply out of fear of rejection and 0 for firms which received all or more than 75% of requested financing, or did not apply because of sufficient internal funds or because of other reasons.

(6) The interest rate offered for bank financing in the past six months was increased by the bank. This variable expresses price constraints reported by firms which applied for bank financing. It takes a value of 1 if the interest rate was increased by the bank and 0 if it was decreased by the bank or remained unchanged.

(7) The collateral requirements for bank financing in the past six months were increased by the bank. This variable expresses part of non-price constraints reported by firms in their application for bank financing. It takes a value of 1 if collateral requirements were increased by the bank and 0 if they decreased or remained unchanged.

We use as explanatory variables a number of firm-specific characteristics such as size, age, export orientation and financial distress. According to size, firms are classified into three size sub-groups: micro (1-9 employees), small (10-49 employees) and medium-sized (50-249 employees). We expect that a firm's financing constraints are negatively related to size. According to age, firms are categorised in two sub-groups: 10 years or more and less than 10 years since establishment. As suggested by existing literature, we expect financing constraints to be less strong for older firms. According to their export orientation, firms are classified into two sub-groups: those with no export activity and those with some export activity (> 0% of turnover).[8] We expect that a firm's financing constraints are negatively related to its export activity. Finally, a firm is considered to be performing weakly if it reports that its turnover, profitability and own capital all decreased in the past six months. We expect that a firm's weak performance will be positively related to financing constraints.

It should be noted that we also used the ownership and sectoral criteria in several estimations. However, the ownership variable does not seem to add much information, perhaps due to a high correlation with firm size, as micro firms are more likely to be owned by one person only or family. Sectoral variables also provide inconclusive results; this could be due to the widespread nature of the economic recession that preceded the sample period or due to the particular conditions prevailing in sub-sectors and which escape the scope of this analysis.

As our dependent variables are of a qualitative nature and binary, our analysis is conducted using the following probit model. The model expresses the probability of a firm reporting a certain financing constraint —as described by our seven dependent variables above— as a linear function of the independent variables describing firm-specific characteristics which are available in the SAFE as well as certain macroeconomic or financial variables:

$$Financing\ Constraint_i = \sum_j b_j \left(firm\ characteristic_j\right)_i + a\ macro/financial + e_i$$

where *Financing Constraint*$_i$ is the reply of firm i indicating a perceived decrease in availability of financing, a perceived increase in financing needs, actual demand/application for financing, experiencing quantity constraints, experiencing quantity constraints or being a

8 Alternatively, according to the export criterion, firms are classified into those with export activity of up to 50% of turnover and those with more than 50% of turnover.

discouraged borrower, experiencing price or collateral constraints. The variable *firm characteristic*$_j$ is a vector of firm structural features such as size, age, export orientation and performance. As in Holton et al. (2014), we also run some additional specifications including, one at a time, macroeconomic or financial variables capturing different aspects of the economic crisis. Specifically, in the case of bank credit, we successively use the growth rate of real economic activity, the bank capital adequacy ratio, the growth rate of private sector bank deposits, and the composite bank funding cost from both deposit funding and central bank funding for the six-month period covered by each wave of the survey, so as to also put into perspective the broader conditions prevailing in the economy and the banking system during this time period. In the case of trade credit, we use the growth rate of real economic activity and the ten-year Greek sovereign bond yield, respectively. The disturbance parameter e_i is normally distributed and uses standard maximum likelihood estimation. Standard errors have been clustered by wave, in order to take into consideration possible correlation between the waves of the survey.

4 RESULTS

(a) Bank financing

As far as bank financing is concerned, Tables 2-4 report our probit regression results for the above dependent variables in relation to the examined firm-specific characteristics and other economic/financial variables. Perceived availability constraints (columns 1, 1a-1d) seem to be more likely for micro and small firms compared with medium-sized ones, as well as for weakly performing firms. Contrary to what one would expect, the likelihood of reporting decreased availability of bank credit is found to be lower and statistically significant for younger firms, possibly stemming from a higher optimism of these firms. With reference to the results of the same regression including an economic or financial variable, the evolution of economic activity is negatively related to the probability of perceiving bank credit availability decreases, while all financial variables, i.e. bank capital adequacy, private sector deposits and bank funding costs, are also found to be statistically significant: decreases in bank capital adequacy or bank deposit growth are associated with a higher probability of firms reporting reductions in bank credit availability, while increases in bank funding cost also relate to an increased probability of firms reporting reductions in bank financing availability.

With regard to the perceived needs for bank financing (columns 2, 2a), available results show that there is a higher probability for micro firms to report increased financing needs; this is also the case with weakly performing firms, as the relevant coefficients are found to be positive and statistically significant. Then, the inclusion of the real economic activity variable in the regression shows that an improvement in general macroeconomic conditions increases the probability of firms reporting rising financing needs. Turning to actual demand for bank financing (i.e. actual application submitted to the bank, columns 3, 3a), smaller firms show a lower probability of applying. In addition, a positive and statistically significant effect arises for exporting firms, which present a higher probability of applying for bank credit compared with non-exporting firms. Contrary to what is expected, the inclusion of the economic activity variable takes a negative sign in the bank credit application regression, possibly indicating that firms may turn to internal sources of financing as cash flows increase at the first stages of an economic recovery or borrowers' discouragement.

As far as our first measure of actual quantity constraints is concerned, it should be noted that this regression refers to the very limited sub-sample of firms which actually applied for bank credit (around 800 observations, columns 4, 4a-4d). Notwithstanding, available results suggest that the smaller the size of the firm, the higher the probability of being refused ade-

Table 2 Regression results for constraints in bank financing (credit lines and term loans) as reported by Greek SMEs participating in the SAFE (2014H1-2017H2)

	Availability decreased (1)	(1a)	(1b)	(1c)	(1d)	Needs increased (2)	(2a)	Actually applied (3)	(3a)
Firm characteristics:									
micro	0.13*** (4.07)	0.13*** (3.99)	0.13*** (4.08)	0.13*** (4.11)	0.13*** (4.05)	0.04** (2.54)	0.04*** (2.75)	-0.18*** (-4.65)	-0.18*** (-4.58)
small	0.09*** (5.56)	0.09*** (5.55)	0.10*** (5.21)	0.09*** (5.06)	0.10*** (4.98)	0.03 (1.16)	0.03 (1.38)	-0.07*** (-3.15)	-0.07*** (-3.01)
age<10 years	-0.03* (-1.71)	-0.04*** (-3.17)	-0.03** (-2.02)	-0.04** (-2.36)	-0.04*** (-2.91)	-0.02 (-0.53)	0.00 (0.12)	0.02 (1.14)	0.02 (0.87)
export activity>0% of total turnover	-0.01 (-0.58)	-0.01 (-0.40)	-0.01 (-0.59)	-0.01 (-0.47)	-0.01 (-0.48)	0.04 (1.62)	0.04 (1.60)	0.06*** (4.94)	0.06*** (4.90)
export activity>50% of total turnover	-0.01 (-0.31)	-0.00 (-0.02)	0.00 (0.14)	0.00 (0.10)	0.01 (0.37)	0.04 (1.28)	0.03 (1.01)	-0.01 (-0.64)	-0.01 (-0.46)
weak performance	0.32*** (8.96)	0.32*** (8.35)	0.31*** (7.57)	0.31*** (7.69)	0.31*** (8.06)	0.11** (2.31)	0.13*** (3.91)	-0.03 (-1.36)	-0.03** (-2.05)
Economic variables:									
real GDP		-0.11*** (-4.39)					0.19** (2.32)		-0.05* (-1.67)
bank capital adequacy			-2.70*** (-4.24)						
private sector deposits				-0.01*** (-3.15)					
bank funding cost					0.23** (2.17)				
N	3,291	3,291	3,291	3,291	3,291	3,428	3,428	3,922	3,922
pseudo-R^2	0.06	0.08	0.07	0.07	0.07	0.01	0.05	0.03	0.04

Notes: Marginal effects. Z-statistics reported in parentheses. Standard errors clustered by wave. Regarding firm size, medium-sized enterprises are the reference group; regarding age, firms of over 10 years are the reference group; regarding export activity, firms with no exports (0% of total turnover) or, alternatively, firms with less than 50% export activity are the reference group. * statistical significance at 10% confidence level, ** statistical significance at 5% confidence level, *** statistical significance at 1% confidence level.
Source: Own estimations on data from EC/ECB Survey on the access to finance of enterprises in the euro area, ELSTAT and Bank of Greece.

quate credit from banks, while the same effect also seems to clearly hold for weakly performing firms. In the respective specifications with the economic and financial variables discussed above, a higher level of bank funding cost seems to be related to an increased probability of firms being quantity constrained, while this is also true, albeit to a lesser extent, for bank liquidity constraints; real economic activity and bank capital adequacy are not found to be statistically significant in the respective regressions, possibly due to the small number of observations included in this particular specification.

As already discussed, the measure of overall bank financing constraints captures not only firms that have been quantity constrained, but also the so-called discouraged borrowers who refrain from applying for bank credit as they believe a priori that they will be rejected, thus combining both supply and demand considerations (columns 5, 5a-5d). The results of this set of regressions confirm that smaller firms as well as firms performing weakly are more likely to encounter bank financing constraints. On the other hand, relatively younger firms and firms which are mainly exporting (> 50% of turnover) record a lower probability of being credit constrained: further regressions to test this result show that for younger firms it rather stems from their lower discouragement, while for exporting firms it may arise from both lower discouragement

Table 3 Regression results for constraints in bank financing (credit lines and term loans) as reported by Greek SMEs participating in the SAFE (2014H1-2017H2)

	Quantity constrained (4)	(4a)	(4b)	(4c)	(4d)	Financially constrained (5)	(5a)	(5b)	(5c)	(5d)
Firm characteristics:										
micro	0.27*** (5.76)	0.27*** (5.91)	0.27*** (5.92)	0.27*** (5.84)	0.27*** (6.01)	0.17*** (6.62)	0.17*** (6.99)	0.17*** (6.99)	0.17*** (6.93)	0.17*** (7.15)
small	0.14* (1.72)	0.14* (1.72)	0.14* (1.71)	0.14* (1.72)	0.14 (1.64)	0.12*** (3.75)	0.12*** (3.74)	0.12*** (3.79)	0.12*** (3.83)	0.12*** (3.79)
age<10 years	-0.01 (-0.21)	-0.01 (-0.25)	-0.01 (-0.24)	-0.02 (-0.52)	-0.02 (-0.52)	-0.04** (-2.38)	-0.04*** (-2.62)	-0.04*** (-2.63)	-0.05*** (-2.75)	-0.05*** (-2.87)
export activity>0% of total turnover	0.02 (0.54)	0.02 (0.53)	0.01 (0.50)	0.01 (0.47)	-0.01 (-0.48)	0.00 (0.20)	0.00 (0.23)	0.00 (0.15)	0.00 (0.24)	0.00 (0.25)
export activity>50% of total turnover	-0.02 (-0.61)	-0.06 (-0.55)	-0.02 (-0.55)	-0.02 (-0.51)	-0.01 (-0.32)	-0.04** (-2.17)	-0.04** (-1.95)	-0.04** (-1.99)	-0.04* (-1.88)	-0.03* (-1.67)
weak performance	0.27*** (6.04)	0.26*** (6.22)	0.26*** (6.70)	0.26*** (6.08)	0.25*** (5.86)	0.19*** (10.88)	0.18*** (9.78)	0.18*** (9.65)	0.18*** (9.80)	0.18*** (9.30)
Economic variables:										
real GDP		-0.02 (-0.35)					-0.05** (-2.02)			
bank capital adequacy			-0.85 (-0.68)					-1.36*** (-3.09)		
private sector deposits				-0.01* (-1.87)					-0.00*** (-3.26)	
bank funding cost					0.22*** (3.72)					0.18*** (7.15)
N	783	783	783	783	783	3,610	3,610	3,610	3,610	3,610
pseudo-R^2	0.06	0.06	0.06	0.07	0.07	0.04	0.04	0.04	0.04	0.04

Notes: Marginal effects. Z-statistics reported in parentheses. Standard errors clustered by wave. Regarding firm size, medium-sized enterprises are the reference group; regarding age, firms of over 10 years are the reference group; regarding export activity, firms with no exports (0% of total turnover) or, alternatively, firms with less than 50% export activity are the reference group. * statistical significance at 10% confidence level, ** statistical significance at 5% confidence level, *** statistical significance at 1% confidence level.
Source: Own estimations on data from EC/ECB Survey on the access to finance of enterprises in the euro area, ELSTAT and Bank of Greece.

and more likely use of bank financing.[9] Additionally, and as expected, an improvement in the macroeconomic environment or in bank capital or liquidity positions decreases the firm-level probabilities of being credit constrained, while this probability increases when bank funding costs rise.

Regarding the terms and conditions of bank credit, available evidence is presented in Table 4. Smaller firms show a higher probability of reporting increases in interest rates (columns 6, 6a-6d), while no other firm-specific characteristic is found to have a statistically significant effect. The inclusion of economic/financial variables in subsequent specifications suggests that improvements in economic activity, bank capital adequacy or bank liquidity are associated with a lower probability of reporting interest rate increases, while a tightening in bank funding cost is positively related to the firm-level probability of reporting interest rate increases. With reference to the probability of reporting collateral constraints (columns 7, 7a-7d), a strong positive effect arises for weakly performing firms, providing some support to the argument that, irrespective of the price of loans, banks are able to discriminate between potential borrowers by differentiating collateral require-

9 Respective results available upon request.

Table 4 Regression results for constraints in bank financing (credit lines and term loans) as reported by Greek SMEs participating in the SAFE (2014H1-2017H2)

	Interest rate constrained (6)	(6a)	(6b)	(6c)	(6d)	Collateral constrained (7)	(7a)	(7b)	(7c)	(7d)
Firm characteristics:										
micro	0.12** (2.51)	0.12** (2.30)	0.13*** (2.75)	0.13*** (2.72)	0.13*** (2.78)	0.10* (1.86)	0.10* (1.95)	0.09* (1.70)	0.10* (1.80)	0.10* (1.91)
small	0.08*** (3.30)	0.07*** (3.19)	0.08*** (3.78)	0.07*** (3.66)	0.07*** (3.72)	0.10* (1.73)	0.10* (1.77)	0.10* (1.68)	0.10* (1.74)	0.09* (1.69)
age<10 years	0.07 (1.60)	0.06 (1.47)	0.07 (1.56)	0.06 (1.46)	0.06 (1.42)	0.02 (0.35)	0.02 (0.37)	0.02 (0.37)	0.02 (0.36)	0.01 (0.20)
export activity>0% of total turnover	-0.05 (-1.47)	-0.05 (-1.34)	-0.05 (-1.51)	-0.05 (-1.39)	-0.05 (-1.44)	-0.04 (-0.73)	-0.04 (-0.76)	-0.04 (-0.72)	-0.04 (-0.73)	-0.04 (-0.70)
export activity>50% of total turnover	-0.04 (-0.90)	-0.04 (-0.83)	-0.04 (-0.81)	-0.02 (-0.51)	-0.03 (-0.72)	-0.07** (-2.27)	-0.07** (-2.15)	-0.07** (-2.11)	-0.04** (-1.88)	-0.03* (-1.67)
weak performance	0.07 (1.37)	0.06 (1.28)	0.06 (1.12)	0.06 (1.14)	0.06 (1.23)	0.21*** (3.96)	0.21*** (4.35)	0.22*** (4.87)	0.21*** (4.43)	0.20*** (3.90)
Economic variables:										
real GDP		-0.05** (-2.48)					0.02 (0.46)			
bank capital adequacy			-1.71*** (-3.59)					0.77 (0.89)		
private sector deposits				-0.01*** (-5.60)					0.00 (0.30)	
bank funding cost					0.15*** (3.10)					0.20** (2.30)
N	911	911	911	911	911	932	932	932	932	932
pseudo-R^2	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.03

Notes: Marginal effects. Z-statistics reported in parentheses. Standard errors clustered by wave. Regarding firm size, medium-sized enterprises are the reference group; regarding age, firms of over 10 years are the reference group; regarding export activity, firms with no exports (0% of total turnover) or, alternatively, firms with less than 50% export activity are the reference group. * statistical significance at 10% confidence level, ** statistical significance at 5% confidence level, *** statistical significance at 1% confidence level.
Source: Own estimations on data from EC/ECB Survey on the access to finance of enterprises in the euro area, ELSTAT and Bank of Greece.

ments. In addition, firms with strong export orientation (> 50% of turnover) are less likely to report increased collateral requirements. Somewhat weaker evidence is reported for firm size: smaller firms more often report collateral constraints, but this effect is only statistically significant at the 10% level. Among economic/financial variables included in subsequent regressions, only increases in bank funding costs seem to be positively related to a higher probability of firms reporting increased collateral constraints.

Overall, and in line with other existing empirical evidence,[10] our findings on firm characteristics suggest that firm size is an important explanatory factor for bank credit constraints among Greek SMEs: smaller firms were more likely to report such constraints across almost all our estimations. This is not surprising insofar as a small firm size may reflect broader weaknesses or structural characteristics of SMEs in the Greek economy, such as the fact that they operate in low value-added sectors; limited ability to exploit economies of scale or scope; cultural preferences to remain small or under the owner's control; a low degree of

10 Firm size has also been found to significantly affect access to bank finance in several other studies: for example, Öztürk and Mrkaic (2014) provide such evidence for stressed economies, while Andrieu et al. (2018), Artola and Genre (2011), Leitner and Stehrer (2015) provide similar evidence for euro area firms and Levenson and Willard (2000) for US firms.

export- or innovation-orientedness; an undifferentiated customer base; high dependency on the domestic banking system for financing or lenders' difficulties in collecting reliable information on these firms. Moreover, weakly performing firms are more likely to report bank credit constraints, providing evidence that the borrower's performance and associated risk profile play a key role in bank credit constraints.[11] Some evidence also emerges that, when borrowers' discouragement is taken into account, relatively younger firms and firms with a strong export orientation were overall less likely to report constraints. Findings on economic and financial factors confirm the significance of domestic macroeconomic conditions for bank credit constraints and are also in favour of a bank lending channel in the economy operating through bank balance sheet conditions.[12]

(b) Trade credit

The corresponding results on trade credit are presented in Tables 5-6. Regarding perceived trade credit availability constraints (columns 1, 1a-1b) and in line with the findings on bank credit, our evidence points to a higher probability of reporting decreases in availability the smaller the firm size is,[13] while a similar positive and statistically significant effect seems to exist for weakly performing firms. Firms which are mainly exporting show a lower probability

11 The financial position of firms or, more generally, their creditworthiness has been stressed as a key factor behind financing constraints faced by SMEs in a number of studies, such as Holton et al. (2014) and Öztürk and Mrkaic (2014).
12 The significance of bank balance sheet conditions for access to bank credit in stressed economies and SMEs in particular is also shown in Öztürk and Mrkaic (2014).
13 Andrieu et al. (2018) also provide evidence on the significance of firm size for access to trade credit. The same effect is also confirmed in Garcia-Teruel and Martinez-Solano (2010) by using, however, financial statement data.

Table 5 Regression results for constraints in trade credit as reported by Greek SMEs participating in the SAFE (2014H1-2017H2)

	Availability decreased (1)	(1a)	(1b)	Needs increased (2)	(2a)	(2b)	Actually applied (3)	(3a)	(3b)
Firm characteristics:									
micro	0.07** (2.37)	0.07** (2.30)	0.08** (2.31)	0.03 (0.89)	0.03 (0.90)	0.03 (0.90)	-0.08** (-2.30)	-0.08** (-2.29)	-0.08** (-2.32)
small	0.07*** (3.58)	0.07*** (3.63)	0.08*** (3.17)	0.03 (0.79)	0.03 (0.78)	0.03 (0.81)	0.00 (0.04)	0.00 (0.04)	0.00 (0.06)
age<10 years	-0.03 (-0.82)	-0.03 (-1.15)	-0.03 (-1.26)	0.04** (2.53)	0.04** (2.39)	0.04** (2.32)	0.02 (1.14)	0.02 (1.06)	0.02 (1.06)
export activity>0% of total turnover	-0.03 (-1.22)	-0.03 (-1.18)	-0.03 (-1.31)	0.03* (1.98)	0.03* (1.84)	0.03* (1.84)	0.08*** (5.43)	0.08*** (5.23)	0.08*** (5.29)
export activity>50% of total turnover	-0.06** (-2.22)	-0.06** (-2.08)	-0.06** (-2.03)	-0.02 (-0.70)	-0.02 (-0.66)	-0.02 (-0.65)	-0.02 (-0.95)	-0.02 (-0.90)	-0.02 (-0.90)
weak performance	0.27*** (13.12)	0.25*** (11.11)	0.24*** (10.41)	0.15*** (6.31)	0.14*** (6.04)	0.14*** (6.25)	0.04** (2.12)	0.04* (1.89)	0.04** (1.76)
Economic variables:									
real GDP		-0.11*** (-2.74)			-0.02 (-1.20)			-0.03*** (-2.82)	
10-year gov. bond yield			5.1*** (12.29)			0.87** (2.01)			0.96*** (2.81)
N	2,751	2,751	2,751	2,791	2,791	2,791	2,805	2,805	2,805
pseudo-R^2	0.05	0.07	0.09	0.01	0.01	0.01	0.01	0.02	0.01

Notes: Marginal effects. Z-statistics reported in parentheses. Standard errors clustered by wave. Regarding firm size, medium-sized enterprises are the reference group; regarding age, firms of over 10 years are the reference group; regarding export activity, firms with no exports (0% of total turnover) or, alternatively, firms with less than 50% export activity are the reference group. * statistical significance at 10% confidence level, ** statistical significance at 5% confidence level, *** statistical significance at 1% confidence level.
Source: Own estimations on data from EC/ECB Survey on the access to finance of enterprises in the euro area, ELSTAT and Bank of Greece.

of reporting decreased availability of trade credit, suggesting that highly exporting firms, taking advantage of more stable relationships with their suppliers, may have had better access to trade credit. No statistically significant effect is found for firm age. As expected, the real economic activity variable seems to be negatively and statistically significantly related to the probability of firms reporting decreases in trade credit availability, while the level of the ten-year government bond yield, as an indicator of economic uncertainty, is positively related to this probability. In the regression of perceived needs for trade credit (columns 2, 2a-2b), firm size is not found to be statistically significant. However, relatively younger as well as weakly performing firms show a higher probability of reporting increased trade credit needs, while a less strong effect (significant only at the 10% level) is also found for exporting firms. Rising government bond yields are associated with a higher probability of firms reporting increasing trade credit needs. As far as actual demand for trade credit is concerned (columns 3, 3a-3b), firm size is negatively related to the probability of actually requesting trade credit, but only in the case of micro firms. It seems that, compared with the respective result for bank financing, the size effect is less strong in the case of trade credit, which is consistent with the view that information asymmetries are less severe for trade credit applications than for bank loan applications and that SMEs can more easily demonstrate their creditworthiness to trade credit suppliers than to banks (Andrieu et al. 2018; Biais and Gollier 1997). A higher and statistically significant probability of requesting trade credit is found for exporting as well as for weakly performing firms. As in the case of bank credit and contrary to what might be expected,

Table 6 Regression results for constraints in trade credit as reported by Greek SMEs participating in the SAFE (2014H1-2017H2)

	Quantity constrained (4)	(4a)	(4b)	Financially constrained (5)	(5a)	(5b)
Firm characteristics:						
micro	0.05** (2.38)	0.05** (2.38)	0.05** (2.31)	0.09*** (3.28)	0.09*** (3.30)	0.09*** (3.33)
small	0.02 (0.40)	0.02 (0.39)	0.02 (0.40)	0.09** (2.19)	0.09** (2.17)	0.09** (2.22)
age<10 years	0.08 (1.49)	0.08 (1.54)	0.08 (1.45)	-0.00 (-0.22)	-0.00 (-0.30)	-0.00 (-0.42)
export activity>0% of total turnover	-0.01 (-0.40)	-0.01 (-0.41)	-0.01 (-0.40)	0.02 (1.22)	0.02 (1.24)	0.02 (1.21)
export activity>50% of total turnover	-0.07** (-2.11)	-0.07** (-2.20)	-0.07** (-2.10)	-0.05** (-2.13)	-0.04** (-1.95)	-0.04*** (-2.03)
weak performance	0.22*** (4.87)	0.22*** (4.69)	0.22*** (4.70)	0.13*** (5.67)	0.13*** (5.53)	0.12*** (5.03)
Economic variables:						
real GDP		0.09 (0.31)			-0.02 (-0.75)	
10-year gov. bond yield			0.68 (0.75)			1.54** (1.98)
N	724	724	724	2,702	2,702	2,702
pseudo-R^2	0.03	0.03	0.07	0.02	0.02	0.02

Notes: Marginal effects. Z-statistics reported in parentheses. Standard errors clustered by wave. Regarding firm size, medium-sized enterprises are the reference group; regarding age, firms of over 10 years are the reference group; regarding export activity, firms with no exports (0% of total turnover) or, alternatively, firms with less than 50% export activity are the reference group. * statistical significance at 10% confidence level, ** statistical significance at 5% confidence level, *** statistical significance at 1% confidence level.
Source: Own estimations on data from EC/ECB Survey on the access to finance of enterprises in the euro area, ELSTAT and Bank of Greece.

the economic activity variable takes a negative sign in the trade credit demand equation, possibly suggesting increased use of internal funds during the first stages of an economic recovery.

Furthermore, according to columns 4, 4a-4b of Table 6, micro firms and weakly performing firms are more likely to report quantity constraints on trade credit, while for highly exporting firms (> 50% of turnover) this probability is found to be lower and statistically significant. No effect is detected for the economic/financial variables used in other specifications, possibly due to the relatively small number of firms requesting trade credit.

Results on the broader measure of overall trade credit constraints (columns 5, 5a-5b), which apart from quantity constraints also incorporates discouraged borrowers, also point out that both firm size and weak performance are positively and statistically significantly related to the probability of reporting credit constraints. Moreover, firms with strong export orientation seem to be less likely to report trade credit constraints. When uncertainty conditions prevail in the economy and government bond yields increase, firms tend to more often report such constraints.

5 CONCLUSIONS

In this paper, we examined the effect of firm characteristics on financing constraints faced by SMEs in Greece by exploiting micro data on Greek SMEs from the EC/ECB's SAFE for the period 2014-2017. The multi-dimensional dataset provided by the survey allows us to investigate how firm-level characteristics may interact with credit conditions faced by SMEs. Complementarily, we take into account some key macroeconomic and financial variables capturing several aspects of the receding economic and financial crisis.

Our empirical results on bank credit show that firm size and performance are important firm characteristics associated with financing constraints faced by SMEs in Greece. On the demand side, although there is a higher probability for smaller and weakly performing firms to report increased needs for financing, the respective probability of actually applying for bank financing was found to be negatively related to these two factors. We also find some evidence that exporting firms actually applied more often for bank credit. On the supply side, again these two characteristics (size and performance) emerge as significant in explaining the probability of facing bank financing constraints. On top of these effects, when discouraged borrowers are taken into account as an indication of borrowers' appetite for requesting a loan, relatively younger firms and firms which are mainly exporting show a lower probability of reporting constraints. As far as the terms and conditions of bank credit are concerned, available evidence suggests that smaller firms are more likely to be constrained by the price of credit. Weakly performing firms seem to be more likely to be constrained by collateral requirements, while highly exporting firms face a lower probability of reporting collateral constraints.

Comparing the corresponding results on bank financing and trade credit, in both cases exporting firms are found to report a higher demand for financing, possibly stemming from higher growth opportunities arising for SMEs which do not exclusively rely on the domestic market, as well as a higher confidence of export-oriented SMEs in a successful loan application. Firm size is also a common important explanatory factor: smaller firms are found to apply less often for financing, but the size effect seems to be less strong in the case of trade credit. It is also worth noting that firms identified as weakly performing show a lower probability of applying for bank credit but a higher one in the case of trade credit, while highly exporting firms are less likely to report decreased availability of trade credit, possibly implying that some firms may have taken advantage of stable relationships with suppliers. With reference to our broader measure of financing constraints encompassing dis-

couraged borrowers, available evidence suggests that firm size and performance were important limiting factors in firms' access to finance, while firms with strong export orientation were less likely to report credit constraints. Furthermore, the interaction of the firm-level data of the SAFE on Greek SMEs with broader economic and financial factors corroborates the importance of domestic macroeconomic conditions and bank balance sheet strength for the severity of credit constraints encountered by SMEs.

Overall, our results provide empirical support to the hypothesis that firms smaller in size or with weaker performance face more intense credit constraints. These two factors may be intertwined, to the extent that they reflect characteristics inherent to Greek SMEs, such as the fact that they operate in low value-added sectors, limited capacities to exploit economies of scale or scope, a low degree of export- and innovation-orientedness, cultural preferences of the owner, a high dependency on the domestic banking system or difficulties in the collection of reliable information on these firms, which make these groups of firms particularly vulnerable to credit risk and economic shocks. These firm characteristics, combined with bank capital and profitability considerations and the fact that banks, in the process of addressing the issue of non-performing loans, are less able to bear credit risk compared with the pre-crisis period, point to the need for effective policy action towards channelling available funds to financially sound investment projects and productive small and medium-sized firms with a high growth potential. To this end, productive, exporting and innovative SMEs operating in dynamic sectors should be assigned a central role, which would be beneficial to economic stability and the long-run potential growth of the Greek economy.

Current initiatives aimed at supporting SME financing through national and EU structural funds, resources from the European Investment Bank (EIB) and the European Investment Fund (EIF) in cooperation with Greek banks, and new alternative financing tools have already been designed towards strengthening SMEs' productivity, extroversion and innovation. Beyond these initiatives, SMEs' access to finance would benefit from the establishment of a central credit register, which, along with current Bank of Greece efforts to collect data on a loan-by-loan basis, could enhance the availability of timely and reliable information on SMEs' creditworthiness. Furthermore, effective procedures for restructuring financially distressed but viable SMEs and coordinated action to cover important gaps in SMEs' awareness and technical knowhow of available programmes and innovative financing tools could also contribute to ensuring a more favourable environment for SME financing.

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STRUCTURAL DETERMINANTS OF FDI INFLOWS AND THE CASE OF GREECE

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ABSTRACT

Foreign direct investment (FDI) has grown strongly as a major form of international capital transfer over the past decades. Countries all over the world compete for such investment flows, as they are considered less volatile than portfolio investment and are expected to spur long-term growth. The attraction of FDI flows depends on a number of host country attributes, including macroeconomic, geographical and institutional variables. Additionally, the extent to which FDI inflows contribute to domestic productivity and long-term growth is conditional on characteristics that shape a country's absorptive capacity. Relying on the relevant empirical literature and most recent data, this study aims to describe the trends in a wide range of variables that determine the direction of FDI flows as well as the potential of host economies to enjoy the knowledge and technology spillover effects. Special emphasis is given to the case of the Greek economy, with the trajectory of key variables explaining the overall lacklustre performance as well as the upward and downward trends in the 21st century. In conclusion, the data underline the need for the continuation of reforms in product, labour and financial markets, with a view to keeping up the positive momentum of the last two years. Moreover, the state of the Greek economy's absorptive capacity is concomitant with the generation of substantial positive externalities from FDI inflows.

Keywords: Foreign direct investment, absorptive capacity, economic growth, externalities

JEL classification: O43, F21, F38, F65, G20

ΔΙΑΡΘΡΩΤΙΚΟΙ ΠΡΟΣΔΙΟΡΙΣΤΙΚΟΙ ΠΑΡΑΓΟΝΤΕΣ ΤΩΝ ΡΟΩΝ ΞΑΕ ΚΑΙ Η ΠΕΡΙΠΤΩΣΗ ΤΗΣ ΕΛΛΑΔΟΣ

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ΠΕΡΙΛΗΨΗ

Οι ξένες άμεσες επενδύσεις (ΞΑΕ) έχουν αναπτυχθεί ραγδαία ως κεντρική μορφή διεθνούς μεταφοράς κεφαλαίου κατά τις περασμένες δεκαετίες. Οι χώρες ανά την υφήλιο ανταγωνίζονται για την προσέλκυση ΞΑΕ, καθώς παρουσιάζουν μικρότερη μεταβλητότητα από τις ροές χαρτοφυλακίου και αναμένεται να ευνοήσουν τη μακροπρόθεσμη οικονομική μεγέθυνση. Η προσέλκυση ροών ΞΑΕ εξαρτάται από μια πλειάδα χαρακτηριστικών της χώρας υποδοχής, συμπεριλαμβανομένων μακροοικονομικών, γεωγραφικών και θεσμικών μεταβλητών. Επιπροσθέτως, ο βαθμός στον οποίο οι ροές ΞΑΕ συνεισφέρουν στην εγχώρια παραγωγικότητα και οικονομική μεγέθυνση είναι συνδεδεμένος με χαρακτηριστικά που καθορίζουν τη δυνατότητα απορρόφησης της οικονομίας. Ακολουθώντας τη σχετική εμπειρική βιβλιογραφία και τα πιο πρόσφατα δεδομένα, η παρούσα μελέτη έχει σκοπό την περιγραφή των τάσεων σε ένα

ευρύ φάσμα μεταβλητών, οι οποίες καθορίζουν τόσο την κατανομή των ροών ΞΑΕ όσο και τη δυνατότητα των χωρών υποδοχής να εκμεταλλευθούν τα αποτελέσματα διάχυσης τεχνολογίας και γνώσης. Ειδική μνεία γίνεται στην περίπτωση της ελληνικής οικονομίας, καθώς η διαχρονική εξέλιξη των σχετικών μεγεθών προς την προσέλκυση επενδύσεων εξηγεί τη συνολικά μέτρια πορεία της χώρας αλλά και τις περιπτώσεις ραγδαίας ανόδου και πτώσης στις ροές ΞΑΕ μετά το 2000. Εν κατακλείδι, τα δεδομένα υπογραμμίζουν την ανάγκη συνέχισης των διαρθρωτικών μεταρρυθμίσεων στις αγορές προϊόντων και εργασίας αλλά και στο χρηματοπιστωτικό τομέα, ούτως ώστε να διατηρηθεί η ανοδική δυναμική των τελευταίων δύο ετών. Ακόμη, η δυνατότητα απορρόφησης της ελληνικής οικονομίας είναι συμβατή με τη δημιουργία σημαντικών θετικών εξωτερικοτήτων από τις ροές ΞΑΕ.

STRUCTURAL DETERMINANTS OF FDI INFLOWS AND THE CASE OF GREECE

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I INTRODUCTION

Foreign direct investment (FDI) has grown strongly as a major form of international capital transfer over the past decades. Between 1980 and 2014, the world FDI stock —defined as cross-border expenditures to acquire or expand corporate control of productive assets— has increased from less than USD 1 trillion (or 6% of world GDP) to almost USD 25 trillion (or 33% of world GDP). Notwithstanding a small drop in the years following the global financial crisis, this development largely reflects the increased global integration and the gradual harmonisation of policies regarding trade and FDI barriers. Countries all over the world actually compete for such investment flows, as they are considered less volatile than portfolio investment (Campos and Kinoshita 2008) and are expected to spur long-term growth (Sekkat and Veganzones-Varoudakis 2007). Nonetheless, the extent to which the presence of Multinational Corporations (MNCs) generates positive spillovers for domestic growth is dependent on a number of host country characteristics (De Mello 1999) as well as on the specific traits of the capital inflows (Blomström et al. 1999; Dunning and Fontanier 2007).

The case of Greece is of particular interest given the country's near ten-year experience with an unprecedented recession and a secular drop in private investment. The record low levels of gross fixed capital formation, coupled with the inability to boost aggregate demand through countercyclical fiscal policy, underline the importance of attracting capital from abroad. The overall performance of the Greek economy in the realm of FDI inflows can be described as lacklustre, considering global trends and the performance of countries with common characteristics such as location and stage of economic development. In this paper it is argued that this is a consequence of poor performance in key economic variables that are determinants of FDI inflows following the extensive theoretical and empirical literature on the topic.[1] More specifically, in the sphere of major structural reforms, Greece still falls short of best practices. Nonetheless, the most recent data (OECD, UNCTAD) reveal a surge in inward flows in 2016 and also a gradual shift towards harmonisation with peers in the field of institutional performance and structural reform.

The aim of this paper is to describe and assess developments in inward FDI for the Greek economy and try to identify the structural characteristics that drive FDI inflows.

Taking into consideration a battery of empirical studies, we attempt to summarise the potential positive impact of moving towards best practices in key reform areas. On top of acting as significant pull factors for MNC investment, many of the structural variables in question facilitate the absorption of FDI and catalyse the positive spillovers for the host economy (Blomström and Kokko 1998). To this end, we explore the growth potential of increased FDI flows based on the economy's absorptive capacity as well as the nature of the flows in terms of origin country, sector of focus and technological component.

This paper is organised as follows: The next section presents the data on FDI inflows to Greece. Section 3 draws comparisons with selected countries and regions, while Section 4 reviews the economic and institutional determinants of FDI with a focus on Greece. Section 5 analyses the attributes that invigorate

* This research was conducted when Konstantinos Dellis was visiting Bank of Greece on the Bank's programme of cooperation with universities. The views expressed in this article are those of the author and do not necessarily reflect those of the Bank of Greece. The author is responsible for any errors or omissions.

1 See Blonigen and Piger (2011) for a critical overview of the empirical literature on FDI determinants.

the absorptive capacity of a host economy and Section 6 concludes.

2 OVERVIEW OF RECENT TRENDS IN GREEK FDI INFLOWS

2.1 TOTAL FDI INFLOWS

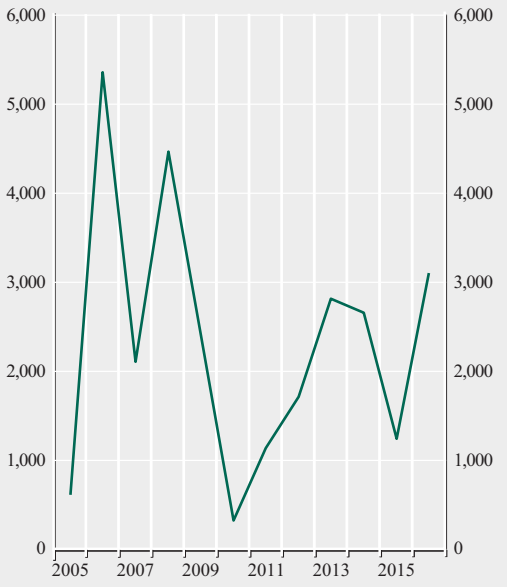
Our analysis starts by looking at the most recent data from the OECD *Benchmark Definition 4* (BMD4)[2] for total FDI inflows. From 2005 to 2016, Greece received, on average, USD 2.7 billion of FDI,[3] albeit with notable volatility, as can be seen in Chart 1. The highest value was recorded in 2006 with USD 5.3 billion, and also 2008 saw a total inflow of more than USD 4 billion. This process of increased integration was abruptly reversed after 2008, following the decline in global trade and capital flows as well as the severe recession in the euro area and Greece in particular. Nonetheless, a rebound to USD 3.15 billion in 2016 could point to a new virtuous circle for FDI inflows to the Greek economy. According to the most recent data from the OECD (2018), net FDI inflows to Greece surpassed USD 4 billion in 2017, indicating that the performance of the previous year was not just a spike in the data. Once we disaggregate according to the type of FDI, it is evident that net equity FDI has remained in positive territory, compensating for the continuously negative position of debt flows and the sharp drop in earnings reinvestment.

In relative terms, we turn to FDI inflows as a percentage of Greek gross domestic product (GDP), as depicted in Chart 2. With a peak close to 2% of GDP, Greece lies below EU and OECD averages, as we will clearly see in Section 3. It is also worth considering that the upward trend from 2010 to 2013 is augmented by the fall in Greek GDP during that period. This is also one of the factors behind the performance of 2016 (1.6% of GDP) surpassing that of 2008, since in Chart

2 The OECD does not report data for non-resident Special Purpose Entities (SPEs) in the case of Greece.
3 All data refer to net inflows.

Chart 1 Greece: Inward FDI (2005-2016)

(USD millions)



Source: OECD.

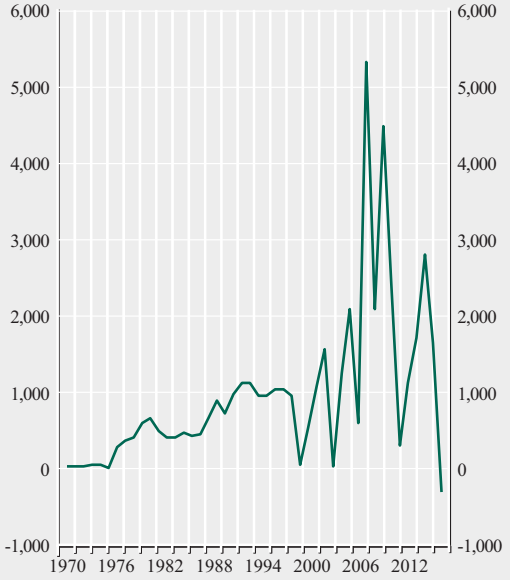
Chart 2 Greece: Inward FDI as a percentage of GDP (2005-2016)

(%)

Source: OECD.

Chart 3 Greece: FDI inflows (1970-2015)

(USD millions)



Source: UNCTAD.

1 we can see that the value in millions was larger in 2008.[4]

In order to put foreign capital flows into Greece into historical perspective, we augment the analysis using data from the United Nations Conference for Trade and Development (UNCTAD), which date back to 1970. Differences in methodology notwithstanding,[5] this allows for a broader examination of trends in FDI over the past forty years.

The utilisation of historical data from UNCTAD going back to 1970 reveals a sharp increase after 1976 and relatively stable flows during the 1980s (see Chart 3). The forces of globalisation seem to take effect in the early 1990s with a sudden dip in 1998. The USD 1 billion threshold was reached for the first time in 1990, and the real take off occurred after the adoption of the common currency in 2002, albeit short-lived due to the crisis of 2008. As we will elaborate in the next section, Greece failed to fully participate in the global FDI boom after 1989 and since 1980 has experienced the FDI cycle with a slight lag compared with other EU and OECD economies.

2.2 FDI FLOWS BY INDUSTRY AND SECTOR

A particular area of interest is the allocation of these FDI inflows across industries and sectors within the economy. The most pronounced feature from this analysis is that capital flows towards specific sectors are particularly volatile, consisting of notable peaks and troughs. Taking this fact into consideration, some patterns emerge from the data commencing in 2000.

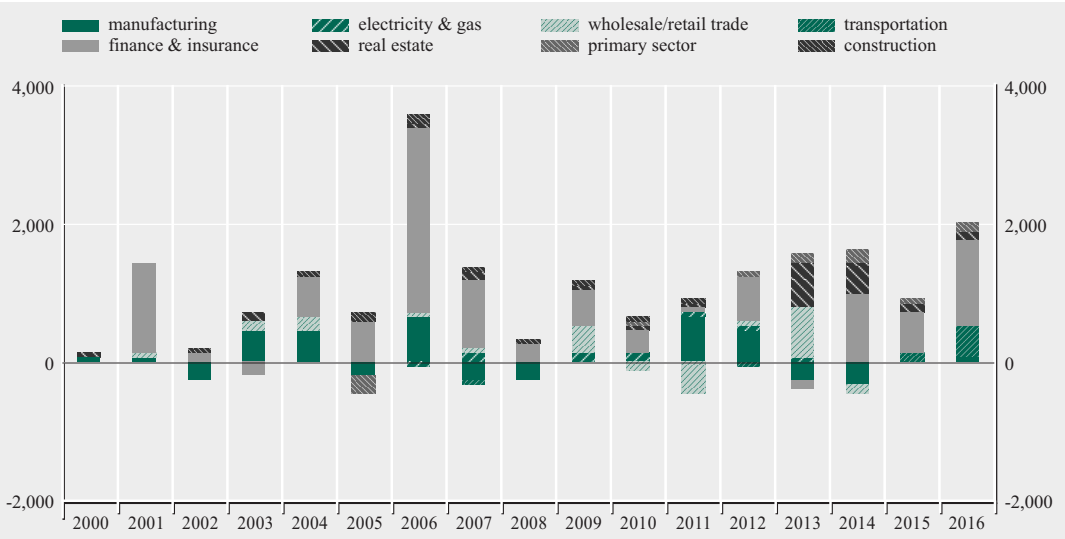
The first and most robust conclusion that stems from examining the sectoral allocation of FDI in Greece is the overwhelming concentration in the services sector. The inflows to the services economy[6] stood at USD 2.3 billion and accounted for 83% of total inflows in 2016. This effect is not temporary, as the average share for the 2000-2016 period stands at 81.2%. Within the services economy, the financial sector attracts the lion's share of FDI in the period after 2000 and is largely responsible for the impressive hike in 2006,[7] as shown in Chart 4. The vulnerability of the Greek financial and banking sector following the sovereign debt crisis is reflected in a sharp drop in FDI flows between 2011 and 2013. Recent data, however, underscore the importance of the financial sector for the revival of inbound FDI flows in 2016.

Foreign involvement in Greek banks is evident in the EUR 3 billion inflows in the financial intermediation sector during the 2010-2011 period. At the same time though, auxiliary financial institutions recorded substantial negative flows (EUR 2.6 billion) that

4 Recently released OECD data for 2017 measure the ratio of FDI to GDP at slightly above 2% (not depicted in Chart 2).
5 Both institutions report net FDI inflows, so that a negative sign implies a net decrease in the liabilities of the affiliated company; however, UNCTAD data do not account for the presence of Special Purpose Entities (SPEs).
6 The services economy covers NACE codes G through U.
7 The value of net FDI inflows to the financial sector in 2006 reached EUR 2.3 billion, largely attributable to the acquisition of 71.9% of Emporiki Bank by French bank Crédit Agricole.

Chart 4 Greece: FDI inflows by sector (2000-2016)

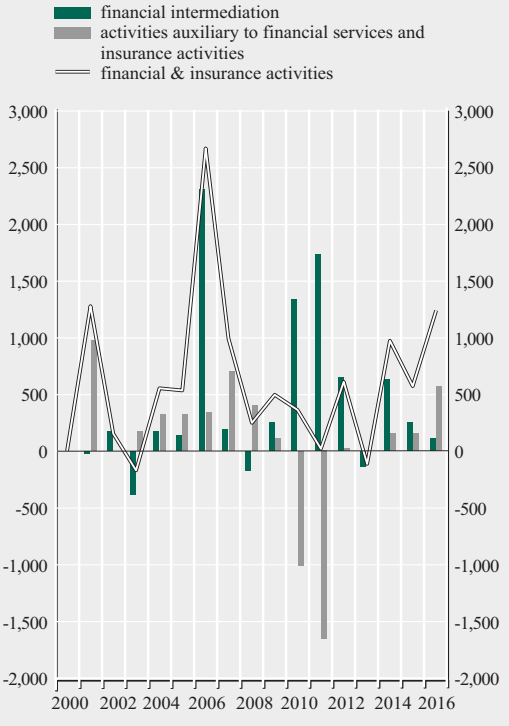
(EUR millions)



Source: Bank of Greece.

Chart 5 Greece: FDI flows into the financial sector (2000-2016)

(USD millions)



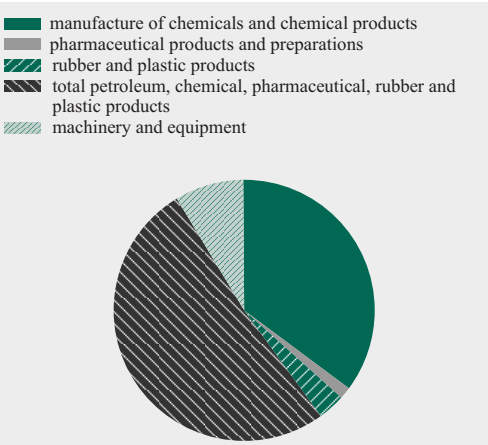
Source: OECD.

brought down the overall value for the financial sector. In 2016 FDI inflows of EUR 576 million were recorded for activities auxiliary to financial services. Chart 5 illustrates the trajectory of these two variables, compared with that of the financial sector as a whole (including insurance).

Focusing on the other services sectors, what catches the eye is the EUR 2.8 billion inflows in the information and communication industry in 2008 (not shown in Chart 4), which is a clear outlier when looking at the data for the sector in the years following 2000. This amount is almost in its entirety (EUR 2.5 billion) attributable to the acquisition of the Hellenic Telecommunications Organization (OTE) by Deutsche Telekom. More recent data show a notable increase in real estate activities after 2012, following a decade of positive, stable but limited flows. The insurance sector has picked up during the past two years, with cumulative flows reaching EUR 560 million in 2015 and 2016.

Furthermore, the negligible role of the primary sector in attracting foreign capital is visible

Chart 6 Greece: FDI flows into manufacturing (2000-2016)



Source: Bank of Greece.

throughout this period. The share of the agricultural sector with respect to the sum of FDI flows to the economy has been below 1% every year since 2006, with the exception of 2010 (3.2% of total flows). Having mentioned that, a pick-up in mining activity was observed after 2012, mostly related to El Dorado Gold investing in the Chalkidiki mines. The high degree of volatility is the key takeaway from the manufacturing data, for which the standard deviation of EUR 330 million stands out. A further point to note is that not only does it shift in magnitude but also in sign as we focus on net capital flows. The strongest industry within the manufacturing sector is undoubtedly the chemical, pharmaceutical and petroleum industry, attracting EUR 500 million in 2006, EUR 150 million in 2015 and EUR 117 million in 2016 (see Chart 6). The food industry has experienced mostly negative flows after 2003 and so has the textile industry.

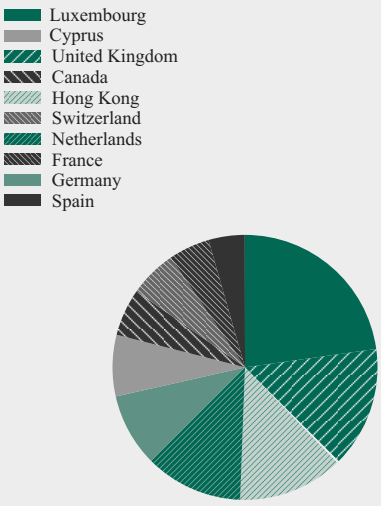
In conclusion, the forces of the global economy and the emergence of the financial crisis have led to substantial volatility in the sectoral allocation of FDI flows to Greece since the year 2000. As noted above, despite the occurrence of one-off spikes, some noteworthy patterns manifest themselves; nonetheless, the course of the following years will demonstrate their robustness.

2.3 FDI BY PARTNER COUNTRY

A further breakdown of FDI activity in Greece by origin country of the parent firm allows us to elaborate on the type of capital inflows accruing to the country. In the absence of firm-level data, we look at overall country characteristics that could provide useful information on the potential technology component and spillovers of foreign investment.[8] To this end, we utilise data from the Bank of Greece that further distinguish flows according to activity on top of origin country.

Chart 7 reports data for the top ten investors in 2016. Nonetheless, data on Luxembourg should be treated with caution due to the extremely high number of SPEs (Dellis et al. 2017). Once Luxembourg is omitted from the sample, the UK emerges as the main contributor of capital flows into Greece; however, this

Chart 7 Top 10 investor countries in Greece (2016)

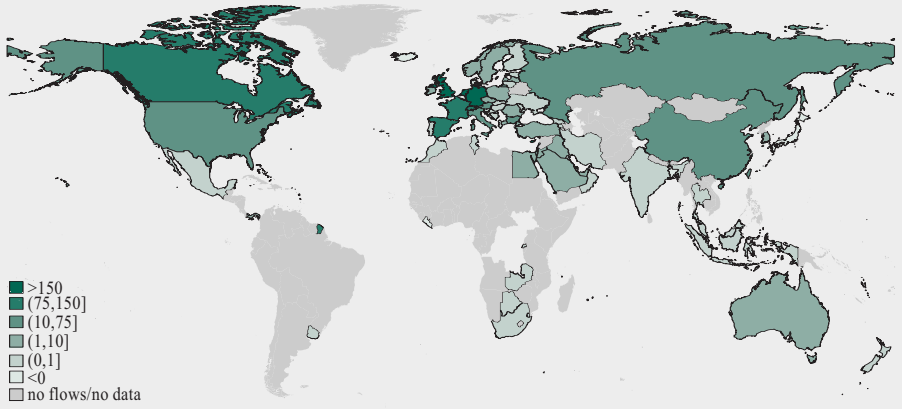


Source: Bank of Greece.

8 See the discussion on origin country characteristics in Gorodnichenko et al. (2014).

Chart 8 Net FDI inflows by parent country (2016)

(EUR millions)



Source: Bank of Greece.

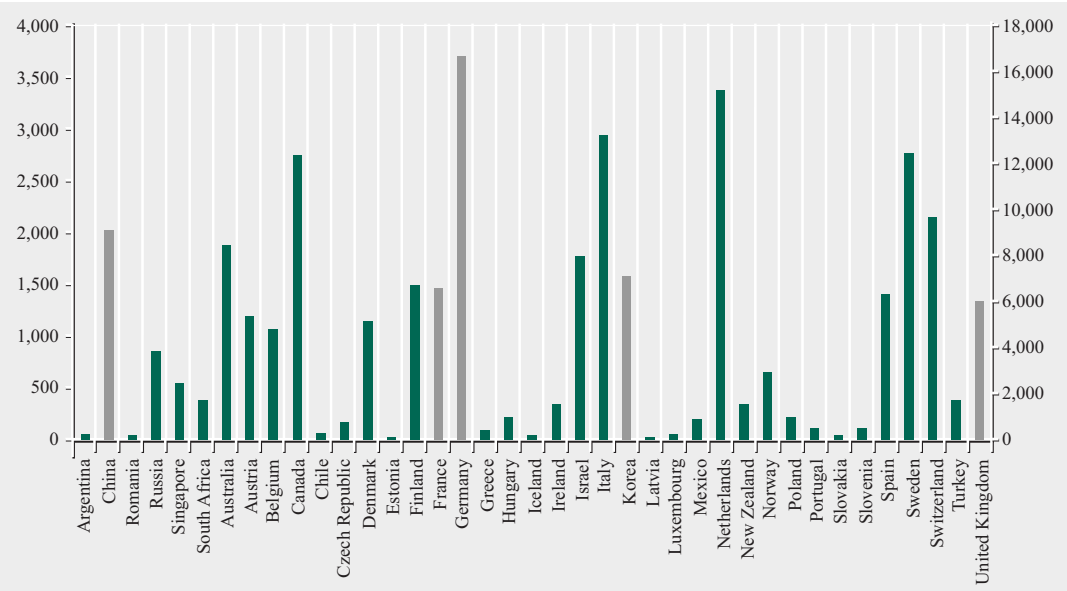
relationship has been far from stable. Data for the period after 2000 also contain significant negative net flows (2008, 2009 and 2014), which point to the volatility of direct capital from the UK. Cross-checking the data with the OECD database on Research and Development (hereinafter R&D) expenditures as a percentage of GDP, it can be deduced that the largest share of investment comes from countries with total R&D spending above the sample median value of 1.765% of GDP. The vast majority of investor countries in 2016 are high-income OECD economies with strong R&D performance. As we will see in Section 4.4, this increases the probability of productivity spillovers stemming from foreign capital. Notable exceptions include Bermuda in the 10th place (however, this clearly implies some intermediation from SPEs) and Bulgaria in the 14th place. The map above illustrates the relative intensity of FDI flows by parent country in 2016.

Turning to the overall picture after 2000, we can note that the top three investor countries are France, Germany and the United States, with average flows above EUR 100 million per year. All these countries spend on average more than 2% of their GDP on R&D activities. This, in turn, implies that, given adequate foundations and absorptive capacity, Greek domestic firms and the economy as a whole can enjoy positive technology spillovers. Moreover, these three economies are among the pillars of global innovation, as can be seen from the number of patents filed each year. The United States stands out with more than 47,000 patents filed, but France and Germany lead the table once we exclude the United States and Japan, as shown in Chart 9.

France and Germany also rank high on the European Commission's Summary Innovation Index, on average, from 2000 to 2016. In addition, Switzerland, which is the 7th most important investor on average, clearly leads the innovative economy. The importance of the productivity of the parent company for positive productivity spillovers to occur is underscored inter alia by Peri and Urban (2006). At the aggregate level, given the country-level data used in this study, technology and innovation variables at the economy level can serve as a proxy for the productivity differential of parent companies. The knowledge intensity of FDI, as measured by the innovative capacity of parent firms, is a pivotal catalyst for the positive effects of FDI on the host economy (Crespo and Fontoura 2007; Guellec and van Pottelsberghe de la Potterie 2004). A further elaboration of this point is carried out in Section

Chart 9 Parent country patents (2000-2016)

(number of patent applications filed under the PCT, averaged country data)



Source: OECD.
Note: China, France, Germany, Korea and the UK are plotted on the right-hand scale.

5.3; however, the bilateral country data clearly show that Greece can tap into advanced technology, given that a significant part of its inflows comes from technologically advanced economies.

3 GREEK FDI IN THE GLOBAL CONTEXT

3.1 GREECE AND THE EURO AREA/EUROPEAN UNION

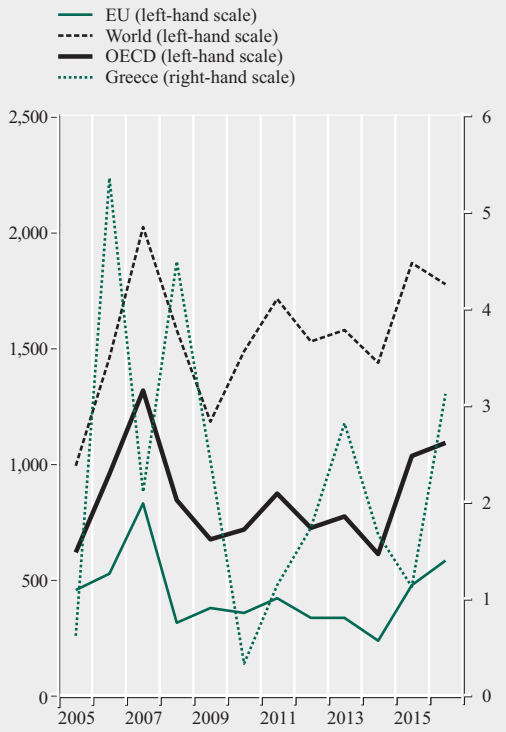
As shown by Chart 10, Greece capitalised on the gradual increase of FDI flows to the euro area (hereinafter the EA), which had peaked in 2002 (not shown in Chart 10), with a lag. The country's record year in terms of inflows was 2006, but this development was heavily reversed after 2008 both for the entire economic area and for the country. The EA saw its share in world FDI inflows fall steeply to less than 15%, losing ground to East Asian economies with or without China and the other BRICS.[9] After 2012, these regions outperformed the EA in terms of global share. In the European Union (hereinafter the EU) FDI stalled from 2008 to 2014, with negative growth in all years except 2011. Greece experienced a modest growth in inflows over the 2011-2014 period, but did not keep pace with the sharp increase of 2005 in the EU. Most recent data, however, point to a rapid expansion in 2016 towards the levels of 2008 and 2006, should this trend continue. Measured as a fraction of GDP, the 2016 value is very close to that of 2006. The share of FDI inflows accruing to the EU reached its highest level in 2000, i.e. 50%, according to data from UNCTAD.

Historical FDI data suggest that Greece follows the surges in advanced economies' FDI with a slight lag, only after the adoption of the euro. On average, the Greek economy remains broadly in line with the advanced world. Nonetheless, the largest shift in inbound capital flows took place in the 2002-2008 period for Greece, whereas the most pronounced spike in FDI inflows for the EA and

9 Brazil, Russia, India, China and South Africa.

Chart 10 FDI inflows: Greece, European Union, OECD and world (2005-2016)

(USD billions)



Source: OECD.

the EU is recorded in the 1997-2001 time interval. The situation after 2010 is much more volatile in Greece than in the EU and the EA, with a sharp rise from 2010 to 2012 followed by a substantial dip and a subsequent upturn in 2016.

Descriptive statistics show significantly lower FDI as a percentage of GDP for Greece throughout the 1980-2015 period, but with lower volatility. This divergence is driven by developments after 1995, as clearly depicted in Chart 11. The Greek economy was slow to adapt to the paradigm of increased trade and capital flows that emerged after 1990 and missed the FDI boom that took place in the developed world towards the end of the 20th century. However, the burst of the tech bubble in the US and Greece's trajectory towards the euro closed the gap from 2001 to 2004, mostly through the convergence of other advanced economies to Greece's more modest inflows measured as a share of economic activity.

Looking closely at the countries that comprise the EA periphery known as GIIPS[10] in Chart 12, one can note the relatively poor performance of Greece compared with economies also hit severely by the recession after 2008. We account for this factor by reporting Greek FDI as a percentage of GDP, which remained at low levels after 2008 but picked up in 2016, reaching the same levels as in Spain and Italy and converg-

10 Acronym for Greece, Ireland, Italy, Portugal and Spain.

Table 1 FDI as a percentage of GDP (1990-2015)

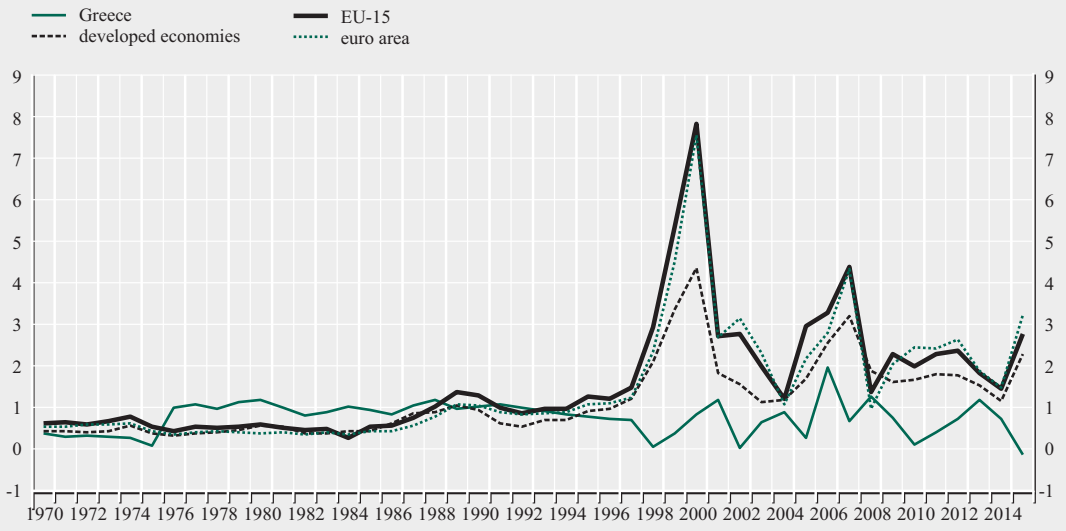
(%)

Country/region	mean	median	min	max	cv[1]
Greece	0.795459	0.840132	-0.14993	1.959317	0.510315
Advanced economies	1.366993	1.135954	0.372478	4.35806	0.669512
Transition economies	2.093192	2.028252	0.002093	5.136684	0.698594
BRICS	1.627338	1.787619	0.268551	3.079911	0.617734
EU-15	1.866625	1.369594	0.267071	7.830622	0.822271
EA	1.748984	1.088667	0.339706	7.543812	0.85573
OECD	1.355606	1.153402	0.384561	4.237956	0.649666
World	1.569841	1.501543	0.43548	4.131455	0.607423

1 Coefficient of variation (cv) is defined as the ratio of the standard deviation to the sample mean.

Chart 11 FDI inflows: Greece, developed economies, EU-15 and euro area (1970-2015)

(% of GDP)



Source: UNCTAD.

ing to the levels of Portugal. Ireland has been excluded from this analysis since it is a clear outlier, with FDI inflows averaging above 18% of GDP for the 2000-2016 period. Portugal in particular experienced increased flows in absolute terms after 2009 with the exception of 2013. This fact, coupled with the slowdown in economic activity, explains the increase from 0.8% of GDP in 2009 to 4% of GDP in 2012. By contrast, despite the greater recession in Greece, FDI inflows also decreased, preventing the ratio from rising substantially until the surge recorded in 2016 and 2017.

The evolution of the dynamics of capital flows over time in Greece and other advanced economies can be assessed also by looking at the change in FDI flows within five-year intervals. The divergent path of Greece during the first spike of FDI in the late 1990s is evident, as the flows towards the EU almost tripled in the 1995-2000 period, while remaining practically the same for Greece. Chart 13 shows the Greek hysteresis in FDI inflow growth more prominently through the remarkable increase that was observed during the first decade of the 21st century, although it should be noted that

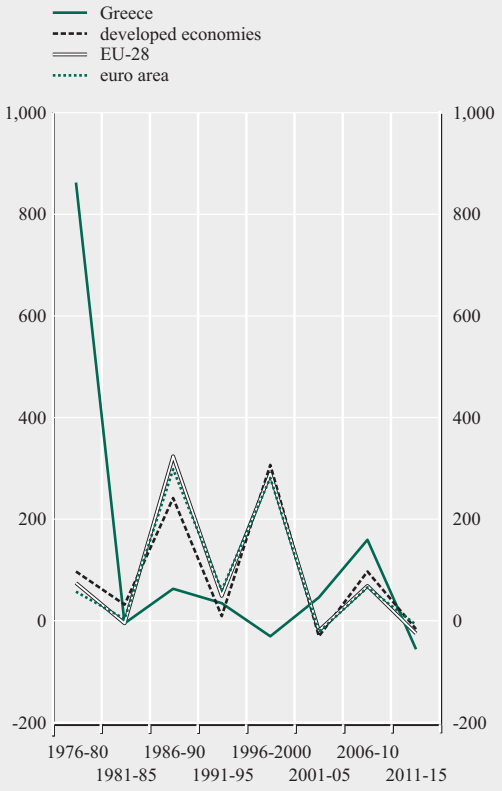
Chart 12 FDI inflows: Greece, Italy, Portugal and Slovenia (2005-2016)

(% of GDP)

Source: OECD.

Chart 13 Percentage changes in FDI inflows

(average five-year percentage changes)



Source: UNCTAD.

this increase came to a sudden halt after 2008. By contrast, the EU and the EA experienced their highest changes in inbound FDI in the late 1980s and late 1990s. A further breakdown of the historical data can help identify "spikes" in FDI inflows. Taking yearly data, we define such a spike as a year-on-year growth rate of FDI inflows that is higher than one sample standard deviation of the overall growth rate. Such incidents for Greece are observed in 1976, 1999, 2003 and 2006, following similar trends in the EU-28 (1998, 2005). A similar picture is also evident when looking at the data for the EA.

Overall, Greece seems to follow the European pattern, as shown by the longer UNCTAD series on FDI inflows. Nonetheless, the country's inflows exhibit a 0.47 correlation coefficient with total EU flows but a higher value (0.47) with lagged (by 1 period) flows. On average (1970-2015), Greece accounts for slightly over 1% of total EU inflows, with the UK being the champion accounting for a quarter of total inward flows. The volume of the EU share is unsurprisingly low given the country's small relative size. What is of greater interest is the evolution of this share over the years. The highest share was recorded in 1984 (6%) before the big boom of the 1990s. Once the data series is restricted to 1990 onwards, the average Greek share drops to 0.6%. After the 1990s, Greece lags behind Portugal almost every year. The most recent OECD data paint a brighter picture, as FDI flows into Greece reached 1.7% of GDP in 2016 and were marginally over 2% of GDP in 2017, a figure that beats the previous record high of 2006 (1.9%). This development, coupled with the structural reforms taking place after 2011 (see Section 4 for details), could mark a period of sustainably high foreign capital flows into the country.

3.2 GREECE AND THE WORLD

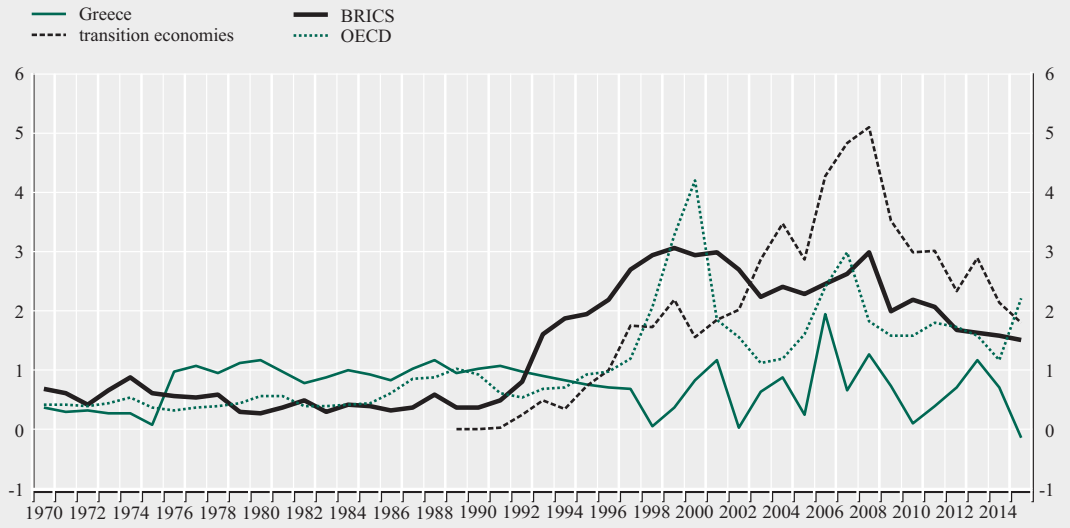
As emphasised in the previous section, Greece seems to follow developments in the OECD countries and the developed world in general, albeit less markedly in terms of absolute flows and as a percentage of GDP. The transition economies and BRICS have witnessed a significant rise in the FDI that they received after 1990 and exhibit a divergent behaviour compared with the advanced economies, as depicted in Chart 14.

Chart 15 clearly shows a surge in capital flows towards transition economies. To be more precise, the period following the transition up until the onset of the global financial crisis was marked by a pronounced movement of capital towards these economies. For example, FDI flows from 1994 to 2008 averaged almost 8% of GDP in Estonia, 5.7% in the Czech Republic and 6.2% in Hungary.[11] During the

11 Hungary is a special case due to many SPEs which are not controlled for in the UNCTAD data.

Chart 14 FDI inflows: Greece, transition economies, BRICS and OECD (1970-2016)

(% of GDP)

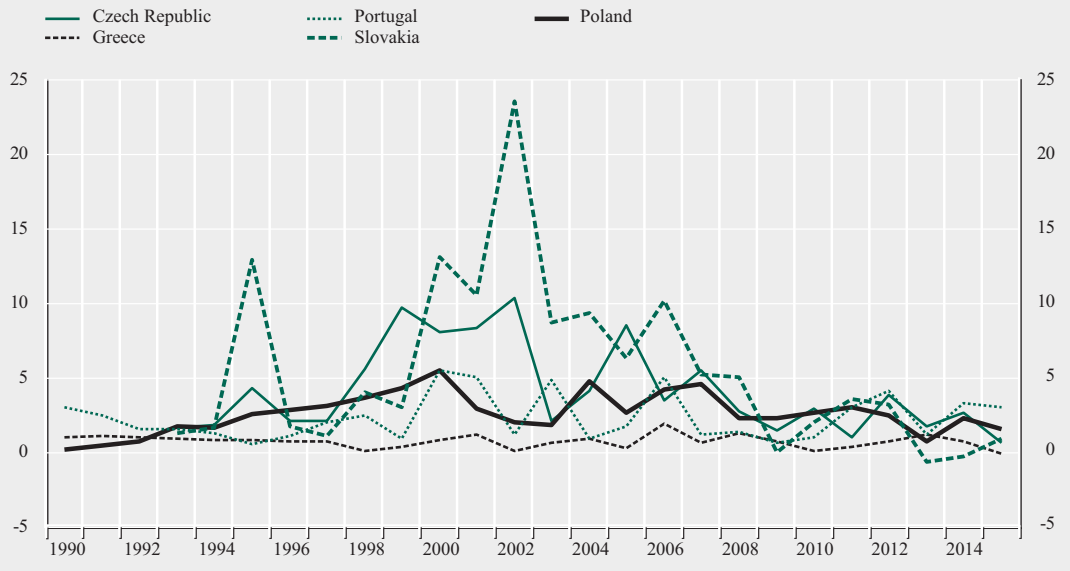


Source: UNCTAD.

same period, FDI flows averaged 0.7% of GDP in Greece. Nonetheless, the data imply a convergence in shares to below 2% of GDP after 2010. As will be discussed in Section 4, the high capital flows recorded in the transition economies in Europe can be attributed to a number of economic and institutional factors, as these economies shifted from central

Chart 15 FDI inflows: Greece, Portugal and transition economies (1990-2015)

(% of GDP)



Source: UNCTAD.

planning to increased openness to trade and investment and rapid liberalisation policies in labour and product markets. Bevan and Estrin (2004) also underline the differences in unit labour costs relative to Western European economies, as well as the countries' proximity to major source countries such as Germany and France.

4 DETERMINANTS OF FDI INFLOWS AND THE CASE OF GREECE

4.1 ECONOMIC FACTORS

The host country characteristics that act as pull factors for foreign capital inflows have been investigated thoroughly in the empirical literature.[12] Building on the pioneering work of Dunning (1973, 1980) and the introduction of the *Ownership-Location-Internalisation (OLI) paradigm*, scholars have focused on location advantages that could affect the decisions of a multinational corporation. The OLI paradigm refers to economic, structural and geographical variables that prevail in a potential host economy. In order to identify these determinants, one has to consider the purpose of FDI; that is, whether the goal is market seeking (horizontal FDI), efficiency seeking (vertical FDI) or, as introduced more recently, export-platform FDI[13] (producing in a host economy with the main purpose of exporting to a third country). More recently, the *Knowledge-Capital Model* (Helpman 1984; Markusen 1984; Markusen and Maskus 2002) represents an attempt to combine the two incentives for FDI in a unified theoretical model, by accounting for divergence in skills between the source and the host economy.

A wide range of host country determinants have gained traction in the literature, most importantly the size and potential of the host market (measured by GDP, GDP per capita and GDP growth) to explain horizontal FDI as well as factor prices (measured primarily by unit labour costs and wages) to identify the reasons behind vertical FDI.[14] On top of that, macroeconomic stability approximated by low inflation and a stable exchange rate, a favourable and simple tax regime, openness to international trade, sound infrastructure and geographical proximity are at the epicentre of empirical studies (Wheeler and Moody 1992; Gastanaga et al. 1998; Alam and Shah 2013 inter alia). Apart from geographical proximity, other "distance" measures in terms of culture, institutional performance and relative labour costs are encompassed in studies that utilise bilateral FDI data and develop a gravity model as in international trade theory.[15] Finally, an array of institutional and structural factors is considered to play a significant role in attracting FDI flows[16] and will be specifically discussed in Sections 4.2 and 4.3.

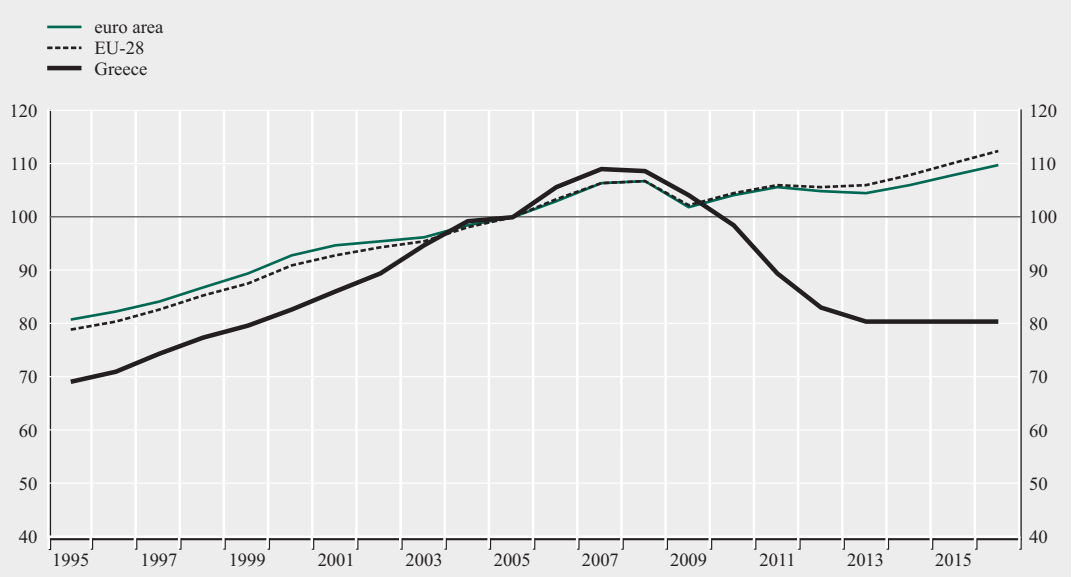
The empirical evidence finds the model of horizontal FDI more plausible for developed economies (Martinez-San Roman et al. 2012; Shatz and Venables 2000), with variables capturing market size and potential proving to be more significant than labour costs. Nonetheless, low unit labour costs are also found to influence investment decisions in some studies (Alam and Shah 2013; Dellis et al. 2017) and thus incentives for vertical FDI cannot be completely ignored. The evidence points to a significant positive effect of trade openness on FDI flows (Albuquerque et al. 2005; Schmitz 2009; Lee 2006) and an adverse effect of high taxation, although with a mixed record in terms of statistical significance (Wei 2000; Razin et al. 2005; Alam and Shah 2013).

In the light of the above and following Dellis et al. (2017) in the formation of a compact set of economic determinants, we turn to the profile of the Greek economy and the variables that can act as FDI pull factors. First, Greece enjoys a location advantage as it is geograph-

12 See, for example, Blonigen (2005) for a review of the relevant empirical literature.
13 See Ekholm et al. (2003) and Baltagi et al. (2007) for a detailed analysis of export-platform FDI.
14 Blonigen and Piger (2011) conduct a meta-analysis on the variables used in the literature.
15 See, for example, Gast (2005), Demekas et al. (2007) and Canton and Solera (2016).
16 See Bénassy-Quéré et al. (2007).

Chart 16 Gross Domestic Product (1995-2016)

(2005=100)



Source: Eurostat.

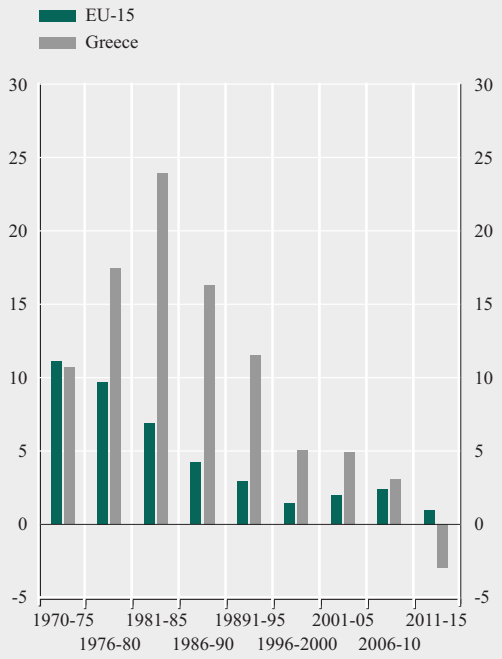
ically close to advanced economies with companies that engage in FDI. Shatz and Venables (2000) identify proximity as a significant determinant of foreign capital attraction. Greece's close cultural ties with many of its EU partner countries also act in favour of FDI; however, Greece does not share a common language with any of the major investing economies (Germany, UK, US), which is considered an advantage in attracting FDI.[17] As far as market size is concerned, Greece is a relatively small market, with real GDP (2010 prices) standing at EUR 184.5 billion.[18] Most importantly, the GDP dynamics has been dire over the past eight years with negative annual growth rates from 2008 to 2015, with the exception of 2014. As depicted in Chart 16, the country was severely hit by the global financial crisis that turned into a sovereign debt and banking crisis of disproportionate dimensions compared with the rest of the EU. However, the negative trend came to a halt in 2016 (marking a 1.4% GDP growth in 2017), while projections from the Bank of Greece and the OECD predict a GDP growth rate close to 2% for 2018.

The divergent path of unit labour costs between Greece and the rest of the EU can be cast as significant factors for the failure of the Greek economy to take advantage of the "first wave" of the surge in FDI inflows in the 1990s. Chart 17 shows average five-year changes in unit labour costs. Excessive labour costs compared with the EA core were a common factor in all peripheral countries after 1980, as reflected in the inflated unit labour cost growth rates in these countries. Nevertheless, Greece exhibited the highest distance-to-frontier score among them, but this was radically reversed in the 2010s, as depicted in Chart 17. Low unit labour costs are commonly associated with the attraction of vertical FDI and are mostly identified as a significant factor in developing and emerging economies;[19] however, the variable is also included in studies using data from OECD and EU countries (Dellis et al. 2017; Martinez-San Roman et al.

17 Antonakakis and Tondl (2012) acknowledge this as a decisive factor for UK investment in Ireland.
18 Source: European Commission, AMECO Database.
19 For example, Demekas et al. (2007) find low labour costs to significantly determine FDI inflows for Southeast European countries.

Chart 17 Unit labour cost growth: Greece and EU-15

(average five-year percentage changes)



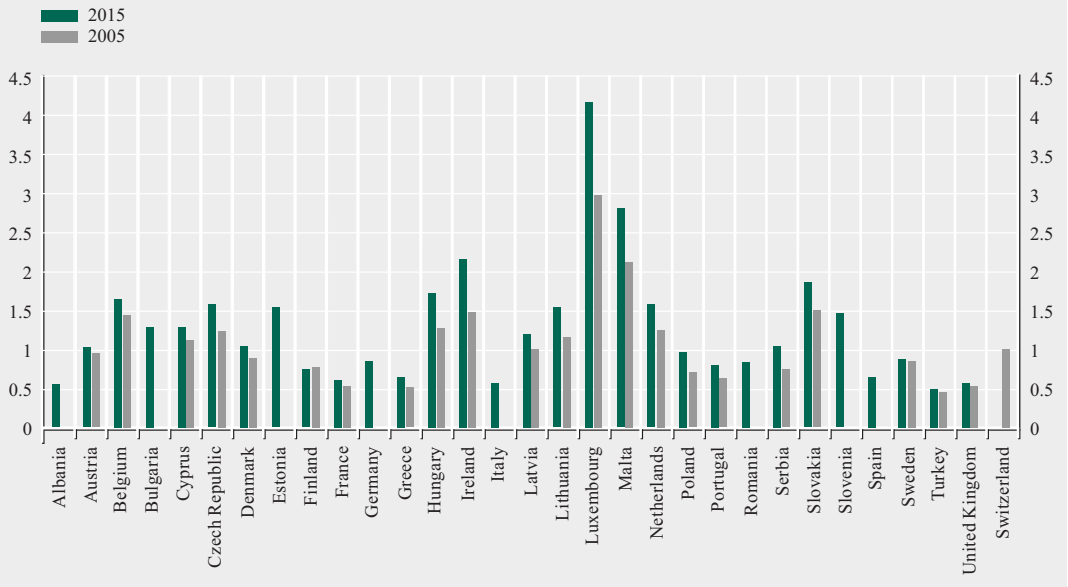
Source: European Commission, Ameco Database.

2012). According to the latest data by Eurostat, Greece is not an outlier in terms of hourly labour costs in manufacturing and other industry sectors within the EU; on the contrary, it is below the EU average in both wage and non-wage costs.

Apart from labour costs, a factor that has been found by researchers to significantly affect investment decisions for multinational corporations is openness to trade. The ratio of imports plus exports to GDP indicates the economy's participation in global trade, and many empirical studies have found it to be a strong complement of, rather than a substitute for, FDI flows in developed economies (Schmitz 2009; Albuquerque et al. 2005; Sekkat and Veganzones-Varoudakis 2007; Martinez-San Roman et al. 2012). Greece has made significant progress in this area, reaching a peak of 70% of GDP in 2013; however, one should bear in mind the downward trajectory of GDP during the 2009-2014 period. On the other hand, Chart 18 evidently shows that Greece is still a fairly closed economy rel-

Chart 18 Trade openness (2005, 2015)

(exports + imports/GDP)



Source: Eurostat.

Chart 19 Tax revenue from indirect taxation (2005, 2015)

(% of GDP)

Source: European Commission, Ameco Database.

ative to its European peers. Moreover, the impact of a favourable tax environment for enterprises is not uniform, as expected in the empirical studies of FDI determinants. Alam and Shah (2013) and Bénassy-Quéré et al. (2003) fail to find a significant link between taxation and FDI flows. According to the OECD (2003), what matters most is a transparent and simple tax system rather than tax incentives (in the form of tax exemptions, tax holidays, etc.).

Considering the case of Greece, the economic adjustment programme that started in 2010 has brought about a steady increase in both tax rates and tax revenues. The current corporate tax rate of 29%, however, is not an outlier within the EU. What should perhaps be stressed is the heavy reliance on indirect taxation compared with other EU members, as depicted in Chart 19.

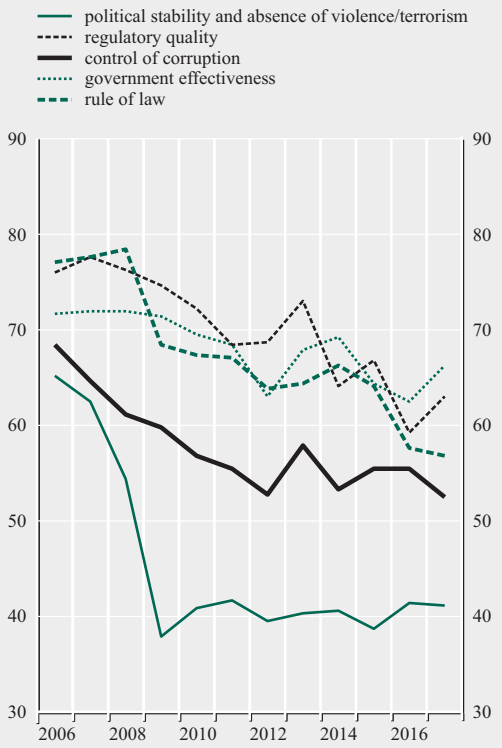
4.2 INSTITUTIONAL ENVIRONMENT AND PRODUCT MARKETS

On top of the economic factors driving the choices of MNCs in terms of the host economy, researchers have emphasised the role of institutions and structural reforms to explain patterns in capital flows (Antonakakis and Tondl 2012; Campos and Kinoshita 2008; Bevan and Estrin 2004). More specifically, it is argued that the extent of trade barriers, the effectiveness and degree of competition in product markets as well as the flexibility of labour markets are the focal point of the literature that aims to address FDI determinants (Blonigen and Piger 2011; Walsh and Yu 2010; Demekas et al. 2007). Dunning (2005) notes that "Institutions are location bound extra market instruments designed to facilitate economic activity (including FDI), by reducing ... transaction costs". Investment abroad by a multinational corporation typically involves increased sunk costs, and therefore a high degree of uncertainty due to host country risk or inadequate protection of property could shift FDI elsewhere (Bénassy-Quéré et al. 2007). The latter effect is emphasised in the work of Blonigen (2005), who argues that poor legal protection of the firm's assets increases the probability of future expropriation by the host country government and thus deters FDI. Canton and Solera (2016) argue that the institutional environment is of particular importance for greenfield FDI, due to the fact that the latter reflects long-term planning on the part of the multinational corporation. Furthermore, government policies in the field of market structure affect entry rates as well as potential efficiency gains and future profitability (Walsh and Yu 2010), thereby influencing the location choice of the multinational corporation.

Sound institutions and the overall effectiveness of government are shown to significantly affect inward capital flows (Busse and Hefeker 2007; Asiedu 2013). Tackling corruption is among the documented determinants of inbound FDI (Dabla-Norris et al. 2010; Antonakakis and Tondl 2012; Wei 2000; Grigonyte 2010) as is

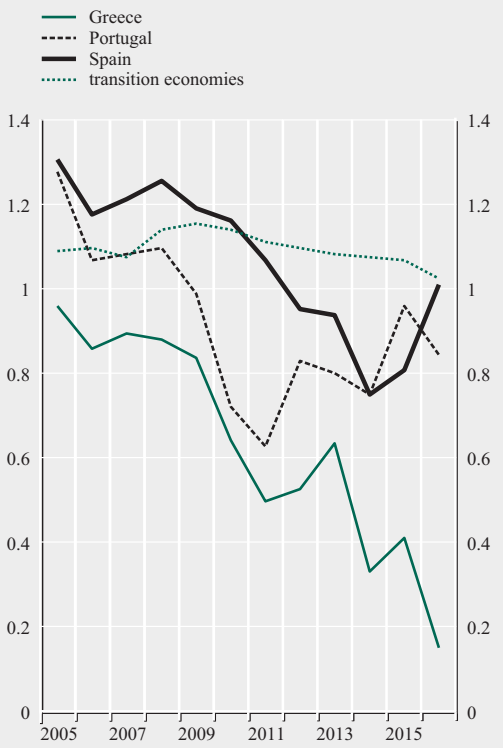
Chart 20 Governance indicators: Greece (2006-2017)

(percentile rank)



Source: World Bank, WGI.
Note: Scale 0-100. Higher value denotes better performance.

Chart 21 Regulatory quality index: EU South and transition economies (2006-2016)

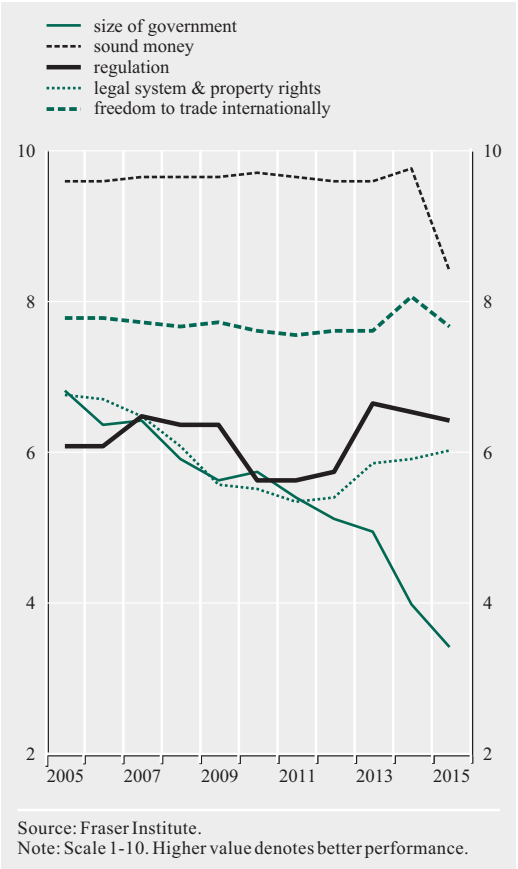


Source: World Bank, WGI.
Note: Scale -2.5-2.5. Higher value denotes better performance.

the case for the rule of law, with strong empirical support for its significance (Wernick 2009; Campos and Kinoshita 2008). Data from the Worldwide Governance Indicators (World Bank) reveal a downward path in all aspects of governance after 2008, albeit with signs of moderation from 2015 onwards, as pictured in Chart 20. In the field of corruption, the rise of the indicator after 2012 reflects a slow but gradual improvement. This particular index has been identified in the empirical literature as one of the significant structural pull factors of FDI (Sanchez-Martin et al. 2014; Ajide and Raheem 2016).

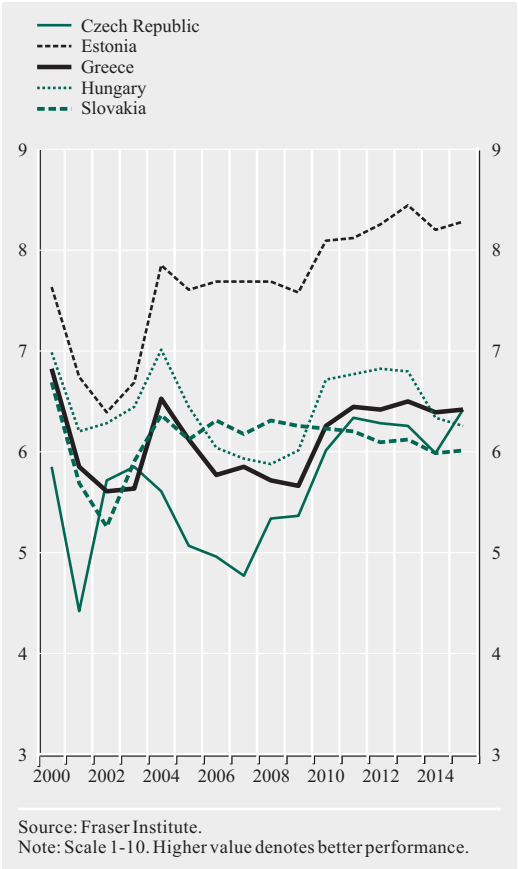
On the other hand, the country still lags behind most advanced and transition economies in the area of regulatory quality (see Chart 21) and prevalence of rule of law. Researchers tend to find a robust connection between these indices and inward FDI (Mina 2007; Antonakakis and Tondl 2012; Globerman and Shapiro 2002), which could account for part of Greece's lagging performance as a destination for FDI. Indices measuring economic freedom in broad terms have been included in empirical specifications for FDI flows by Albuquerque et al. (2005) and Gast (2005) among others. Data from both the Fraser Institute and the Heritage Foundation reveal a somewhat sluggish performance from Greece. Its highest ranking on the Heritage Foundation index is 63.4, which is still lower than the smallest value for countries like Ireland, Sweden and Spain, whereas the Fraser Institute Index of Economic Freedom ranks Greece in the 116th place for 2015. The country's score steadily deteriorated from 2006

Chart 22 Economic freedom index: Greece (2005-2015)



Source: Fraser Institute.
Note: Scale 1-10. Higher value denotes better performance.

Chart 23 Economic freedom-Business regulation index (2000-2015)

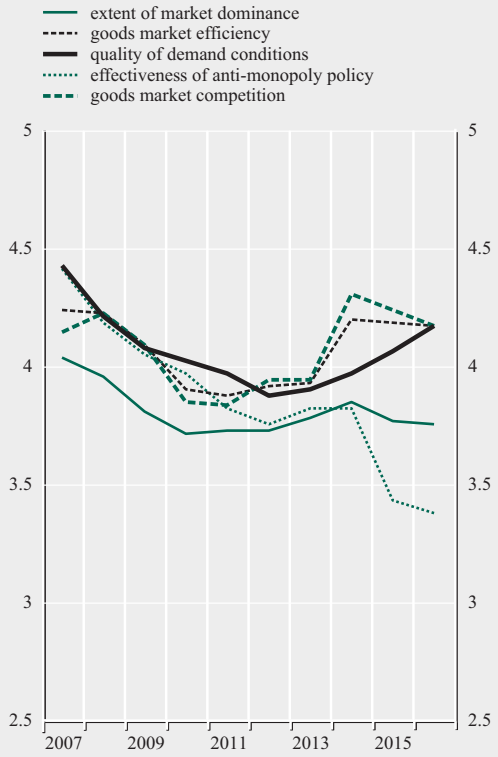


Source: Fraser Institute.
Note: Scale 1-10. Higher value denotes better performance.

until 2012 and again after 2014 to levels considerably lower than the respective scores of other EA countries or East European countries. That being said, we must acknowledge that composite indicators such as this one can be misleading as they encompass many aspects of institutional performance. Chart 22 outlines the movement of the five main sub-indicators. The data clearly point out that the deterioration in economic freedom is predominantly due to adverse conditions in the categories of *Sound Money* and *Size of Government*. Greece actually shows improvement in the areas of *Legal Systems and Property Rights* as well as *Regulation*, which, as discussed above, matter to the attraction of foreign capital. A closer look at the various disaggregated indicators yields some fruitful results, for example when one examines the score on *Business Regulation* (see Chart 23). A transparent and simple regulatory environment can positively affect the decision of a MNC to invest in a given economy. The data signal an improvement for Greece in the relevant sector, with the most recent score placing the country on a par with most of the emerging economies of Eastern Europe.

A steadily improving path appears to emerge after 2012, mainly owing to reform implementation in labour and product markets. Labour market flexibility has been identified as a decisive pull factor by Azémar and Desbordes (2009), Dellis et al. (2017), Walsh and Yu (2010) and will be analysed in Section 4.3 herein. Product market regulation and com-

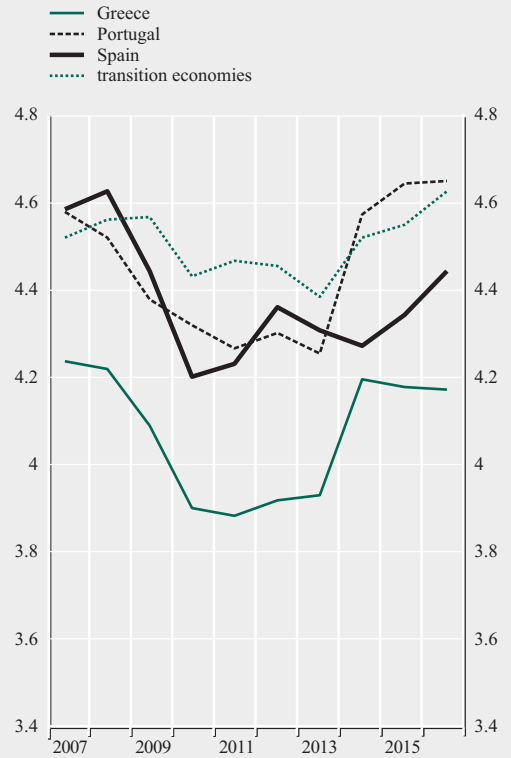
Chart 24 Competitiveness indicators: Greece (2007-2016)



Source: World Economic Forum, Global Competitiveness Indicators.
Note: Scale 1-7. Higher value denotes better performance.

Chart 25 Goods market efficiency: EU South and transition economies (2007-2016)

(index)

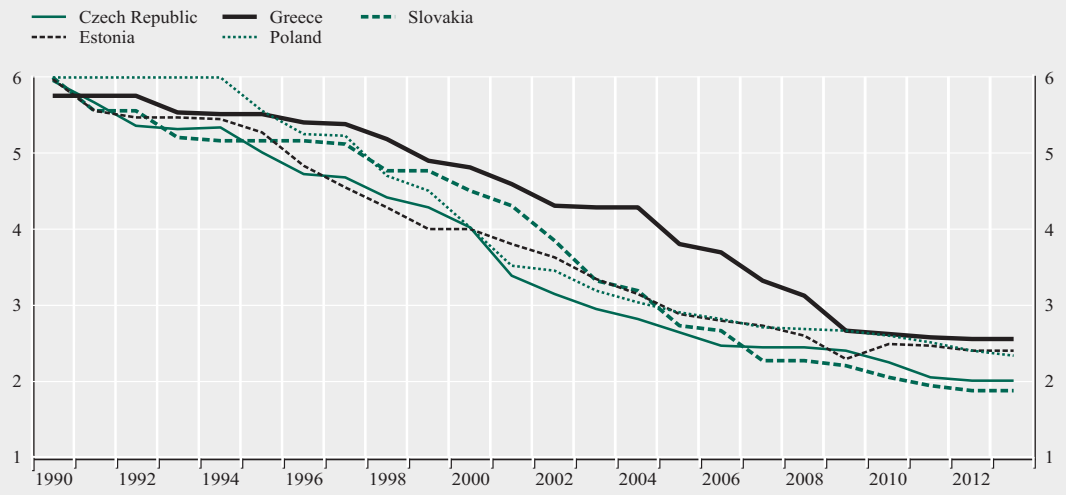


Source: World Economic Forum, Global Competitiveness Indicators.
Note: Scale 1-7. Higher value denotes better performance.

petition in the area of goods markets also significantly attract FDI flows (Ciriaci et al. 2016; Canton and Solera 2016). In the vein of Aghion et al. (2005), healthy competition in product markets facilitates the process of creative destruction and promotes the evolution of productive, innovative firms. In the event that MNCs encompass these traits, then product market liberalisation could act as a pull factor for capital inflows. Belderbos et al. (2008) postulate that product market competition acts as an incentive for leading firms to undertake R&D activities abroad (through FDI), while laggards concentrate on the domestic market.

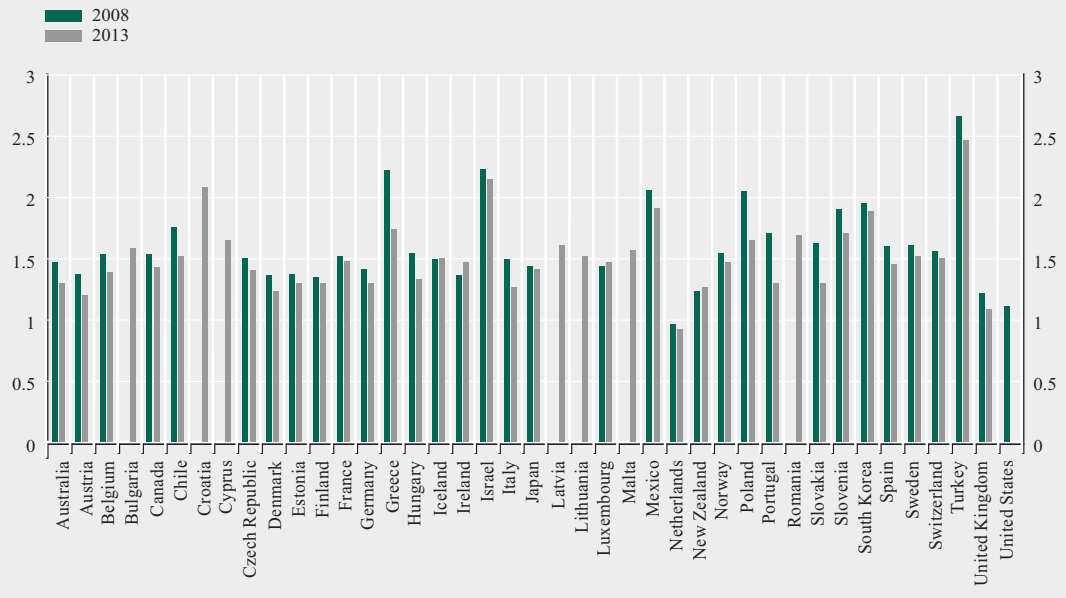
Competition as well as efficiency in product markets have been at their highest levels since 2006, according to the indices from the World Economic Forum's *Global Competitiveness Report* (Global Competitiveness Indicators, hereinafter GCI). Chart 24 also underscores an improvement in demand conditions after the decline that followed the outbreak of the financial crisis in 2009. This improvement has assisted Greece in partially closing the gap compared with other economies (see Chart 25). After 2014, the main driver of this divergence is the poor performance of anti-monopoly policy, whereas Greece is catching up in the area of competition. The positive dynamics of the reform process can be corroborated by OECD data on Product Market Regulation (PMR). With lower values dictating a less regulated sector, the index is reported every 5 years since 1998 for non-manufacturing sectors of the econ-

Chart 26 Energy, transport and communications regulation index (1990-2013)



Source: OECD.
Note: Scale 1-6. Higher value denotes more regulation.

Chart 27 Product market regulation index (2008, 2013)



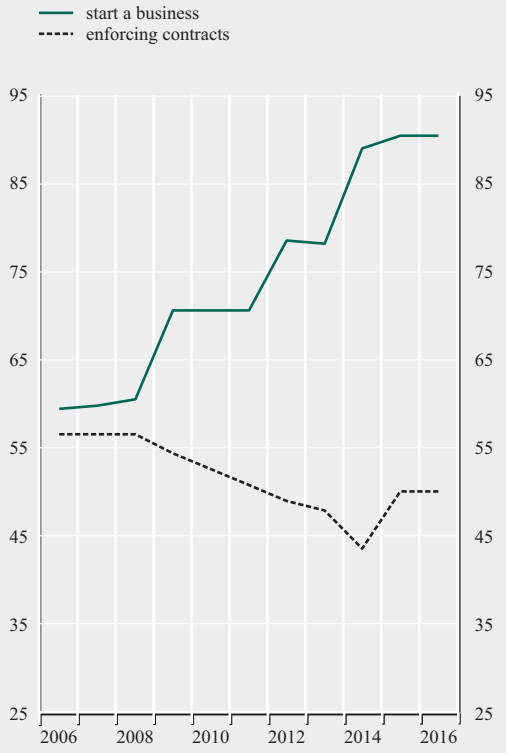
Source: OECD.
Note: Scale 0-6. Higher value denotes more regulation.

omy.[20] Data on the composite index for Energy, Transport and Communications, which are presented in Chart 26, clearly show a positive shift for Greece during the past ten years.

According to the latest available data (2013) on PMR for the whole economy, Greece has a

20 Energy, Transport, Communication, Professional Services and Retail Distribution. For details, see Alemani et al. (2013).

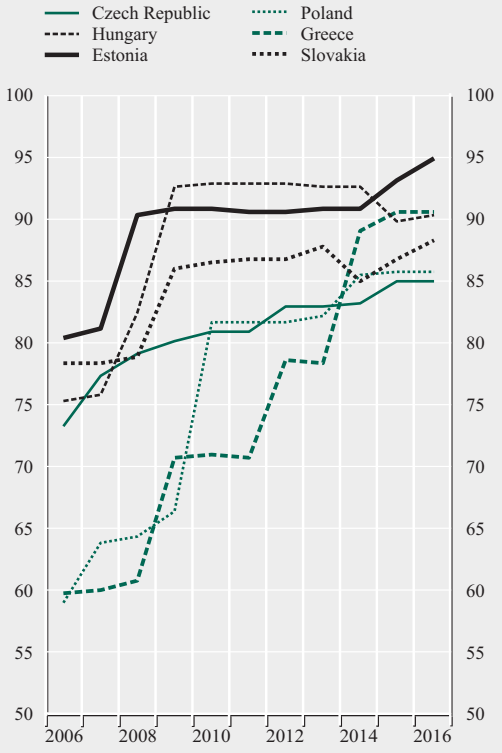
Chart 28 Doing Business Indicators: Greece (2006-2016)



Source: World Bank.
Note: Scale 1-100. Higher value denotes better performance.

Chart 29 Doing Business-Start a business: Greece and transition economies (2006-2016)

(index)



Source: World Bank.
Note: Scale 1-100. Higher values denote better performance.

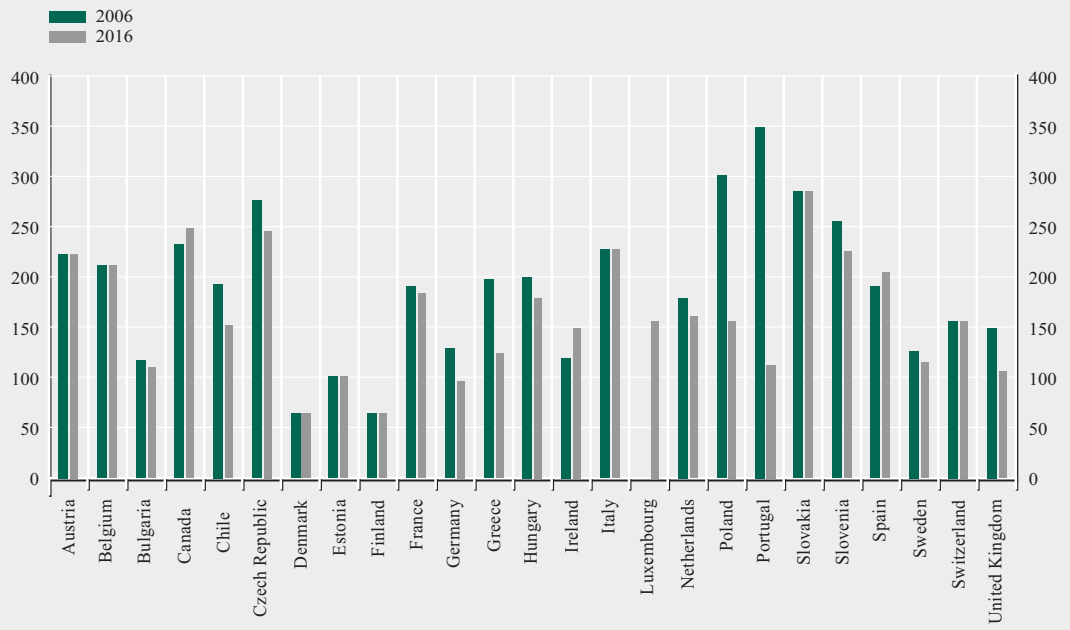
higher index than the OECD average (meaning it is more restrictive). However, the country has achieved the highest improvement since 2008, reducing its score from 2.21 to 1.74 (see Chart 27). Despite a marked reduction, the index for professional services still remains among the highest within the OECD country group, indicating that there is room for reform. According to Canton and Solera (2016), the decision of a multinational corporation to invest in a potential host economy is significantly affected by regulation in product markets, as measured by the PMR index.

The prevalence of a business-friendly environment, captured by the World Bank's *Ease of doing business* indicators is also of increased importance as a driver of international capital flows (Azémar and Desbordes 2009; Gastanaga et al. 1998). Fostering a business-friendly climate is underscored by Ciriaci et al. (2016) as enhancing the probability of a country being the target of MNCs.

In Chart 28, we monitor the course of the indicators capturing the ease of starting a business and the efficiency in enforcing contracts.[21] One can note the improved conditions for starting a business in Greece, albeit starting from a somewhat low point, whereas the second indicator has reversed its downward path after 2015. To put it in a regional context, Chart 29 shows that Greece has outperformed many transition economies, despite starting far below. More specifically, the procedures required to start a

21 Dellis et al. (2017) find these two variables to be robust determinants of FDI flows.

Chart 30 Days for construction permit (2006, 2016)



Source: World Bank.

new business venture in Greece have decreased substantially from 15 in 2011 to just 5 in 2016, i.e. below the global average of 5.8. In terms of days to start a business, the number has declined steeply from 39 to 13 and is much closer to the best practices. Nevertheless, there is still a modest gap compared with countries like Hungary (5 days), Portugal (2.5 days) and Ireland (6 days). An underlying feature of the World Bank data is that Greece exhibited a lacklustre performance in most of the categories that are presented, but is currently implementing reforms to gradually upgrade the institutional environment that can potentially attract foreign investment.

A closer look at the data at hand can validate this argument, for example considering the days required for a construction permit, as depicted in Chart 30. Starting from 198 days required in 2006, the number has fallen to 124, which not only is a marked improvement, but places Greece higher than countries like the Netherlands, Spain, Ireland and Switzerland.

The highest distance to the global frontier for Greece in 2016 is recorded in the area of registering property, where the score has actually deteriorated from 59.6 in 2005 to 49.6 in 2016, contradicting the otherwise encouraging picture of the reform effort over the past years. Bénassy-Quéré et al. (2007) find statistical evidence that the security of property rights of a potential host country is a significant determinant of FDI flows.[22] The effective protection of property rights, insofar as they are gauged by this indicator, has been rather sluggish in Greece, compared with other EA peripheral economies as well as with former communist countries, as depicted in Chart 31. Again, the pick-up in the score after 2014 may be seen as a sign of improvement. The effort to build resilience through sound institutions is also visible in Chart 32, which captures the score referring to resolving insolvencies. The index for Greece continues to lie below the other peripheral economies (referred to as GIIPS),

22 See also Li and Resnick (2003) and Lee and Mansfield (1996).

Chart 31 Doing Business-Registering property: EU South and transition economies (2006-2016)

(index)

Source: World Bank.
Note: Scale 1-100. Higher value denotes better performance.

Chart 32 Doing Business-Resolving insolvency: GIIPS (2006-2016)

(index)

Source: World Bank.
Note: Scale 1-100. Higher value denotes better performance.

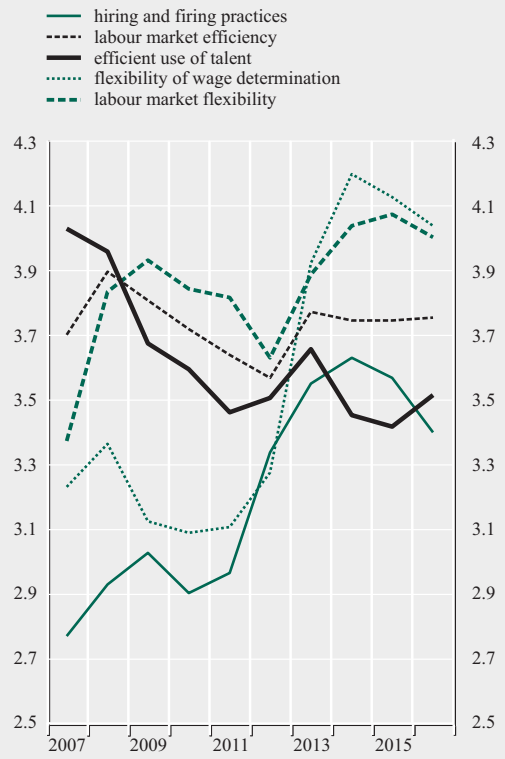
although an improvement is clear after 2014 and points to a more effective environment for conducting business. The conclusion is similar when we turn our focus to the comparison with East European economies.

4.3 LABOUR MARKETS

Efficient labour markets, that combine flexibility and security for the working population, have also been recognised as a key prerequisite for the activity of multinational corporations in a host country (Ciriaci et al. 2016). The issue was given key priority in the European Commission's Five Presidents' Report in 2015. The stringency of employment protection legislation (EPL) can have adverse effects on FDI, as it reduces the firm's incentives for R&D activities and can hamper profitability (Ciriaci et al. 2016). The EPL indicator for Greece lies above the OECD average over the 1990-2013 period, although following a downward trend. In line with the evolution of relative labour costs and the lack of flexibility and efficiency of the labour market (as evidenced by the GCI data), this could have been among the factors behind the Greek economy's rather mediocre FDI record over these years.

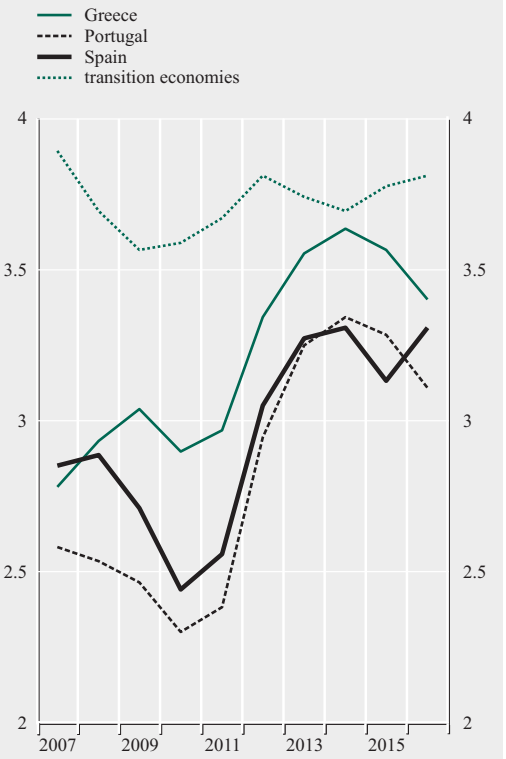
However, turning our attention to Chart 33, we can recognise a shift towards a more flexible market both overall and in terms of wage determination. The composite index for efficiency has a less pronounced performance, which can be attributed mostly to a deterioration in the efficient use of talent, mainly owing

Chart 33 Labour market indicators: Greece (2007-2016)



Source: World Economic Forum, Global Competitiveness Indicators.
Note: Scale 1 -7. Higher value denotes better performance.

Chart 34 GCI-Hiring and firing practices: EU South and transition economies (2007-2016)



Source: World Economic Forum, Global Competitiveness Indicators.
Note: Scale 1-7. Higher value denotes better performance.

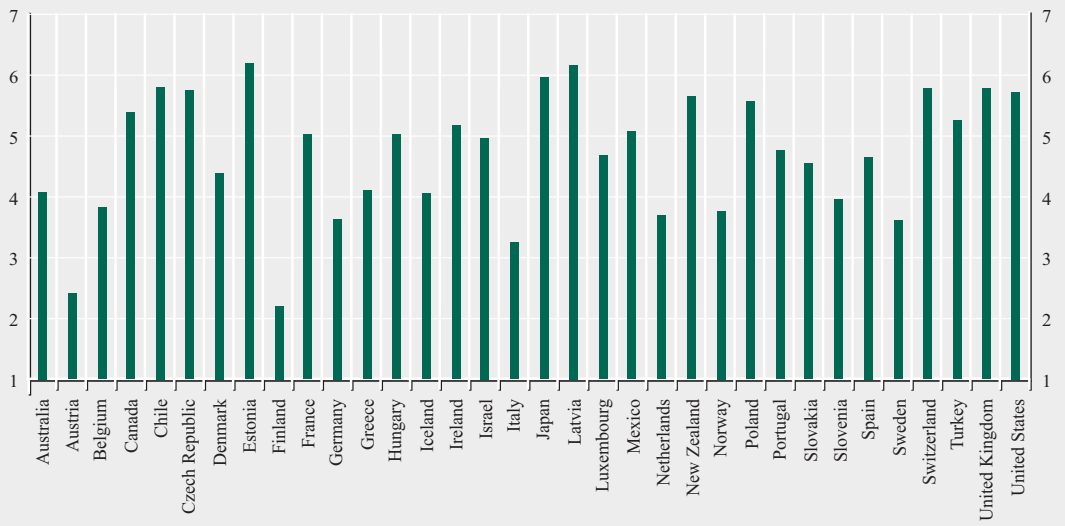
to the effect of brain drain that took place in years following the financial crisis. Chart 34 compares performance in the area of labour market flexibility for several European economies, more specifically the flexibility in hiring and firing personnel. The flexibility regarding this aspect is recognised as a significant catalyst for FDI attraction in studies by Azémar and Desbordes (2009) and Walsh and Yu (2010). Countries in the EU South have made significant steps towards liberalisation after 2010, with Greece leading this convergence with the transition economies.[23]

According to the latest data from the World Economic Forum, Greece has significantly reduced the coverage of collective bargaining, thus reaching a score of 4.1 on the respective index, which may be lower than the OECD average but is substantially elevated compared with a 3.5 score that was recorded in 2014 (see Chart 35). Moreover, redundancy costs such as advance notice requirements, severance payments[24] and penalties due when terminating a redundant worker have declined from 69 to 16 weekly wages during the 2007-2016 period, thereby creating a more business-friendly environment.[25] The steps towards a more flexible labour market can be recognised also by looking at data from the ICTWSS database,[26] which

23 Here: Estonia, Czech Republic, Poland, Hungary and Slovakia.
24 Azémar and Desbordes (2009) conclude that reducing severance payments facilitates FDI inflows.
25 Data from the World Bank published in the *Global Competitiveness Report* of the World Economic Forum.
26 Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts compiled by the Amsterdam Institute for Advanced Labour Studies (AIAS).

Chart 35 Collective wage bargaining (2015)

(index)



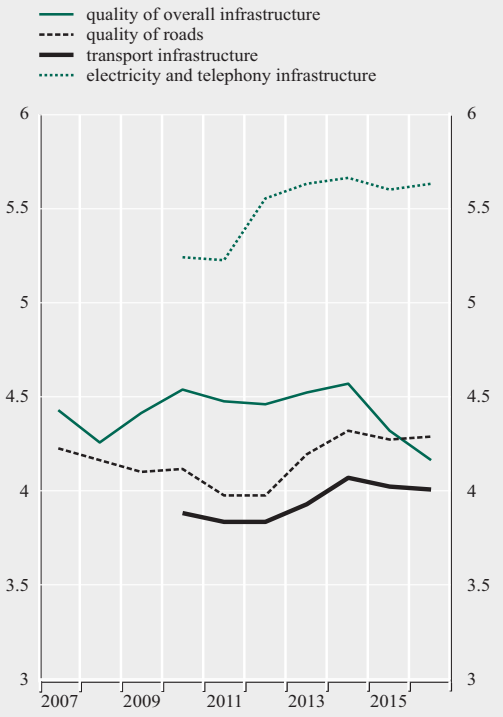
Source: World Economic Forum, Global Competitiveness Indicators.
Note: Scale 1-7. Lower value denotes stronger collective bargaining.

reports labour market indicators from 1960 up to 2014. For example, the percentage of workers in the private sector that are covered by collective bargaining has dropped from 82% in 2006 to 42% in 2014.

4.4 INFRASTRUCTURE

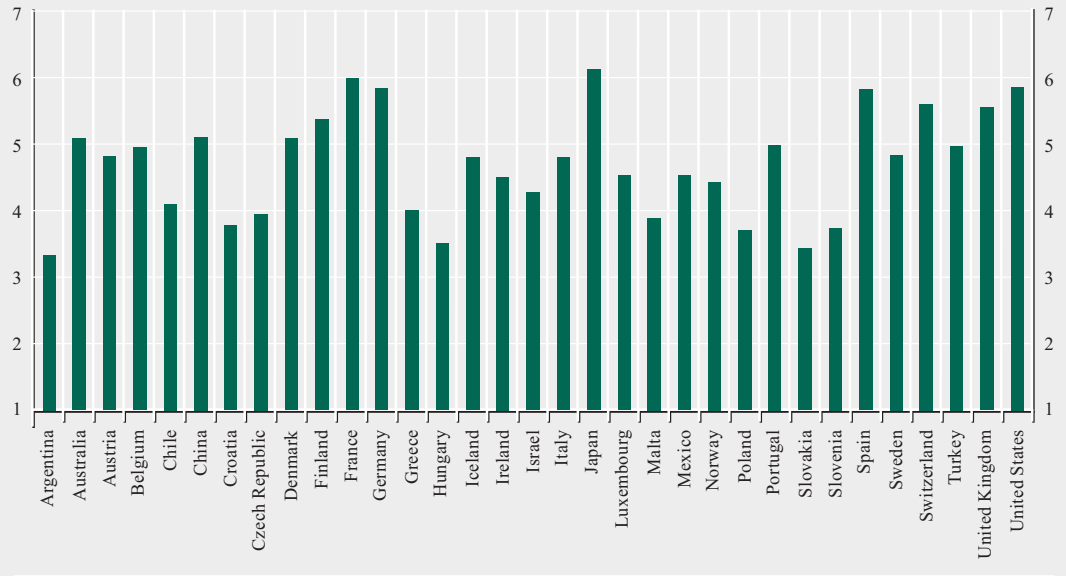
The quality of physical infrastructure is addressed separately as it receives special attention in the empirical literature on FDI determinants (see inter alia Campos and Kinoshita 2003; Demekas et al. 2007; Alam and Shah 2013). The evidence provides strong support for the hypothesis that sound infrastructure affects MNC decisions, albeit predominantly for developing and emerging economies. On the other hand, Walsh and Yu (2010), using data for developed and emerging economies, infer that infrastructure quality attracts FDI flows into the tertiary sector irrespective of a country's level of development. According to the World Economic Forum, Greece has made progress in the composite indicator of transport infrastructure as well as in individual indicators measuring the quality of roads, ports and electric network quality. In terms of air transport

Chart 36 Infrastructure indicators: Greece (2007-2016)



Source: World Economic Forum.
Note: Scale 1-7. Higher value denotes better performance.

Chart 37 Transport infrastructure index (2016)



Source: World Economic Forum, Global Competitivenes Indicators.
Note: Scale 1-7. Higher value denotes better performance.

quality, the relevant indicator has declined by half a point over the last decade, while the country marks a rather low score in the area of rail transport infrastructure (see Chart 36). According to data for 2016, Greece lags behind some of its European "competitors" in FDI regarding the composite indicator for transport infrastructure (see Chart 37). The pattern holds even if we do not consider railroad quality in the overall index. Greece is on a par with most OECD economies in terms of fixed and mobile telephone lines per head; however, this variable is almost exclusively accounted for in studies referring to emerging and developing economies (e.g. Asiedu 2002).

5 ABSORPTIVE CAPACITY

The bulk of the literature and policy prescriptions with respect to determinants of FDI inflows are justified insofar as foreign capital is a legit and acceptable policy target for a given economy. The latter seems plausible since FDI is accompanied by physical capital and generates employment. Nonetheless, apart from these static gains, host economies aim to exploit long-term gains through the positive spillovers that FDI generates. Such spillovers are perceived as the transfer of MNCs' superior technology through market and non-market transactions (Blomström and Kokko 1998). The non-rival nature of knowledge embedded in new technology makes it possible for non-performers of such technology to reap gains and foster productivity growth.[27] Multinational corporations are among the vessels that transmit new knowledge and serve as a conduit of technology transfer (Guellec and van Pottelsberghe de la Potterie 2004; Keller 2004; van Pottelsberghe de la Potterie and Lichtenberg 2001). Traditionally, researchers distinguish between horizontal spillovers (within the same sector or industry) and vertical spillovers, which in turn are divided into backward and forward linkages (Görg and Strobl 2005). Horizontal positive spillovers can occur through

27 A common caveat in empirically assessing technology spillovers is the definition of knowledge (Görg and Strobl 2005) and the measurement of productivity (Lipsey and Sjöholm 2004).

imitation (reverse engineering) from domestic firms and local employees leaving the multinational corporation to start their own enterprise (Aitken and Harrison 1999). Moreover, increased competition in a given sector is an incentive for innovation and higher productivity for incumbents. On the other hand, the presence of technologically superior foreign firms can shrink demand for domestic enterprises, thereby reducing their profitability and perhaps spurring their exit from the market. Markusen and Venables (1999) justify the existence of positive forward spillovers through the supply of high-quality inputs from MNCs to domestic clients. Backward linkages, on the other hand, are generated through the high-quality standards that MNCs apply to their suppliers, training sessions for workers of domestic companies in order to meet these standards, and the potential economies of scale created by the increased demand for locally produced inputs (Rodriguez-Clare 1996; Javorcik 2004).

The productivity-enhancing effects of FDI are not unambiguous and are actually conditional on an array of economic and institutional factors of the host economy (Lipsey and Sjöholm 2004; Crespo and Fontoura 2007). Blomström et al. (1999) concur that the equilibrium value of FDI spillovers is determined by a set of supply and demand factors, that is variables and actions of the multinational corporation and the host country, respectively. According to Dimelis and Louri (2004) with regard to FDI spillovers, "Their magnitude and scope depend on the development stage of the economy, particular characteristics of the host markets, the structure of industries, institutional factors, trade regimes as well as attributes of the local workforce". It comes as no surprise that empirical studies attempting to measure FDI spillover effects are largely inconclusive, depending on the different kinds of data, approach and methodology used (Peri and Urban 2006). One of the first studies in this field, by Aitken and Harrison (1999), found no support for knowledge spillovers, using plant-level panel data for Venezuela. The notion of backward vertical linkages appears to be more robustly validated by the data, as demonstrated in studies by Javorcik (2004), Kugler (2006) and Smarzynska and Wei (2009), while statistical evidence on forward linkages is rather scarce.[28] According to Lipsey and Sjöholm (2004), "An explanation that seems plausible at this point is that countries, and firms within countries, might differ in their ability to benefit from the presence of foreign-owned firms and their superior technology".

As underscored above, the degree to which a host economy can benefit from the presence of multinational corporations relies on its "absorptive capacity", which refers to the structural factors that affect a country's ability to enhance productivity through FDI.[29] Absorptive capacity is fostered through economic, technological and structural factors in the host economy. The literature recognises among other things the domestic level of knowledge (approximated by R&D intensity and innovative activity) and productivity (Griffith et al. 2003b; Sjöholm 1996; Kinoshita 2001), the level of human capital (Blomström et al. 1999; Criscuolo and Narula 2008; Narula and Marin 2003) and the size of domestic firms (Dimelis and Louri 2004; Girma and Wakelin 2001). In terms of institutional factors, researchers have focused on intellectual property rights (Beugelsdijk et al. 2008; Lee 2006; Glass and Saggi 2000), domestic market competition (Blomström and Kokko 1998; Glass and Saggi 2001) and financial system development (Alfaro et al. 2004; Hermes and Lensink 2003). Having said that, technological and development conditions in the parent economies are also expected to be of relevance for the extent of technology transfer and productivity spillovers that are theoretically associated with FDI (Gorodnichenko et al. 2014; Crespo and Fontoura 2007).[30]

28 For a more detailed review of the relevant literature, see Beugelsdijk et al. (2008).
29 The definition of a firm's absorptive capacity is introduced in Cohen and Levinthal (1989) as "the faction of knowledge in the public domain that the firm is able to assimilate and exploit".
30 Most of the studies measure the host and parent attributes at the firm level; however, this analysis adopts a macroeconomic perspective.

5.1 TECHNOLOGY AND INNOVATION

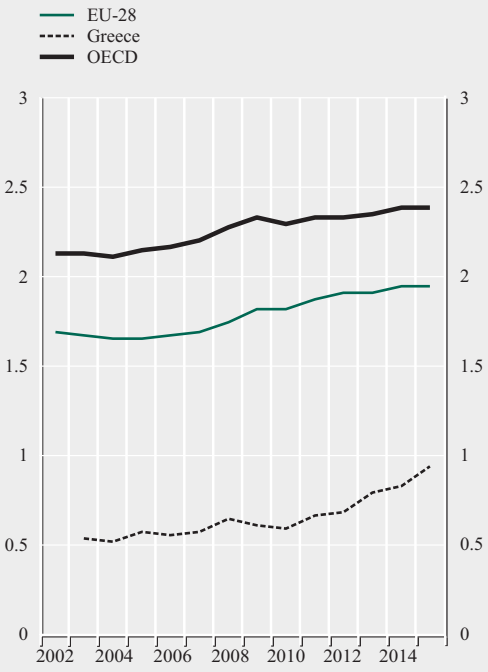
A prominent position in endogenous growth theory is held by technological progress and innovation (Romer 1986; Aghion et al. 1992). Investment in R&D and a robust innovative performance also enhance the productivity spillovers that can be generated by foreign firm entry (Duverger and van Pottelsberghe de la Potterie 2011). Setting technology thresholds through private and public initiatives thus increases the probability that the technological advances usually inherent in FDI pass through to the domestic economy, raising productivity and living standards. To this end, we map the technological and innovative environment in terms of input (R&D expenditure) and output (patents and overall innovation score).

Chart 38 paints a graphic and alarming picture, as Greece is a clear negative outlier both among OECD countries and in the EU in terms of total R&D expenditure. The European Commission in the context of its "Europe 2020" Strategy has a target of investing 3% of GDP in R&D, with Greece standing at practically 1% (0.97%), according to the latest (2016) OECD data. Contrary to fellow peripheral economies like Portugal and Spain, Greece did not experience a sharp increase in R&D spending over the 2005-2010 period. The upward trend recorded after 2010 is also partly attributable to the decline in economic activity. The gap is even more pronounced when one looks at business R&D in particular. While government and higher education R&D expenditures for 2015 are in line with the EU mean value, the ratio of business R&D to GDP is almost one tenth. Chart 39 reveals the poor record of Greek firms in R&D activities, which has detrimental implications for domestic absorptive capacity (Griffith et al. 2003a), i.e. the ability of local firms to commercialise knowledge embedded in FDI flows. Nonetheless, Chart 40 shows a gradual pick-up in R&D expenditures across economic sectors since 2010.

It should be pointed out that, on top of the absolute performance of the Greek economy

Chart 38 Total R&D expenditures: Greece, EU-28 and OECD (2002-2015)

(% of GDP)



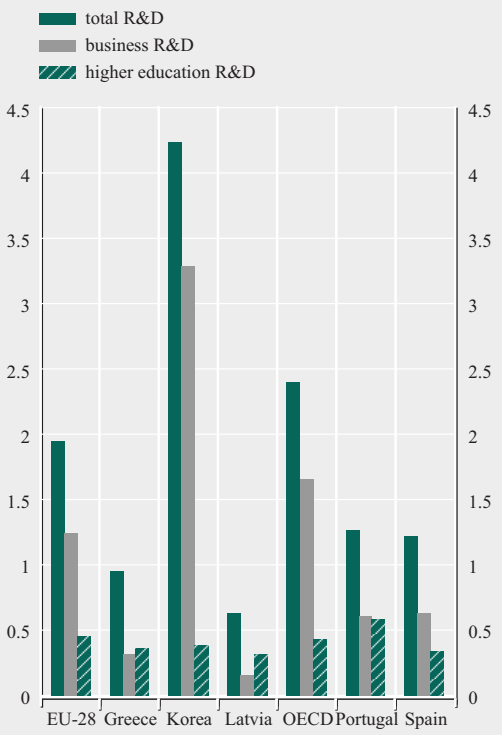
Source: OECD.

in R&D, the implied large technological distance from its trading partners is also an inhibiting factor for the absorption of technology embedded in capital inflows from abroad.[31,32] The literature on the absorptive capacity of the receiving economy focuses predominantly on the firm level (Kokko 1994; Sjöholm 1996; Lin and Saggi 2007; Stancik 2007) and is not conclusive with respect to the importance of technology gaps. Nonetheless, the data presented in this section suggest that Greece is not the case where a very small R&D gap minimises the impact of technology transfer from MNCs, but is rather at the other end of the spectrum. Hence, the lagging R&D intensity of the Greek economy as a whole

31 Gorodnichenko et al. (2014) find that distance-to-frontier has a negative effect on horizontal and vertical spillovers at the firm level.
32 The literature on absorptive capacity acknowledges, though, that a very small technology gap between home and foreign firms will lead to less technology transfer (Wang and Blomström 1992) and that a moderate gap would imply the largest spillovers (Crespo and Fontoura 2007).

Chart 39 R&D expenditure by sector: Greece and selected economies (2015)

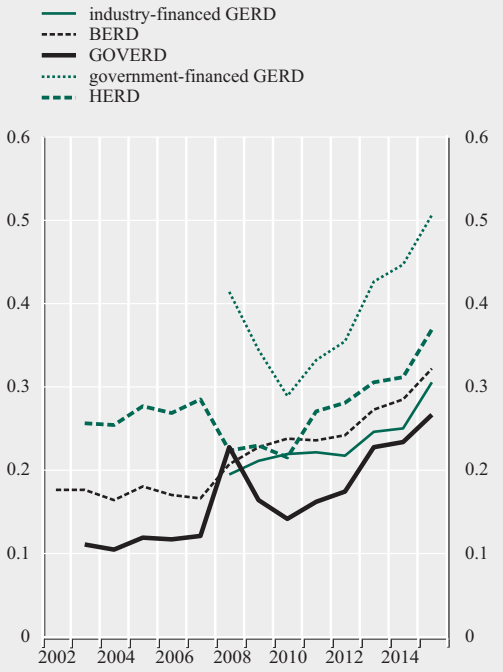
(% of GDP)



Source: OECD.

Chart 40 R&D expenditure by sector and source of funds: Greece (2002-2015)

(% of GDP)



Source: OECD.
Note: GERD: Gross Expenditure on R&D. BERD: Business Expenditure on R&D. GOVERD: Government Expenditure on R&D. HERD: Higher Education Expenditure on R&D.

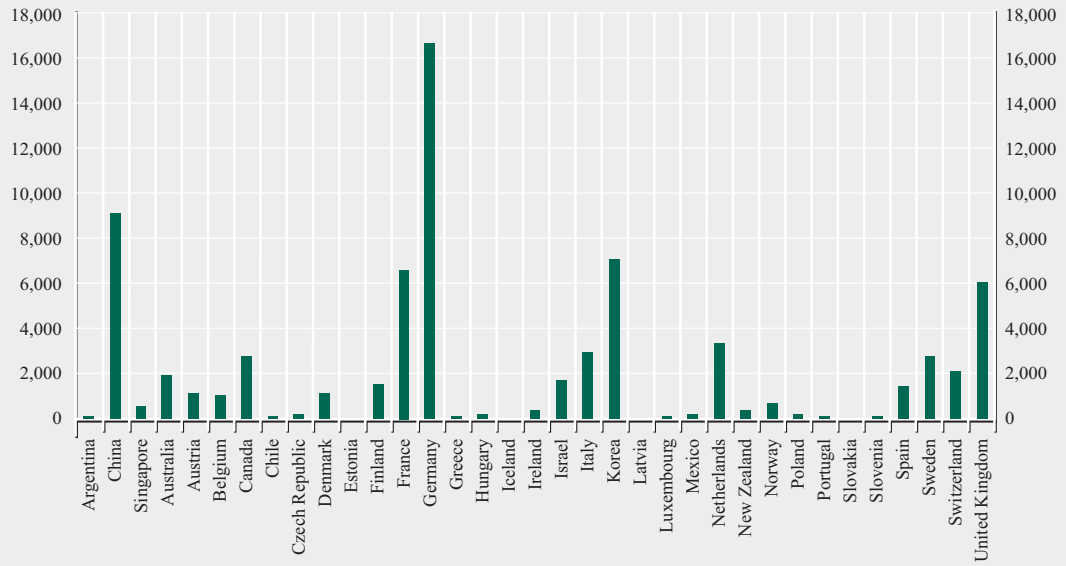
indicates that Greek firms are faced by obstacles to absorbing foreign technology; however, the silver lining is that a positive development in R&D would bring about significant productivity spillovers, since domestic firms have a wide "distance" to cover.[33]

This development is reflected in the meagre number of patent filings on behalf of Greek enterprises. The Summary Innovation Index published in the European Innovation Scoreboard also places Greece lower than its European peers. Average patents under PCT[34] are shown in Chart 41 and demonstrate the disappointing innovative performance of the Greek economy.[35] The latest available data report 116 patents filed in 2014, compared with 422 from Ireland and 2,048 from Israel. Low innovation capacity, as captured by patents and the Innovation Index, seriously hinders the imitation and commercialisation of foreign knowledge possibly embedded in FDI. The innovative performance excluding patents is moderate, according to the European Innovation Scoreboard published annually by the European Commission which places Greece in the third tier of countries (moderate innovators) with an overall score of 68.2 in 2016. This score is partly driven by the poor patenting performance and very low high-technology exports; however, the innovation-driven activities of Greek SMEs score above the EU average. More specifically, in the area of SMEs "innovating in-house" and "introducing marketing or organisational

33 The notion that more backward firms and sectors will benefit more by foreign technology is referred to as the "Veblen-Gerschenkron" effect (see Peri and Urban 2006).
34 Patent Cooperation Treaty.
35 The United States, Japan and Germany are excluded from the chart as they are by far the top performers.

Chart 41 Patents (2000-2015)

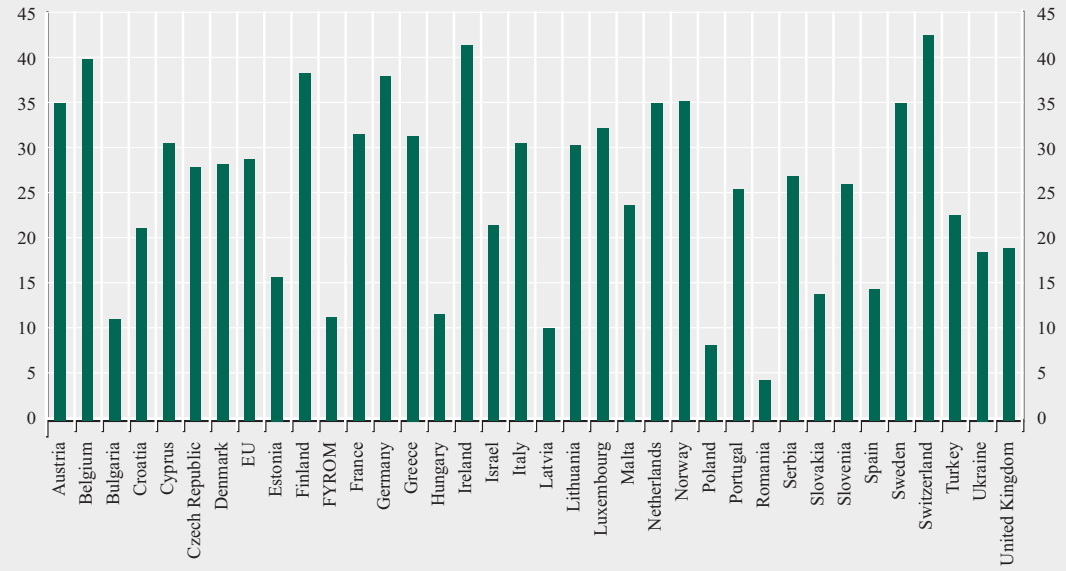
(country averages)



Source: OECD.

Chart 42 SMEs innovating in-house (2015)

(% of total SMEs)



Source: European Commission.

innovations" Greece outperforms the EU average, despite a deterioration observed during the 2010-2016 period. In 2015 40% of Greek SMEs introduced marketing and organ-

isational innovations, compared with 34.9% in the EU as a whole.

While the Greek economy fails to adequately foster an innovation-friendly environment and continues to lag behind in business R&D intensity, the innovative effort of Greek SMEs and their high degree of collaboration can enhance the country's absorptive capacity to adapt to and commercialise the advanced technology embedded in FDI flows.

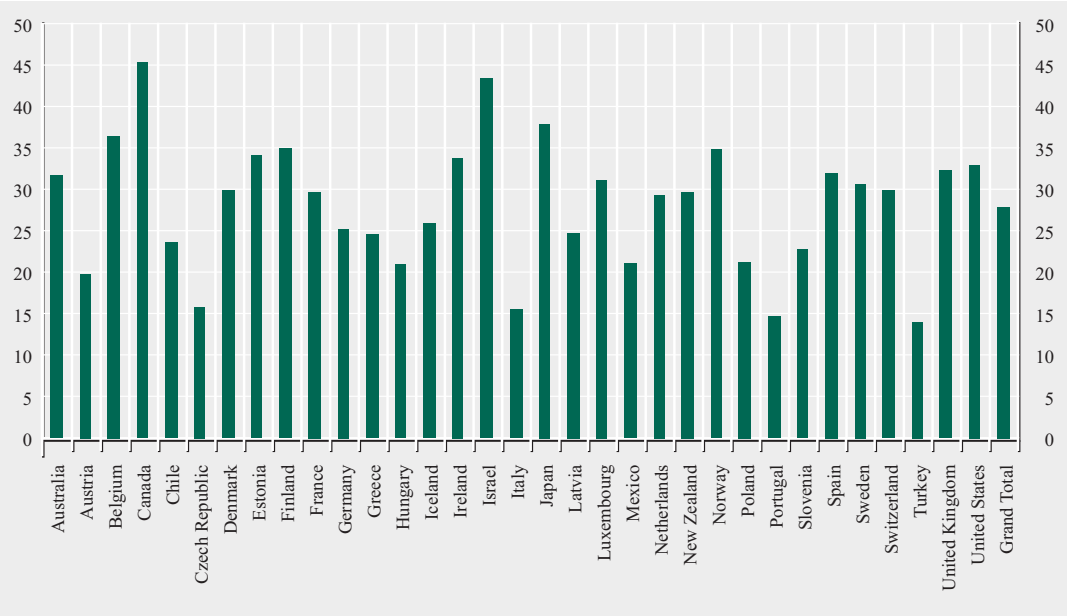
5.2 HUMAN CAPITAL

Absorptive capacity is also influenced by the human capital of the host economy (Blomström and Kokko 1998; Narula and Marin 2003; Gorodnichenko et al. 2014). Crespo and Fontoura (2007) and Blomström et al. (1999) note that FDI-induced spillovers are more likely to manifest themselves if the host economy possesses a high proportion of skilled labour force. The cognitive skills and level of knowledge of employees in domestic firms are directly linked with the ability to assimilate and adopt processes and organisation skills pertaining to advanced multinational corporations (Blomström and Kokko 1998). The qualitative attributes of a host country's labour force should be examined to fully grasp the development of human capital. Firstly, data from the World Bank reveal that a fairly high share of the Greek labour force has completed tertiary education (see Chart 43).

Greece with a 24.6% share of tertiary education graduates stands very close to the EA and EU averages, while the OECD average (28.3%) is mainly driven by Canada and the United States. An important point to note is that Greece fares better than its regional competitors in attracting foreign capital such as Bulgaria, Romania and Croatia and also outperforms (on average) countries of the EA periphery like Portugal and Italy. On the other hand, recent evidence on the skills of the domestic workforce paints a more dismal picture. The OECD provides data on the level of ICT skills and problem solving abilities in the workforce, as presented in Chart 44. Greece is

Chart 43 Labour force with tertiary education (2000-2015)

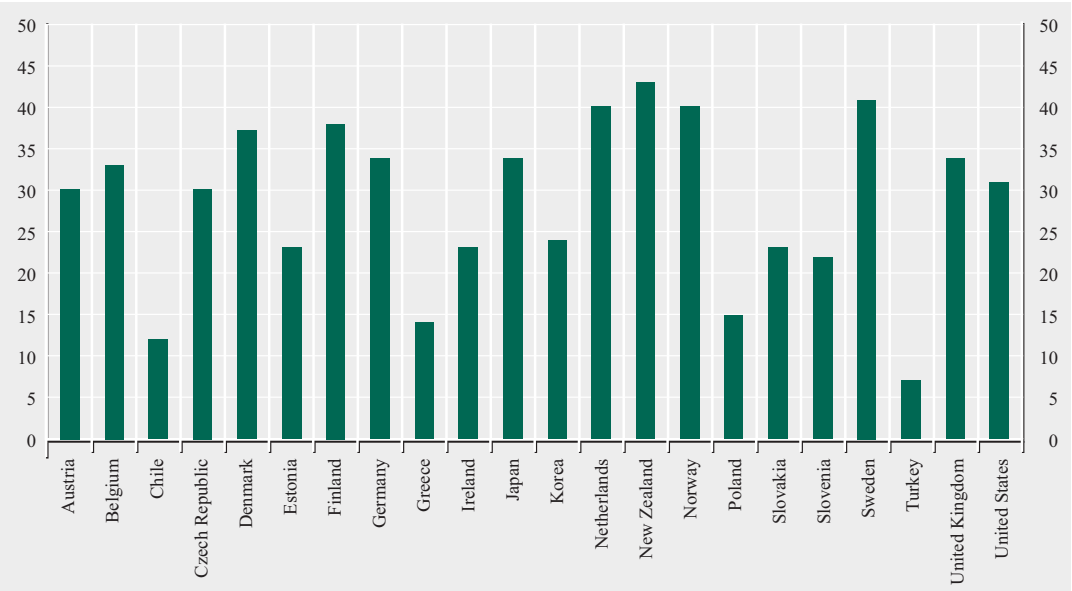
(% of total labour force)



Source: World Bank.

Chart 44 Labour force with ICT skills (2015)

(% of total population, all education levels)



Source: World Bank.

a laggard in this very important category with a mere 14%, only surpassing Chile and Turkey. By contrast, the respective shares for Estonia, Israel and Slovakia are above 22%. The conclusion remains unchanged if we control for the segment of the workforce with tertiary education. Having said that, the share of tertiary education graduates working in STEM fields (Science, Technology, Engineering and Mathematics) comes to 28% according to OECD data (last measured in 2015), thus positioning Greece in the middle of the table of advanced economies. According to more recent data from Eurostat (2017), 38.5% of the country's active population is employed in science and technology services, compared with an average of 46.6% in the EA.

In line with the discussion in Section 5.1, the Greek labour force appears to have attained a higher education level. Moreover, the higher education sector is consistent with best practices in terms of both input, as reflected in R&D spending, and output, as the share of published scientific papers in the top journals exceeds the EU average (European Commission 2017). What appears to be lacking is the diffusion and commercialisation of new knowledge in the business sector (with the exception of some favourable data on SMEs, as outlined above), which could boost productivity and raise living standards. That said, the presence of technologically advanced MNCs, combined with domestic human capital, could lead to greater efficiency and innovation.

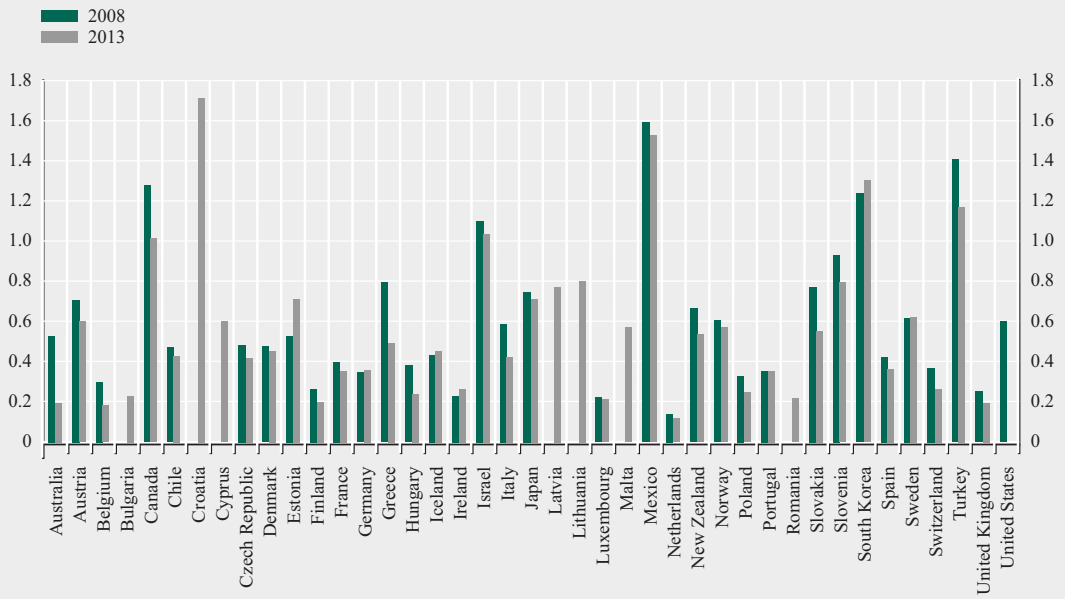
5.3 INSTITUTIONAL ENVIRONMENT

The institutional environment within which multinational corporations operate, as well as the absorptive capacity at the industry and the firm level in a given host economy play a pivotal role in the commercialisation of positive growth spillovers from foreign to domestic firms (Blomström et al. 1999; Javorcik 2004).

5.3.1 Domestic market competition

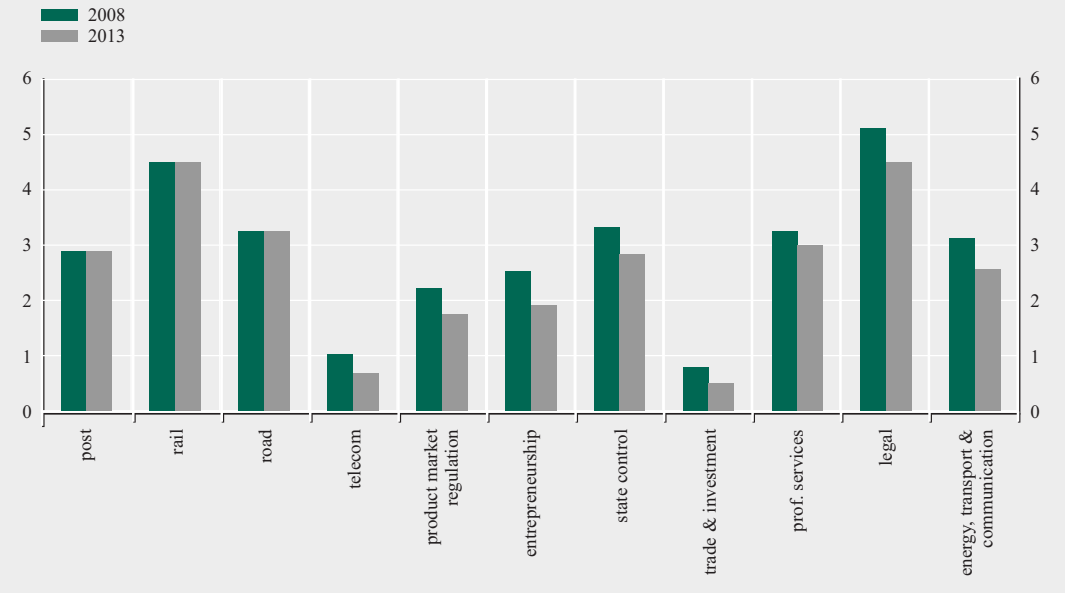
According to the literature, multinational firms are more likely to disseminate technology and

Chart 45 Product market regulation index-Barriers to trade and investment (2008, 2013)



Source: OECD.
Note: Scale 0-6. Higher value denotes more barriers.

Chart 46 Sectoral regulation: Greece (2008, 2013)



Source: OECD.
Note: Scale 0-6. Higher value denotes less competition.

knowledge to their affiliates, the higher the degree of competition in the sector in which they operate (Blomström and Kokko 1998). The rationale behind this argument is that a highly competitive environment urges the enterprise to engage in innovation and use advanced technology to distinguish itself from its peers.[36] Wang and Blomström (1992) develop a theoretical model concluding that MNC affiliates use more advanced technology in sectors where competition is strong. This catalysing effect of competition on FDI spillovers is cumbersome to disentangle empirically since MNC affiliates are expected to increase competition in a given sector; hence, there lies an issue of reverse causality (Crespo and Fontoura 2007).

As outlined in Section 4.2 (see Charts 45 and 46), Greece has undertaken a serious reform effort, which is mirrored in the decreased values of the OECD Product Market Regulation (PMR) index for various sectors and referring to several aspects of regulation. For example, the downward course of the regulation index covering the barriers to trade and investment stands out among the OECD economies (see Chart 45).

In addition, Chart 46 demonstrates the deregulation in favour of competition in almost all sectors. This shift could contribute to greater technology diffusion from parent companies to their affiliates, which in turn can spill over to the Greek economy both within and across sectors.

5.3.2 Financial development

A developed and efficient domestic financial system acts as a conduit for the transfer of knowledge from foreign to domestic firms, according inter alia to Alfaro et al. (2004) and Hermes and Lensink (2003). The former highlight that domestic firms require new machinery and equipment, capital and organisational structure in order to fully benefit from MNC presence. To this end, they need external finance provided by the domestic financial system. Moreover, potential entrepreneurs that aspire to benefit from FDI are heavily dependent on finance. The study also provides an example from Indonesia where 90% of car parts for Japanese firm Suzuki are supplied by domestic firms, which would not have been possible without external financing. Hermes and Lensink (2003) conclude that "FDI and domestic financial markets are complementary with respect to enhancing the process of technological diffusion, thereby increasing the rate of economic growth". They empirically investigate the enhancing role of financial development, approximated by domestic credit to the private sector (as a percentage of GDP), for 67 developing economies and conclude that a developed financial system facilitates FDI spillovers. According to Omran and Bolbol (2003) who use data for 17 Arab countries from 1975 to 1999, there is a certain threshold of financial development above which FDI creates spillover effects. More specifically, this threshold value stands at 13.8% of GDP when the authors focus on domestic credit to the private sector and at 47% of GDP when measuring the ratio of commercial bank assets to the sum of commercial and central banks' assets.

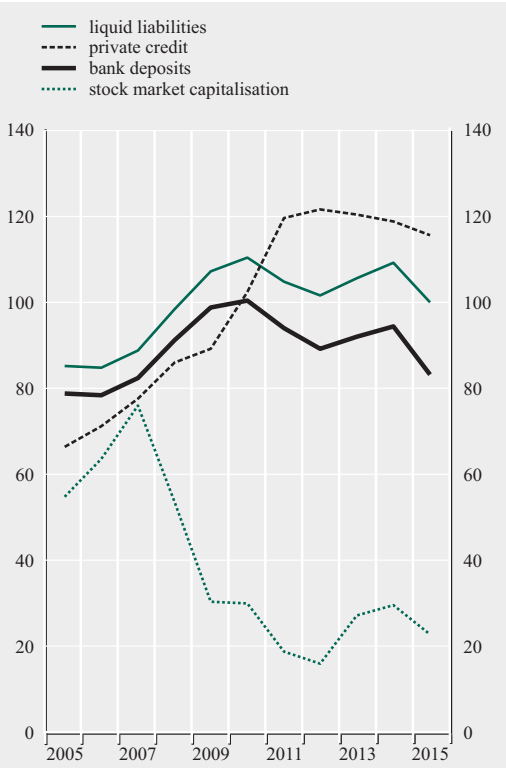
Although multinational corporations are not financially constrained at the domestic level, financial development in the host economy appears to matter significantly to FDI inflows.[37] Hence, the depth and efficiency of the financial system not only serves as a conduit for the dissemination of technology and knowledge concomitant with FDI but acts as an additional pull factor to those outlined in Section 4. Empirical studies highlight the importance of financial depth for inbound FDI flows (Campos and Kinoshita 2008), as well as for domestic stock market capitalisation (Soumaré and TchanaTchana 2011;

36 Aghion and Howitt (2009) argue that the relationship between innovation and competition is non-monotonic. Expenditure in R&D activities might also increase in sectors with limited competition, allowing the firm to generate more profits.

37 This phenomenon is described by Campos and Kinoshita (2008) as a "paradox of finance". It is also addressed in Henry (2000), Desai et al. (2006) and Crespo and Fontoura (2007).

Chart 47 Financial structure indicators: Greece (2005-2015)

(% of GDP)



Source: World Bank.

Otchere et al. 2015) and capital account restrictions (Desai et al. 2006; Blundell-Wignal and Roulet 2017).

The financial indicators from the World Bank's Financial Structure Database demonstrate the challenging times for the Greek financial sector after 2012. Following a rapid expansion in the first decade of the 21st century, private credit, liquid liabilities and bank deposits have all declined as a percentage of GDP (see Chart 47). Another fact worth mentioning is the deterioration in the stock market capitalisation. After a modest rebound from the 1999-2000 stock market crash, the stock market capitalisation-to-GDP ratio fell sharply again after 2007.

In Greece, market capitalisation of domestic firms has declined from 83% of GDP in 2007 to 19% in 2016. Nonetheless, Greek systemic banks appear to have strengthened after years of turbulence, with their capital-to-assets ratio surpassing 10 in 2016 according to the World Bank. On the other hand, all the relevant indicators in the *Global Competitiveness Report* (WEF) indicate a decline in the effectiveness and development of financial services. It is evident that this downward trajectory is driven by the financial crisis, credit tightening in contrast with monetary easing in the EA and finally the capital controls that were imposed in 2015.

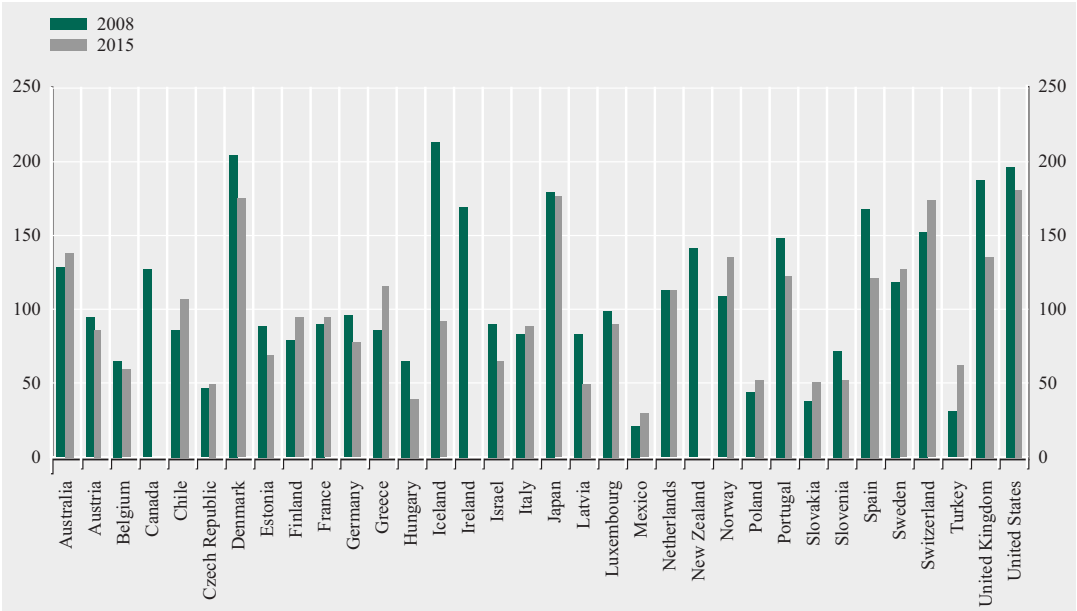
As illustrated in Chart 48, the ratio of private credit to GDP in Greece has expanded since 2008 and is still in line with EA economies such as Germany and France. A similar conclusion is drawn when one examines the ratio of liquid liabilities to GDP. The data from the World Bank do not cast Greece as an outlier among developed economies, with a ratio very close to 100%, i.e. higher than the EU average. The two aforementioned variables are commonly used in the empirical literature to capture the depth of the financial system (see Campos and Kinoshita 2003; Otchere et al. 2015).

Chart 49 shows the path of financial development through the evolution of the IMF's composite index of Financial Development for a key set of countries up to 2013. This aggregate index is compiled using data from the IMF's Financial Development Database and assesses the efficiency, depth and accessibility of financial markets and financial institutions.[38] The latest available value for Greece lies at 0.59 (the index is normalised from 0 to 1), i.e. seven percentage points below the sample average. However, the country is outperformed by EA peers Ireland, Spain and Portugal. Disentangling the building blocks of the index, the country's performance appears balanced among both composite categories (institutions and markets). Taking stock of the final level of disaggregation, what is notable is the relatively poor performance in the area of depth of

38 A detailed description is available in Svirydzenka (2016).

Chart 48 Private credit by banks and other financial institutions (2008, 2015)

(% of GDP)



Source: World Bank.

financial institutions,[39] where Greece records a value of 0.38 compared with the advanced economies' sample average of 0.61. It should be stressed that the data for the compilation of these indices refer to the period prior to the 2015 capital controls.

Chart 50 shows the values of the updated Chinn-Ito Index (Chinn and Ito 2015) on capital account openness. This is a composite index examining the existence of multiple exchange rates, restrictions on current and capital account transactions, and the surrender requirement for export proceeds.[40] It is normalised from zero to one, with values closer to zero indicating a high degree of capital restrictions. A score close to one implies that there are no substantial frictions in the financial system, thus making transactions easier and helping domestic firms benefit from the presence of MNCs. Moreover, Blundell-Wignal and Roulet (2017) find that financial openness as measured by the Chinn-Ito index is a key driver of bilateral FDI flows. Greece is lagging behind top performers in this area, as data for 2015 can reveal, mostly reflecting the capital controls that were imposed that year and frictions in the banking system. The continued gradual easing of capital controls is expected to have improved the country's score in the year halves that followed.

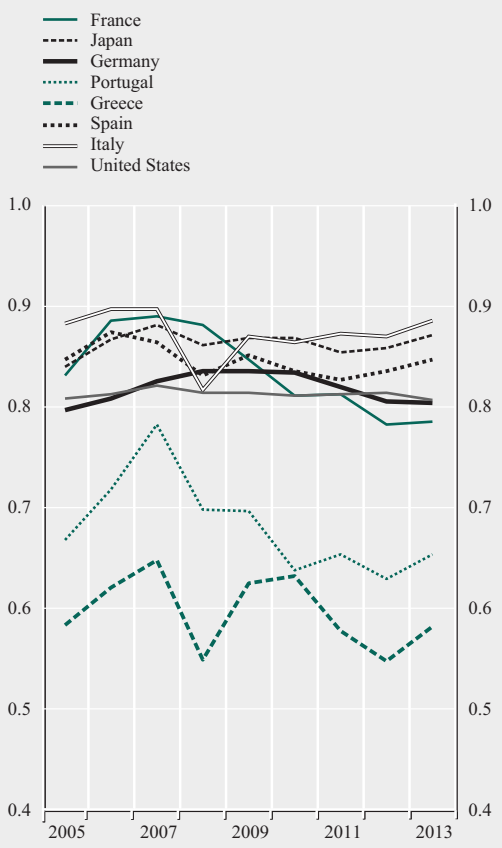
Apart from depth and efficiency, another important factor is the diversity of the financial system so that domestic firms can have access to alternative sources of finance. Data on stock market capitalisation as a percentage of GDP from the World Economic Forum show a 22% value for Greece, compared with an average of 65% for advanced economies in 2015. Besides, the venture capital index[41] compiled by the same group places Greece at the bottom of the distribution, as depicted in Chart

39 Depth of financial institutions covers private credit over GDP, pension and mutual fund assets over GDP and insurance premiums over GDP.

40 The underlying data are from the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)*.

41 The index ranges from 1 to 7 and is based on questionnaires asking "In your country, how easy is it for start-up entrepreneurs with innovative but risky projects to obtain equity funding?".

Chart 49 Financial development index (2005-2013)



Source: IMF.
Note: Scale 0-1. Higher value denotes better performance.

51. Both indicators reveal the relatively high financing burden faced by firms, especially small and medium-sized enterprises that are expected to be more apt to new technologies and knowledge.[42]

Overall, the financial turmoil of the last decade is reflected in Greece's subpar performance in a series of variables and indicators that aim to capture the notion of financial development. Nevertheless, the gradual return to normality and the improvement of banks' financial positions are expected to provide domestic firms with a favourable environment in order to increase their absorptive capacity. The Bank of Greece in its *Annual Report* (2018) highlights the importance of financial depth as a prerequisite for the necessary pick-up in private investment. The report notes that trust in the Greek financial system is being restored and this is expected to continue over the following years. Having said that, the European Commission (2018b) underscores the pivotal role of restoring financial stability in the 2015 ESM stabilisation programme and concludes that: "Following the review of bank boards by the Hellenic Financial Stability Fund (HFSF) under the second review, the four systemic banks implemented important governance changes. Concerning the governance reform of the four systemic banks, the reconstitution process in their boards of directors can be regarded as materially completed. As of today, the bank boards have been substantially reshaped and only two board members remain non-compliant with the HFSF Law criteria despite the HFSF having made all reasonable efforts to obtain their removal."[43]

These encouraging developments can be accompanied by the completion of the EU Banking Union as well as of the Capital Markets Union that aim to remove financial frictions within the EU over the coming years. A deeper integration of financial markets can assist in removing barriers to finance for many firms throughout the continent and thus encourage FDI projects and also increase Member States' absorptive capacity.[44]

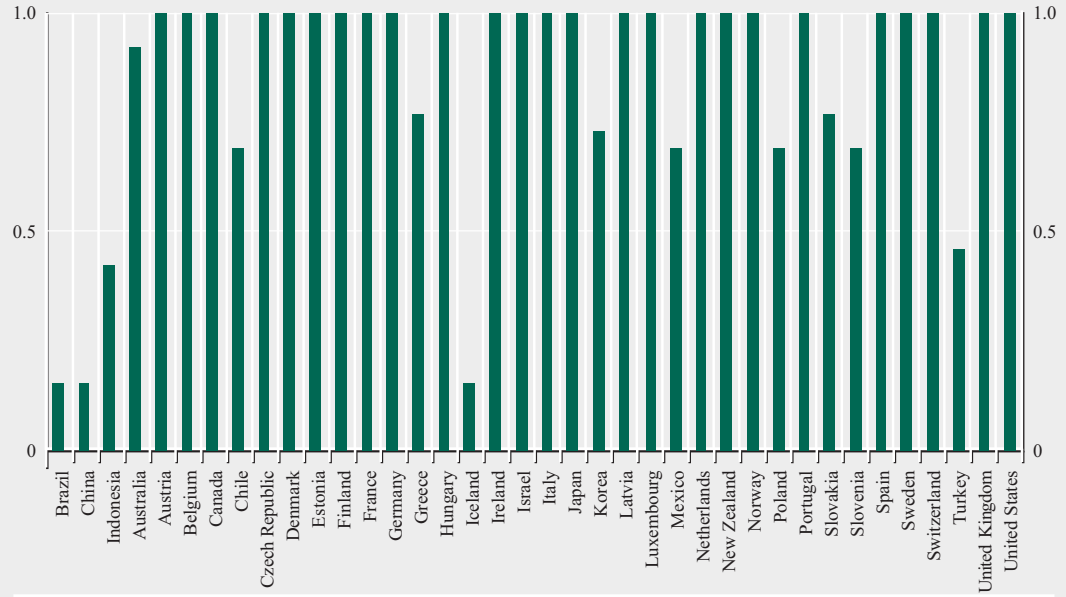
5.3.3 Other factors

An array of other country-specific features have been distinguished as factors enhancing the spillover process associated with FDI. The size of domestic firms, for example, is considered important insofar as it affects the potential effects of foreign technology concomitant with FDI. If large domestic firms operate at a

42 Braunerhjelm et al. (2010) argue that entrepreneurial activity thrives in a knowledge-intensive environment and, in turn, serves as a conduit for new ideas to spill over to the economy, thereby leading to innovation and economic growth.
43 European Commission, *Compliance Report – ESM Stability Support Programmee for Greece – Third Review*, March 2018, p. 18.
44 On the scope and benefits of the Banking Union and the Capital Markets Union, see ECB (2018) and European Commission (2018a).

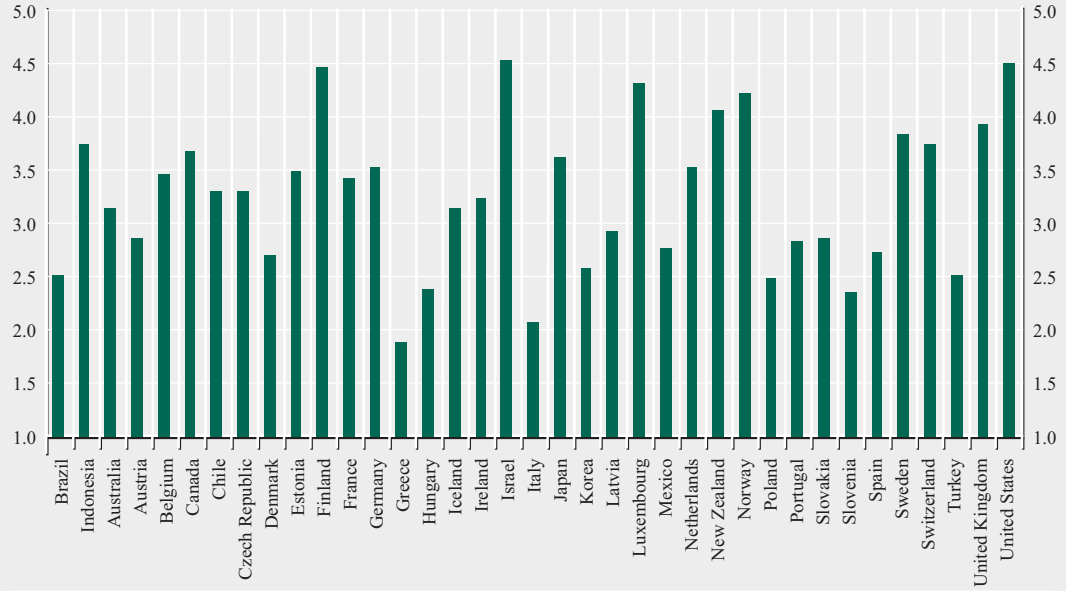
Chart 50 Financial openness (2015)

(Chinn-Ito index)



Source: Chinn & Ito (2015).
Note: Scale 0-1. Higher value denotes a more open financial system.

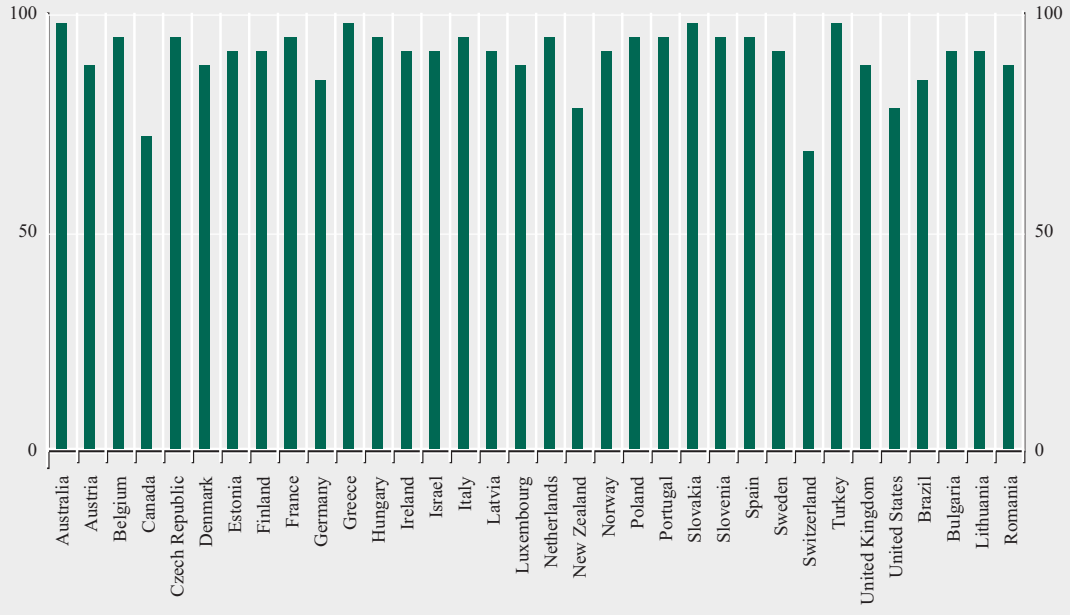
Chart 51 Venture capital availability index (2015)



Source: World Economic Forum.
Note: Scale 1-7. Higher value denotes better performance.

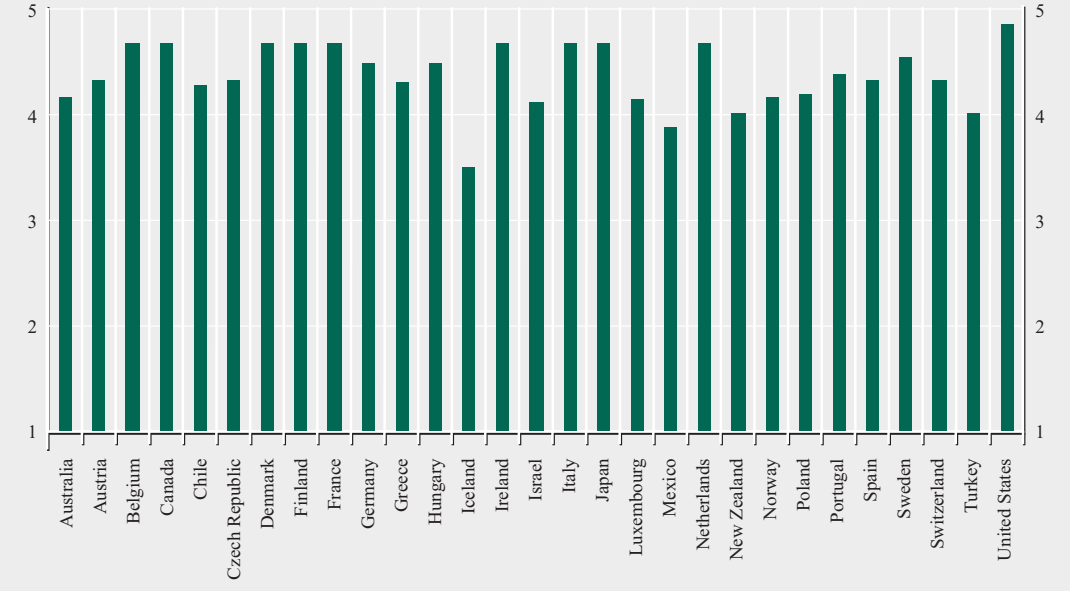
Chart 52 Firms under 10 employees (2014)

(% of total firms)



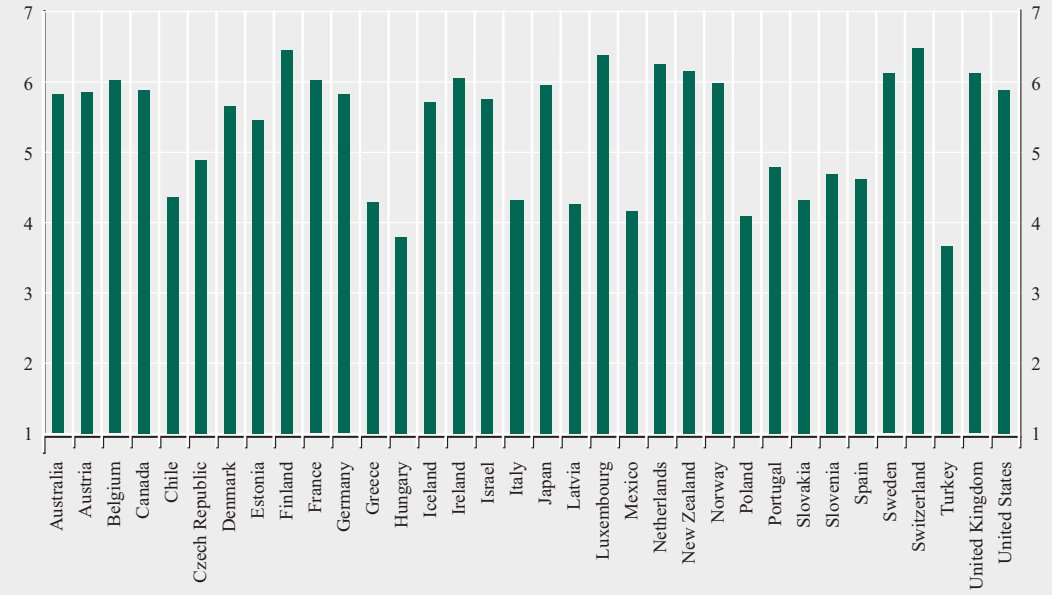
Source: OECD.

Chart 53 Patent protection index (2005)



Source: Park (2008).
Note: Scale 1-5. Higher value denotes protection.

Chart 54 Intellectual property protection index (2016)



Source: World Economic Forum.
Note: Scale 1-7. Higher value denotes better performance.

high technological capacity, there is little room for technology transfer, as discussed in Section 5.1. In this case, small and medium-sized enterprises (SMEs) are expected to benefit more from the presence of MNC affiliates, as noted by Dimelis and Louri (2004). Contrary to their theoretical predictions however, the authors find robust evidence of spillovers only for large Greek firms. The opposite is found in the study by Aitken and Harrison (1999), who use data for over 6,000 Venezuelan firms for the 1976-1989 period. Gorodnichenko et al. (2014) also find that smaller firms experience, on average, greater backward spillovers and that improvements in the institutional environment enhance the spillover mechanism for all firms but to a larger extent for smaller ones. In this respect, the participation of SMEs in the Greek economy is substantial (see Chart 52) and, as underscored above, these firms actively engage in innovative activities. Hence, the absorption of new technology in processes, products and organisational structures is possible.

Furthermore, as mentioned in Section 2.3, the origin of the parent company plays an integral part in the technology gains attributed to FDI. Gorodnichenko et al. (2014) empirically validate that FDI from advanced economies is associated with higher technology transfer. However, Hu and Jefferson (2002) find that the negative horizontal effects from competition are stronger when FDI originates in a more developed economy. In conjunction with the discussion in Section 5.1 and the findings in Section 2.3, we can postulate that foreign capital flowing from innovating economies into Greece can generate positive vertical spillovers, given the moderate technological level of the majority of domestic firms. To put it more simply, domestic firms have much to absorb from FDI that originates in technologically advanced economies.

Another institutional feature that could affect the knowledge transfer from foreign affiliates to the domestic economy is the protection of intellectual property rights, as emphasised by

Mansfield (1994) and Blomström and Kokko (1998). The strong protection of intellectual property not only affects the decision by a multinational corporation on whether to invest but also encourages the establishment of high technology activities in the host economy (Crespo and Fontoura 2007). By contrast, the inability to protect its technology and knowledge would force the multinational corporation to focus on low technology processes for its affiliates. The concept of intellectual property rights is not easy to gauge. We rely on the International Patent Protection Index reported by Park (2008). Chart 53 demonstrates the strength of patent protection in Greece as being close to OECD average values. For the latest data point in 2005, the index stood at 4.3 for Greece, compared with a global mean of 3.34.[45] Furthermore, this marks a single-point increase relative to 1995 and a two-point rise from the 1960-1990 average index value. Moreover, the World Economic Forum publishes a composite index of Intellectual Property Protection in its *Global Competitiveness Report*. The most recent data mark the highest recorded value of the index (4.26) for 2016, showing a steady upward trajectory. Nevertheless, the country lags behind most of its peers in this respect, as shown in Chart 54.

6 CONCLUSIONS

Foreign direct investment (FDI) has gained importance in the globalised world of increased trade and interdependence. Apart from being less volatile than portfolio financial flows, it contributes to capital formation and employment creation in the host country. Furthermore, in addition to these static effects, investment by multinational corporations (MNCs) can raise domestic productivity and support economic growth through the superior technology that these enterprises usually possess. To this end, researchers have been empirically investigating the host country determinants that attract FDI flows. We identify some of these factors and link them to the FDI performance of OECD economies, with Greece as our focal point. In broad terms, Greece has been a laggard within the OECD and the EU country groups, but has recorded a substantial upswing in net FDI inflows in 2016 and 2017. The possible reasons explaining the performance after 1990 can be traced to rigidities in product and labour markets as well as frictions in the financial sector. The latter exacerbated after the financial crisis of 2008, which also led to a deterioration of key macroeconomic variables for FDI attraction, namely GDP and economic growth. The timing was unfortunate, as 2006 and 2008 witnessed the highest values for FDI inflows. Nonetheless, the ongoing reform process and the recent improvement of structural economic indicators can prove to be invigorating for the attraction of foreign capital.

The aforementioned long-term benefits stemming from FDI are not uniform and have not been unanimously identified in the empirical literature. The main factor behind this paradox is that host country conditions also matter to the diffusion of knowledge to the domestic economy. In order for FDI to disseminate technology and create positive spillovers, domestic firms need to enhance their absorptive capacity. The latter term encompasses all the structural and institutional features that allow knowledge to be appropriated by non-performers, in which case domestic firms. The intensity of R&D activities, firms' innovative capacity, human capital and the degree of competition in domestic markets are among the catalysts for knowledge diffusion. Insofar as we can rely on aggregate data for this information, it can be concluded that Greece fits the profile of an economy with mechanisms that allow for fast absorption. Domestic firms have a modest but not huge technology gap relative to firms from major parent economies, the workforce has potential and knowledge but systematically fails to apply those skills in the production process, and product market reforms to increase competition are already under way. On top of that, the source of FDI (developed,

45 Park (2008) includes 110 countries in his sample.

innovative economies) and the prevalence of small and medium-sized firms with significant innovative activity provide buffers for the generation of productivity spillovers, as well as dynamic gains for the Greek economy. Finally, the gradual return of the domestic financial system to pre-crisis normality is an additional factor that enables both the attraction of FDI in the economy as well as the generation of spillovers that could boost productivity.

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GREEK GDP REVISIONS AND SHORT-TERM FORECASTING

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ABSTRACT

Indicators of economic activity, such as gross domestic product (GDP), are usually published with a significant delay, meaning that central banks and ministries rely on estimates or predictions of the key economic indicators in order to conduct monetary and fiscal policy. The econometric methodology that is commonly used to provide a timely estimation of the current state of the economy is referred to as nowcasting and is based on the use of economic indicators that are published earlier and at a higher frequency than the target variable. This study focuses on the Greek economy and particularly on Greek GDP and examines the effect of GDP data revisions on the out-of-sample forecasting outcome of alternative nowcasting models, by utilising real-time GDP data. To that end, we construct a real-time GDP database and we compare the predictive ability of alternative nowcasting models using both last vintage and real-time databases. The empirical results for an out-of-sample period of ten years (2007-2017) show that usually a model with a small set of real variables and the PMI can consistently produce good GDP forecasts as we move closer to the GDP publication date; most importantly, this result is not affected by the GDP revisions and holds true using both the last vintage GDP and the real-time GDP data.

Keywords: Nowcasting, Bayesian shrinkage, real-time data, Greek crisis

JEL classification: C11, C22, C53

ΑΝΑΘΕΩΡΗΣΕΙΣ ΤΟΥ ΕΛΛΗΝΙΚΟΥ ΑΕΠ ΚΑΙ ΒΡΑΧΥΠΡΟΘΕΣΜΕΣ ΠΡΟΒΛΕΨΕΙΣ

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ΠΕΡΙΛΗΨΗ

Οι δείκτες οικονομικής δραστηριότητας, όπως το ακαθάριστο εγχώριο προϊόν (ΑΕΠ), δημοσιεύονται συνήθως με σημαντική χρονική υστέρηση, γεγονός που σημαίνει ότι οι κεντρικές τράπεζες και τα υπουργεία στηρίζονται σε εκτιμήσεις ή προβλέψεις των κύριων οικονομικών δεικτών προκειμένου να ασκήσουν νομισματική και δημοσιονομική πολιτική. Η οικονομετρική μεθοδολογία που χρησιμοποιείται για την παραγωγή έγκαιρων προβλέψεων για το τρέχον επίπεδο οικονομικής δραστηριότητας ονομάζεται nowcasting και βασίζεται στη χρήση οικονομικών δεικτών που δημοσιεύονται πιο έγκαιρα αλλά και με μεγαλύτερη συχνότητα από ό,τι η μεταβλητή που επιθυμούμε να προβλέψουμε. Η παρούσα μελέτη επικεντρώνεται στην ελληνική οικονομία και πιο συγκεκριμένα στο ελληνικό ΑΕΠ και επιχειρεί να εξετάσει αν οι εκτός δείγματος βραχυχρόνιες προβλέψεις οι οποίες παράγονται από οικονομετρικά υποδείγματα nowcasting επηρεάζονται από τις αναθεωρήσεις του ΑΕΠ. Για το σκοπό αυτό, κατασκευάζουμε μια βάση δεδομένων σε πραγματικό χρόνο για το ΑΕΠ και συγκρίνουμε την προβλεπτική ικανότητα εναλλακτικών υποδειγμάτων nowcasting χρησιμοποι-

ώντας τόσο τα τελευταία αναθεωρημένα στοιχεία όσο και τα δεδομένα πραγματικού χρόνου. Τα εμπειρικά αποτελέσματα για μια εκτός δείγματος περίοδο δέκα ετών (2007-2017) δείχνουν ότι συνήθως ένα υπόδειγμα που χρησιμοποιεί ένα μικρό σύνολο πραγματικών μεταβλητών καθώς και το δείκτη PMI μπορεί να παράγει με συνέπεια ποιοτικές προβλέψεις για το ΑΕΠ καθώς πλησιάζουμε προς την ημερομηνία δημοσίευσης. Το πιο σημαντικό όμως εύρημα είναι ότι το αποτέλεσμα αυτό δεν επηρεάζεται από τις αναθεωρήσεις του ΑΕΠ, καθώς ισχύει είτε χρησιμοποιούμε τα τελευταία διαθέσιμα στοιχεία είτε τη βάση δεδομένων σε πραγματικό χρόνο.

GREEK GDP REVISIONS AND SHORT-TERM FORECASTING*

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1 INTRODUCTION

Indicators of economic activity, such as gross domestic product (GDP), are usually published with a significant delay. Thus, institutions involved in policy making, such as central banks and ministries, conduct monetary and fiscal policy without knowing with certainty the current state of the economy. In some cases, where the publication lag exceeds a period of two months, policy makers set their policies without even knowing the level of GDP in the previous quarter. Therefore, in practice, real-time economic policy is conducted in an uncertain environment of incomplete information, where policy makers rely on estimates or predictions of the current state of the economy.

The methodology that is widely used to provide a timely estimation of the current state of the economy is referred to as nowcasting, which is a portmanteau term from "now" and "forecasting". Nowcasting was introduced in economics by Giannone et al. (2008) and the term is usually used to describe the prediction of next, current and previous quarter GDP or some other economic indicator before its official release. Nowcasting techniques are widely based on the use of economic indicators that are published earlier and at a higher frequency than the target variable (see Bańbura et al. (2013) for an excellent review of nowcasting methods). Monthly economic indicators such as industrial production, retail sales, unemployment, prices, etc., financial variables (e.g. interest rates, stock indices) or "soft" data including survey-based indicators (e.g. economic sentiment indicators) are usually the main inputs in nowcasting models for GDP. The key point in nowcasting is to exploit the information content of these coincident or leading indicators of economic activity, which are usually published in a more timely fashion than the target variable, resulting in a timely prediction of current GDP. Thus, in real-time nowcasting processes, the forecaster has to work with an unbalanced data set due to the mixed frequencies of the variables (quarterly and monthly) and the so-called "ragged" or "jagged" edge problem, which refers to the non-synchronous publication of the various indicators resulting in missing observations at the end of the sample.

This study concentrates on the Greek economy and particularly on Greek GDP and aims to examine, among other things, the effect of GDP data revisions on the forecasting outcome of alternative nowcasting models, by utilising real-time GDP data.[1] The use of real-time data in forecasting studies is not new in the literature (see e.g. Clements (2016) and Louzis (2018) for recent examples and references therein), but it may be crucial in terms of forecasting and policy analysis since macroeconomic data series are typically heavily revised over time and these revisions may contain new valuable information that was not available at initial release (Orphanides 2003). Therefore, it is important to assess the forecasting ability of nowcasting models, using data available at each point in time and not the fully revised data as is the case in pseudo out-of-sample forecasting exercises. Overall, in a real-time forecasting exercise, the researcher tries to replicate as closely as possible the information available to the decision maker when she forecasts GDP in real time (Antolin-Diaz et al. 2017).

Unfortunately, a real-time macroeconomic database is not available for Greece, unlike

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1 In a recent contribution by Lamprou (2016), the author also assesses the impact of data revisions on nowcasting Greek GDP. Our work differs from hers in three main points: (i) we use a real-time data set rather than only two data vintages (2013 and 2015); (ii) we use both hard and soft indicators as predictors instead of only hard indicators; and (iii) we rely on Bayesian techniques for the estimation of the models.

what is the case with a number of major economies such as the US, the UK and the euro area.[2] Therefore, we follow the recent contribution of Bragoli and Fosten (2018) and we construct real-time vintages for GDP using publicly available information from the website of the Hellenic Statistical Authority (hereinafter ELSTAT). In particular, we use the ELSTAT archive of GDP press releases dating back to 2005:Q1 and the data history available in each of these to reconstruct a real-time GDP database. Then, as already mentioned, we use the real-time GDP vintages to perform out-of-sample nowcasting and compare its results with a pseudo out-of-sample exercise using only the last vintage GDP data.

The various nowcasting models implemented in this study are based on the bridge equations methodology that has been widely used by central banks and is currently used as a benchmark in most of the nowcasting studies (Foroni and Marcellino 2014; Luciani and Ricci 2014; Bragoli and Fosten 2018). In brief, in the bridge equation approach we deal with the "jagged" edge problem of the monthly indicators by employing auxiliary, typically autoregressive models to produce forecasts for the missing observations. Then, using monthly variables aggregated at the quarterly frequency, we estimate a regression with the target variable, e.g. the GDP growth rate, being the independent variable and monthly indicators being the explanatory variables.

The alternative models employed here differ from each other in terms of the set of explanatory variables used. Thus, we first examine whether the information content of survey indicators, nominal (e.g. price indices) and financial variables (e.g. stock indices) helps improve the accuracy of Greek GDP forecasts. To this end, we first use a standard baseline nowcasting model consisting of a small set of real variables and then compare its nowcasting ability with models that also include survey and/or nominal/financial variables.[3] Real variables, also known as "hard" indicators, are considered to generate more accurate signals for the current state of economic activity, but suffer from large publication lags.[4] On the other hand, survey and financial indicators are less accurate, but are typically much timelier. Nonetheless, the empirical evidence in the literature regarding the predictive ability of nominal, financial and survey indicators is generally inconclusive and the results depend largely on the economy or the methods used.[5] Second, we also assess the information content of the disaggregate or sectoral subindices of the real and survey indicators. The literature suggests that a "medium-scale" set of disaggregate variables typically provides the best forecasting results (see e.g. Alvarez et al. 2012), but given the small set of explanatory variables in our application we proceed with a large model that uses all the available subindices.

Recent advances in Bayesian macroeconometrics suggest that Bayesian shrinkage is a prerequisite for exploiting the information content of nearly collinear regressors (see Bańbura et al. 2010; Giannone et al. 2015; Carriero et al. 2016; D'Agostino et al. 2015 among others). Therefore, we depart from the recent literature on bridge equation modelling, which uses classical estimation techniques and simple averages across alternative univariate models (see e.g. Luciani and Ricci 2014; Bragoli and Fosten 2018), and we use Bayesian techniques to estimate the forecasting regressions

2 Publicly available macroeconomic real-time databases are the Archival Federal Reserve Economic Data (ALFRED) of the Federal Bank of St. Louis and the Real Time Data Set for Macroeconomists (RDTSM) of the Federal Bank of Philadelphia for the US economy; the Euro Area Business Cycle Network (EABCN) Real Time Database for the euro area and major European economies; and the OECD real-time database.

3 As thoroughly presented in Section 3, the real variables used in the model are the Industrial Production index, the Retail Sales index and the number of unemployed.

4 E.g. the Industrial Production index is published with a two-month delay.

5 For example, Giannone et al. (2005) find that prices and monetary indicators do not improve GDP nowcasts, while Forni et al. (2003) for the euro area and Stock and Watson (2003) for the US find mixed results for the financial variables. On the other hand, Bańbura and Rünstler (2011) find that survey-based and financial indicators contain valuable information for GDP prediction in the euro area, but this can be revealed only if the more timely publication of the monthly indicators is taken into account properly. Another example is the study of Bragoli and Fosten (2018), who document that nominal and financial variables contribute to GDP forecasting in the developing economy of India.

in the spirit of Carriero et al. (2016).[6] This approach may also be considered as a benchmark method for nowcasting studies that propose a new model or method.

To sum up, this study contributes to the nowcasting/forecasting literature by (i) constructing a real-time database for Greek GDP using publicly available data; (ii) examining the information content of survey, nominal/financial and disaggregate real and survey indicators in nowcasting Greek GDP using both real-time and pseudo real-time GDP data; and (iii) extending the standard bridge equations methodology using Bayesian shrinkage methods to account for the overparameterisation problem.

The empirical application involves estimating all competing models and producing forecasts/nowcasts for the 2007:Q4-2017:Q4 out-of-sample period, using both real-time and pseudo real-time GDP data so as to detect possible differences in the forecasting quality of the competing models. It is worth noting that the out-of-sample period is rather challenging in terms of forecasting, because it contains the severe sovereign crisis period of 2008-2013 and the current weak recovery period starting approximately in 2014 (see Chart 1) with the GDP series being possibly subject to structural breaks. Given the importance of the accuracy of short-term GDP estimates in conducting economic policy, examining the predictive ability of the various models in real time is a policy-relevant exercise. That is, models whose forecasting performance deteriorates in a real-time out-of-sample exercise compared with a pseudo out-of-sample exercise may be inappropriate for decision making due to lower forecasting quality in a real-time environment.[7]

The remainder of the paper is organised as follows: Section 2 presents the econometric methodology, while Section 3 describes the construction of the real-time GDP data, the variables used as regressors and the competing models. In Section 4, we present the forecasting results using both real-time and pseudo real-time GDP data. Section 5 provides some robustness checks, while Section 6 summarises and concludes.

2 ECONOMETRIC METHODOLOGY

2.1 BRIDGE EQUATIONS MODELLING

This section describes the standard nowcasting methodology of bridge models, which tackles the mixed frequency of the data and the "ragged" edge of the sample. Bridge modelling is one of the first attempts to utilise mixed frequency variables in order to provide an estimate of the current and short-term developments of low frequency (e.g. quarterly) variables, such as GDP, which are usually published with a considerable time lag, using high-frequency (e.g. monthly) indicators such as industrial production, retail sales, etc. (see e.g. Baffigi et al. 2004). This is a relatively simple technique which largely relies on a linear regression of the following general form:

$$y_t^Q = c + a(L)y_t^Q + \Sigma_{i=1}^{n}\beta_i(L)x_{i,t}^Q + \varepsilon_t^Q,\ \varepsilon_t^Q \sim N(0,\ \sigma_\varepsilon^2) \quad (1)$$

where y_t^Q is the quarterly target variable, x_t^Q is the monthly indicator aggregated at the quarterly frequency, n is the number of regressors, $a(L) \cong a_1 L + ... + a_p L^p$ and $\beta_i(L) \cong \beta_{i,0} + \beta_{i,1} L ... + \beta_{i,q} L^q$ are lag polynomials, $L^l\ y_t = y_{t-l}$ is the standard backshift operator, ε_t^Q is the error term distributed as iid Normal with zero mean and constant variance and T is the number of quarters in the sample.

There are a couple of points here that should be discussed. First, the quarterly aggregates of the monthly indicators are defined as the simple monthly averages, $x_{i,t}^Q = \Sigma_{m=1}^{3} \frac{1}{3} x_{m,t}^i$ where $x_{m,t}$ is the monthly indicator observed in month m of quarter t.[8]

6 The authors use the insights of the Minnesota prior (Litterman 1986) to impose Bayesian shrinkage and estimate mixed frequency regressions for nowcasting purposes.
7 As mentioned above, economic policy is conducted in a real-time environment.
8 For flow variables, one may sum high-frequency variables over a lower-frequency period.

Second, it is obvious that equation (1) uses not only lags of the monthly indicators, but also their contemporaneous value, i.e. it uses the term $\beta_{i,0} x_{i,t}^{Q}$ on the right-hand side of the equation. This implies that x_t^Q, or alternatively $\{x_{t,m}\}_{m=1}^{3}$, should be available to generate an estimate of the target variable at quarter t, $\hat{y}_t^Q$. However, monthly indicators are not always available for all $m=1,...,3$ due to publication lags, thus we use an auxiliary "bridging" autoregressive (AR) model to produce forecasts over the remainder of the quarter. It should also be noted that, depending on the publication lag of each monthly indicator, the forecasting horizon for each monthly variable may differ. The number of lags in the AR model is usually selected on the basis of some information criterion, which, here, is the Bayesian Information Criterion (BIC) using a maximum number of 12 lags.

Third, we depart from the literature and estimate equation (1) using Bayesian methods to deal with the overparameterisation problem. Specifically, the number of parameters in equation (1) is $k=(p+1)+n\times(q+1)$ and obviously can grow very large so that $k \gg T$. This may lead to increased parameter uncertainty and poor forecasting performance and inference if we rely on standard (e.g. ordinary least squares, OLS) estimation methods.[9] Bayesian estimation uses informative priors that shrink regression coefficients towards a specific prior mean, thus mitigating the overparameterisation problem (see Giannone et al. (2015) and the references therein for a related discussion). We will not give the full computational details of the posterior distribution in this paper, and the interested reader is referred to Koop (2003) for a textbook treatment. Here, it suffices to say that we follow Carriero et al. (2016) and use a Normal-diffuse prior for the regression parameters and the variance of the residuals with the prior on the regression coefficients being:

$$b \sim N(b_0, V_b)$$

where b is a $k\times1$ vector collecting all the regression coefficients, b_0 is $k\times1$ vector of prior means and V_b is the $k\times k$ prior diagonal covariance matrix. We set all elements of b_0 equal to zero except for the autoregressive coefficient of the first own lag, which is set equal to 0.8 to account for the persistence of the GDP growth rate. The prior covariance matrix is elicited by using the insights of the Minnesota prior (see e.g. Litterman 1986). Specifically, the prior standard deviation (sd) for the intercept is:

$$sd_b^{int} = 100\sigma_y$$

For the l-th lag of the dependent variable, the prior sd is:

$$sd_{b,l}^{y} = \lambda_1 / l \text{ with } l=1,...,p$$

Finally, for the l-th lag of the x monthly regressor, the prior sd is formulated as:

$$sd_{b,l}^{x} = \frac{\sigma_y}{\sigma_x} \frac{\lambda_1 \lambda_2}{(l+1)}, \text{ with } l=0,...,p$$

where σ_y and σ_x are the residual standard deviations of an AR(1) model for the y_t^Q and $\{x_{i,t}^Q\}_{i=1}^{n}$ variables, respectively. Hyperparameter λ_1 controls for the overall tightness of the prior, while λ_2 controls for the tightness of the prior on the coefficients of the lagged regressors (Carriero et al. 2016). The structure of the covariance matrix implies that the prior variances become tighter around the prior mean, b_0, as the lag length increases. The rationale is that the long-lagged variables are less important than the short-lagged ones, thus the prior distribution should be tighter around its prior mean, which is set to zero by default. In general, as the hyperparameters approach zero, the prior becomes very tight around zero, meaning that prior beliefs play a crucial role in the estimation. On the other hand, the higher the value of the hyperparameters, the looser the prior, meaning that posterior estimates depend more on the data. We discuss the choice for the value of the hyperparameters, λ_1 and λ_2, in Section 3.2. Finally, we use a flat prior on the intercept of the regression equation.

9 For example, if we use $p=1$ lag for the lagged dependent variable, $q=4$ lags for the various regressors and a small number of regressors, e.g. $n=4$, then we have to estimate $k=21$ parameters.

2.2 AN ILLUSTRATIVE EXAMPLE OF THE FORECASTING PROCEDURE

The following example aims to shed some light on the forecasting procedure described in Section 2.1. Let us assume that there are two available indicators of monthly frequency, namely $CI_{t,m}$ and $IP_{t,m}$, which denote a confidence indicator (CI) and the Industrial Production (IP) index with one and two months of publication lag, respectively. Let us also assume that the quarterly target variable is the gross domestic product, i.e. GDP_t, which is released two months after the reference quarter. In this hypothetical exercise, we are interested in forecasting the *third quarter of 2010* (2010:Q3) figure with all the information available till the end of *September*, i.e. the end of Q3. This means that for the two monthly indicators the sample ends in August and July of 2010 (2010:M8 and 2010:M7), respectively, due to publication lags. Assume also that the sample of this hypothetical exercise begins in 2000:Q1 and ends in 2010:Q2 for the quarterly GDP variable, while for the two monthly variables, IP and CI, the sample spans from 2000:M1 to 2010:M7 and from 2000:M1 to 2010:M8, respectively. Given this information, we proceed with the following two-step procedure.

First, we estimate the two AR models for each of the monthly indicators producing 1- and 2-step ahead forecasts for the CI and IP indicators, respectively. In this way, we produce estimates of the missing observations till the end of the reference quarter, that is September 2010. More specifically, we use the sample 2000:M1-2010:M7 (2000:M1-2010:M8) for the IP (CI) variables to estimate an AR(p) model, where the number of lags, p, is determined by the BIC metric. Then, using the estimated parameters, we produce forecasts for August and September for the IP index and only for September for the CI index.

Second, we aggregate the monthly indicators at the quarterly frequency and use the available sample, i.e. 2000:Q1-2010:Q2, to estimate the model in equation (1) assuming that $L=1$, i.e. we estimate the following equation:

$$y_t^Q = c + a_1 y_{t-1}^Q + \beta_{CI,0} CI_t^Q + \beta_{CI,1} CI_{t-1}^Q + \beta_{IP,0} IP_t^Q + \beta_{IP,1} IP_{t-1}^Q + \varepsilon_t^Q$$

where CI_t^Q and IP_t^Q are the monthly indicators aggregated at the quarterly frequency. Once the model is estimated, we use its estimated parameters, i.e. the posterior medians, to produce the nowcast of interest as follows:

$$GDP_{2010:Q3} = \hat{c} + \hat{a}_1 GDP_{2010:Q2} + \hat{\beta}_{CI,0} \hat{CI}_{2010:Q3}^Q + \hat{\beta}_{CI,1} CI_{2010:Q2}^Q + \hat{\beta}_{IP,0} \hat{IP}_{2010:Q3}^Q + \hat{\beta}_{IP,1} IP_{2010:Q2}^Q$$

where $\hat{CI}_{2010:Q3}^Q = 1/3(\hat{CI}_{2010:M9} + CI_{2010:M8} + CI_{2010:M7})$

and $\hat{IP}_{2010:Q3}^Q = 1/3(\hat{IP}_{2010:M9} + \hat{IP}_{2010:M8} + IP_{2010:M7})$

and $\hat{CI}_{2010:M9}$, $\hat{IP}_{2010:M9}$ and $\hat{IP}_{2010:M8}$ are the corresponding forecasts obtained in the first step.

3 THE DATA SET

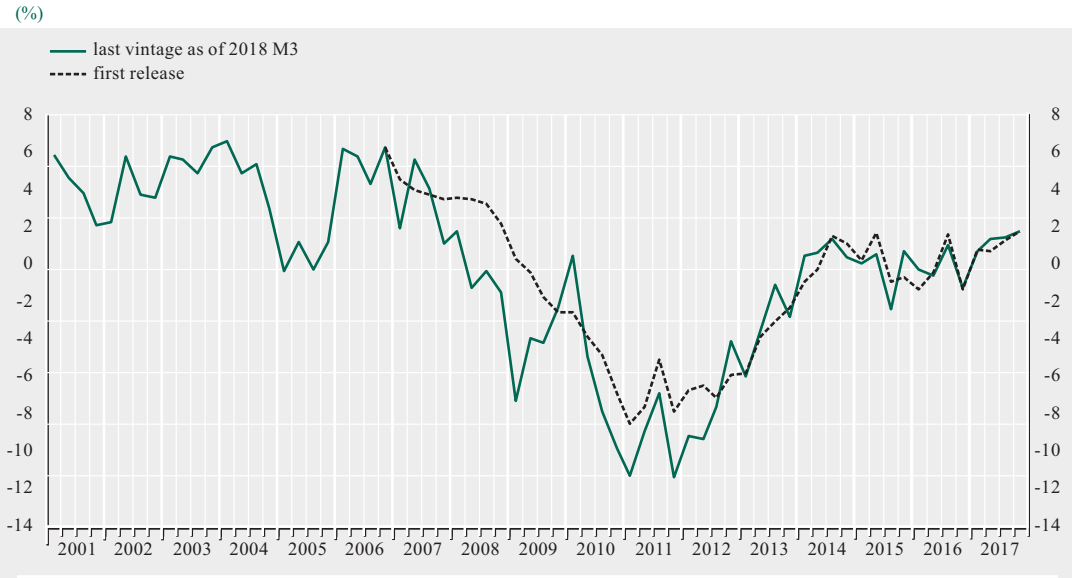
3.1 A REAL-TIME GDP DATABASE

The target variable of this study is the real GDP growth rate, which is produced and published quarterly by ELSTAT with a delay of nearly two months. This means, for example, that for the last quarter of each year (October to December) the first GDP figure is officially released in early March —usually within the first 5 to 10 calendar days— while for the first quarter of each year (January to March) the first release for GDP is within the first days of June, etc.[10]

ELSTAT typically revises GDP because of incoming new information in later quarters, changes in the methodology, e.g. changes in the European System of Accounts (ESA), or

10 See the ELSTAT calendar of press releases: http://www.statistics.gr/documents/20181/12044283/elstat_press_releases_calendar_2019_en.pdf.

Chart 1 First release versus fully revised year-on-year GDP growth for Greece



Source: Hellenic Statistical Authority (ELSTAT).

statistical changes such as a change of base years or seasonal weights; methodological changes are usually referred to as *benchmark revisions* and should be carefully treated in out-of-sample exercises (Aruoba 2008).[11] A real-time database for the Greek GDP is not currently available, not even in the OECD database.[12] Thus, we follow the recent contribution of Bragoli and Fosten (2018) and construct a real-time data set for Greek GDP from the press releases of ELSTAT which are publicly available on its website.[13]

More specifically, starting from the 2005:Q1 vintage, we construct a real-time database for the non-seasonally adjusted real GDP figure (chain-linked volumes) for Greece. The first available vintage, i.e. 2005:Q1, includes data from 2001:Q1 to 2004:Q4, the second available data vintage, i.e. 2005:Q2, includes data from 2001:Q1 to 2005:Q1, etc. We choose to work with the non-seasonally adjusted figures because the seasonally adjusted figures are not available in each and every press release. Nonetheless, this is not a problem, since we work with year-on-year (y-o-y) growth rates, which account for seasonality (Bragoli and Fosten 2018).

Chart 1 presents the last vintage data as of March 2018, which for the purposes of our study are considered as the fully revised GDP, and the first release data which are available from 2007:Q1. Obviously, during the first years of the sovereign debt crisis 2007-2012, there are substantial differences between the first-release and the fully revised data. The latter are almost always far lower than the former, implying that mostly downward revisions occurred during that period. The crucial question that this article tries to address is whether these differences in real-time and last vintage data affect the overall forecasting output of standard econometric methods.

3.2 PREDICTORS OF GDP

The first column of Table 1 shows the set of input *monthly* variables used to predict the

11 ELSTAT currently uses the ESA 2010 with reference year 2010.
12 See the OECD Main Economic Indicators, Revisions Analysis Dataset – Infra-annual Economic Indicators at https://stats.oecd.org/ Index.aspx?DataSetCode=MEI_ARCHIVE#. The real-time OECD database has currently real-time data for the Industrial Production Index, the Consumer Price Index and Unemployment and for vintages starting from 2015, which obviously are not useful for the present analysis.
13 See http://www.statistics.gr/el/statistics/-/publication/SEL84/- .

Table 1 GDP predictors, publication lags, transformations and sources

Indicator	Baseline	Model 1	Model 2	Model 3	Publication lag	Unit/ Trans-formation	Source
Industrial Production Index (IP index)	X	X	X	X	2 months	Index/ y-o-y %	ELSTAT
IPI sectoral indices				X	2 months	Index/ y-o-y %	ELSTAT
Retail Sales (RS) volume	X	X	X	X	2 months	Index/ y-o-y %	ELSTAT
RS sectoral indices				X	2 months	Index/ y-o-y %	ELSTAT
Unemployed	X	X	X	X	3 months	Thousands/ y-o-y %	ELSTAT
Purchase Managers' Index (PMI)		X	X	X	Current	Index/ none	Markit
PMI disaggregate indices				X	Current	Index/ none	Markit
Consumer Price Index (CPI)			X		1 month	Index/ y-o-y %	ELSTAT
M1 Money supply			X		1 month	Millions / y-o-y %	BoG
Athens Stock Exchange Index			X		Current	Index/ y-o-y %	Datastream

Note: BoG stands for the Bank of Greece.

real GDP growth rate. This set includes three main categories of variables widely used in the recent nowcasting/forecasting literature (see e.g. Lucianni and Ricci 2014; Carriero et al. 2015; Marcellino et al. 2016; Antolin-Diaz et al. 2017; Bragoli and Fosten 2018 among others). More specifically, we use: (a) real or *hard* indicators, such as the Industrial Production Index (IP), the volume of retail sales (RS) and the number of unemployed persons in Greece; (b) survey or soft indicators, such as the Purchase Managers' Index (PMI); (c) nominal/financial variables such as the Consumer Price Index (CPI), M1 money supply and the Athens stock exchange index. It is worth mentioning that the choice of the variables is also partially dictated by data limitations, given that many of the other potential predictors of GDP are not available at the monthly frequency or their sample is not long enough for an out-of-sample exercise.[14] Moreover, all real variables and the CPI are generally subject to revisions; however, the construction of a real-time database from the ELSTAT data is infeasible, thus we rely on the fully revised data for these indicators.

In Table 1, we also show the different models employed in this study depending on the set of regressors used in equation (1). In particular, the *Baseline* model uses only the real variables, while *Model 1* uses the real variables and the manufacturing PMI, a survey index that is widely monitored by economic agents due to its timeliness and its ability to depict accurately the current state of the economy (see e.g. Antolin-Diaz et al. 2017). The third model, *Model 2*, uses the variables of *Model 1* plus the nominal/financial indicators (prices, M1 money supply and the stock exchange index),

14 Survey indicators could also include the Economic Sentiment Indicator (ESI) and its disaggregate indices published by the European Commission. We experimented with the ESI as an input variable in all models and found that it does not lead to any forecasting improvements, thus we decided to exclude the ESI from the analysis. Moreover, we also decided to exclude the 10-year Greek government bond yield to avoid the distortion of our results because of the outliers during the sovereign debt crisis. To circumvent this problem, one can use the Dynamic Factor Model (DFM) in the spirit of Antolin-Diaz et al. (2017), which can deal with missing values due to outliers.

while *Model 3* uses the variables of *Model 1* plus the disaggregate and sectoral subindices for the IP, RS and PMI indices.[15] Obviously, the choice of the variables in each model serves the purspose of our analysis which, among other things, is to assess the information content of nominal/financial and disaggregate indicators in nowcasting/forecasting the real GDP growth rate in Greece.

Before proceeding to the forecasting analysis of the alternative models, we briefly discuss the choice of the shrinkage hyperparameters, λ_1 and λ_2, which play an important role in forecasting (Bańbura et al. 2010). Based on the theoretical results of De Mol et al. (2008), Bańbura et al. (2010) (see also Giannone et al. 2015) argue that the degree of prior shrinkage should be chosen in relation to the size of the model, i.e. the number of the explanatory variables, in order to extract the valuable information carried by the near-collinear covariates. Therefore, following Carriero et al. (2016) among others, we set the overall shrinkage hyperparameter, λ_1, equal to 0.5 for the small *Baseline* model and *Model 1*, while we apply a tighter prior for *Model 2* and *Model 3* that include a larger number of variables, by setting λ_1=0.2. Finally, hyperparemeter λ_2 is set equal to 0.2 across all models (Carriero et al. 2016). Nonetheless, in the empirical section we also experiment with a looser degree of overall shrinkage by setting λ_1=0.5 for the largest models, i.e. *Model 1* and *Model 2*, thus examining also the effect of the Bayesian shrinkage on our results.

Table 1 also presents the publication lags of the various predictors with respect to the reference quarter, that is the number of months after the last day of quarter *t* that a specific monthly indicator becomes available.[16] For example, the Industrial Production index for the first quarter (January to March) of each year becomes available after two calendar months, i.e. in May, etc. Obviously, as already mentioned, survey and financial indicators become available in a more timely manner compared with hard indicators. The crucial question here is whether the former carry substantial information content as predictors of the current state of the economy. Lastly, we transform the variables to achieve stationarity, as is typically the case in the literature (e.g. Antolin-Diaz et al. 2017; Bragoli and Fosten 2018).

4 EMPIRICAL ANALYSIS

4.1 THE TIMELINE OF THE FORECASTING PROCEDURE

In this section, we provide empirical evidence regarding the forecasting ability of the various models using both pseudo real-time and "quasi" real-time out-of-sample forecasting exercises. In this study, a pseudo real-time forecasting exercise uses the last vintage, i.e. the fully revised data for both GDP and regressors, while a "quasi" real-time forecasting exercise uses the real-time vintages for GDP and the fully revised data for the regressors. A proper real-time out-of-sample exercise, as implemented for instance in Louzis (2018), also requires real-time vintages for those regressors that are usually subject to revisions (e.g. real variables and the CPI). Nonetheless, as explained in Section 3.2, real-time vintages for the regressors are not available and cannot be reconstructed from the publicly available information of ELSTAT.

The out-of-sample period is from 2007:Q4 to 2017:Q4, spanning ten years, and includes both a crisis and a recovery phase of the Greek business cycle (see Chart 1), enhancing the robustness of our empirical results. All models are estimated recursively, meaning that we first estimate the models for the initial sample 2001:Q1-2007:Q3 and then add one observation at a time as we move forward in the sample in order to generate forecasts for the full out-of-sample period.

15 Details on the disaggregate or sectoral indices are provided in the Appendix due to space considerations.
16 Publication lags are based on the press release calendar of ELSTAT.

Table 2 The timeline of the forecasting procedure

Forecast period Quarter *t*-1			Nowcast period Reference quarter *t*			Backcast period Quarter *t*+1		
Month 1	Month 2	Month 3	Month 1	Month 2	Month 3	Month 1	Month 2	Month 3
For each of the months (1, 2, 3) within the quarter, we generate GDP forecasts for the reference quarter, *t*.			For each of the months (1, 2, 3), we generate GDP nowcasts for the reference quarter, *t*.			For the first two months (1 and 2), we generate GDP backcasts for the reference quarter, *t*. The first figure of GDP is published during the first days of Month 3 of the current quarter, *t*+1.		

Following the recent literature, for a given reference quarter, we provide monthly forecasts three months before the beginning of the quarter, i.e. the "forecast period", during the reference quarter, i.e. the "nowcast period", and two months after the end of the reference quarter, i.e. the "backcast period". The aforementioned forecasting procedure is presented schematically in Table 2.

The predictive ability of the models is evaluated using two standard evaluation metrics: the root mean squared forecast errors (RMSE) and the mean absolute deviation (MAD) defined as:

$$RMSE_j = \sqrt{\frac{1}{T_{out}}\sum_{t=1}^{T_{out}}\left(GDP_t - \widehat{GDP}_{j,t}\right)^2}$$

$$MAD_j = \frac{1}{T_{out}}\sum_{t=1}^{T_{out}}\left|GDP_t - \widehat{GDP}_{j,t}\right|$$

where $j=1,\ldots,m$, with m being the number of models employed in this study, T_{out} is the number of out-of-sample observations and $\widehat{GDP}_{j,t}$ is the GDP growth rate prediction produced by the j-th model. Following the standard practice in the literature, we present the relative RMSE and MAD defined as $RMSE_j/RMSE_{AR}$ and MAD_j/MAD_{AR}, respectively, where $RMSE_{AR}$ and MAD_{AR} are the evaluation metrics produced by a benchmark AR(1) model estimated with OLS. Thus, for values below 1, the j-th model outperforms the benchmark and vice versa. Finally, we also provide a rough gauge of whether the improvement in the forecasting accuracy relative to the AR model is statistically significant by implementing the Diebold and Mariano (1995) t-statistic for equal RMSE and MAD compared against normal critical values (see Louzis 2018 for a recent application and the discussion therein).

4.2 COMPARATIVE PERFORMANCE USING PSEUDO REAL-TIME AND QUASI REAL-TIME DATA

In this subsection, we compare the forecasting ability of the various models using pseudo real-time data and quasi real-time data. Table 3 presents the results of the pseudo real-time forecasting exercise, where we use the last vintage or fully revised GDP data to assess the out-of-sample forecasting ability of the alternative specifications.

Overall, the results presented in Table 3 clearly show that *Model 3* is the best performing model for the nowcast (Months 2 and 3) and backcast evaluation periods across both evaluation metrics, while *Model 2* augmented with nominal and financial variables outperforms its rivals mainly for the forecast evaluation period. Moreover, *Model 1* outperforms the *Baseline* model, highlighting the importance of the survey PMI indicator as a predictor of the current state of the Greek economy. It is also worth noting that *Model 1*, comprising only aggregate real variables and the PMI, is typically the second best performing model for the last month of the nowcast evaluation period and for the entire backcast period. Moreover, all three models outperform the benchmark AR(1) model across almost all evaluation periods and

Table 3 Forecasting results using last vintage (fully revised) GDP data

Panel A: RMSE				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	0.983	0.978***	**0.925*** **	0.945**
Month 2	0.963*	0.955**	**0.920*** **	0.940*
Month 3	1.008	1.000	**0.928*** **	0.960*
Nowcast period				
Month 1	0.962	0.947***	**0.906*** **	0.921**
Month 2	0.930***	0.921***	**0.902*** **	**0.888*** **
Month 3	0.937***	0.920***	**0.929*** **	**0.909*** **
Backcast period				
Month 1	0.928***	**0.903*** **	0.923***	0.905***
Month 2	0.904***	0.884***	0.916***	**0.874*** **
Panel B: MAD				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	0.956	0.947	**0.898** **	0.945*
Month 2	0.935	0.910**	**0.880** **	0.938
Month 3	0.998	0.990	**0.912*** **	0.975
Nowcast period				
Month 1	0.947***	0.910***	**0.877*** **	0.916**
Month 2	0.906***	0.882***	0.880***	**0.873*** **
Month 3	0.916***	0.900***	0.921***	**0.866*** **
Backcast period				
Month 1	0.903***	0.874***	0.913***	**0.859*** **
Month 2	0.880***	0.867***	0.910***	**0.838*** **

Notes: The table presents the RMSE and MAD ratios of the *Baseline* model, *Model 1, Model 2* and *Model 3* (see Section 3.2 and Table 1 for a definition of the models) relative to the RMSE and MAD of the benchmark AR(1) model. Bold-faced numbers indicate the best-performing model. Asterisks denote that the ratios are significantly below one at *10%, **5% and ***1% significance level. The out-of-sample period is from 2007:Q4 to 2017:Q4.
Source: Author's calculations.

metrics, with forecasting gains being up to 12.6% and 16.2% for the RMSE and MAD metrics, respectively.

The empirical evidence presented so far is largely in line with the findings of Bańbura and Rünstler (2011), who find that survey and financial indicators contribute to the accuracy of GDP forecasts in the euro area, while the role of real variables is relatively more important during the backcast period. The good forecasting behaviour of *Model 2* during the forecast evaluation period and the first and second months of the nowcast period can be partially attributed to the significant publication lag of hard indicators, meaning that their figures are not published before the end of the reference quarter. However, the picture changes when hard indicators become gradually available, starting from the last month (Month 3) of the reference quarter and during the backcast period, when ELSTAT publishes both IP and

Table 4 Forecasting results using real-time GDP data (forecast evaluation using first release data)

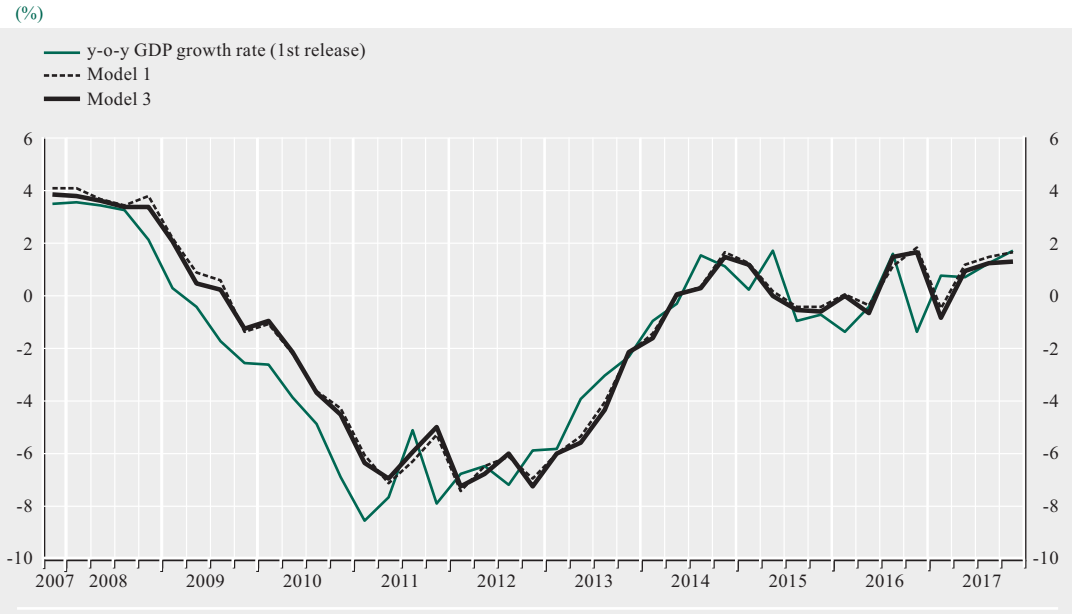
Panel A: RMSE				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	1.007	0.974	**0.878****	0.941
Month 2	0.960	0.922	**0.856****	0.902
Month 3	0.993	0.962	**0.855*****	0.933
Nowcast period				
Month 1	0.964	0.921	**0.847*****	0.883
Month 2	0.919	0.865**	0.836***	**0.834****
Month 3	0.885**	0.851***	0.853***	**0.832****
Backcast period				
Month 1	0.875**	0.834***	0.850***	**0.800*****
Month 2	0.841***	0.807***	0.850***	**0.776*****
Panel B: MAD				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	0.995	0.930	**0.811****	0.933
Month 2	0.915	0.843	**0.780****	0.855
Month 3	0.957	0.903	**0.820****	0.902
Nowcast period				
Month 1	0.928	0.854	**0.794****	0.826**
Month 2	0.897	0.803**	0.792**	**0.787****
Month 3	0.839***	0.816***	0.827***	**0.789*****
Backcast period				
Month 1	0.825***	0.790***	0.825***	**0.771*****
Month 2	0.802***	0.772***	0.827***	**0.761*****

Notes: The table presents the RMSE and MAD ratios of the *Baseline* model, *Model 1, Model 2* and *Model 3* (see Section 3.2 and Table 1 for a definition of the models) relative to the RMSE and MAD of the benchmark AR(1) model. Bold-faced numbers indicate the best-performing model. Asterisks denote that the ratios are significantly below one at *10%, **5% and ***1% significance level. The out-of-sample period is from 2007:Q4 to 2017:Q4.
Source: Author's calculations.

RS indices for all three months of the reference quarter (Months 1 and 2 for the unemployed). These results clearly show that hard indicators give a precise signal for the current state of the Greek economy, and a more timely release of these indicators would possibly benefit decision making.

A policy-relevant question, here, is whether these results hold when we use real-time —or at least quasi real-time— data, because policy makers make their decisions in real time with the information available at each point in time. Large discrepancies in the forecasting quality of the various competing models between pseudo real-time and real-time data forecasting exercises may indicate that forecasting models evaluated using only fully revised data are inappropriate for policy making decisions due to their low forecasting quality. Next, we attempt to address this question by repeating the forecasting analy-

Chart 2 Year-on-year GDP growth rate forecasts at the end of the reference quarter



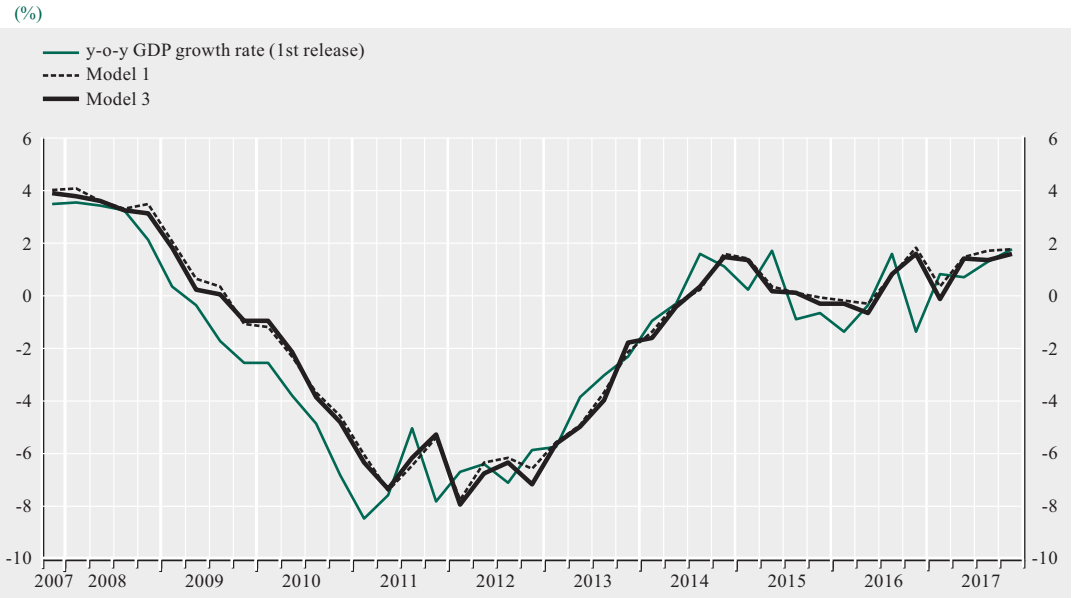
Source: Hellenic Statistical Authority (ELSTAT) and author's estimations.

sis presented in Table 3 using the real-time GDP data.

A rather critical point in real-time forecasting exercises is the choice of the observed value of the GDP growth rate in the forecasting evaluation procedure, i.e. the actual value of GDP growth rate, GDP_t, that is used in the computation of RMSE and MAD metrics (see also the discussion in Clark 2011). Here, we follow the recent contribution of Antolin-Diaz et al. (2017) and choose the first release of the GDP figure (published approximately 2 months after the end of the reference quarter) as the actual value used in the forecasting evaluation (see also Chart 1). First release figures have two important advantages over other choices such as the fully revised data: (a) they are typically used by policy makers as benchmarks to check the accuracy of their predictions; and (b) they are usually unaffected by benchmark revisions which may distort the evaluation process. Nevertheless, in the robustness check section, we also use the second release and the fully revised data as the actual GDP growth rate to evaluate the forecasting ability of the models.

Table 4 presents the forecasting results using the real-time GDP data, constructed as described in Section 3, which are qualitatively similar to those of Table 3. Again, the large model with the disaggregate real and survey (PMI) variables is the best performing model for the last two months of the nowcast evaluation period and the full backcast period, followed by the parsimonious *Model 1* with the aggregate real and PMI variables. The information content of the price index and the financial variables proves to be useful for forecasting purposes only during the forecast period and the first two months of the nowcast period possibly exploiting the forward-looking nature of the stock exchange index, while the PMI index helps improve the forecast quality of the *Baseline* model. Moreover, all models almost always outperform the benchmark, with forecasting gains ranging approximately between 3% and 24% across evaluation metrics. It is also evident that the largest forecasting gains are generated during the last month of the backcast period when hard indicators become available, as expected. Thus, the main conclusions of the analysis based on the

Chart 3 Year-on-year GDP growth rate forecasts at the end of the backcast period



Source: Hellenic Statistical Authority (ELSTAT) and author's estimations.

results of Table 3 still hold true for the quasi real-time forecasting exercise.

Next, we proceed with a visual inspection of the nowcasts produced by *Model 1* and *Model 3* at the end of the reference quarter (Month 3 of the nowcast evaluation period) and at the end (Month 2) of the backcast period in Charts 2 and 3, respectively. Overall, the differences in the forecasts generated by the two competing models are rather small, practically following the same pattern. Nevertheless, the most striking feature of Charts 2 and 3 is that both models produce upward-biased GDP nowcasts during the first 5 years of the crisis (2007:Q4-2012:Q4), during which y-o-y GDP growth dropped abruptly from 4% in 2008:Q1 to -8.5% in 2011.[17] It is also evident that turning points are usually picked up with a lag due to the high persistence of the autoregressive parameter. These results probably indicate that constant parameter models are not capable of capturing abrupt structural changes in the unconditional mean and the volatility of the GDP time series and imply that time-varying parameter models may improve the forecasting accuracy, as shown in Carriero et al. (2016), Marcellino et al. (2016) and Antolin-Diaz et al. (2017).

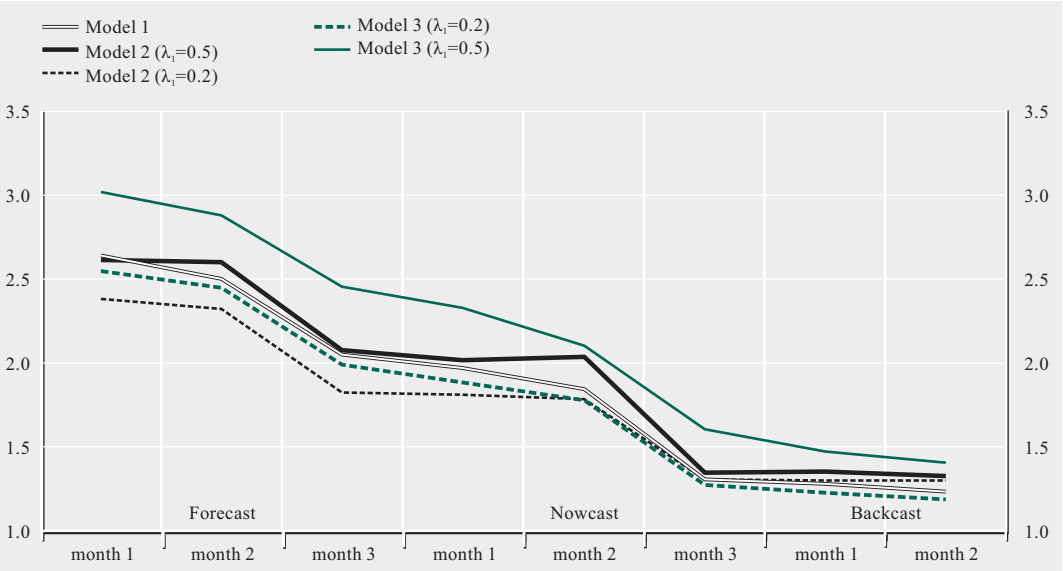
5 ROBUSTNESS CHECKS

As also mentioned in Section 3.2, an important aspect in the forecasting performance of models with a large set of regressors is the degree of Bayesian shrinkage, as expressed by hyperparameter λ_1 in our case. In the results presented so far, *Model 2* and *Model 3* use a tighter prior (λ_1=0.2) compared with the more parsimonious *Baseline* model and *Model 1* (λ_1=0.5) for reasons briefly explained in Section 3.2. Now, we investigate the role of Bayesian shrinkage by performing a sensitivity analysis with respect to λ_1. In particular, we repeat the out-of-sample exercise using the real-time GDP data and the first release data for the forecast evaluation by setting λ_1=0.5 for the large mod-

17 This result is even more striking, considering that all models use the fully revised hard indicators (e.g. IP) which are associated with the fully revised GDP that is itself considerably lower than the first release GDP figure.

Chart 4 The role of Bayesian shrinkage in forecasting GDP

(RMSE)



Source: Author's calculations.

els (*Model 2* and *Model 3*). The forecasting results are presented in Chart 4, where we plot the RMSE against the evaluation periods for five models: *Model 1*, *Model 2* with λ_1=0.2 and λ_1=0.5 and *Model 3* with λ_1=0.2 and λ_1=0.5.

The results are clear-cut as to the beneficial effects of tighter priors in large models. More specifically, both *Model 2* and *Model 3* with a higher degree of shrinkage (λ_1=0.2) —depicted with dashed lines— outperform those with a looser prior (λ_1=0.5) —depicted with solid lines— as the RMSE is consistently lower across evaluation periods.[18] A second question that Chart 4 tries to address is whether the degree of shrinkage can distort the final outcome of the specific forecasting exercise. The answer is yes, because *Model 1* would have been the best performing model across all evaluation periods (see the black solid line) if we had used λ_1=0.5 across all models. Thus, we see that Bayesian shrinkage plays a significant role in exploiting the information content of financial or disaggregate indicators in nowcasting Greek GDP, and the degree of shrinkage should be carefully chosen. However, the main drawback of such an approach is that the shrinkage hyperparameter is an ad hoc choice of the forecaster; a possible extension that circumvents this problem is to use the insights of the hierarchical Bayesian modelling and choose the degree of shrinkage optimally (see e.g. Giannone et al. 2015 and Louzis 2018, among others, for a relevant discussion on hierarchical modelling in macroeconomic forecasting).

Finally, we also perform a robustness check regarding the choice of the observable value of GDP in the spirit of Antolin-Diaz et al. (2017). Tables 5 and 6 repeat the quasi real-time out-of-sample forecasting exercise, the results of which are presented in Table 4, but this time we use the second release and the last vintage GDP data (as of March 2018), respectively, for the assessment of the forecasts via the two evaluation criteria. In both tables, the forecasting results follow an almost identical pattern to the one presented in Tables 3 and 4 in Section 4.1. That is, *Model 2* enhanced with nominal and financial variables usually fore-

18 The results with the MAD criterion are qualitatively similar.

Table 5 Forecasting results using real-time GDP data (forecast evaluation using second release data)

Panel A: RMSE				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	1.009	0.980	**0.892****	0.948
Month 2	0.973	0.937	**0.875****	0.920
Month 3	0.992	0.963	**0.880****	0.939
Nowcast period				
Month 1	0.969	0.923	**0.864*****	0.896
Month 2	0.922	0.869**	0.853***	**0.845****
Month 3	0.895*	0.857**	0.872***	**0.835****
Backcast period				
Month 1	0.892**	0.849**	0.870***	**0.823****
Month 2	0.862**	0.822***	0.864***	**0.791*****
Panel B: MAD				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	0.993	0.935	**0.825****	0.927
Month 2	0.932	0.874	**0.806****	0.873
Month 3	0.976	0.922	**0.857***	0.916
Nowcast period				
Month 1	0.928	0.861	**0.824****	0.856*
Month 2	0.918	0.827**	0.817**	**0.809****
Month 3	0.837***	0.807***	0.840***	**0.803*****
Backcast period				
Month 1	0.825***	0.793***	0.833***	**0.785*****
Month 2	0.802***	0.778***	0.831***	**0.769*****

Notes: The table presents the RMSE and MAD ratios of the *Baseline* model, *Model 1, Model 2* and *Model 3* (see Section 3.2 and Table 1 for a definition of the models) relative to the RMSE and MAD of the benchmark AR(1) model. Bold-faced numbers indicate the best-performing model. Asterisks denote that the ratios are significantly below one at *10%, **5% and ***1% significance level. The out-of-sample period is from 2007:Q4 to 2017:Q4.
Source: Author's calculations.

casts well during the forecast period and the first months of the nowcast period, with *Model 3* being the overall best performing model for the last months of the nowcast period and the full backcast period.

6 SUMMARY, DISCUSSION AND CONCLUSIONS

Economic policy is conducted in an uncertain environment which requires, at least, accurate estimates for the current state of economic activity, as synopsised in the GDP figure. Thus, it is considered crucial in terms of forecasting accuracy and decision making to examine the forecasting ability of the alternative econometric models using real-time data, replicating as close as possible the situation of the policy maker who has to predict the GDP figure with information available at a given point in time.

Unfortunately, real-time GDP data are not publicly available for Greece, and the first goal of this study is to construct a real-time data-

Table 6 Forecasting results using real-time GDP data (forecast evaluation using last vintage data)

Panel A: RMSE				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	1.035	1.023	**0.952**	1.010
Month 2	1.006	0.987	**0.936****	0.987
Month 3	1.019	1.009	**0.941****	0.990
Nowcast period				
Month 1	0.993	0.967	**0.927*****	0.950
Month 2	0.960	0.938	0.920***	**0.916***
Month 3	0.949	0.935*	0.927**	**0.917**
Backcast period				
Month 1	0.942	0.924*	0.926**	**0.905***
Month 2	0.917*	0.897**	0.918***	**0.878****
Panel B: MAD				
Forecast period	**Baseline**	**Model 1**	**Model 2**	**Model 3**
Month 1	1.004	0.987	**0.902***	0.976
Month 2	0.958	0.935	**0.876****	0.941
Month 3	1.002	0.988	**0.906****	0.986
Nowcast period				
Month 1	0.962	0.914	**0.883*****	0.921
Month 2	0.936	0.886**	0.884***	**0.875****
Month 3	0.926*	0.903**	**0.898*****	0.905*
Backcast period				
Month 1	0.911**	0.884**	0.893***	**0.886****
Month 2	0.886**	0.863***	0.887***	**0.853*****

Notes: The table presents the RMSE and MAD ratios of the *Baseline* model, *Model 1*, *Model 2* and *Model 3* (see Section 3.2 and Table 1 for a definition of the models) relative to the RMSE and MAD of the benchmark AR(1) model. Bold-faced numbers indicate the best performing model. Asterisks denote that the ratios are significantly below one at *10%, **5% and ***1% significance level. The out-of-sample period is from 2007:Q4 to 2017:Q4.
Source: Author's calculations.

base for Greek GDP using publicly available information from the national statistical authority. To this end, we exploit the information available in the press releases and construct a real-time GDP database dating back to 2005:Q1. Next, we examine the information content of survey, nominal/financial and disaggregate real and survey indicators in forecasting/nowcasting Greek GDP for an out-of-sample period spanning from 2007:Q4 to 2017:Q4. We exploit the newly constructed real-time database and compare the predictive ability of the models using both real-time and pseudo real-time data. Lastly, to address the overparameterisation problem we rely on Bayesian shrinkage methods to estimate the standard bridge equations widely used in nowcasting.

Overall, we provide robust empirical evidence that a model with a small set of real variables and the PMI can consistently produce good GDP forecasts as we move closer to the GDP publication date. Its forecasting performance

can be further enhanced if we account for the information content of the disaggregate subindices of the Industrial Production Index, the Retail Sales Index and the PMI survey indicator. On the other hand, nominal/financial variables such as prices, M1 money supply and the stock exchange index can improve short-term forecasting of the Greek GDP growth rate for periods of up to two months before the end of the reference quarter. However, it should be noted that a prerequisite for the two latter results is to apply appropriate Bayesian shrinkage so as to exploit the information content of the near-collinear regressors. Lastly, we show that the widely used PMI survey indicator carries significant information on the current state of the economy, since it consistently improves the forecasting ability of a model consisting of only real variables.

The most important empirical finding of this study is that these results hold true using both the last vintage GDP and the real-time GDP data. This is a policy-relevant result: in economies with a lack of real-time data sets, forecasters and policy makers usually examine the predictive ability of their models in pseudo out-of-sample forecasting exercises using fully revised data but, at the same time, they have to make decisions in real time using the available, non-revised data. Possible discrepancies in the forecasting performance of models using fully revised and real-time data may be crucial for policy decisions, because policy makers may favour a model that performs well in pseudo out-of-sample forecasting but, in practice, forecasts poorly in real time, leading to poor decision making.

Although our results are robust to the choice of different "observed" data in the forecasting evaluation procedure, they should be, in general, treated cautiously, mainly for two reasons. First, the real variables and the price index used in this study —that is, the Industrial Production Index, the Retail Sales Index, the number of unemployed and the CPI— are also subject to (relatively small) revisions. However, we could not reconstruct a real-time database for these indices and instead relied on the fully revised data. The extent to which this choice distorts the final forecasting outcome should be investigated empirically as soon as real-time data become available. Second, from a more technical point of view, the results are largely based on the appropriate choice of the degree of shrinkage, as shown in a sensitivity analysis in the robustness check section. This may be a problem for the inexperienced Bayesian user who wants to experiment with alternative sets of explanatory variables and probably implies that we should move towards more automated methods which restrict the role of subjective inputs in the setting of the priors.

In future research, the models presented here can be extended to account for structural breaks in the mean of the GDP series, as well as to consider fat-tailed and heteroscedastic error terms, thereby possibly leading to considerable forecasting improvements. Other potential avenues for further research could involve the implementation of the recent advances in mixed frequency Dynamic Factor models to nowcast Greek economic activity and also explore the role of macroeconomic uncertainty in nowcasting.

APPENDIX

Table A.1 Industrial Production, Retail Sales and PMI subindices

Indices	Subindices
Industrial Production (IP)	IP manufacturing
	IP energy
	IP intermediate goods
	IP capital goods
	IP consumer durables
	IP consumer non-durables
Retail Sales (RS)	RS excl. automotive fuel
	RS food sector
	RS non-food sector
	RS super markets
	RS department stores
	RS automotive fuel
	RS food, beverages, tobacco
	RS pharmaceutical
	RS clothing and footwear
	RS household equipment
	RS books etc.
PMI	Input prices
	New orders
	Stocks of finished goods
	New export orders

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WORKING PAPERS (JULY – DECEMBER 2018)

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CONTENTS

Loan-to-value ratio limits: an exploration for Greece

Working Paper No. 248
Hiona Balfoussia, Harris Dellas and Dimitris Papageorgiou

The paper studies the role of the loan-to-value (LTV) ratio instrument in a DSGE model with a rich set of financial frictions (Clerc et al. 2015). It is found that a binding LTV ratio limit in the mortgage market leads to lower credit and default rates in that market as well as to lower levels of investment and output, while leaving other sectors and agents largely unaffected. Interestingly, when the level of capital requirements is in the neighbourhood of its optimal value, implementing an LTV ratio cap has a negative impact on welfare, even if it leads to greater macroeconomic stability. Furthermore, the availability of the LTV ratio instrument does not impact on the optimal level of capital requirements. It seems that once capital requirements have been optimally deployed to tame banks' appetite for excessive risk, the use of the LTV ratio could prove counterproductive from a welfare point of view.

Fiscal structural reforms: the effect of card payments on VAT revenue in the euro area

Working Paper No. 249
George Hondroyiannis and Dimitrios Papaoikonomou

The use of traceable payment methods presents an additional reform option for improving tax compliance. As regards consumption, card payments are the main alternative to cash in the euro area. Although the use of microdata has provided clear evidence in favour of increasing information trails, time series evidence on the role of card payments in increasing compliance has been scarce and confined to the recent experience of Greece. The effect of card payments on VAT revenue is investigated using quarterly panel data for the 19 euro area economies covering the period 2003Q1-2016Q4. Time-varying coefficient methods are employed in order to estimate the country-specific contribution of compliance to revenue growth as a function of card payments. In line with the microdata literature, the analysis indicates that increasing the share of card payments in private consumption expenditure improves VAT tax compliance. The gains are found to increase: (i) the lower the initial level of card use; (ii) the higher the share of self-employment; and (iii) the lower the level of revenue efficiency. The highest benefits are estimated for Greece and Italy.

Risk perceptions and fundamental effects on sovereign spreads

Working Paper No. 250
Dimitris A. Georgoutsos and Petros M. Migiakis

The paper examines the determinants of spreads based on views regarding sovereign riskiness. The empirical analysis relies on panel data estimation techniques for 30 sovereign bonds for the period of 2009Q1 to 2017Q1, with data in quarterly frequency. The analysis shows that indeed there is a wide asymmetry in the effects exercised by sovereign spreads' determinants, which is related to the riskiness of the sovereign. Low-risk spreads are found to

be more sensitive to the prospects of higher growth rates and inflation; high-risk spreads are found to be more sensitive to idiosyncratic volatility and global volatility. Also, the results indicate that primary surpluses indeed lower spreads, but this reduction is not strong enough to shield the sovereign against volatility; thus, policy makers should avoid "noise" that may undermine investor confidence by increasing idiosyncratic volatility.

Why exports adjust: missing imported inputs or lack of credit?

Working Paper No. 251
Antonis Kotidis and Dimitris Malliaropulos

This paper examines the role of imported intermediate inputs and credit constraints on exports adjustment. For identification, we study an episode of capital controls on outflows that exogenously restricted firms' ability to pay for imports and the large-scale credit crunch that followed the imposition of controls in Greece in June 2015. Exploiting within-firm variation across sectors, it is found that lack of imported inputs explains the drop in exports at the intensive margin, while lack of long-term credit is associated with adjustments at the extensive margin. Multinationals overcome liquidity constraints because of access to parents' internal funds, but not import constraints because of stronger linkages for specialised inputs abroad. The findings point to a novel result: the importance of both channels —real and finance— in jointly determining trade adjustment, and the different implications for the margins of trade.

Rent seeking activities and aggregate economic performance – The case of Greece

Working Paper No. 252
Stylianos G. Gogos, Dimitris Papageorgiou and Vanghelis Vassilatos

The study builds upon Angelopoulos et al. (2009) and employs a dynamic general equilibrium model in order to examine the interrelated role of rent seeking activities, institutions and government policy variables, like tax rates and public spending, on Greece's economic performance during the last fourty years. The analysis focuses on the period 1979-2001. According to Kehoe and Prescott (2002, 2007) this period can be characterised as a great depression. The model is the standard neoclassical growth model augmented with a government sector and an institutional structure which creates incentives for optimising agents to engage in rent seeking contests in order to extract rents from the government. This behaviour creates a cost to the economy in the form of an unproductive use of resources. The main findings are as follows: First, in terms of the path of key macroeconomic variables, the model fits the data quite well. Second, by conducting a growth accounting exercise, it is found that during the period 1979-1995 a non-negligible proportion of the decline of total factor productivity (TFP) can be accounted for by rent seeking activities. Third, the model produces an index which can be interpreted as a measure of the quality of institutions in the Greek economy. The model-based index exhibits a resemblance with the internal country risk guide (ICRG) index, which is widely used in the literature as a proxy for the quality of a country's institutions.

Quantitative Easing and sovereign bond yields: a global perspective

Working Paper No. 253
Dimitris Malliaropulos and Petros Migiakis

We document the existence of a global monetary policy factor in sovereign bond yields in a panel of 45 countries, consisting of both developed and emerging economies. This global factor is related to the size of the aggregate balance sheet of the four major central banks (Fed, ECB, Bank of Japan and Bank of England). Our estimates suggest that large-scale asset purchases and liquidity provision of major central banks following the Global Financial Crisis have contributed to a significant and permanent decline in long-term yields globally, ranging from 250 basis points for AAA-rated sovereigns to 330 basis points for B-rated sovereigns. Our findings have important policy implications: normalising monetary policy by scaling down the expanded balance sheets of major central banks to pre-crisis levels may lead to sharp increases in sovereign bond yields globally, with severe consequences for financial markets and the global economy.

Financial development and FDI inflows: evidence from advanced economies

Working Paper No. 254
Konstantinos Dellis

Foreign direct investment (FDI) has grown dramatically as a major form of international capital transfer over the past decades. This rapid growth in cross-border investment has to a large part been due to the reduction in trade and investment barriers, the harmonisation and mutual recognition of regulation and the removal of domestic impediments through reform and privatisation (see OECD 2001). Amongst the numerous FDI determinants studied in the literature, the development and depth of the financial sector has gained importance during the last decade. According to the Paradox of Finance hypothesis, despite the fact that Multinational Corporations (MNCs) are not locally financially constrained, their affiliates interact significantly with the domestic financial system. Hence, a deep and efficient financial system should act as a pull factor for FDI flows. Using up-to-date FDI data for OECD economies, this research explores the role of previously unavailable financial variables in attracting FDI flows. The results show that fostering an efficient financial sector with diversified funding sources for enterprises contributes to increased participation by MNCs in the host economy. This insightful policy implication for advanced economies is that the restructuring of the financial system can contribute to economic recovery through the FDI channel as well. Finally, the results highlight the importance for the full implementation of the Banking Union and the Capital Markets Union in the EU.

Total factor productivity (TFP) and fiscal consolidation: how harmful is austerity?

Working Paper No. 255
Ioanna Bardaka, Ioannis Bournakis and Georgia Kaplanoglou

Departing from the expansionary austerity literature, this study assesses empirically whether fiscal consolidation propagates changes in the supply side of the economy that

can potentially influence total factor productivity. Using a panel dataset of 26 OECD countries over the period 1980-2016 and employing panel vector autoregressive and error correction model specifications, we present evidence of both short-run and long-run negative effects of fiscal consolidation on TFP. The short-run impact is disproportionately more damaging for the TFP of low debt countries, while, contrary to the expansionary austerity thesis, our empirical results would advise against spending-driven fiscal consolidation, since such consolidation undermines capacity due to the importance of government spending in shaping productive capital. Our results have serious policy implications for the implementation and design of fiscal adjustment programmes.

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