Banco de Portugal Economic Studies

Volume III

BANCO DE PORTUGAL
EUROSYSTEM

4

4

volume III

Banco de Portugal Economic Studies

Please address correspondence to
Banco de Portugal, Economics and Research Department
Av. Almirante Reis 71, 1150-012 Lisboa, Portugal
T +351 213 130 000 | estudos@bportugal.pt

BANCO DE
PORTUGAL
EUROSYSTEM

Lisbon, 2017 • www.bportugal.pt

BANCO DE PORTUGAL ECONOMIC STUDIES | Volume III - n.º 4 | Lisbon 2017 • Banco de Portugal Av. Almirante Reis, 71 | 1150-012 Lisboa • www.bportugal.pt • Edition Economics and Research Department • Design Communication and Museum Department | Publishing and Image Unit • ISSN 2183-5217 (online)

Content

Editorial

October 2017

The fourth issue of Banco de Portugal Economic Studies for 2017 contains three essays that could hardly deal with a greater variety of topics since they cover the characteristics of firms engaging in foreign trade, banking prudential regulations, and the recent evolution of housing prices in Portugal. These essays provide new or updated information on facts and behavior, enriching our knowledge of the workings and performance of the Portuguese economy.

The first paper, by João Amador and Luca David Opromolla, is entitled "Trade Margins and Cohorts of Traders in Portugal". The paper examines the microeconomic structure underlying the exports and imports of goods. The authors use detailed data for the period 1995-2015, covering, on average, about 80 and 90% of the total exports and imports of goods, respectively. They characterize the types of firms that engage in exports or imports, the destination or origin country for each export or import, and the products that are exported or imported by each firm and how these three types of dimensions change over time. The results show that roughly three fourths of the exporters and more than 90% of the exports correspond to firms that maintain a stable presence in the export market (henceforth continuing firms). Single-year exporters represent slightly more than five percent of the exporting firms in any given year and close to only one percent of total exports. Entering and exiting firms constitute the remainder exporters and are responsible for the remainder exports of goods. The situation for importer firms is similar.

The paper then goes on to assess the importance of the overall intensive margin on cumulative export and import growth. The intensive margin includes the growth of exports (imports) of continuing products in continuing destinations (origins) by continuing firms. The extensive margin includes the growth of exports (imports) due to net firm, product and destination (origin) entry. While the aggregate exports of goods increased by 89% in the period 1996-2014, the cumulative extensive and intensive margins increased by 23 and 55%, respectively, with the remainder growth explained by interactions between the two dimensions across time. Again, imports present a similar picture. The importance of the intensive margin presents a picture of stability in the industrial structure of both exports and imports, but the accumulated role of the extensive margin over time cannot be forgotten as the source of the changes that are relevant in the long run.

A look at the results over time shows that the collapse in international trade following the great recession started in 2007 had a large impact on the intensive margin of exports by Portuguese firms but not on the extensive margin. On the other hand, during the Portuguese economic and financial

assistance program there were visible negative effects mostly on the intensive margins of imports.

The paper takes advantage of the longitudinal nature of the database and also studies entry, survival and exit of successive cohorts of firms. Findings include that the exit rate of new exporters in the first year of life is almost a third. This exit rate drops to about 15% in the second year and slowly decreases afterwards. Almost 60% of new exporters exit in the first five years of activity. The exports per firm increase on average about 70% in the first year of the cohort, meaning that those that survive strongly increase exports. This growth rate decreases to an average of 10% in the second year, stabilizing afterwards on a range between 4 and 9%. The results for importers are roughly similar. Interestingly, firms that started to export in crisis years are not scarred by the experience as they display survival patterns similar to others and have a good performance in terms of total exports. All in all, the work of Amador and Opromolla reminds us that international trade begins just as most ordinary economic activity does: with a prominent role for firms.

The second paper in this issue, by Dina Batista and Sudipto Karmakar, is titled "Understanding the Basel III Leverage Ratio Requirement". One of the key instruments used to regulate banks is the risk weighted capital ratio requirement. In a simple and abstract case, just for providing intuition, that would correspond to imposing a regulatory minimum requirement on the ratio between the equity of a bank and the sum of its assets weighted by a measure of risk specific to each asset class. The past few years revealed that having ex ante sizeable capital ratio was not enough for troubled banks to deal with their losses, generating systemic risks. The problem is that the risks associated to loans, and bank assets in general, increase as the business cycle deteriorates but the risk weights calculated during good times, when banks expand their assets, do not fully reflect that possibility. This has happened during the recent crisis despite several attempts to improve the calculation of risk weights. To reinforce this basic idea, the authors use a business cycle model with a detailed banking sector to show that in response to positive shocks on the economy the risk weights behave counter cyclically.

To mitigate this problem, the new Basel III regulations has included an additional leverage ratio requirement over and above the risk weighted capital ratio requirement. In the simplest case, this means there will be a lower limit on the ratio of a bank's equity to a broad exposure measure (non risk-weighted loans in the context of the model). The advantage of this requirement is that it is not sensitive to risk and so it may become a binding constraint more easily in the positive phases of the business cycle. In these phases, the risk weights tend to be low and banks have incentives to expand their loans without being constrained by the risk weighted capital requirements. In this process, they generate additional leverage that may become excessive at later phases of the business cycle. The leverage

requirement is aimed at limiting bank leverage and it is meant to act as a backstop to risk sensitive requirements.

How is leverage ratio requirement likely to affect Portuguese banks? The authors examined the available data and they found that the average risk weights on the balance sheets of Portuguese banks are significantly higher than for their European peers. This situation is compounded by the methods used locally to calculate the risk weights that are far less sensitive to the business cycle than other methods used by banks in other countries. According to the authors, these facts suggests that for Portuguese banks the risk weighted capital requirements will continue to be the binding constraint and that the new leverage ratio requirement, currently calibrated at 3%, will not be very relevant for the operations of domestic banks. However, they warn that increasing the strictness of the requirements may happen in a not so distant future, in which case even Portuguese banks may find themselves constrained by these new regulations.

In the third paper, by Rita Lourenço and Paulo Rodrigues and entitled "House prices in Portugal - what happened since the crisis?", the authors study the factors driving house prices in Portugal. Deflating house prices indices by the consumption deflator, the authors obtain a measure of the real price of housing from the first 1996 quarter up to the second quarter of 2017. The data show that the real price index for housing in Portugal declined between 2007 and 2013 and has been increasing since then. However, by mid-2017 they are still below pre-crisis levels. The authors base their initial analysis on a linear regression model that explains the quarterly changes in the real prices of housing by changes in the GDP per capita, in the residential investment, in the unemployment rate, in mortgage rates, and in the foreign direct investment in housing. The results obtained for the entire dataset indicate that the main drivers of real house price growth are changes in the per capita GDP and in the unemployment rate. As expected, an increase in per capita GDP has a positive impact on house prices, while an increase of the unemployment rate leads to their decrease. The other variables do not seem to be statistically significant.

A problem with this initial analysis is that the relationship between house prices and the fundamentals may change over time. Translating that possibility into the model, the linear regression coefficients size, sign and statistical significance may differ across periods. This problem was addressed by estimating a more sophisticated model allowing for the endogenous determination of structural breaks, also known as regime switches. The results show that there are indeed two breaks defining three different periods. The authors report detailed results for the last two periods. In the crisis period (2007Q2-2011Q3), housing prices are a function of the growth of GDP per capita, the changes of residential investment, the changes in foreign direct investment in housing, and the changes in the unemployment rate. However, in the post crisis period (2011Q4- 2017Q2) the variable coefficients stop being statistically significant except for changes in GDP per capita.

A final analysis codes price changes into a zero-one variable, with the value one attributed to all periods with price increases. A probit model was estimated for this data. The results suggest that the probability of further increases in house prices is still high. Hopefully, those price increases will be moderate and in line with fundamentals.

Trade Margins and Cohorts of Traders in Portugal

João Amador
Banco de Portugal and
Nova SBE

Luca David Opromolla
Banco de Portugal and
CEPR, CESifo, UECE

October 2017

Abstract
This article assesses the contribution of intensive and extensive margins in the firm, destination and product dimensions to yearly changes in total Portuguese exports and imports of goods. In addition, we compare cohorts of international traders in terms of number of firms and trade flows. Moreover, the long time-horizon considered in the article makes it possible to observe the impact of two important events: the great trade collapse that occurred in 2008-2009 and the Portuguese economic and financial adjustment program that was initiated in 2011 and lasted until mid-2014. The analysis builds on a detailed database of international trade transactions in the Portugese economy in the period 1995-2015. (JEL: F1, L25, D21)

Introduction

This article updates and expands the analysis carried out in Amador and Opromolla (2013), which established several stylized facts about the firm's joint decision of where (destinations) and what (products) to export, using the universe of exports by firms located in Portugal in the period 1996-2005. In the last decade, the academic and policy attention to the drivers of trade performance and the increasing availability of transaction-level databases in international trade have been feeding this literature. Nowadays, the existence of longer dynamic data panels makes it possible to study specific shocks and observe the performance of cohorts of traders.

The literature on the margins of international trade is too large to be listed here. The seminal contributions are those of Eaton *et al.* (2004), Schott (2004), Bernard *et al.* (2007), Bernard *et al.* (2010), Iacovone and Javorcik (2010) and Arkolakis and Muendler (2011). Many contributions followed, mostly consolidating stylized facts initially identified. Wagner (2012a) presents a tabular survey of 147 empirical studies for 39 countries, plus 8 studies for multiple countries, that use transaction level data on exports or imports of

Acknowledgements: The authors thank comments and suggestions by Sónia Cabral and Miguel Gouveia. The opinions expressed are the sole responsibility of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem.

E-mail: jamador@bportugal.pt; ldopromolla@bportugal.pt

firms. Very recent contributions to the analysis of trade margins are those of Wagner (2016) for Germany and Galuscak and Sutoris (2016) for the Czech Republic in the period 2006-2014.

It is acknowledged that the literature has been giving less attention to the margins of import flows. This may be driven by the simplistic notion that exports contribute to economic growth while imports do not. However, in a world organized along global value chains there is high foreign value added embodied in exports. Therefore, imports are necessary to support domestic production and their margins of change are worthwhile analysing. As for the analysis of cohorts of international traders, there is also little literature because it requires databases that track traders along a relatively large sequence of years. One exception is Wagner (2012b) which studies the cohorts of exporters in Germany that started to export between 1998 and 2002. Still, the author can follow the cohorts of new exporters only over five years after the start.

As for the Portuguese economy, some stylized facts about exporters and export margins have been established. Amador and Opromolla (2013) find that multi-product and multi-destination exporters are in majority and account for a more than proportional share of total goods exports. In addition, the range of products that they export is very diversified. Second, roughly one quarter of the variation in firms' exports is explained by the variation in the number of destinations served and higher sales in a destination are mainly due to the product intensive margin, i.e., higher product sales instead of sales of more products. Amador and Opromolla (2013) also show that both the firm-level extensive (entry and exit of exporters) and intensive margin (sales of continuing exporters) are important in driving the year-to-year variation in aggregate exports. In addition, variation over time in the sales of continuing exporters is mainly driven by the intensive margin at the destination-level, i.e., by variation in the sales of continuing exporters in continuing destinations. Similarly, the latter closely follows the sales of continuing products, by continuing exporters in continuing destinations, i.e. the intensive margin at the firm-destination-product level. At all dimensions (firm, destination, and product) the level of churning is quite high, implying that gross entry and exit flows are much bigger than net flows. Finally, Amador and Opromolla (2013) find evidence that continuing firms enter in new markets mainly by selling old products, i.e., products that were previously sold somewhere by the same firm.

In this article we confirm results obtained earlier and contribute to the literature in different ways. Firstly, we compare results obtained for exports with those that emerge from a parallel analysis for imports. Although some differences exist, the main facts are similar in both types of trade flows. Secondly, we make use of the relatively long time-span in the data to analyse the impact of the great collapse in international trade, which occurred after the onset of the international economic and financial crisis of 2008. The impact of the great trade collapse at the firm-level has been studied for some countries

(e.g., Giri *et al.* (2014) and Eppinger *et al.* (2015)), pointing to the existence of a relatively lower impact at the extensive margin of exports. We also examine the period 2011-2014 that corresponds to the operation of the Portuguese economic and financial assistance program, which erupted within the context of the sovereign debt crisis in the euro area. With the exception of a brief reference in Banco de Portugal (2016), there is still very limited evidence on the impact of this program on Portuguese international trade. We find that the Portuguese economic and financial adjustment program reduced the imports' intensive and extensive margins as well as the cohorts of importers that started to operate in those years.

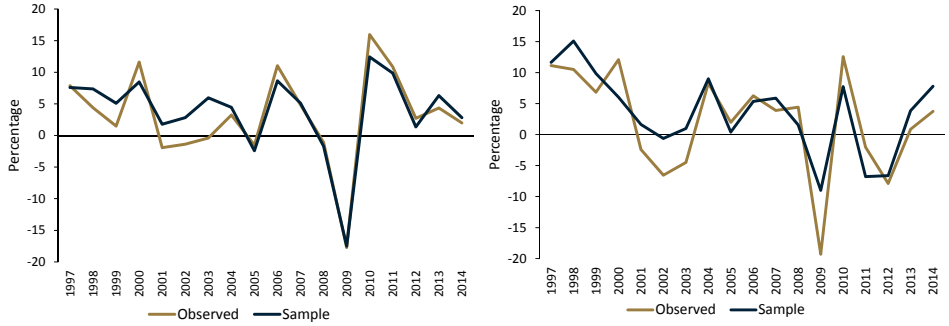
The article is organized as follows. In the next section we describe the database used for the analysis and assess its representativeness. Next, results are organized along three blocks. Firstly, we present the structure of international traders according to their status as continuing, entering, exiting and single-year firms and how much each of these blocks represented in export and import flows. Secondly, we focus on the contribution of the intensive and extensive margins along firm, destination and product dimensions for export and import flows in the period considered. Thirdly, the article examines the exit rates for each cohort of traders after 1997 and their share in total trade flows. In the last section we present some concluding remarks.

Database

The analysis of product and destination mix is made possible by the use of a database that combines detailed and comprehensive information on trading behavior of firms. The data used comes from customs forms in the case of extra-EU trade and from the Intrastat form in the case of intra-EU trade, aggregating to total Portuguese exports and imports of goods, as reported by the Statistics Portugal (Instituto Nacional de Estatística). The database includes all export and import transactions by firms that are located in Portugal, on a monthly basis, from 1995 to 2015. A transaction record includes the firm tax identification, an eight digit Combined Nomenclature product code, the value of the transaction, the quantity of traded goods (expressed in kilos), the destination or origin country, the type of transport, the relevant international commercial term (e.g, FOB, CIF) and a variable indicating the type of transaction (e.g., transfer of ownership after payment, return of a product).[1]

1. The Combined Nomenclature system is comprised of the Harmonized System (HS) nomenclature with further European Union subdivisions and is run by the World Customs Organization (WCO).

In the analysis, we take account of the existence of reporting thresholds for exports and imports, which have changed several times in the two decades studied. In order to have a comparable set of firms and to avoid attributing entrance and exit of traders to changes in the reporting threshold, we take the highest report limit in the entire period and apply it to all years, after adjusting for inflation with the consumer price index. This corresponds to considering thresholds of 0.9 and 0.7 million euros for exports and imports, respectively. Therefore, we eliminate small and medium international traders, especially when compared with the sample used in Amador and Opromolla (2013). Nevertheless, our data covers, on average, about 80 and 90 per cent of total exports and imports of goods, respectively. In what concerns the time path of export and imports flows, our sample closely tracks the growth rates of the aggregate trade flows (Figure 1). The data is aggregated at the annual level and all values are expressed in current euros. Although it would be possible to work at the six digits Combined Nomenclature level, we define products at four-digit level according to the HS. This allows us to avoid classification problems related to revisions of the Combined Nomenclature and still allows for a set of more than 1000 potential products. Basic descriptive statistics on the sample used for the article are presented in the Appendix.



(A) Exports of goods (B) Imports of goods

FIGURE 1: Sample and aggregate growth rates of exports and imports

Trade Margins: Firms, Destinations and Products

One of the main purposes of this article is to decompose Portuguese total export and import growth rates into the contribution of three distinct decisions: the decision to entry/stay/exit in export/import markets, the decision of where to export/import and the decision of what to export/import. Consistently with what was done in Amador and Opromolla (2013), we first decompose total export growth in the contribution of

"entering", "exiting" and "continuing" traders, that is, in the extensive and intensive margin at the aggregate level along the firm dimension. We follow Eaton *et al.* (2007) in defining firm's categories. Entrants in year t are those firms that did not trade in $t-1$, trade in t and will trade in $t+1$ as well; exiters in year t are those firms that traded in $t-1$, trade in t but will not trade in $t+1$; continuing firms in year t are those firms that traded in $t-1$, trade in t and will trade in $t+1$ as well; finally, single-year traders in year t are those firms that did not trade in $t-1$, trade in t but will not trade in $t+1$. A simpler approach, used in the calculation of the trade margins below, consists in disregarding the block of single-year traders, basing all categories on information regarding just two periods.

$$\Delta Y_t = \sum_{j \in N} \Delta Y_{jt} + \sum_{j \in X} \Delta Y_{jt} + \sum_{j \in C} \Delta Y_{jt}, \tag{1}$$

where ΔY_t is the change in Portuguese exports from year $t-1$ to year t, N is the set of entering exporters, X is the set of exiting exporters and C is the set of continuing traders. The next step is to break down the change in export shipped by continuing traders into "added destinations" (AD), "dropped destinations" (DD) and "continuing destinations" (CD), that is, in the extensive and intensive margin at the firm level along the destination dimension.

$$\sum_{j \in C} \Delta Y_{jt} = \sum_{j \in C} \left[\sum_{z \in AD} \Delta Y_{zjt} + \sum_{z \in DD} \Delta Y_{zjt} + \sum_{z \in CD} \Delta Y_{zjt} \right], \tag{2}$$

Next, we consider the product that firms choose to export in "continuing" and "added" destinations. First we distinguish among "added" (AP), "dropped" (DP) and "continuing" (CP) products exported by firms in "continuing destinations", that is, the extensive and intensive margin at the firm level along the product dimension.

$$\sum_{z \in CD} \Delta Y_{zjt} = \sum_{z \in CD} \left[\sum_{v \in AP} \Delta Y_{vzjt} + \sum_{v \in DP} \Delta Y_{vzjt} + \sum_{v \in CP} \Delta Y_{vzjt} \right], \tag{3}$$

Finally, we split the export change associated to new destinations into products already sold by the firm somewhere, i.e. old products (OP), and products that were not sold by the firm anywhere, i.e. new products (NP). We consider this as an interaction between the extensive margin along the destination dimension and the product margin.

$$\sum_{z \in AD} \Delta Y_{zjt} = \sum_{z \in AD} \left[\sum_{v \in OP} \Delta Y_{vzjt} + \sum_{v \in NP} \Delta Y_{vzjt} \right]. \tag{4}$$

Therefore, we can write the change in Portuguese exports as:

$$\begin{aligned}\Delta Y_t = &\sum_{j\in N}\Delta Y_{jt} + \sum_{j\in X}\Delta Y_{jt} \\ &+ \sum_{j\in C}\left[\sum_{z\in AD}\left[\sum_{v\in OP}\Delta Y_{vzjt} + \sum_{v\in NP}\Delta Y_{vzjt}\right] + \sum_{z\in DD}\Delta Y_{zjt}\right] \\ &+ \sum_{j\in C}\sum_{z\in CD}\left[\sum_{v\in AP}\Delta Y_{vzjt} + \sum_{v\in DP}\Delta Y_{vzjt} + \sum_{v\in CP}\Delta Y_{vzjt}\right] \quad (5)\end{aligned}$$

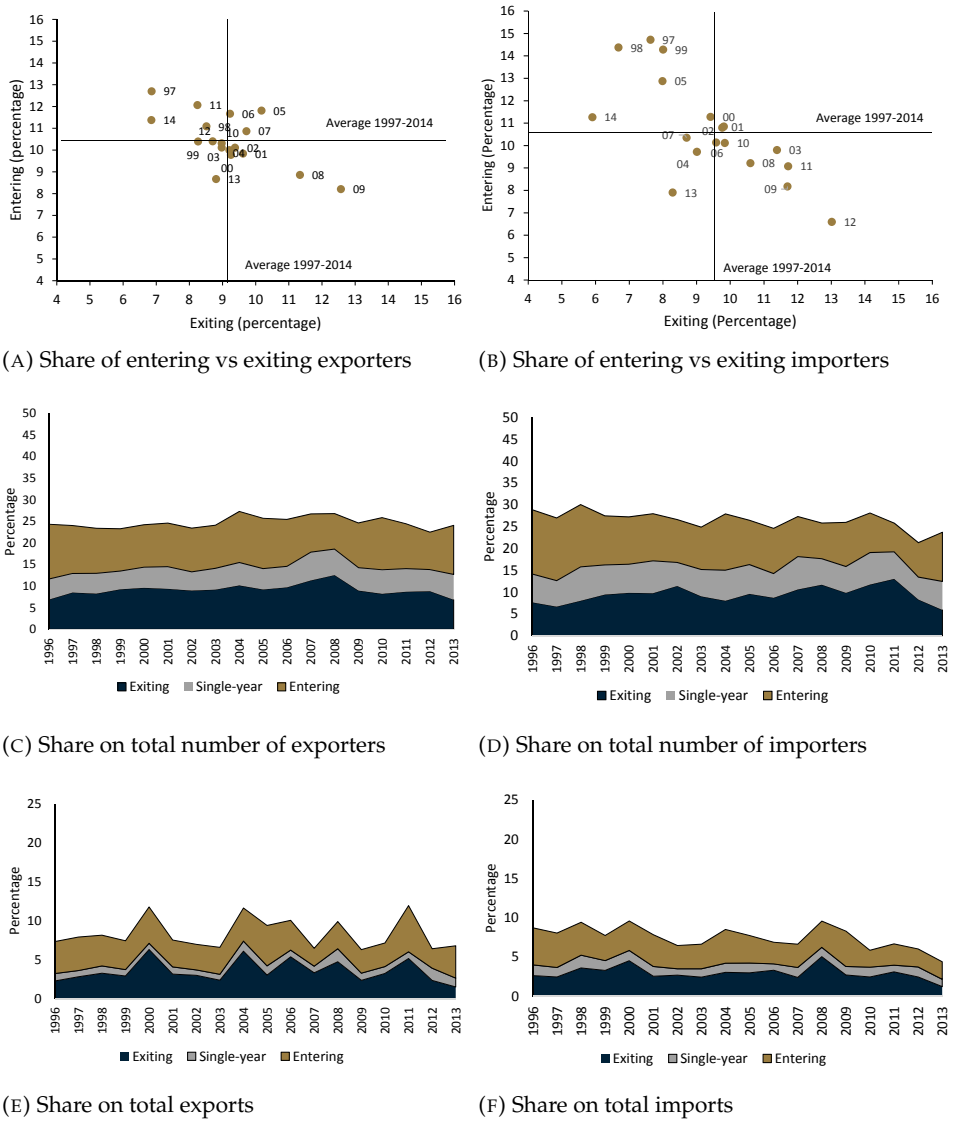
We compute the percent change in total export by dividing each term in equation 5 by $(Y_t + Y_{t-1})/2$, i.e. the average between exports in t and $t-1$. As for the decomposition of total import growth, a similar approach can be easily replicated.

Results

Continuing, entering, exiting and single-year traders

In the first set of findings we consider the firm dimension, i.e., the share of continuing, exiting and entering firms and their relevance in terms of total exports/imports. Panel A of figure 2 compares the share of entering and exiting exporters for the years considered, showing that in 2008 and 2009 strong exit and weak entrance took place. In addition, from 2012 to 2013 the share of exiting firms slightly increased while that of entering firms decreased. As for the import side, in panel B of the figure, the negative relationship between entrance and exiting is tighter, with the period 2012-2013 witnessing a clear move towards lower exit and stronger entrance of importers of goods.

A complementary approach is to analyse the structure of firms and their total exports/imports along each category from a time simple series perspective. While the share of entering and exiting firms is relevant, their net effect is much lower than that of continuing traders. The latter group represents around three fourths of total firms both in exports and imports (the complementary area up to 100 per cent in the lower panels of figure 2). Moreover, single-year exporters or importers represent slightly more than 5 per cent of firms in their respective blocks. All these shares are broadly stable along the period analysed (panels C and D).



(A) Share of entering vs exiting exporters

(B) Share of entering vs exiting importers

(C) Share on total number of exporters

(D) Share on total number of importers

(E) Share on total exports

(F) Share on total imports

FIGURE 2: Structure of traders along the firm dimension

Note: Entrants in year t are those firms that did not trade in $t-1$ and will trade in t and exiters in year t are those firms that traded in t but do not trade in $t+1$. In panels A and B, labels identify the actual years of entry (t) and exit ($t+1$).

As for the share of entering, exiting and single-year on total exports and imports of goods, results are reported in panels E and F of figure 2. The share of single-year exporters and importers on the respective trade flows is smaller than their share on the number of firms, standing close to 1 per

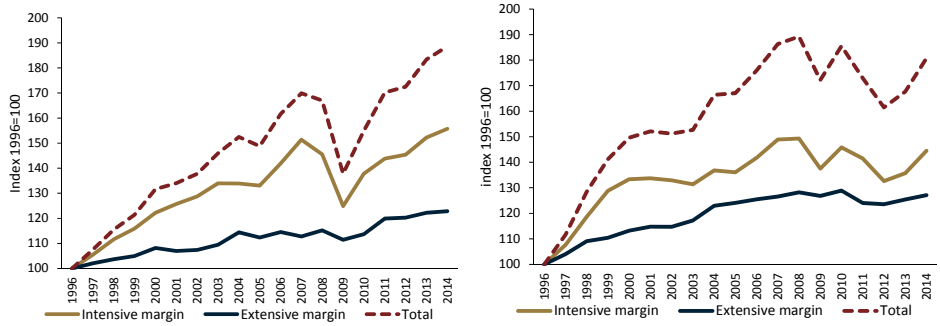
cent. Conversely, continuing traders represent more than 90 per cent of goods exports and imports flows. Therefore, as expected, entering and exiting firms are typically smaller than those continuing. This is in line with Eaton *et al.* (2007) findings, notably the relevance of single-year exporters and their small export and import sales.

Trade margins

In this subsection we assess the importance of the overall intensive margin on cumulative export and import growth. In addition, we breakdown the yearly overall contributions along the firm, destination and product dimensions. The contribution of these three distinct firm's decisions in the years of the great trade collapse and in the period of the Portuguese economic and financial adjustment programme provides further insights on the mechanisms at play.

The panels of figure 3 plot the contribution of the intensive and extensive margins to the accumulated export and import growth over the period 1996-2014. The intensive margin includes the growth of exports (imports) of continuing products in continuing destinations (origins) by continuing firms. The extensive margin includes the growth of exports (imports) due to net firm, product and destination (origin) entry, as explained in equation 5.

Nevertheless, it should be mentioned that the conclusions based on the cumulative impact of the extensive margins convey a conservative message in terms of its role to trade flows. By definition, a new trader, a new destination (origin) or a new product by continuing traders are only accounted for in the extensive margin in the initial period. After the initial period they become part of the intensive margin. Therefore, the decisions of international traders with different ages feed the intensive margin exactly in the same way. To better understand the differential contribution of old and new international traders to export and import developments we need to follow each cohort separately.



(A) Exports (B) Imports

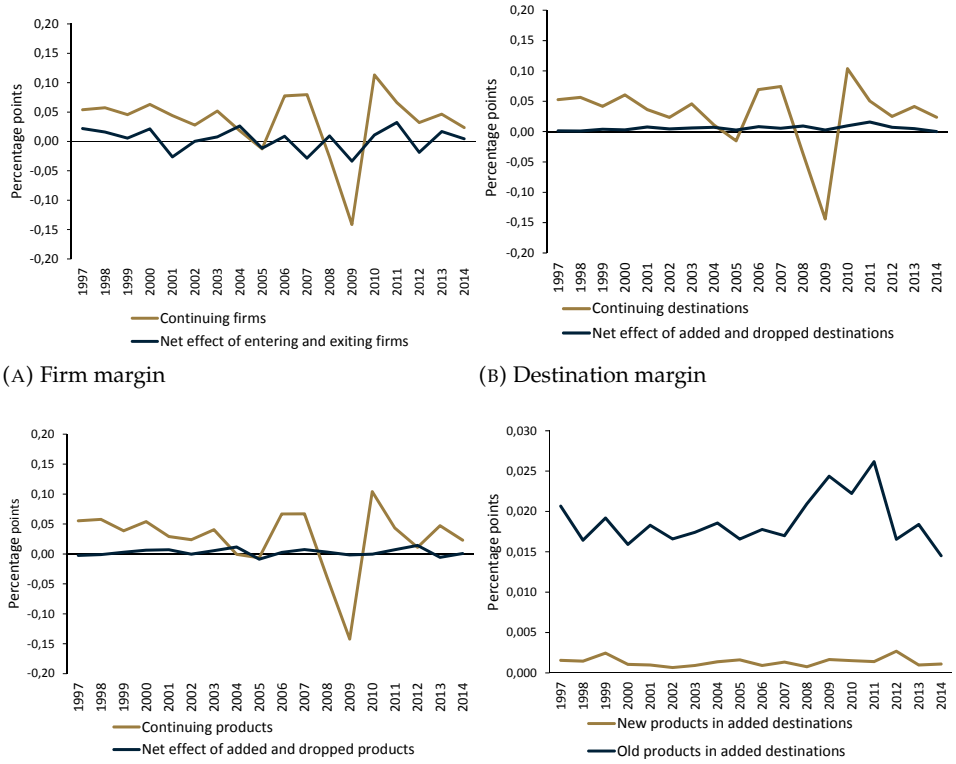
FIGURE 3: Cumulative intensive and extensive margins

As for the export side, it is clear that, after 18 years, the overall intensive margin represents a sizeable share of cumulative export growth. Nominal exports of goods increased by 89 per cent in the period 1996-2014, while the cumulative extensive and intensive margins increased by 23 and 55 per cent, respectively. The interaction between the intensive and extensive margins along the time dimension, interpreted as changes in exports by formerly new exporters, added destinations or added goods, explains why their cumulative growth rates do not add up to cumulative total export growth. A somewhat similar picture is visible for imports of goods. Nominal imports of goods grew by 80 per cent in the referred period, while the overall extensive and intensive margins grew by 27 and 45 per cent, respectively. Therefore, although the extensive margin is relatively small on an yearly basis, it is important in cumulative terms.

Panel A of figure 3 shows a very strong impact of the great trade collapse in the intensive margin but not in the extensive margin. A similar result was highlighted for the Czech Republic by Galuscak and Sutoris (2016). In addition, Bricongne *et al.* (2012) state that the bulk of the collapse in France trade is due to the drop in export volume of large exporters. This is compatible with the well-established fact that exports to foreign markets involve important entry and re-entry costs. For example, firms must allocate resources to adapt to local legislation, establish retail channels and sometimes adjust to local preferences. Therefore, after having paid such foreign market entry costs, in periods of crisis firms prefer to reduce exports rather than completely withdrawing products or immediately exiting from those markets.

A similar analysis conducted for the import side leads to somewhat different results. The total effect of the great trade collapse is smaller than in exports, suggesting that firms that import have lower costs at cutting supplier relationships. Conversely, the negative impact on imports of the sovereign debt crisis in the euro area and of the Portuguese economic and financial assistance program in 2010-2012 is visible in the extensive and, mostly, in intensive margins.

The results regarding the detailed yearly contribution of extensive and intensive margins at the firm, destination and product dimensions to the nominal export growth of goods are presented in figure 4. As mentioned above, we also breakdown the contribution of products by continuing firms in added markets into new or old products (relatively to the firm portfolio). Panel A refers to the firm dimension and shows that the continuing firms (intensive margin) explain an important part of the drop in exports that occurred in 2009. The contribution of the firm extensive margin, i.e., the net effect of entry and exit, in each year is very small and does not significantly contribute to exports in accumulated terms. However, the gross entry and exit, which is a measure of churning, is higher than the intensive margin. For the average of the period 1997-2014, gross entry of exporters represented 5 percentage points of the yearly export nominal growth rate, while gross exit



(A) Firm margin

(B) Destination margin

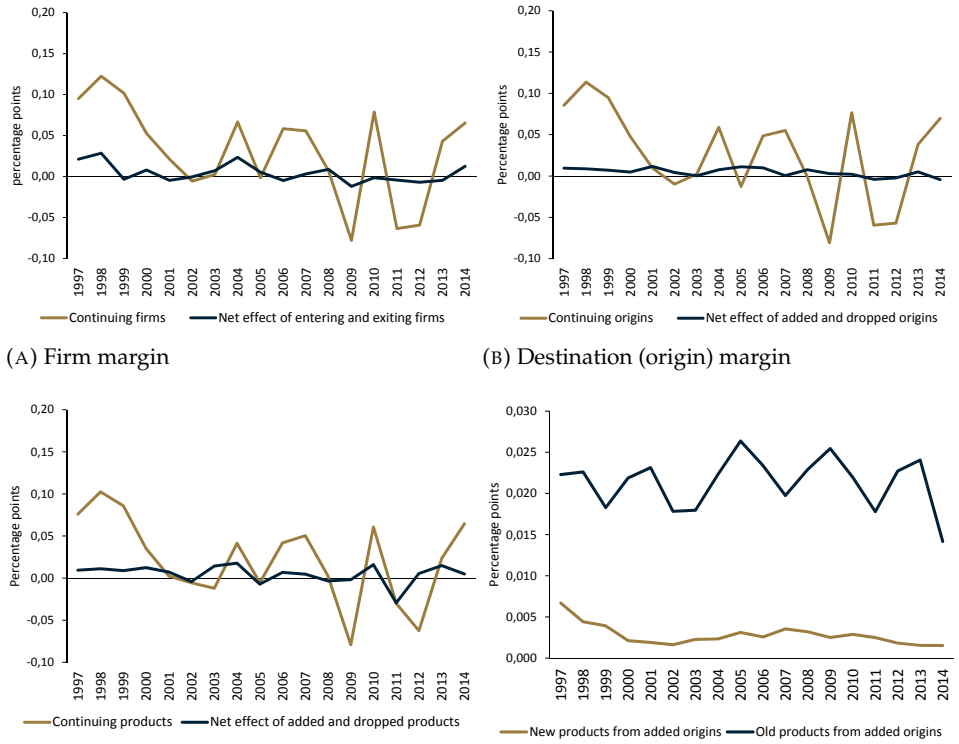
(C) Product margin

(D) Old vs new products

FIGURE 4: Nominal export growth of goods: Intensive and extensive margins

flows represented -4 percentage points. It should be born in mind that such entry and exit in domestic and foreign markets tends to be a positive feature in the economy as inefficient firms should free up resources for new ones. In addition, in a Schumpeterian world, entering is a way to test innovative products and technologies and those that are not valuable for consumers should exit.

The effects of the destination and product dimensions are presented in panels B and C, respectively. In these dimensions the contribution of the extensive margin is even smaller than in the firm dimension but it is positive in most years, thus becoming relevant in cumulative terms. For the period 1996-2014, the accumulated extensive margin in destinations and products contributed to total nominal goods export growth by 10 and 5 percentage points, respectively. Finally, although the level of the contribution to yearly export growth is very low, when continuing firms enter new markets they do it with products that are old in the firm, that is, there is almost no entry in foreign markets with newly developed products (panel D).



(A) Firm margin

(B) Destination (origin) margin

(C) Product margin

(D) Old vs new products

FIGURE 5: Nominal import growth of goods: Intensive and extensive margins

In figure 5 we take the analysis performed above to the import side and most of the results are similar to those recorded for exports. Panel A plots the margins for the firm dimension and shows that the volatility in the nominal growth rate of imports, associated with the trade collapse and the Portuguese economic and financial adjustment programme, was mostly driven by the intensive margin. The extensive margin presents contributions around zero, but remained in negative territory from 2008 to 2013. As in the case of exports, the gross entry and exit of importers (churning) is substantial, representing on average 4 and -4 percentage points of the yearly nominal growth rate of imports in Portugal. The margins associated to the destination and product dimensions (panels B and C) show a similar pattern, with a modest role for the extensive margin, even in cumulative terms. Finally, panel D shows that continuing importers enter new source markets mostly to buy products that are old in the firm. However, there is some entry in foreign markets to reach new products. Although small, the extensive margin in this dimension is higher that the one observed in the export side.

Cohorts of exporters and importers

An important approach in the analysis of the growth rate of exports and imports is the contribution of the successive cohorts of traders. First, it is interesting to assess the pattern for their survival and growth. Second, it is relevant to evaluate whether events like the great trade collapse or the Portuguese economic and financial assistance programme have lasting effects on the cohorts of traders that enter international trade on those years.

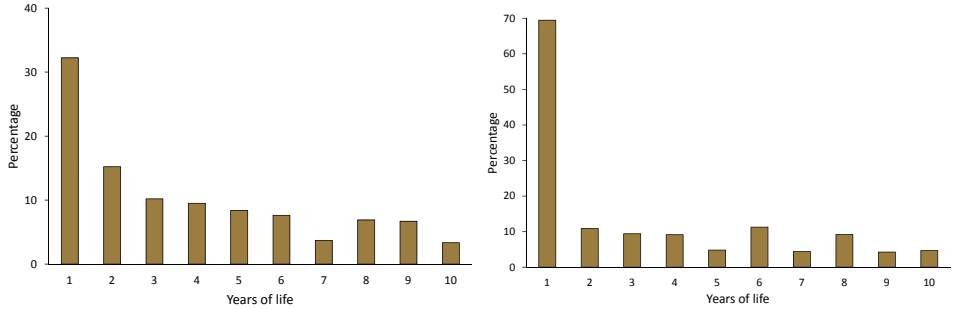
Figure 6 presents the average exit rate per year of life for the cohorts of exporters that started activity in the years 1996-2014 (panel A), as well as the average growth rate of exports per firm (Panel B). The exit rate of new exporters is particularly high in the first year of life, as almost one out of three exits foreign markets. This exit rate drops to about 15 per cent in the second year and slowly decreases afterwords. In our sample, almost 60 per cent of new exporters exit in the first five years of activity. Although the empirical literature on the cohorts of international traders is limited, this number is higher than the one reported by Wagner (2012b), which is based on cohorts of new exporters in Germany from 1998 to 2002 and finds that between 30 percent and 40 per cent of the new exporters sell on the international market in all five years after starting to export.[2]

The ratio of exports per firm increases on average about 70 per cent in the first year of the cohort, meaning that those that survive strongly increase exports. This growth rate decreases to an average of 10 per cent in the second year, stabilizing afterwards on a range between 4 and 9 per cent.

The yearly number of firms and the value of their exports for each cohort is difficult to represent in a meaningful way. The panels of figure 7 suggest a representation that plots cohorts as stacked layers. Therefore, on an horizontal perspective, the thickness of each layer defines the evolution in the cohort's number of firms (panel A) and their exports (panel B), while a vertical reading gives the breakdown of the total number of exporters starting activity after 1997 and their exports by cohort.

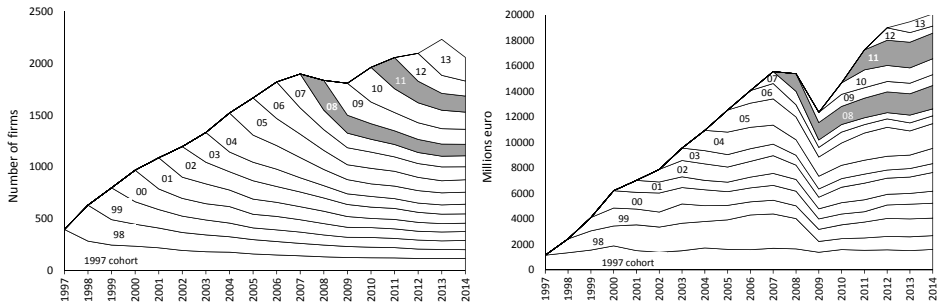
Panel A of figure 7 shows that the size of each cohort in terms of number of firms virtually stabilizes after around eight years, which corresponds to the information conveyed by the exit rates presented above. The cohorts born in 2008 and 2011, which correspond to the beginning of the great trade collapse and the first year of the Portuguese economic and financial assistance program, follow a normal pattern in terms of number of exporters and a comparatively good performance in terms of total exports, especially the 2011

2. Félix (2017) analyses overall firm creation and survival in Portugal. The article estimates a Kaplan-Meier survival function and reports that 48 per cent of new firms survive throughout the 8-year sample period (2005-2012). Nevertheless, these rates cannot be compared with those in this article because exit from foreign markets does not necessarily correspond to the death of the firm.



(A) Exit rate of exporters (B) Growth rate of exports per firm

FIGURE 6: Exit rate of exporters and average growth rate of exports, per year of life

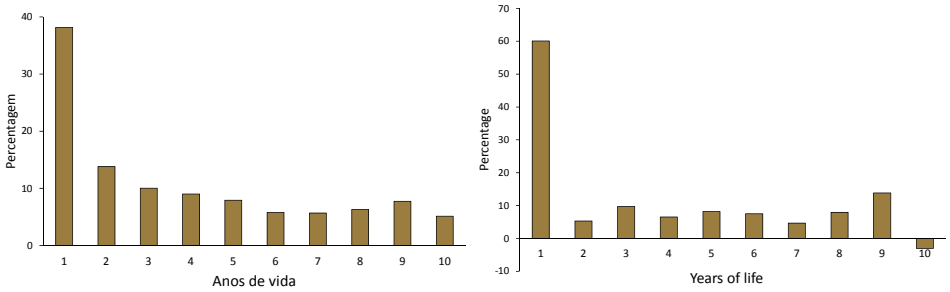


(A) Number of exporters (B) Value of Exports

FIGURE 7: Number of exporters and value of goods exports per cohort in each year

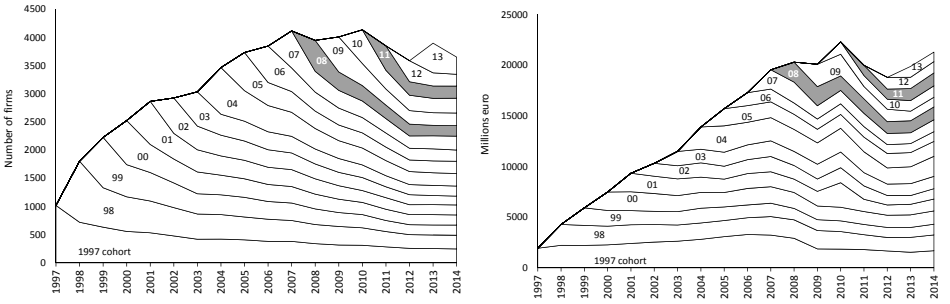
cohort. This suggests that firms that start to export in crisis years, and manage to survive, are not handicapped. These exporters show ability to act in times of higher uncertainty and structural trends related with international trade participation and specialization may dominate macroeconomic fluctuations. In the Portuguese case, the 2008 and 2011 crisis took place against a background of strong export growth that had been initiated several years before. Indeed, Portuguese firms were adjusting for some time to a new pattern of comparative advantages, which followed the shocks of Asian competition and EU enlargement to Central and Eastern European Countries.

Next we repeat the cohort analysis for the import side. Figure 8 presents the average exit rate per year of life for the cohorts of importers that started activity in 1996-2014 (panel A) and also the average growth rate of imports per firm (Panel B). Similarly to what was observed for exports, the exit rate of new importers is very high in the first year of life. However, this exit rate drops faster than in the export case. In parallel, the ratio of imports per firm



(A) Exit rate of importers (B) Growth rate of imports per firm

FIGURE 8: Exit rate of importers and average growth rate of imports, per year of life



(A) Number of importers (B) Value of Imports

FIGURE 9: Number of importers and value of goods imports per cohort in each year

increases on average about 60 per cent in the first year of life of the cohort but decreases to values below 10 per cent in the following years.

As for the cohorts of importers of goods in the Portuguese economy (figure 9), we observe that the initial number of firms in each cohort has been decreasing, notably after 2008, but those that survive seem to increase in number. In 2014, the share of importers born in post-1996 cohorts is relatively close, despite the difference in terms of age. Nevertheless, the value of imports per cohort evolves in somewhat different ways. For example, the post-2008 and, mostly, post-2010 cohorts show lower import levels. This relates with the macroeconomic turmoil that followed the latest international economic and financial crisis, which hit the Portuguese economy in a set up of strong macroeconomic imbalances. The Portuguese economic and financial assistance program, which took place in the context of the European sovereign debt crisis, led to a significant contraction of imports.

Final Remarks

This article examines the path of the extensive and intensive margins in the Portuguese exports and imports of goods in the period 1995-2015. Although the literature on trade margins is large, the time dimension is just starting to be explored. This research requires a long dynamic panel of transactions in international trade, which is typically non-available. Moreover, the literature on trade margins considers all continuing firms in the same way, independently of their age. In order to address this criticism, in this article we also analyse the cohorts of international traders in terms of their exit rate and trade values per firm.

The article concludes that the contribution of the intensive margin to total nominal export growth is higher than that of the extensive margin, though in cumulative terms the latter posts a significant number. The same pattern is visible for imports but the cumulative effect of the extensive margin is higher and closer to the intensive margin.

As for the impact of the great trade collapse, it is clearly visible on the exports' intensive margin, while the Portuguese economic and financial assistance program mostly reduced the imports' intensive margin. The disaggregation of the extensive margin along the firm, destination and product dimensions corroborates their low yearly contributions to the growth rate of exports and imports of goods. Nevertheless, the gross contributions of these margins are important.

The cohort analysis shows that the exit of international traders is higher in the early years of life and the growth rate of exports per firm is very large in the first year. Moreover, the cohorts born in 2008 and 2011, which correspond to the beginning of the great trade collapse and the first year of the Portuguese economic and financial assistance program, perform well. Therefore, firms that start to export in crisis years, and manage to survive, are not necessarily handicapped. As for imports of goods, the number of new firms has been decreasing, as well as total value imported by younger cohorts.

References

Amador, João and Luca Opromolla (2013). "Product and destination mix in export markets." *Review of World Economics*, 149(1), 23–53.

Arkolakis, C. and M. Muendler (2011). "The Extensive Margin of Exporting Goods: Firm-level Analysis." *mimeo*.

Banco de Portugal (2016). "Portuguese international traders: Some facts about age, prices and markets." Special issue October 2016, Banco de Portugal.

Bernard, A., J. Jensen, S. Redding, and P. Schott (2007). "Firms in International Trade." *Journal of Economic Perspectives*, 21(3), 105–130.

Bernard, A., S. Redding, and P. Schott (2010). "Multi-Product Firms and Product Switching." *The American Economic Review*, 100(1), 70–97.

Bricongne, Jean-Charles, Lionel Fontagné, Guillaume Gaulier, Daria Taglioni, and Vincent Vicard (2012). "Firms and the global crisis: French exports in the turmoil." *Journal of International Economics*, 87(1), 134–146.

Eaton, J., M. Eslava, M. Kugler, and J. Tybout (2007). "Export Dynamics in Colombia: Firm-Level Evidence." NBER Working Paper 13531, Cambridge, MA: National Bureau of Economic Research.

Eaton, J., S. Kortum, and F. Kramarz (2004). "Dissecting trade: firms, industries and export destinations." *American Economic Review: Papers and Proceedings*, 94(2), 150–154.

Eppinger, Peter S., Nicole Meythaler, Marc-Manuel Sindlinger, and Marcel Smolka (2015). "The Great Trade Collapse and the Spanish Export Miracle: Firm-level Evidence from the Crisis." IAW Discussion Papers 120, Institut für Angewandte Wirtschaftsforschung (IAW).

Félix, S. (2017). "Firm creation and survival in Portugal." *Banco de Portugal Economic Studies*, III(1), 31–42.

Galuscak, Kamil and Ivan Sutoris (2016). "Margins of Trade: Czech Firms Before, During and After the Crisis." Working Papers 2016/12, Czech National Bank, Research Department.

Giri, Rahul, Enrique Seira, and Kensuke Teshima (2014). "Exporters During the Trade Collapse: The (Surprising) Resiliency of the Small Exporter." Working Papers 2014-06, Banco de México.

Iacovone, L. and B. Javorcik (2010). "Multi-product exporters: product churning, uncertainty and export discoveries." *The Economic Journal*, 120(544), 481–499.

Schott, P.K. (2004). "Across-Product Versus Within-Product Specialization in International Trade." *Quarterly Journal of Economics*, 119(2), 647–678.

Wagner, J. (2012a). "German multiple-product, multiple-destination exporters: Bernard-Redding-Schott under test." *Economics Bulletin*, 32(2), 1708–1714.

Wagner, J. (2012b). "The Post-Entry Performance of Cohorts of Export Starters in German Manufacturing Industries." *International Journal of the Economics of Business*, 19(2), 169–193.

Wagner, Joachim (2016). "Still Different After All These Years Extensive and Intensive Margins of Exports in East and West German Manufacturing Enterprises." *Journal of Economics and Statistics (Jahrbuecher fuer Nationaloekonomie und Statistik)*, 236(2), 297–322.

Appendix: Descriptives based on the data used

	Number of firms	Exported products Mean	Exported products Median	Destination countries Mean	Destination countries Median	Exports by firm Mean	Exports by firm Median
1995	2286	7,1	4	9,8	8	12,7	4,5
2000	2693	7,3	4	10	7	14,1	4,2
2005	2905	7,4	4	9,3	6	12,8	3,6
2010	2876	10,4	4	10,1	7	12,7	3,3
2014	3160	12,2	5	11,6	7	13,3	3,2

TABLE A.1. Number of products, destinations and value of exports by firm

Note: The values for the mean and median exports by firm in the two last columns of the table are expressed in million euros of 2014.

		Distribution of exports 1995	2000	2005	2010	2014	Distribution of exporters 1995	2000	2005	2010	2014
1	Live animals and animal prods	1,4	1,7	1,8	2,8	2,7	2,6	3,5	4,1	5,8	6,6
2	Vegetable products	0,7	0,8	1,2	1,7	1,9	2,2	2,6	4,0	5,1	4,9
3	Fats and oils	0,4	0,3	0,4	0,5	0,8	0,3	0,3	0,6	0,7	1,2
4	Food, beverages and tobacco	4,3	3,9	4,7	6,1	6,3	4,7	4,0	4,3	4,3	4,2
5	Mineral products	5,0	3,3	5,6	9,0	11,3	1,4	1,2	1,8	2,1	2,2
6	Chemical products	3,5	4,0	4,7	5,2	5,2	4,1	3,6	5,8	6,1	5,9
7	Plastics and rubber	2,6	3,6	5,8	7,1	7,7	5,8	6,8	8,0	9,7	9,7
8	Hides and leather	0,3	0,3	0,2	0,3	0,5	1,1	1,2	1,6	1,9	2,3
9	Wood and furniture	4,5	4,7	4,3	3,6	3,3	7,2	6,5	5,6	4,2	4,4
10	Pulp and paper	6,7	5,5	4,7	5,8	5,2	1,7	2,6	2,4	2,9	2,6
11	Textiles and textile articles	23,5	18,4	13,0	10,7	10,1	36,0	32,2	24,4	19,4	18,7
12	Footwear	7,8	6,2	4,4	4,1	4,3	10,5	9,6	7,9	8,7	8,6
13	Non-metal mineral products	3,9	3,2	3,5	3,5	3,1	6,0	5,6	5,2	4,4	4,1
14	Precious materials and jewelry	0,4	0,3	0,1	0,8	0,7	0,2	0,3	0,1	0,3	0,5
15	Base metals	4,0	5,4	7,7	7,6	7,7	5,1	6,5	8,3	8,8	8,9
16	Machinery and electric equip.	17,7	20,2	19,4	14,0	13,8	6,1	8,6	9,6	8,6	8,9
17	Transport equipment	10,4	15,3	14,6	13,0	10,7	2,1	1,9	2,7	2,6	2,6
18	Optical and precision equip.	1,1	0,7	0,7	0,9	1,3	0,5	0,5	0,4	0,6	0,4
19	Arms and ammunition	0,2	0,2	0,1	0,1	0,1	0,1	0,1	0,0	0,0	0,0
20	Miscellaneous manuf.	1,5	1,7	2,8	3,0	3,2	2,0	2,3	3,1	3,3	3,0
21	Works of art	0,0	0,0	0,0	0,0	0,0	0,1	0,2	0,2	0,2	0,2
	Sum	100	100	100	100	100	100	100	100	100	100

TABLE A.2. Distribution of exports and exporters per sector

	Number of firms	Imported products		Origin countries		Imports by firm	
		Mean	Median	Mean	Median	Mean	Median
1995	4330	19,9	13	6,8	6	10,2	2,9
2000	5864	19,0	12	6,3	5	10,9	2,7
2005	6273	19,9	13	6,3	5	9,8	2,2
2010	6059	24,8	13	6,7	5	10,4	2,1
2014	5757	25,2	14	7,1	6	10,1	2,1

TABLE A.3. Number of products, origins and value of imports by firm

Note: The values for the mean and median imports by firm in the two last columns of the table are expressed in million euros of 2014.

		Distribution of imports					Distribution of importers				
		1995	2000	2005	2010	2014	1995	2000	2005	2010	2014
1	Live animals and animal prods	4,2	3,9	4,3	4,8	5,5	5,8	6,2	7,0	8,4	8,2
2	Vegetable products	4,4	2,7	2,7	3,9	4,1	4,1	4,5	5,0	5,9	5,8
3	Fats and oils	0,8	0,3	0,5	0,8	0,8	1,1	0,8	0,6	0,7	1,1
4	Food, beverages and tobacco	4,2	4,0	3,6	4,5	4,7	4,1	3,4	3,9	4,4	4,6
5	Mineral products	9,1	11,1	15,5	15,6	18,4	4,4	4,2	5,1	4,7	4,6
6	Chemical products	8,6	7,7	9,0	10,3	10,5	17,7	17,3	17,5	18,9	19,8
7	Plastics and rubber	4,6	4,4	4,6	5,1	5,8	14,3	14,7	13,8	15,2	15,1
8	Hides and leather	1,4	1,0	0,8	0,9	1,3	2,9	3,5	3,4	3,2	3,1
9	Wood and furniture	1,0	1,3	1,1	1,0	1,2	1,2	2,3	1,9	1,6	1,4
10	Pulp and paper	3,0	2,6	2,4	2,4	2,0	4,7	4,4	4,3	3,7	3,4
11	Textiles and textile articles	8,6	7,0	5,3	5,3	5,7	10,1	7,6	6,5	5,2	5,6
12	Footwear	0,9	0,9	0,8	1,0	1,1	0,9	0,8	0,7	0,7	0,9
13	Non-metal mineral products	1,1	1,2	1,2	1,1	1,0	2,3	2,1	1,9	1,6	1,5
14	Precious materials and jewelry	1,0	0,8	0,3	0,3	0,3	0,9	0,8	0,4	0,2	0,5
15	Base metals	7,7	7,0	8,0	7,8	7,6	8,9	8,2	9,0	8,0	8,1
16	Machinery and electric equip.	21,0	22,4	21,1	16,7	15,1	12,7	13,0	13,3	12,5	11,5
17	Transport equipment	14,9	17,5	14,4	14,3	10,6	1,9	2,9	2,6	2,5	2,4
18	Optical and precision equip.	2,0	2,3	2,1	2,1	2,1	0,9	1,3	1,4	1,4	1,5
19	Arms and ammunition	0,1	0,1	0,1	0,1	0,1	0,1	0,0	0,0	0,0	0,0
20	Miscellaneous manuf.	1,4	1,9	2,0	2,1	2,1	1,1	1,7	1,7	1,1	1,0
21	Works of art	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
	Sum	100	100	100	100	100	100	100	100	100	100

TABLE A.4. Distribution of imports and importers per sector

Understanding the Basel III Leverage Ratio Requirement

Dina Batista
Banco de Portugal

Sudipto Karmakar
Banco de Portugal and UECE

Abstract
One of the main reasons for the global financial crisis was the excessive build up of leverage by the banks. To tackle this issue, the new set of Basel III regulations calls for a minimum leverage ratio requirement for banks, in addition to the existing risk-weighted capital requirement. In this article we explore in detail the main motivations for the introduction of the leverage ratio requirement. We also study how the banks' leverage ratio and the risk-weighted capital ratio are complementary to each other and how they co-move over the business cycle. Finally, we present the case of Portuguese banks faced with this new regulatory instrument. (JEL: G21, G28, G32)

Introduction

The recent financial crisis has exposed the shortcomings of one of the key instruments, used by policymakers, to regulate banks, namely, the risk-weighted capital ratio requirement. In the run up to the crisis, banks had been accumulating substantial amounts of leverage while maintaining robust capital ratios, all along. In the peak of the crisis, when credit risk materialization was high, banks were forced to rapidly deleverage to stay compliant with prudential regulations. This exacerbated the overall economic downturn. Having the benefit of hindsight, now, we know that ex ante high capital ratios were not adequate to absorb ex post losses on the balance sheets of troubled banks. What could be the reason behind this mismatch between ex ante safety and ex post distress? The answer lies in understanding how the regulation is devised in the first place. Put simply, the risk-weighted capital ratio requirement (RWR) is that the bank capital should be a certain fraction of its' risk-weighted assets (say 8%). The problem is that the risk-weights that are applied to the various asset categories might not be able to reflect the true risk of a particular asset. Despite numerous refinements and revisions over the last two decades, the weights applied to asset categories seem to have failed to

Acknowledgements: We would like to thank Luisa Farinha, Leonardo Gambacorta, Miguel Gouveia, Ana Cristina Leal, and the seminar participants at the Bank of Portugal for helpful comments and discussions. The views expressed here are our own and do not necessarily reflect the views of the Bank of Portugal or the Eurosystem.

E-mail: drbatista@bportugal.pt; skarmakar@bportugal.pt

fully reflect banks' portfolio risk causing an increase in systemic risk (Acharya and Richardson (2009), Hellwig (2010), and Vallascas and Hagendorff (2013)).

The new Basel III regulations proposes a minimum leverage ratio requirement (LR), defined as a bank's Tier 1 capital over an exposure measure, which is independent of risk assessment (Ingves (2014)), and this is the fundamental difference between this new requirement and the already existing risk-weighted capital requirement. The aim of the leverage ratio is to act as a complement and a backstop to the risk-weighted capital requirement. It should counterbalance the build-up of systemic risk by limiting the effects of risk weight compression during booms. The leverage ratio is therefore expected to act counter-cyclically, being tighter in booms and looser in recessions.[1] The leverage ratio indicates the maximum loss that can be absorbed by equity, while the risk-based requirement refers to a bank's capacity to absorb potential losses.

The main difference between the LR and the RWR stems from the risk weights that are applied to various asset categories. During the boom phase of the business cycle, credit risk materialization is low. Hence banks have an incentive to expand the size of their balance sheets. This results in the lowering of risk weights, giving the impression that banks are well capitalized. Overoptimistic assessment of risk weights lead to large-scale extension of credit and hence decline in lending standards. The reduction of risk weights could be particularly strong in a period in which interest rates are low.[2] When credit risk materializes, bank capital serves as a cushion to absorb the losses. It is mainly for this reason that we need a non risk based measure that will complement the RWR. The LR would counterbalance the effects of falling risk weights. It would be the stricter constraint during booms and thereby prevent excessive increase in the size of bank balance sheets.

The opposite happens during economic downturns. During such times, risk weights are high and hence the capital requirement constraint tightens but the leverage requirement is unaffected by the changes in risk weighting. The RWR will be the tighter constraint in recessions while the LR remains slack. It must be clarified here that the LR does not provide information about the underlying risks on the banks' balance sheets. This insensitivity to risk may incentivise banks to take on riskier positions, which is what the RWR should account for. The RWR and the LR, therefore, are complements - and not substitutes - within the broader regulatory framework. They should work together to limit the boom-bust cycle. For this synchronization to work, in technical terms, the LR should be more countercyclical than the RWR

1. We will demonstrate this with the help of a simple theoretical framework and also be specific about the Portuguese case later in the article.

2. This is the so-called the risk-taking channel (Borio and Zhu (2008), Adrian and Shin (2014), Altunbas et al. (2014)).

and indeed we have empirical evidence to show that it is the case, Brei & Gambacorta (2016).

The use of a LR requirement is not a new concept. A similar measure has been in force in Canada and the United States since the early 1980s. Canada introduced it in 1982 after a period of rapid leveraging-up by its banks, and tightened the requirements in 1991. In the United States, the LR requirement was introduced in 1981 amid concerns over bank safety due to falling bank capitalization and a number of bank failures. The introduction of a leverage ratio requirement for large banking groups was announced in Switzerland in 2009 (FINMA, 2009). Similar requirements have been proposed, more recently, in other jurisdictions as well, with a view to implementing them by 2018 (BCBS, 2014b).

The goal of this article to explore this new regulation further and understand some of the key issues involved. We first start with the formal definition and motivation of introducing this new regulation in the Basel III guidelines. Next, we try to analyze the dynamics (and understand the main mechanism) of the LR and RWR using a simple model. Lastly, we look at the case for Portuguese banks and how they are set to fare once this new regulation is fully implemented in Portugal.

The Leverage Ratio Requirement

The Basel Banking Regulations have undergone quite a few changes since their inception in the late 1980s. The first accord (Basel I) was adopted in 1988. The aim of this accord was to harmonize bank capital regulation across countries. It also aimed at making the international banking system more resilient when faced with adverse economic scenarios. Different asset classes were assigned risk weights ranging between 0 and 100% according to the bank's perceived risks. The banks had to hold a minimum amount of capital relative to the total risk-weighted assets. Basel II was first published in 2004. There were quite a few changes made to the Basel I framework but, probably, the most significant deviation from Basel I was perhaps that it allowed banks to use their internal models to evaluate risk, once they were approved by the respective supervisory authorities. With the onset of the global financial crisis in 2008, a number of weaknesses were perceived in the existing regulatory framework. The Basel Committee on Banking Supervision developed the third Basel Accord (Basel III) with the aim of implementing it in 2018. The fundamental concern was that the risk weights applied to the various asset categories had failed to fully reflect the underlying risk in banks' portfolios. Therefore, there was need for an additional (complementary) instrument that could act as a backstop for the already existing risk-based capital ratio

requirements. This was the motivation for the introduction of the leverage ratio requirement.[3]

The leverage ratio requirement, as envisaged in the Basel III framework, is a simple and non-risk based regulatory instrument aimed to act as a credible supplement to the risk-weighted capital requirement. According to BCBS (2014a), the LR is intended to:

- Restrict the build-up of leverage in the banking sector and thereby avoiding the rapid deleveraging process that we observed during the great financial crisis. This is of paramount importance because such rapid deleveraging can be detrimental for the broader financial system and the real economy.
- Act as a "backstop" measure to the more complex RWR.

The LR can be formally written as:

$$\text{Leverage Ratio} = \frac{\text{Capital Measure}}{\text{Exposure Measure}} \geq 3\% \tag{1}$$

The 3% represents the latest regulation as envisaged in Basel III.[4] The capital measure is the Tier 1 capital, the same used in the RWR. The Tier 1 capital in turn consists of Common Equity Tier 1 and Additional Tier 1 capital. Common Equity Tier 1 capital consists of the sum of the following elements:[5]

- Common shares issued by the bank.
- Stock surplus (share premium) resulting from the issue of instruments included Common Equity Tier 1.
- Retained earnings (includes interim profit or loss).
- Other income and disclosed reserves.
- Common shares issued by consolidated subsidiaries of the bank.
- Regulatory adjustments in the calculation of Common Equity Tier 1.

Additional Tier 1 capital consists of the sum of all other instruments issued by the bank, or its' subsidiaries, that are not included in the CET 1 but are eligible to be included in the Additional Tier 1 category.

3. For a more detailed evolution of the Basel Banking Framework, refer Gambacorta and Karmakar (2017).

4. Refer the Group of Central Bank Governors and Heads of Supervision (GHOS) press release dated 11th January, 2016. (http://www.bis.org/press/p160111.htm). There is still an ongoing debate about the possibility of a leverage surcharge for global systemically important banks (G-SIBs). Most of the existing leverage ratio frameworks indicate an additional surcharge of 1-2% (Bank of England, Financial Stability Report, 2016). The additional surcharge for G-SIBs on the risk-weighted capital ratio has been already designed by the Basel III regulation following a bucket approach from 1-3.5% (http://www.bis.org/publ/bcbs255.pdf).

5. Dividends are removed from Common Equity Tier 1 in accordance with applicable accounting standards. Further details can be found in www.bis.org/publ/bcbs189.htm.

A bank's total exposure measure is the sum of: (a) on-balance sheet exposures; (b) derivative exposures; (c) securities financing transaction (SFT) exposures; and (d) off-balance sheet (OBS) items. Banks are not allowed to consider collateral guarantees (of any type) or other credit risk mitigation techniques to reduce the exposure measure. Banks must include all balance sheet assets in their exposure measure, including on-balance sheet derivatives collateral and collateral for SFTs. Liability items such as gains/losses on fair valued liabilities due to changes in the bank's own credit risk must not be deducted from the exposure measure. Off balance sheet items include commitments (including liquidity facilities), direct credit substitutes, acceptances, standby letters of credit, and trade letters of credit. In the risk-based capital framework, OBS items are converted under the standardised approach into credit exposure equivalents. For the purpose of determining the exposure amount of OBS items for the leverage ratio, the credit conversion factors are set out in paragraphs 14 to 22 of the Annex of BCBS (2014a).

Interaction with the Risk-Weighted Capital Requirement

While discussing the interaction between the LR and the RWR, a useful concept to keep in mind is the "density ratio", (DR), Fender and Lewrick (2015). DR is defined as the ratio of the risk-weighted assets (RWA) to the LR exposure measure. The density ratio can also be interpreted as an average risk weight per unit of exposure, for any given bank or banking system. A specific value of the DR for which it is equally likely to be bound by the RWR or the LR is called the Critical Average Risk Weight (CARW). Any bank having a DR less than the CARW is more likely to be constrained by the LR than the RWR while any bank presenting a DR above the CARW is more likely to be constrained by the RWR. The relationship between the LR and the DR can be obtained as follows:

$$\text{LR} = \frac{\text{Capital}}{\text{RWA}} * \frac{\text{RWA}}{\text{Exposure}} = \text{RWR*DR} \tag{2}$$

The LR can thus be expressed as the product of the risk-weighted capital ratio (RWR= Capital/Risk-weighted assets) and the DR. This relationship can help us calibrate a consistent minimum LR requirement.

Let us consider the last equation. If, all else equal, a bank's internal risk model underestimates the risk weights on the various asset classes, this will bias the Tier 1 capital ratio upwards, thereby satisfying the RWR. However, at the same time, the DR is also biased downwards, causing the LR to fall and making it the binding constraint. Conversely, for a given LR requirement, a bank with a relatively low DR will have an incentive to shift its balance sheet towards riskier assets to earn more income - a type of behavior that the RWRs

would constrain. This suggests that banks' risk-weighted capital ratios and the LR provide complementary information when banks' resilience is assessed.

It must be highlighted here that the benefits of implementing the LR requirement outweigh the costs only when done in conjunction with the RWR. What would happen if the LR requirement were the only regulation in operation? The non-risk based nature of the LR would indeed incentivize risk taking by banks. The main concern relates to this risk-insensitivity: assets with the same nominal value but of different riskiness are treated equally and face the same capital requirement under the non-risk based LR. Given that an LR requirement has a skewed impact, binding only for those banks with a large share of low risk-weighted assets on their balance sheets, the move away from a solely risk-based capital requirement may thus induce these banks to increase their risk-taking potentially offsetting the benefit gained from requiring them to hold more capital. These concerns are valid but they need to be analyzed in light of the overall prudential framework in place and not in isolation. When banks increase the risk on their balance sheets, it raises banks' risk-weighted assets, provided that the risk weights are properly determined, so that at some point the risk-weighted capital requirement becomes binding again. Hence, the potential for a marginal increase in risk-taking owing to an LR requirement should be limited as long as both approaches to capital regulation are mutually reinforcing.

A Simple Theoretical Framework

In this section, we briefly discuss the model developed in Gambacorta and Karmakar (2017), which, to the best of our knowledge, is the first paper that attempts to model the two regulatory requirements in the realm of a medium sized dynamic stochastic general equilibrium (DSGE) model. It builds on the model by Gerali et al. (2010) and Angelini et al. (2014). It must be made clear at the very outset that there are some trade-offs to using this framework. The framework incorporates a non-naive financial sector, besides featuring credit frictions, borrowing constraints and a set of real and nominal rigidities. The households and the borrowing constraints of the agents are modeled as in Iacoviello (2005) while the real and the nominal rigidities are similar to the ones developed in Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2003). The borrowing constraints and the bank's regulatory constraints are always binding and not occasionally binding. Further, the banks take the regulation as exogenously given and they are not modeled with an aim to eliminate certain inefficiencies or market failures like moral hazard or bank runs. The model mainly studies the dynamics of the two ratios and how the cyclicality of the risk weights drives a wedge between the RWR and the LR. In that sense, this is a purely positive paper. It does not feature bank defaults and, hence, does not address normative questions regarding

the optimality of these ratios. We refer the reader to the paper (Gambacorta and Karmakar (2017)) for a detailed account of the different agents and their optimization problems. The model can be depicted by means of figure 1. A brief description of the environment is as follows.

- There are two types of households (patient and impatient) who consume, supply labor, accumulate housing (in fixed supply) and either borrow or lend.
- The two types of households differ in their respective discount factors. The difference in discount factors leads to positive financial flows in equilibrium. The patient households sell deposits to the banks while the impatient households borrow, subject to a collateral constraint.
- The entrepreneurs hire labor from the households, and buy capital from the capital goods producers, to produce a homogeneous intermediate good.
- Similar to the impatient households, the entrepreneur also faces a collateral constraint while drawing a loan from the bank.
- The banks accept deposits and supply business and mortgage loans. The banks have a wholesale and a retail unit. They are monopolistically competitive. In other words, they set lending and deposit rates to maximize profits.
- The banks can only accumulate capital through retained earnings i.e. we do not allow for equity issuance.
- On the production side, there are monopolistically competitive retailers and capital goods producers.
- The retailers buy intermediate goods from the entrepreneurs, differentiate and price them, subject to nominal rigidities.
- The capital goods producers manufacture the capital to be used in the production process and in the context of the model, they help us introduce a price of capital to study asset price dynamics.
- The model also features a monetary authority and a macroprudential authority. The monetary authority sets policy rates and follows a standard Taylor rule.
- The macroprudential authority sets the minimum risk based capital and leverage requirements.

We only recreate the two main constraints from bank's optimization problem to understand how the risk weights drive a wedge between the two regulatory ratios. The bank maximizes profits which include receipts from lending to households and entrepreneurs net of deposit financing costs and adjustment costs. Let B_t^H and B_t^E denote lending to households and firms respectively and K_t^b be the bank capital. Then the RWR and the LR can be written as:

$$\frac{K_t^b}{\omega_t^H B_t^H + \omega_t^E B_t^E} \geq \nu_t \tag{3}$$

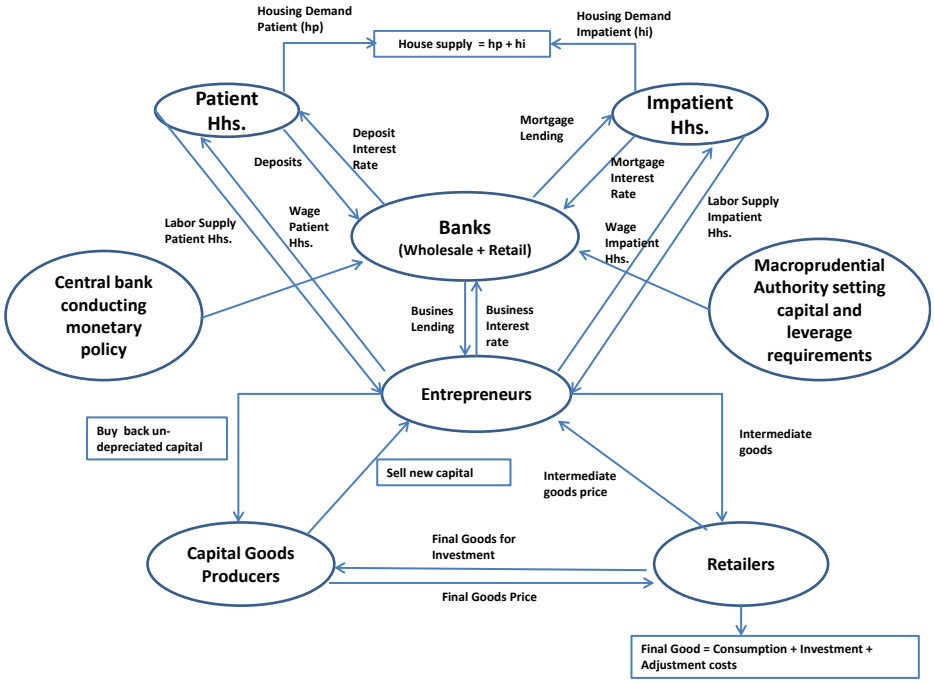


FIGURE 1: The Model Overview: Gambacorta & Karmakar (2017)

$$\frac{K_t^b}{B_t^H + B_t^E} \geq \varphi^b \tag{4}$$

where, φ^b is the LR requirement calibrated at 5%[6] and ν_t is the countercyclical capital requirement which responds to changes in the credit-to-GDP ratio around its steady state value. The steady state value of the risk-weighted capital requirement is set at 8.5%. ω_t^H and ω_t^E are the risk weights attributed to mortgage and business loans respectively. They follow the law of motion:

$$\omega_t^i = (1-\rho^i)\overline{\omega}^i + (1-\rho^i)\chi^i log\left(\frac{Y_t}{Y_{t-4}}\right) + \rho^i\omega_{t-1}^i, \quad i = H, E \tag{5}$$

In the above equation, $\overline{\omega}^i$ corresponds to the steady-state risk weights on household and business lending. $\chi^i < 0$ which means the risk weights tend to be low during booms and high during recessions. The cyclicality of the risk weights is what differentiates a bank's regulatory capital ratio

6. This is a bit higher than the 3% requirement imposed on European banks but this can be justified by the fact that we do not include some of the other exposures that banks might hold, like public debt.

from its leverage ratio. The law of motion for risk weights, though simple, captures one of the main ideas embedded in the Internal Risk Based (IRB) approach to computing risk weight functions. Credit risk in a portfolio may arise owing to systematic or idiosyncratic factors, (BCBS 2006). Systematic risk represents the effect of unexpected changes in macroeconomic and financial market conditions on the performance of borrowers while idiosyncratic risk represents the effects of risks that are particular to individual borrowers. As a lender's portfolio becomes more granular idiosyncratic risk can be completely diversified away. But the situation is completely different for systematic (aggregate) risk as very few firms are completely shielded from the macroeconomic environment in which they operate. Therefore this risk is undiversifiable and hence can cause the riskiness of the borrowers to move countercyclically. The risk-weight function is motivated from this idea. We allow the risk weights attributed to a specific asset class to move with the growth rate of real GDP at time 't', Y_t, which is our proxy for the aggregate risk factor.

Discussion of findings

The authors study the response of the economy to a positive productivity (TFP) shock and a positive shock to the loan to value ratio on mortgage lending.[7] The main mechanism is illustrated by the figure 2. Following a positive TFP shock, the systematic risk in the economy is significantly reduced which is reflected in the dynamics of risk weights, as shown in the left panel. This decline in risk weights could encourage excessive risk taking during booms while maintaining healthy risk-weighted capital ratios and this is precisely what the leverage ratio aims to correct. The right hand panel shows how the leverage ratio and the risk-weighted capital ratio evolve. During booms, lending to households and firms increases, driving down the leverage and the capital ratio. However, risk weights also decline and therefore the decline in the leverage ratio (non-risk-sensitive) is larger than the capital-to-RWA ratio and is hence the more stricter constraint in booms. Note that the reverse happens in recessions when the risk weights increase. The RWR becomes the more binding constraint in economic downturns. Thus the leverage ratio is intended to be the constraining ratio in booms and the milder constraint in a downturn. Note that the assumption made here is that the numerator (bank capital) adjusts slowly and therefore the dynamics of the ratios are mainly driven by the elements in the denominator.

Through a number of other exercises the authors document that the introduction of the leverage ratio requirement can lead to a loss in steady state output and consumption but the volatility reduction in real and nominal

7. The dynamics of the entrepreneurial lending are similar.

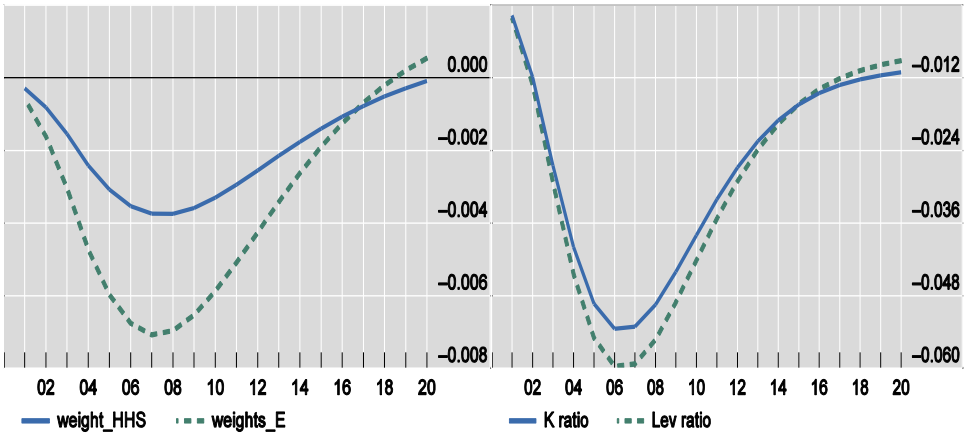


FIGURE 2: Risk Weights & Regulatory Ratios

variables is significantly higher. To provide an example, the authors mention that the introduction of the LR requirement generates a loss in steady-state output in the range of $0.7 - 1.7\%$ but it also reduces output volatility around $24 - 28\%$. To put these magnitudes in perspective, they make a comparison with other studies that have evaluated the impact of Basel III. Simulations conducted in BCBS (2010) using a wide range of econometric tools, mostly DSGE models, find that on average a 2% increase in risk-weighted capital requirements leads to a reduction in the steady-state output of 0.2% and output volatility of 2.6%. The numbers presented in Gambacorta & Karmakar (2017) indicate that introducing the leverage ratio produces a somewhat larger cost on steady state output but the benefits in terms of reduction of output volatility are substantially larger. Besides studying the impact of a positive TFP shock and a shock the LTV ratios, the authors also discuss what would happen if the cyclicality of risk weights were to change. They show that the

benefits of introducing the leverage ratio can be substantially higher when risk weights are more sensitive/responsive to the business cycle.[8]

The case of Portugal

Having built up a broad understanding of the leverage ratio requirement, we now focus our attention to the specific case of Portugal. We address questions such as (i) How do the Portuguese banks' balance sheets fare once faced with the new set of regulations? (ii) How do Portuguese banks compare with their European peers? (iii) Are they likely to be constrained by the RWR or the LR? (iv) What are the cylical properties of the two ratios in Portugal? and (v) Will this regulation be effective for Portugal going ahead in the future, say 2020 when the capital conservation buffer of 2.5% is fully phased in?[9]

Over the recent years major Portuguese banking groups have consistently increased their risk weighted capital ratios, as well as improved their leverage ratios, in line with the current Basel III definitions.[10] In this regard they have accompanied their European peers in the convergence process towards more demanding supervisory requirements, encompassed in the Basel III agreement and in the European regulatory framework. This can be observed in the left panel of figure 3 which plots the RWR and the LR for the Portuguese banks, from March 2005 onward.[11] On the right panel we decompose the ratios and plot the numerator and denominator separately, all normalized to be 1 in Q1:2005.[12]

It is visible that the upward trend of the ratios has been driven by sustained increases to banks' capital, accompanied by the deleveraging process that has been occurring since 2010. By the end of the second quarter 2012 a considerable number of institutions, subject to Banco de Portugal's supervision, had already achieved a Core Tier I ratio in excess of the 10% objective defined in the Economic and Financial Assistance Program, to be

8. If risk weights are calculated using the 'through the cycle' approach (as in Basel III), they are expected to be less procyclical than the formerly used 'point in time' estimates.

9. The capital conservation buffer is designed to ensure that banks build up capital buffers outside periods of stress which can be drawn down as losses are incurred. The requirement is based on simple capital conservation rules designed to avoid breaches of minimum capital requirements.

10. This section is based on the analyses to be published in the December 2017 Financial Stability Report, regarding the introduction of the leverage ratio in the Portuguese macroprudential toolkit.

11. Focusing on the LR it appears that the banks in Portugal are well in compliance with the 3% minimum envisaged in Basel III. The United States and Canada, however, have a requirement which is around 5%.

12. The Portuguese banks who participated in the transparency exercise were Banco BPI, BCP, Caixa Central de Credito Agricola Mutuo, Montepio, CGD, and Novo Banco.

achieved by December 2012. The four major Portuguese banking groups also complied with the prudential recommendations of the European Banking Authority (EBA) for June 2012. This significant increase of original own funds reflected the capitalization operations of the main banking groups. Besides the solvency requirement, the Portuguese banks also had to meet a maximum loan-to-deposit ratio. This accounts for the deleveraging observed in the series for risk-weighted assets and the exposure measure.

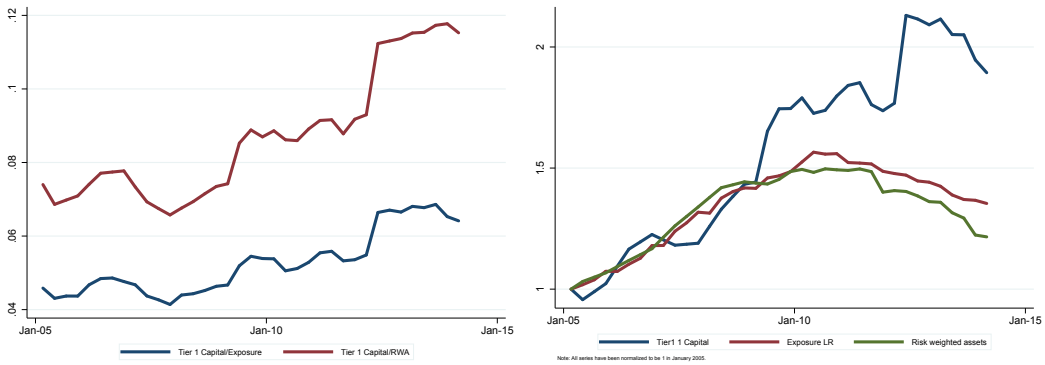
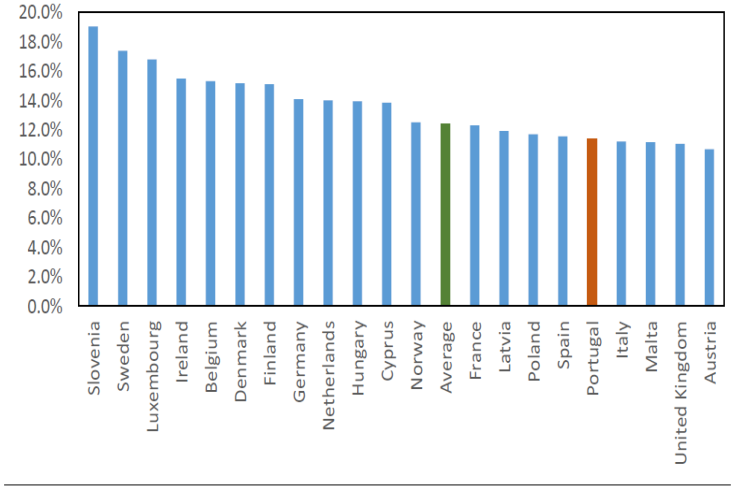


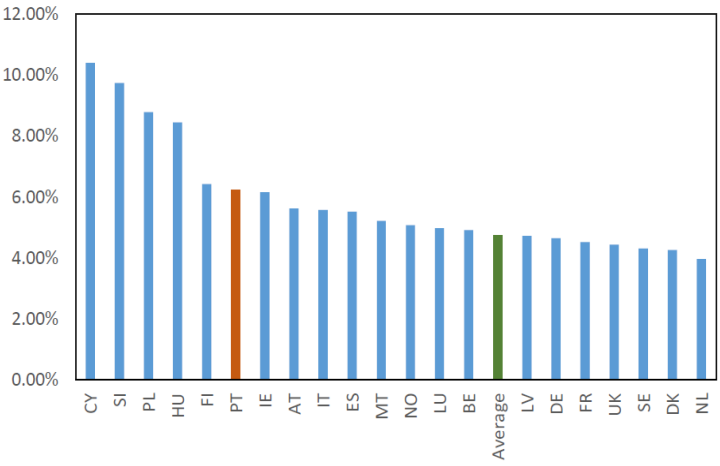
FIGURE 3: Regulatory Ratios & Decomposition

In spite of this recent trend, Portuguese banks have consistently ranked among the lowest capitalized banks in Europe. In fact, in the latest European Banking Authority transparency exercise (December 2016, with reference date June 2016) the participating Portuguese banking groups ranked last regarding the average CET1 ratio. In the previous EBA transparency exercise published on November 2015, with reference date December 2014, the major Portuguese banking groups that participated in the exercise (CGD, BCP, and BPI) presented an average Tier 1 ratio of 11.4%, below the average for European banks (12.4%). In fact, Portuguese banks in the sample ranked 17th out of the 21 countries, regarding the Tier 1 capital ratio, as can be observed from the top panel of figure 4.

In the same exercise, the major Portuguese banking groups presented a weighted average leverage ratio (LR) of 6.2%, which compares with a weighted average of 4.7% for all European banks in the sample. In terms of ranking, Portuguese banks demonstrated the 6th highest average ratio in a sample of 21 countries, bottom panel of figure 4. These, apparently, inconsistent findings can be rationalized if one compares the density ratio (DR) of the Portuguese banks vis-à-vis their European peers. In fact, both in December 2014 and in in long run analysis since the year 2000, the Portuguese banks' risk exposure to total assets has persistently presented higher values than their European counterparts.



Source: 2015 EBA transparency exercise. Tier I capital ratio computed as the quotient between Tier I capital and Risk Weighted Assets.

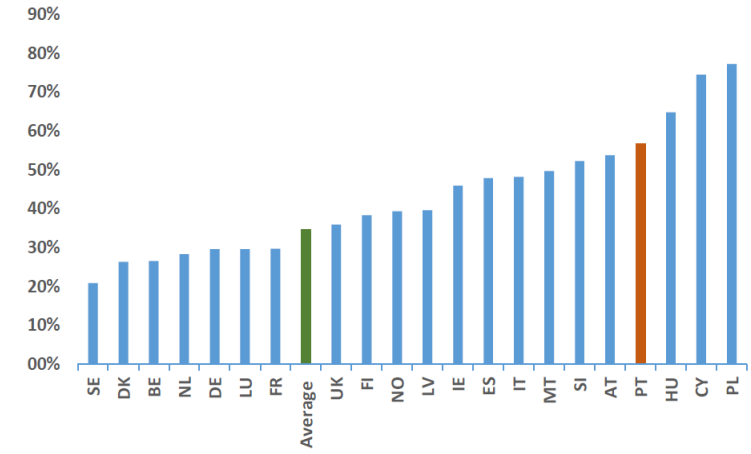


Source: 2015 EBA transparency exercise. Leverage ratio computed as the quotient between Tier I capital and Total Exposure.

FIGURE 4: Tier 1 Capital Ratios & Leverage Ratios

Regarding December 2014, it can be observed that the sample of Portuguese banking groups ranked 4th highest regarding RW density, with an average of 57%, well above the average risk weight density for the European

sample (35%).[13] Results are depicted in figure 5 below and the heterogeneity among European banking systems can also be observed, with average risk weights ranging from 21% in Sweden to 77% in Poland.[14]



Source: 2015 EBA transparency exercise (RWA) and SNL (Assets). Average Risk Weight computed as the quotient between Risk Weighted Assets and Total Assets.

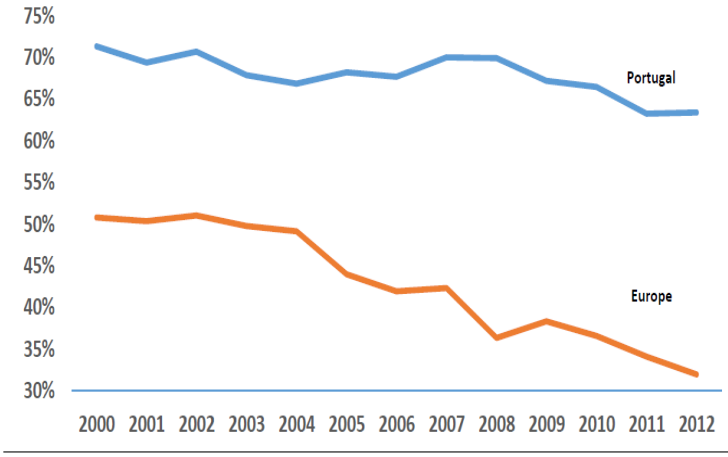
FIGURE 5: Risk Weight Densities

The fact that the Portuguese banks present higher density ratios can also be seen in figure 6, which presents a long run analysis of a larger sample of banks. The density ratio has been falling, both in Portugal and in the sample of other European countries, but at a greater pace in Europe as a whole, thereby, widening the gap that could already be observed in year 2000. Albeit European DR increased slightly in 2009, following the financial crisis, Portuguese DRs kept its downward path and has stabilized in recent periods, above 65%.

Even though these results can be regarded as reflecting the higher riskiness of these banks' portfolio, including country specific risk factors, the result can also be partly attributed to a more conservative methodology in

13. The latest transparency exercise published in December 2016 does not include data regarding the leverage ratio.

14. In this regard, it should be noticed that when the Basel II agreement was implemented regulators set up a backstop system, the so called Basel I floor. In fact, to prevent banks' internal risk weights from reducing risk-weighted assets and thus banks' capital needs too much and too quickly, temporary, lower limits were set for how much capital could be reduced. These limits were set relative to the previous framework, Basel I, which had a fixed set of risk weights and are referred to as the "Basel I floors". It can be argued that the Basel I floor is akin to an implicit leverage ratio requirement.



Source: Bankscope. Average Risk Weight computed as the quotient between Risk Weighted Assets and Total Assets.

FIGURE 6: Risk Weight Densities Overtime in Portugal & the European Union

the assessment of risk weights, in some jurisdictions than others. In fact, simulations with a theoretical portfolio conducted by the Basel Committee on Banking Supervision (BCBS) and the European Banking Authority (EBA) have shown that different institutions obtain results that differ materially, for the same theoretical portfolio.[15] Further, one of the arguments to introduce the LR as binding prudential requirement has been its ability to mitigate the variability in risk weights, for a fixed portfolio. In fact, if a banks' RWA is very low, then, given the same quantum of capital, this bank will have higher capital ratios than a bank with a higher average risk weight. Whether risk based or non-risk based capital requirements are the most constraining depends, inter alia, on the (i) relative calibration of the requirements and (ii) the specific balance sheet of the institution and the risk weights assets calculation, and (iii) the cyclical properties of the regulatory ratios. Let us elaborate on each of these factors.

Relative calibration of the requirements

Equation (2) derives the density ratio given the calibration of the LR and the RWR. We also remind the reader that the CARW is that value of the density

15. https://www.eba.europa.eu/risk-analysis-and-data/review-of-consistency-of-risk-weighted-assets.

ratio such that it is equally likely to be constrained by the LR or the RWR.[16] We reproduce equation (2):

$$\text{LR} = \frac{\text{Capital}}{\text{RWA}} * \frac{\text{RWA}}{\text{Exposure}} = \text{RWR*DR}$$

Hence, given a minimum LR requirement of 3% and a minimum RWR requirement of 8.5%, the CARW would be 0.35. An institution having a DR equal to 0.35 is equally likely to be constrained by either of the two regulatory ratios while an institution with a DR below 0.35 would be more likely to be constrained by the LR requirement. It is clear that each bank will have a different CARW, since some institutions are subject to additional risk weighted requirements, given their systemic relevance (G-SIIs; O-SIIs).[17] Moreover, the countercyclical capital buffer (CCyB) requirements are institution specific, as a result of country specific countercyclical requirements and different country exposures.[18]

In 2017, risk based requirements for all Portuguese banking groups amounts to 7.25% of the total risk exposure amount. This includes the phasing in of the capital conservation buffer, which is currently set at 1.25%. Pillar II requirements are institution specific and confidential. In particular, institutions under the direct supervision of the ECB/SSM, pillar II requirements are material and influence the balance of both requirements. It must be noted that higher pillar II requirements only reinforce our conclusions.

In 2020, the capital conservation buffer will reach its steady state level of 2.5%, hence, total RWR is going to be 8.5% of RWA (6%+2.5%). The maximum O-SII buffer set by the macroprudential authority in 2016 is 1% of risk weighted assets, although it varies across institutions. Therefore, taking this additional 1% O-SII buffer into consideration, the total requirements in 2020, excluding pillar II, are expected to be 9.5% of the risk exposure amount.[19]

Considering a leverage based requirement of 3%, the CARW will be 41% in 2017 and 32% in 2020. Three points should be noted: (i) changes in any one of the requirements alters the CARW and the relative stringency of the

16. It should however be noted that this specification overlooks that the RWR is based on exposure at default values and not total assets and that the LR capital requirement is based on the LR exposure measure and not total assets. Nevertheless, both measures relate to total assets and the additional complexities would not render additional value.

17. G-SIIs implies Globally Systemically Important Institutions and O-SIIs implies Other Systemically Important Institutions. Portugal does not have any banking group categorized as G-SII.

18. For further information, please refer to the Financial Stability Report, Bank of Portugal, November 2016, Box 1.

19. The Countercyclical Capital Buffer (CCB) has been set at zero per cent of the RWA and the Other Systemically Important Institutions buffer (O-SII) will only start to be phased-in in 2018 and, as such, is also zero.

requirements; ii) the relative stringency of the LR will decline with the gradual phasing in of the capital conservation buffer, and iii) for the Portuguese banks, in both of the above situations (2017 and 2020), the average risk weight is above the CARW implied by the given set of regulations.

These broad calculations point to the fact that the Portuguese banks are overall not expected to be constrained by the implementation of the LR requirement. One final point or counterfactual could be taken into consideration. The calculations above consider a LR requirement of 3%, which is indeed the calibration in the latest Basel III guidelines. But, as has been mentioned earlier, in some other jurisdictions like the USA or Canada, the requirement is higher at around 5%. Should the LR requirement be raised in the future, then, considering the pilar I requirement to be 9.5%, the CARW would turn out to be 0.53. With this significantly higher CARW, it is possible that some banks would find themselves constrained. The broad message is that given the current set of regulations, the constraint does not appear to be a binding one in the future but it could be, given alternative calibrations of the key policy parameters.

Institutions' Balance Sheets

It is clear that the specific balance sheet of the institution impacts the average risk weight across portfolios and, as such, if an institution should be above or below the CARW and, consequently if it is constrained by the RWR requirement or by the LR requirement. For instance, if all the assets of a Portuguese bank were constituted by sovereign debt for which a zero risk weight is applicable, then the average risk would be very low and much below the CARW. As such, the LR would be the binding requirement.[20] Therefore the asset composition of banks are crucial in determining which of the regulatory constraints might be the more stringent one.[21]

Cyclicality of the LR and the RWR

One of the main motivations for introducing the LR requirement in addition to the RWR requirement is that the LR is supposed to be more countercyclical than the RWR, thereby, being the binding constraint in booms and the slack constraint in busts. When countercyclical properties of a particular capital ratio is assessed vis-à-vis other capital ratios, the one that demonstrates more countercyclical properties will be the first to signal the need for corrective action from the bank. In this sense, it would be a tighter constraint in booms

20. That is, if it issued by any of EU central governments and also denominated and funded in euros.

21. Indeed that is what happens, inter alia, with Public Development banks in France and Germany, which hold large portfolios of exposures that are guaranteed by the Government.

and a looser constraint in recessions. So, what are the cyclical properties of these ratios in Portugal? In other words, *Is the leverage ratio more countercyclical, than the risk weighted capital ratio, for the Portuguese banking system?*

Building on the methodology implemented by Brei and Gambacorta (2014, 2016), Batista (2015) assesses the cyclical properties of the leverage ratio of the banks in Portugal and compares them with those of other capital ratios (Tier 1 ratio and the accounting leverage ratio). Further, the cyclicality of the various components of the ratios was also assessed. The study was conducted using a sample of the largest banking groups operating in Portugal.[22]

Brei and Gamabacorta (2014, 2016) and EBA (2016)[23] were the first studies to have used the leverage ratio and document its higher countercylicality compared to other risk-based measures. A similar result was expected for Portugal as well. Batista (2015) documents that both Basel III leverage ratio and Tier I ratio are counter-cyclical in Portugal, in line with earlier studies. However, the Tier 1 ratio shows a slightly higher counter-cyclical behavior than the LR. These results tie in with the observations above regarding the average risk weight for Portuguese banks. It has been documented earlier that the average risk weights for Portuguese banks is significantly above the CARW and the empirical analysis simply corroborates the fact these banks are more likely to be constrained by the RWR than the LR.

This difference with other studies could also be attributed to the fact that majority of Portuguese banks use the standardized approach of reporting rather than the internal ratings based methodology, where the risk weights are more sensitive to the business cycle and move countercyclically. The analysis of the data for the major Portuguese banking groups leads to the conclusion that given the relative calibration of risk-based and leverage-based requirements and the high risk weight density of the Portuguese banks, the leverage ratio is not expected to be the constraining capital requirement for these banks. Additionally, the use of the LR as a macroprudential tool does not appear effective at present. Further, any macroprudential add-on to the requirement would have to be calibrated at a very high level in order to contain the buildup of pro-cyclical leverage. Alternatively, if these banking groups increase the holdings of sovereign debt or other low risk weight exposure assets, the existence of the LR requirement will put a limit to the balance sheet size, given a determined risk-weighted capital requirement.

22. Caixa Geral de Depósitos (CGD); Banco BPI (BPI); Banco Comercial Português (BCP); Banco Espírito Santo (ES); Banco Santander Totta (BST), and Caixa Económica Montepio Geral (CEMG).

23. This study adapts Brei and Gambacorta (2014), while focusing on the sample of European banks that have been included in the quantitative impact analysis of Basel III requirements, conducted by the EBA.

Conclusion

In this article we have put forward the rationale for having an additional leverage ratio requirement over and above the risk weighted capital ratio requirement. When risk weights are countercyclical, then in good times, banks can increase the size of their balance sheets while maintaining sound capital ratios. However, as we now know after the financial crisis, sound capital ratios ex ante do not guarantee bank solvency, ex post, in the event of a stress scenario. The LR requirement is aimed at limiting bank leverage and act as a backstop to risk sensitive requirements. In the case of Portugal however this does not seem to be be applicable presently because the average risk weights on the balance sheets of Portuguese banks are significantly higher than their European peers and than the CARW implied by the current set of regulations. Hence the Portuguese banks are more likely to be constrained by the RWR than the LR. Moreover, the LR does not appear to be more countercyclical than the RWR and this could be due to the fact that most Portuguese banks use the standardized method rather than the internal ratings based models, which are far more sensitive to the business cycle.

Even in the near future (in 2020) when the capital conservation buffer comes into full force, the banks in Portugal are unlikely to be constrained by the LR requirement given its current calibration of 3%. It must be noted that if Portuguese banks augment their holdings of sovereign bonds or other assets with low risk weights, that would significantly reduce the average risk weight or the risk weight density on their balance sheets. In that case, the LR could be an effective constraint. The LR could also be binding if the calibration was done at a significantly higher level than what is currently envisaged in Basel III.

References

[1] Acharya, V. and M. Richardson, (2009), "Causes of the financial crisis". Critical Review, Vol. 21, pp. 195-210.

[2] Adrian, T. and H. S. Shin, (2014), "Procyclical leverage and value-at-risk". Review of Financial Studies, vol 27 (2), pp 373-403.

[3] Altunbas, Y., L. Gambacorta, and D. Marques-Ibanez, (2014), "Does monetary policy affect bank risk?". International Journal of Central Banking, vol. 10, no. 1, pp 95-135.

[4] Angelini, P., S. Neri, F. Panetta, (2014), "The interaction between capital requirements and monetary policy". Journal of Money Credit and Banking, 46(6), pp. 1073-1112.

[5] Basel Committee on Banking Supervision (2006), "Studies on credit risk concentration ". BIS Working Paper 15/2006.

[6] Basel Committee on Banking Supervision, (2010), "An assessment of the long-term impact of stronger capital and liquidity requirements", Basel.
[7] Basel Committee on Banking Supervision (2014a), "Basel III leverage ratio framework and disclosure requirements". www.bis.org/publ/bcbs270.pdf.
[8] Basel Committee on Banking Supervision (2014b), "Seventh progress report on adoption of the Basel regulatory framework". www.bis.org/publ/bcbs290.pdf.
[9] Batista, D., (2015), "Is the Basel III leverage ratio countercyclical? A study for Portuguese banks". Work project presented as part of the requirements for the award of a Master's Degree in Finance, NOVA School of Business and Economics.
[10] Borio, C. and H. Zhu, (2014), "Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?". Journal of Financial Stability, vol 8, no 4, pp 236-251.
[11] Brei, M. and L. Gambacorta, (2016), "Are bank capital ratios pro-cyclical? New evidence and perspectives." Economic Policy, 31 (86): 357-403. Previously published as a BIS Working Paper No. 471/2014.
[12] Christiano, L., M. Eichenbaum, and C. Evans (2005), "Nominal rigidities and the dynamic effects of a shock to monetary policy". Journal of Political Economy, 113, 1 - 45.
[13] Fender, I. and U. Lewrick (2015), "Calibrating the leverage ratio". BIS Quarterly Review, December.
[14] FINMA - Swiss Financial Market Supervisory Authority, (2009), "New capital adequacy requirements in Switzerland applicable for large banks: Higher capital ratio targets and leverage ratio".
[15] Gambacorta, L. and S. Karmakar (2017), "Leverage and risk-weighted capital requirements". International Journal of Central Banking, forth-coming.
[16] Gerali, A., S. Neri, L. Sessa, and F.M. Signoretti, (2010). "Credit and banking in a DSGE model of the euro area". Journal of Money Credit and Banking, 42(6), pp. 44-70.
[17] Hellwig, M., (2010), "Capital regulation after the crisis: business as usual?". Working Paper No. 31, Max Planck Institute for Research on Collective Goods.
[18] Iacoviello, M., (2005), "House prices, borrowing constraints, and monetary policy in the business cycle". American Economic Review 95(3), pp. 739-764.
[19] Ingves, S., (2014), "Banking on leverage". Keynote address to the 10th Asia-Pacific High-Level Meeting on Banking Supervision, Auckland, New Zealand, 25-27 February.
[20] Smets, F., and R. Wouters, (2003), "An estimated dynamic stochastic general equilibrium model of the euro area". Journal of the European Economic Association, vol. 1, Issue 5, pp. 1123 - 1175.

[21] Vallascas, F. and J. Hagendorff, (2013), "The risk sensitivity of capital requirements: Evidence from an international sample of large banks". Review of Finance, vol. 17, pp. 1947-988.

House prices in Portugal - what happened since the crisis?

Rita Fradique Lourenço
Banco de Portugal

Paulo M. M. Rodrigues
Banco de Portugal and NOVA SBE

October 2017

Abstract
House prices in Portugal have been increasing in the recent past, following a relatively inexpressive evolution during the 1990s and early 2000s. Prior to the crisis and despite the cyclical nature of residential real estate markets most models did not consider the need for breaks. This article analyses the factors driving house price movements in Portugal, with main emphasis on the crisis and post-crisis periods. First we analyze the relationship between a set of important fundamental variables and house price growth and second, we investigate if there have been any changes in the relevance of the fundamental variables. Finally, we determine whether house prices are likely to increase in the near future and we observe that the estimated probability is high. (JEL: C12, C22)

Introduction

Economic theory states that households' wealth is a key driver of aggregate consumption (Friedman (1957) and Modigliani and Brumberg (1954)). A house is the largest asset of most households and so changes in housing wealth may affect homeowners' consumption (Englund *et al.* (2002) and Case *et al.* (2005)). Moreover, changes in housing wealth are likely to impact more on the economy than changes in wealth caused by stock price movements. Helbling and Terrones (2003) analyze the real term effects of booms and busts on asset prices in industrialized countries and conclude that between 1960 and 2002 every 13 years stock indexes collapsed by 45% from peak to trough. The fall lasted for around 2.5 years and is associated to a contraction of 4% in GDP. In contrast, house price drops were smaller (around 30% and less frequent), but lasted longer, around 4 years, and had a greater negative impact on GDP (over 8%).

Acknowledgements: We thank participants of the Exchange seminar at Banco de Portugal, as well as Ana Filipa Correia, António A. Antunes, Gabriela Castro, Isabel Horta Correia, Miguel Gouveia, Nuno Alves and Vanda Cunha for useful comments and suggestions. The opinions expressed in the article are those of the author(s) and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the author(s).

E-mail: rmlourenco@bportugal.pt; pmrodrigues@bportugal.pt

In recent years, a vast number of studies analyzed the dynamics of real estate markets. Although some relevant fundamental factors driving house prices have been identified over the past decades, the recent worldwide financial crisis, triggered by the collapse of the US house price bubble in 2007, showed that understanding of price determination process in real estate markets still requires further research. The financial crisis also highlighted the importance of housing for macroprudential policy (see e.g. Hartman (2015)).

Long-term determinants of housing demand include growth in household disposable income, shifts in demographics (e.g. the relative size of older and younger generations), features of the tax system which may encourage home ownership, and the average level of interest rates. As to long-term determinants of housing supply the availability and cost of land, as well as the cost of construction and investments in the improvement of the quality of existing housing stock can be considered (Poterba (1991) and Tsatsaronis and Zhu (2004)). Higher GDP and disposable income, or less unemployment are expected to have a positive impact on the housing market. In contrast, higher interest rates are expected to drive borrowing costs up and demand down leading to a subsequent fall in house prices and make alternative applications of wealth more interesting.

The recent financial crisis has caused an unprecedented decline in house prices across the globe and it was particularly severe in countries with a real estate bubble before the crisis. Most economic fundamentals have been affected by credit shortage and failure of many mortgage holders to meet their payments. This study aims to examine the relationship between major economic fundamentals and house price changes in Portugal both during and after the financial crisis. We begin with an analysis of the complete sample considered (1996Q1 to 2017Q2) to test the relationship between a set of selected independent variables and real house price growth, enabling us to identify the directions and extent of the relationship. The results show that most indicators, including interest rates and GDP growth, behaved analogously during and after the financial crisis. However, since the significance and magnitude of parameter estimates may change when the market is in crisis, we also consider a regression framework which allows for breaks.

The sudden downturn in financial markets has attracted a lot of research which has focused on issues such as the causes of the crisis, the factors behind the spread of the crisis, and the impact of the crisis. Some studies investigated the impact of the financial crisis on the housing market (e.g. Dodd and Mills (2008); Qi and Yang (2008); Yener (2009); Bagliano and Morana (2010)). However, studies addressing the economic drivers of the housing market tend not to be looking at the behaviour of these drivers during economic prosperity and crisis periods. This article aims therefore to fill this gap by looking specifically at the determinants of house price growth in Portugal both during and after the financial crisis.

Although the real estate market is considered as one of the causes of the financial crisis, the transmission of financial shocks through banks and different markets does suggest that the real estate market is also a channel of shock transmission. Hence, the conjecture that this market is among the causes and channels of transmission of shocks raises the question of whether the relationship between the previously indicated aggregated variables and house prices is indeed stable.

Different approaches have been used to investigate the factors driving house price movements. For example, Himmelberg and Sinnai (2005) construct an index by comparing imputed rents with actual rents, which is then used to analyse if houses are highly priced. McCarthy and Peach (2004) apply an asset pricing model in order to capture the effect of interest rates on house price movements. Researchers have also used financial ratios, such as house price to annual income (Case and Shiller (2003)), rent to price (McCarthy and Peach (2004)) and rent to income ratios (Himmelberg and Sinnai (2005)) to measure the housing market activity. Each ratio is aimed at capturing the relationship between specific housing market drivers, however, these ratios fail to take into account continuous changes in some of the key variables affecting house prices.

In this paper we start by analyzing which factors drive house price movements in Portugal. As a first approach we consider a regression framework which enables us to evaluate the impact of each factor on house price growth over a period of time and to assess the direction of the relationship between the dependent and independent variables, which are considered in the model. The analysis is then complemented by the application of an approach which allows for parameter estimates to differ within different sub-periods of the sample.

The remainder of the article is organized as follows. Section 2 discusses the evolution of some important covariates following the financial crisis; Section 3 presents the empirical analysis of house price growth determinants; Section 4 analyses the probability of positive house price growth; and Section 5 concludes.

Analysis of house price drivers in Portugal since the beginning of the crisis

Before discussing the results of the empirical analysis of this article it is useful to describe briefly the evolution of some important covariates following the financial crisis, to better understand the dynamics of the real estate market.

House prices in Portugal declined 4% on average per year between 2007 and 2013 and have since been increasing by 4% on average per year. However, house prices are still below their long-term average. If we look at house prices measured in terms of bank appraisals rather than transactions, despite

of banks' cautiousness following the crisis which probably moderated the upward price trend in recent years, the conclusions are similar (Figure 1) [1].

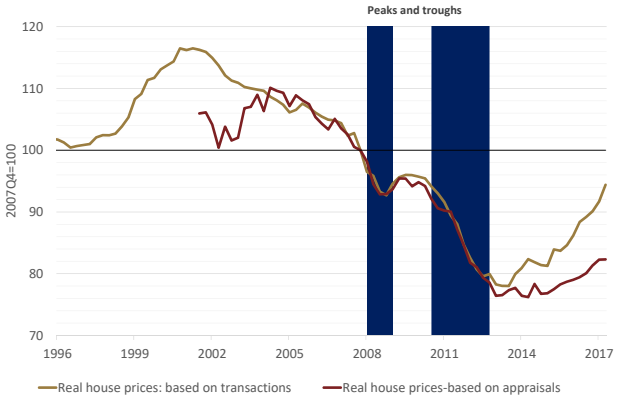


FIGURE 1: Real house prices and house price-appraisals

Sources: Banco de Portugal, INE, Confidencial Imobiliário and OECD.

In terms of residential investment (gross fixed capital formation - GFCF) we see that the downward evolution initiated in the late 1990s proceeded between 2007 and 2013. This class of investment contracted on average 12% per year compared to the 1% average per year fall in GDP. Since 2014 there has been an improvement in residential GFCF and in GDP, both increasing by 2% on average per year (Figure 2).

As to the conditions of the labour market, we observe that after the crisis the unemployment rate rose, reaching a peak in 2013, and that there was a significant decline in the labour force, as a consequence of increased emigration flows and aging of the population (Figure 3).

1. The peaks and troughs presented in Figures 1 - 6 are taken from the business cycle chronology of Rua (2017).

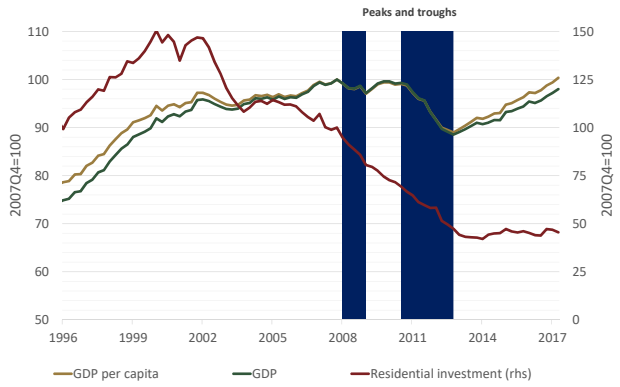


FIGURE 2: Residential GFCF and GDP

Sources: Banco de Portugal and OECD.

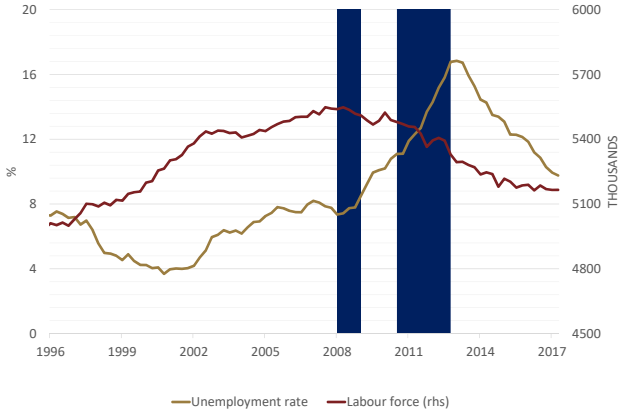


FIGURE 3: Labour market

Sources: Banco de Portugal and OECD.

Households' indebtedness, measured as housing loans in terms of disposable income, picked up from 25% in the mid 1990s to almost 90% by the end of 2007, in a context of rising disposable income and low interest rates (Figures 4 and 5). However, over this period house prices barely changed. Following the sub-prime crisis housing loans have been contracting since 2011 reflecting banks' deleveraging. Interest rates exhibited a lot of volatility in the first two years of the financial crisis (spiking in 2008 and bottoming in 2009 amidst highly expansionary monetary conditions) and again in 2011 reflecting the sovereign debt crisis. Finally, we may also look at what happened to foreign direct investment in housing to have an idea of the external conditions (Figure 6). Housing investment by non-residents has been increasing since the 1990s. Following the 2011 sovereign debt crisis it decelerated but since 2014 it began to accelerate again, growing 9% on average per year.

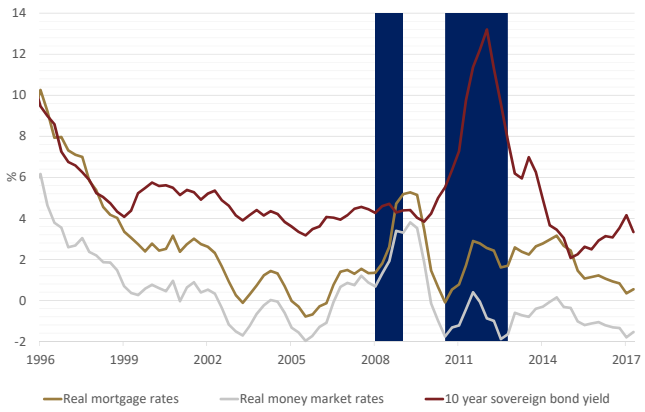


FIGURE 4: Interest rates

Sources: Banco de Portugal and ECB.

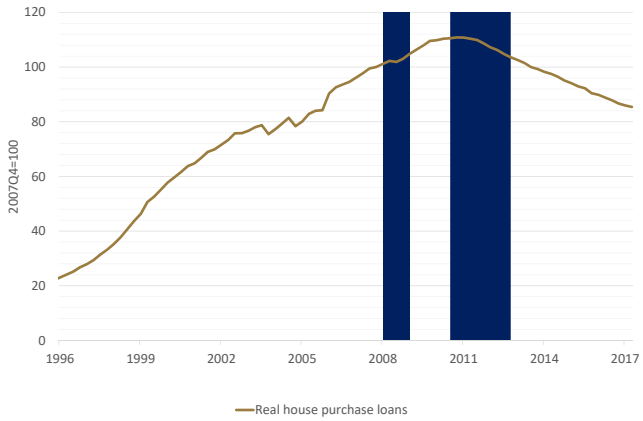


FIGURE 5: Housing loans

Sources: Banco de Portugal and ECB.

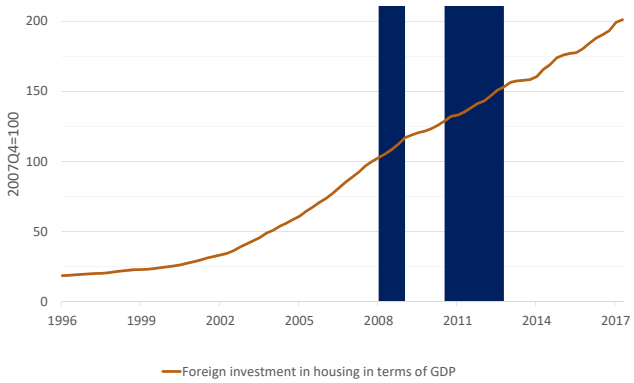


FIGURE 6: Foreign direct investment in housing

Source: Banco de Portugal.

Empirical analysis

Our data set comprises quarterly time series from 1996:Q1 to 2017:Q2 for Portugal. Data on real house prices, disposable income, GDP, private consumption deflator, population, real loan for house purchases, unemployment rate, real money market rate, real mortgage rate, real GFCF housing, foreign investment in housing, and interest rates were collected from the OECD, Banco de Portugal and the European Central Bank.

The house price series considered as from 2009 onwards is the one published by Statistics Portugal. The compilation of this transactions-based house price index is derived from the combination of two different fiscal administrative data sources. Before 2009 the house price index relied on data provided by a private producer using asking prices collected from a real estate portal. However, in both cases (before and after 2009), the calculation of the house price index is based on hedonic approaches to price measurement, characterized by valuing the houses in terms of their attributes (average square meter price, size of the dwellings involved in transactions and their location). All series are in real terms and are computed using the private consumption deflator.

The years of 2007 and 2008 signaled the start of a decrease in real estate prices (a general trend observed in the large majority of countries independently of whether they had gone up or down in previous decades). This reflects how the US sub-prime collapse in 2007 quickly spread worldwide and how housing market developments impact on the economy. However, judging by the recent evolution of house prices it appears that housing markets worldwide have been recovering.

Regression Results

As a first approach of our analysis we consider a standard multiple linear regression framework to examine the relationship between house price growth and a set of covariates. The period covered in this analysis is from 1996Q1 to 2017Q2, which enables us to evaluate the housing market determinants before, during and after the financial crisis.

The final specification of our fixed parameter regression model is,

$$\begin{aligned}\Delta rhp_t &= \alpha_0 + \alpha_1 \Delta GDPpc_{t-1} + \alpha_2 \Delta gfcf_{t-1} + \alpha_3 \Delta unemp_{t-1} \\ &+ \alpha_4 \Delta mtgr_{t-1} + \alpha_5 \Delta invest_{t-1} + e_t \end{aligned} \quad (1)$$

where rhp_t corresponds to the natural logarithm of the real house price index, $GDPpc_t$ is the natural logarithm of real per capita GDP, $unemp_t$ the unemployment rate, $mtgr_t$ is a real mortgage rate, $invest_t$ is foreign direct investment in real estate and Δ is the usual first difference operator.

Table 1 reports the ordinary least squares (OLS) estimates of (1) and robust standard errors based on the approach proposed by Newey and West (1987), which provides consistent estimates of the covariance matrix in the presence of heteroscedasticity and autocorrelation in the residuals of the estimated model.

Var	Coeff	Std.Error	t-stat	Prob
const	-0.0007	0.0032	-0.2230	0.8241
$\Delta GDPpc_{t-1}$	5.1773	1.3625	3.7999	0.0003
$\Delta gfcf_{t-1}$	-0.0241	0.0413	-0.5827	0.5618
$\Delta unemp_{t-1}$	-0.0092	0.0035	-2.6093	0.0109
$\Delta mtgr_{t-1}$	-0.0016	0.0028	-0.5930	0.5549
$\Delta invest_{t-1}$	-0.0565	0.0704	-0.8026	0.4247

R-squared	0.2907	Mean dependent var	-0.0008
Adjusted R-squared	0.2453	S.D. dependent var	0.0141
S.E. of regression	0.0122	Akaike info criterion	-5.9039
Sum squared resid	0.0116	Schwarz criterion	-5.7303
Log likelihood	253.9647	Hannan-Quinn criter.	-5.8341
F-statistic	6.3943	Durbin-Watson stat	1.4022
Prob(F-statistic)	0.0001	Wald F-statistic	8.332
Prob(Wald F-statistic)	0		

TABLE 1. Regression output - determinants of real house price growth

Source: Authors' calculations.

From the estimation results for the whole period under analysis (Table 1) we observe that the main drivers of real house price growth are real per capita GDP and the unemployment rate. The signs are the expected ones, that is, an increase in real per capita GDP has a positive impact on real house prices, while an increase of the unemployment rate leads to a decrease of real house prices. Mortgage rates and residential investment are negatively correlated with house prices but are not statistically significant. The last explanatory variable is housing investment by non-residents. The negative sign of the parameter estimate of this variable is difficult to explain but it is not statistically significant.

Regression results allowing for breaks

To allow for the possibility of regression models with breaks we consider the approach of Bai and Perron (1998) and Bai and Perron (2003a). This approach is particularly suited to test the conjecture that the importance and impact of

fundamentals on house price growth in Portugal may have changed over this period. The Bai and Perron tests are based upon an information criterion in the context of a sequential procedure, and allow one to find the number of breaks implied by the data, as well as the estimation of the timing and confidence intervals of the breaks, and the parameters of the models between breaks (see Appendix for details).

An interesting feature of the Bai and Perron procedure is that it allows testing for multiple breaks at unknown dates, so that each break point is successively estimated based on a specific-to-general strategy in order to determine consistently the number of breaks. An additional advantage of the approach is that it allows us to investigate whether some or all of the parameters of the estimated relationship have changed. Table 2 presents the estimation results using the Bai and Perron approach.

Var	Coeff	Std.Error	t-stat	Prob
		2007Q2 - 2011Q3		
$const$	-0.0385	0.0045	-8.5673	0.0000
$\Delta GDPpc_{t-1}$	12.0742	3.3431	3.6117	0.0006
$\Delta gfcf_{t-1}$	-0.6032	0.1242	-4.8578	0.0000
$\Delta unemp_{t-1}$	0.0204	0.0046	4.4319	0.0000
$\Delta mtgr_{t-1}$	0.0012	0.0038	0.3196	0.7503
$\Delta invest_{t-1}$	0.3338	0.1247	2.6765	0.0094
		2011Q4 - 2017Q2		
$const$	-0.0042	0.0039	-1.0904	0.2795
$\Delta GDPpc_{t-1}$	9.8791	3.0070	3.2853	0.0016
$\Delta gfcf_{t-1}$	-0.0457	0.0594	-0.7701	0.4440
$\Delta unemp_{t-1}$	-0.0065	0.0090	-0.7176	0.4755
$\Delta mtgr_{t-1}$	-0.0135	0.0070	-1.9303	0.0579
$\Delta invest_{t-1}$	0.2164	0.2998	0.7218	0.4729
R-squared	0.6178	Mean dependent var		-0.0008
Adjusted R-squared	0.5193	S.D. dependent var		0.0141
S.E. of regression	0.0097	Akaike info criterion		-6.2364
Sum squared resid	0.0063	Schwarz criterion		-5.7155
Log likelihood	279.9281	Hannan-Quinn criter.		-6.0270
F-statistic	6.2743	Durbin-Watson stat		1.6498
Prob(F-statistic)	0.0000			

TABLE 2. Bai and Perron's regression results

Source: Authors' calculations.

When allowing for breaks, three periods emerge (1996Q1-2007Q1, 2007Q2-2011Q3 and 2011Q4-2017Q2), but we will only focus on the crisis and post-crisis period, i.e., 2007Q2-2011Q3 and 2011Q4-2017Q2 (Table 2), since the period before the crisis has been widely analyzed in the literature (see e.g. Lourenço and Rodrigues (2014)). The results show that the fundamentals and their importance are not the same in the periods during and after the crisis. In the first period, all variables except mortgage rates play a role in explaining house price growth, while in the latter period only per capita GDP and mortgage rates are relevant.

From the beginning of the financial crisis until the end of 2011, house prices fell around 3% on average per year. The sign of per capita GDP is positive and significant as expected. The negative sign in residential GFCF suggests rising house prices as a consequence of a reduction in housing supply. However, it may also reflect that housing demand is lower and so given the existing housing supply, a lower demand would suggest that house prices would decrease. In this case to prevent prices from falling further an adjustment in supply may have occurred. Since house prices did not decline as much as they would if investment had not declined, this seems to be a plausible explanation. Moreover, if there was a housing overhang we would expect house prices to keep adjusting downwards along with declining residential investment. However, in Portugal it seems, that when the crisis began that there was no evidence of excess supply of new houses (see Lourenço and Rodrigues (2014)). The coefficient of housing investment by non-residents ($\Delta invest_{t-1}$) is large and affects positively and significantly house price growth, which is in line with the strong growth observed until 2011. In this case, the upward pressure on house prices given foreign investment may have contributed to contain the decline in house prices. Lastly, unemployment rate is significant but has not the expected sign.[2]

In the second period (2011Q4 - 2017Q2), per capita GDP was significant and positively correlated with house prices as expected. Interest rates were declining resulting in an upward pressure on house prices, possibly because low (or even negative) rates make housing more attractive than deposits as a saving strategy.

Probit Estimation

In this section we redefine the dependent variable as a binary variable, y_t, such that it takes the value of 1 if the quarterly house price growth rate is positive and zero otherwise, i.e., $y_t = 1$ if $\Delta rhp_t > 0$ and $y_t = 0$ otherwise. The latent variable representation for the purpose of Probit estimation is,

$$y_t^* = \gamma_0 + \gamma_1 \Delta GDPpc_{t-1} + \gamma_2 \Delta unemp_{t-2} + \gamma_3 \Delta mtgr_{t-1} + v_t. \qquad (2)$$

where the covariates considered are as defined in the previous section. The model is estimated by maximum likelihood. Hence, equation (2) relates the probability of a positive real house price growth to determinants previously considered, i.e., $P[y_t = 1] = F(y_t^*)$ where F is the normal cumulative distribution.

2. This is an issue that requires further analysis.

Figure 6 presents the evolution of the probability computed from (2) over the sample considered and Figure 7 presents the evolution of the probability computed from a dynamic version of (2), i.e.,

$$y_t^* = \theta_0 + \theta_1 \Delta GDPpc_{t-1} + \theta_2 \Delta unemp_{t-2} + \theta_3 \Delta mtgr_{t-1} + \theta_4 y_{t-1} + a_t. \quad (3)$$

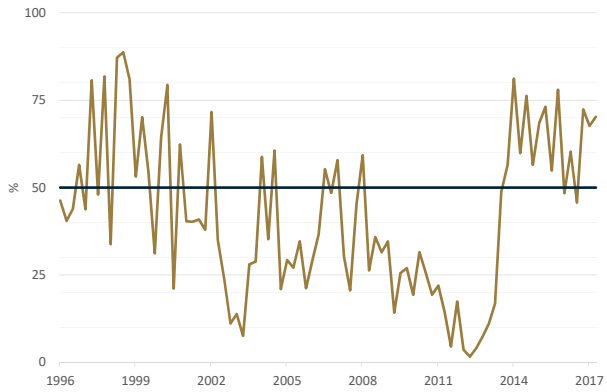


FIGURE 7: Probability of positive growth - Non-dynamic Probit

Source: Authors' calculations.

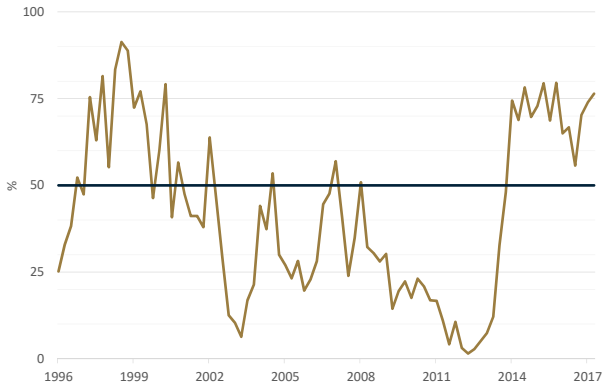


FIGURE 8: Probability of positive growth - Dynamic Probit

Source: Authors' calculations.

From the results of this analysis we observe that the probability of positive house price growth is quite high given the current projections of the Portuguese economy.

Conclusion

This paper presents a first analysis of the factors driving house price movements in Portugal, with main emphasis on the crisis and post-crisis periods. Multiple regression analysis was used to measure the relationship between house price growth and a set of independent variables, which were selected based on the existing housing market literature. The results reveal that interest rates and economic growth have the highest impact on house price growth.

House prices in Portugal have increased lately but are still below pre-crisis levels in real terms. Allowing for breaks (i.e. different regimes) makes it possible to have a fresher look at fundamentals. During the first period, 2007-2011, the fact that residential GFCF fell may have prevented house prices from declining even more during that period attenuating the contraction of housing demand. Also the growth in housing investment by foreigners may have prevented house prices from falling further. In the more recent period, 2011-2017, low (or even negative) interest rates may be affecting house prices

through alternative saving options. Housing investment by non-residents decelerated following the years of the sovereign debt crisis. Finally, the Probit model results indicate that the probability of future positive house price growth is still high in Portugal.

Appendix: The Bai and Perron approach

To briefly illustrate the Bai and Perron approach (see Bai and Perron (1998) and Bai and Perron (2003a)) we consider a linear model with m multiple structural changes (i.e., $m+1$ regimes) as,

$$\begin{aligned} y_t &= x_t'\beta + z_t'\delta_1 + u_t, \qquad t = 1, 2, ..., T_1 \\ y_t &= x_t'\beta + z_t'\delta_2 + u_t, \qquad t = T_1 + 1, ..., T_2 \\ &\vdots \\ y_t &= x_t'\beta + z_t'\delta_{m+1} + u_t, \qquad t = T_m + 1, 2, ..., T \end{aligned}$$

where y_t is the observed dependent variable, $x_t \in \Re^p$ and $z_t \in \Re^q$ are vectors of regressors, β and δ_j $(1 \leq j \leq m+1)$ are the corresponding vectors of coefficients with $\delta_i \neq \delta_{i+1}$ $(1 \leq i \leq m)$, u_t is the error term and m is the number of structural breaks. The break dates $(T_1, ..., T_m)$ are explicitly treated as unknown and $\lambda_i = T_i/T$, $i = 1, ..., m$, with $0 < \lambda_1 < ... < \lambda_m < 1$. Hence, the objective is to estimate the unknown regression coefficients and the break dates (β, δ_1,...,δ_{m+1}, $T_1, ..., T_m$) when T observations are available.

The estimation method considered is based on least-squares; see Bai and Perron (1998). Consider that for each m-partition of $(T_1, ..., T_m)$, denoted T_j, the associated least-squares estimates of β and δ_j are obtained by minimizing the sum of squared residuals

$$\sum_{i=1}^{m+1} \sum_{t=T_{i-1}+1}^{T_i} \left(y_t - x_t'\beta - z_t'\delta_i\right)^2$$

where $T_0 = 0$ and $T_{m+1} = T$, and let $\widehat{\beta}(T_j)$ and $\widehat{\delta}(T_j)$ denote the resulting least-squares estimates. Substituting the latter into the objective function and denoting the resulting sum of squared residuals as $S_T(T_1, ..., T_m)$, the estimated break points $(\widehat{T}_1, ..., \widehat{T}_m)$ are computed as,

$$(\widehat{T}_1, ..., \widehat{T}_m) = \underset{(T_1, ..., T_m)}{\arg\min}\ S_T(T_1, ..., T_m),$$

where the minimization is taken over all partitions $(T_1, ..., T_m)$ such that $T_i - T_{i-1} \geq h$. Note that h is the minimal number of observations in each segment ($h \geq q$, not depending on T). Thus, the break-point estimators are global minimizers of the objective function. Finally, the estimated regression

parameters are the associated least-squares estimates at the estimated m-partition $\widehat{T}_j$, i.e. $\widehat{\beta} = \widehat{\beta}(\widehat{T}_j)$ and $\widehat{\delta} = \widehat{\delta}(\widehat{T}_j)$. For our empirical application, we use the efficient algorithm of Bai and Perron (2003a) based on the principle of dynamic programming which allows global minimizers to be obtained using a number of sums of squared residuals that is of order $O(T^2)$ for any $m \geq 2$.

Bai and Perron (1998) and Bai and Perron (2003a) propose three methods to determine the number of breaks: a sequential procedure (Bai and Perron (1998); the Schwarz modified criterion (Liu *et al.* (1997)) and the Bayesian information criterion (Yao (1988), and suggest several statistics to identify the break points:

- The $supF_T(k)$ test, i.e., a sup F-type test of the null hypothesis of no structural break (m=0) versus the alternative of a fixed (arbitrary) number of breaks (m= k).
- Two maximum tests of the null hypothesis of no structural break (m=0) versus the alternative of an unknown number of breaks given some upper bound M ($1 \leq m \leq M$), i.e., $UDmax$ test, an equal weighted version, and $WDmax$ test, with weights that depend on the number of regressors and the significance level of the test.
- The $supF_T(l+1|l)$ test, i.e., a sequential test of the null hypothesis of l breaks versus the alternative of l + 1 breaks.

The asymptotic distributions of all these tests are derived in Bai and Perron (1998) and the necessary asymptotic critical values are provided in Bai and Perron (1998) and Bai and Perron (2003).

References

Bagliano, F. C. and C. Morana (2010). "Permanent and transitory dynamics in house prices and consumption: some implications for the real effects of the financial crisis." *Applied Financial Economics*, 20, 151–170.

Bai, J. and P. Perron (1998). "Estimating and testing linear models with multiple structural changes." *Econometrica*, 66, 47–78.

Bai, J. and P. Perron (2003). "Critical values for multiple structural change tests." *Econometrics Journal*, 6, 72–78.

Bai, J. and P. Perron (2003a). "Computation and analysis of multiple structural change models." *Journal of Applied Econometrics*, 18, 1–22.

Case, K. E., J. M. Quigley, and R. J. Shiller (2005). "Comparing Wealth Effects: the Stock Market versus the Housing Market." *Advances in Macroeconomics*, 5(Article 1).

Case, K. E. and R. J. Shiller (2003). "Is there a bubble in the housing market?" *Brookings Papers on Economic Activity*, (2).

Dodd, R. and P. Mills (2008). "Outbreak: U.S. subprime contagion." *IMF*, 45.

Englund, P., M. Hwang, and J. M. Quigley (2002). "Hedging Housing Risk." *Journal of Real Estate Finance and Economics*, 24, 167–200.

Friedman, M. (1957). *A theory of the consumption function*. Milton General Series 63, Princeton University Press.

Hartman, P. (2015). "Real estate markets and macroprudential policy in Europe." Working paper, ECB, Series, No 1796, May.

Helbling, T. and M. Terrones (2003). "Real and Financial Effects of Bursting Asset Price Bubbles." *IMF World Economic Outlook, Chapter*, 2, 67–92.

Himmelberg, C. Mayer, C. and T. Sinnai (2005). "Assessing High House Prices: Bubbles, Fundamentals and Misperceptions." *Journal of Economic Perspectives*, 19, 67–92.

Liu, J., S. Wu, and J.V. Zidek (1997). "On segmented multivariate regressions." *Statistica Sinica*, 7, 497–525.

Lourenço, R. and P. M. M. Rodrigues (2014). *The Dynamics and contrast of house prices in Portugal and Spain*. Economic Bulletin December, Banco de Portugal.

McCarthy, J. and R. W. Peach (2004). "Are home prices the next bubble?" *FRBNY Economic Policy Review*, 10, 278–306.

Modigliani, F. and R. Brumberg (1954). *Utility analysis and the consumption function: An interpretation of cross-section data*. In: Post Keynesian Economics, ed. by K.K.Kurihara, Ruthers University Press, New Brunswick New Jersey.

Newey, W.K. and K.D. West (1987). "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica*, 55, 703–708.

Poterba, J. (1991). "House Price Dynamics: The Role of Tax Policy and Demography." *Brookings Papers on Economic Activity*, 2(143).

Qi, M. and X. Yang (2008). "Loss given default of high loan-to-value residential mortgages." *Journal of Banking and Finance*. In press.

Rua, A. (2017). "Dating the Portuguese business cycle." *Revista de Estudos Económicos do Banco de Portugal*.

Tsatsaronis, K. and H. Zhu (2004). *What drives Housing Price Dynamics: Cross Country Evidence*. BIS Quarterly Review, BIS. March.

Yao, Y.-c. (1988). "Estimating the number of change points via Schwarz's criterion." *Statistics and Probability Letters*, 6, 181–189.

Yener, A. (2009). "Securitisation and the bank lending channel." *European Economic Review*, 58(8), 996–1009.