UNIVERSITA' DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "M.FANNO"

CORSO DI LAUREA MAGISTRALE / SPECIALISTICA IN ECONOMIA E FINANZA

TESI DI LAUREA

"Did European Austerity Determine Hysteresis Effects?"

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MATRICOLA N. 1081422

ANNO ACCADEMICO 2016 – 2017

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1. Introduction

Many advanced economies have been hit in a particularly harsh way by various crises in the past decade. Some of them reacted quite quickly, recuperating their losses in GDP in a short time, while some others took longer to exit from recession and stagnation. There is absolutely no possible doubt over such statements. Whether such output loss also affected potential output growth, instead, is far less clear.

Therefore, this paper focuses on the hypothesis that severe crises can affect not only output, but also potential output of an economy. Trying to answer to this, is a crucial point in modern economics, because of its enormous normative implications.

Eurozone countries are mutually bound by monetary and fiscal policy rules, mainly constructed to provide a solid and certain framework for their individual national balance. In such a framework, monetary policy is completely supranational. The European Central Bank does not depend on single Member State's positions, but rather of a complex, coordinated system for decision making.[1] The "tool" with which Member States can steer the economy is thus fiscal policy. However, national governments and parliaments have agreed upon a system of harmonious rules that limit their own actions, for instance limiting debt stocks and deficit financing[2]. Limitations that can be very strong for Member States in a situation of debt overhang or with a high structural deficit.

It appears quite obvious that, in such a setting of limited sovereignty, the reaction of Euro Area Member States to crises is not the same as other countries', which had the possibility to adjust exchange rates and interest rates, as well as their levels of public expenditure and taxation. Even more, the ECB itself has no clear mandate for supporting economic growth, but its sole objective must be to "maintain price stability" (Art. 127 (1) of the Treaty on the Functioning of the European Union). This is a major difference with other Central Banks all over the world, as the Federal Reserve in the United States, thought to ensure the highest possible independence from governments and political forces.[3]

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[1] For the ECB's complete formal organizational structure and decision making bodies: https://www.ecb.europa.eu/ecb/orga/decisions/govc/html/index.en.html

[2] For rules, procedures, programmes and history of the Stability and Growth Pact: https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/stability-and-growth-pact_en

[3] The Fed's statutory objectives for monetary policy are maximum employment, stable prices, and moderate long-term interest rate:s https://www.federalreserve.gov/faqs/money_12848.htm

This means that Eurozone's Member States have, in fighting economic downturns, no possibility to affect monetary policy nor their currency, which is common to other Member States, and a set of relevant limitation on their own fiscal policy. In such a setting, the principal controversy among economists has long been whether to grant Member States some flexibility in the application of the fiscal policy limitations or to apply a strict constancy to them. This dispute has been at the heart of European and national political debate for some years, with a confrontation between the so-called "austerity" and "stimulus" defendants.

The economic literature has been permeated by strongly differing points of view on this issue. One of the fundamental aspects of economics affected by these different ways of thinking about fiscal policy is the analysis of the crisis' impact on growth and on potential growth. While the first has abundantly been conducted, what is missing from the picture is the second. The literature has not sufficiently investigated the effects of crises on potential output levels and their growth over time. In other words, not enough attention has been focused on hysteresis. Hysteresis is a theoretically well-known concept in economics, a concept borrowed from physics and relating to the persistency of an effect on the output at various lags in time.

Shedding light on hysteresis would greatly improve the above-mentioned dispute, providing a more long-term vision when dealing with public finances and the impact of fiscal policy especially in times of crisis. This is the declared intent of the paper, which will yield some hopefully interesting results with a model on hysteresis, crisis, fiscal restrictions and potential output growth.

The economic environment in the years of interested of this paper is introduced in chapter 2, in which there is one paragraph framing the argument on debt and deficit, especially focusing on the Euro area; one paragraph on the Italian specific situation; and one paragraph introducing the concept of output gap. Chapter 3 goes more in depth on hysteresis, providing more elements on potential GDP and its relationship with economic cycles. In chapter 4, the complexity of framing a model on hysteresis and its effects on output is explained, together with a presentation of the model by Mourougane (2017), which will be the baseline for the model proposed by this paper. Chapter 5 will document the results of the proposed model.

In the end, some important conclusions about data production, availability and timing will also be mentioned. They represent the author's view and should be considered as a central part of the paper itself.

2. Fifteen years of global turbulence

The years taken into consideration in this paper are those comprised in the period 2002-2016, which has been chosen for several reasons. First of all, it allows to verify the variations which have occurred not too far in the past, but still considering a sizeable time framework. Secondly, it coincides with the years after the adoption of the Euro as currency by many of the countries central to this paper's focus.[4]

Such period covers very different states of the economy, from the post-"Dot-com bubble" growth to the worldwide spread of the US subprime mortgage crisis in 2008, from the recovery started in 2009 to the Eurozone sovereign bond crisis started in 2011. The analysis is particularly focused on Italy and the Eurozone, with a subset of other significant countries chosen as benchmarks (Spain, France, Germany, Greece, Ireland, US and the aggregate of the Euro Area itself).[5]

Figure 1: Gross Domestic Product as % change
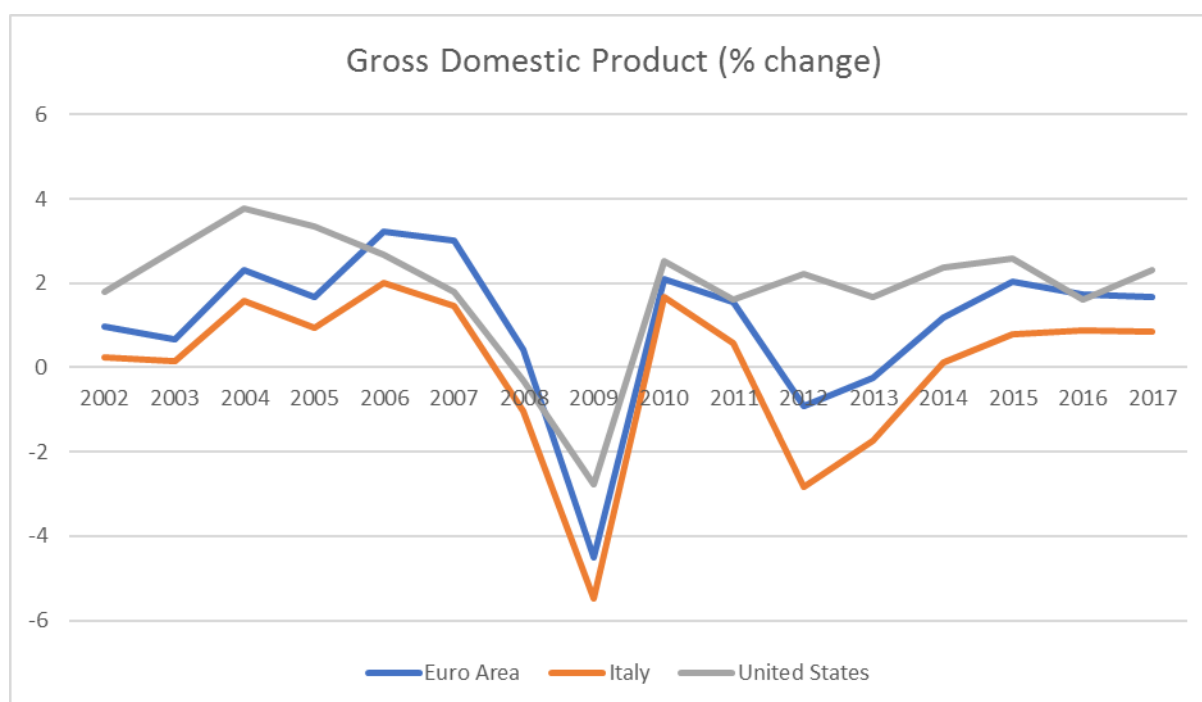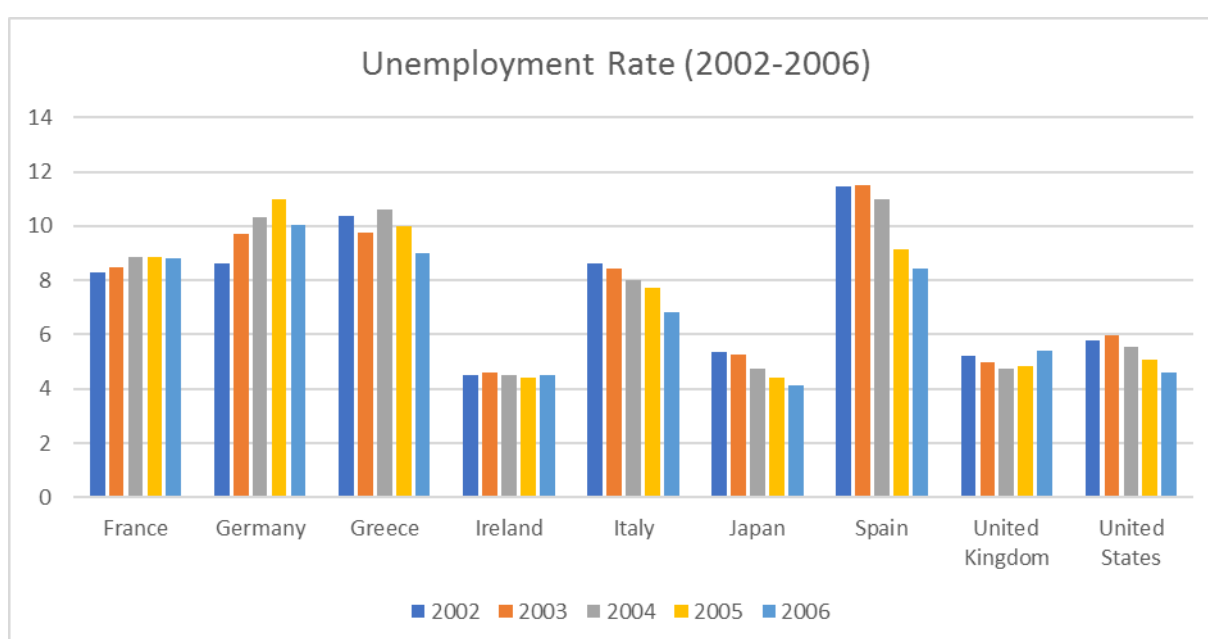

Source: Author's elaboration of IMF's WEO Database (July 2017)

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[4] For more information on the history of the adoption of the Euro as currency: https://ec.europa.eu/info/about-european-union/euro/history-euro/history-euro_en

[5] Data are elaborated from the IMF's World Economic Outlook Database (July 2017) https://www.imf.org/external/pubs/ft/weo/2017/01/weodata/index.aspx).

As Figure 1 shows, the above-mentioned cyclical episodes developed at different paces at the Italian, Eurozone, US and worldwide level. From 2002 to 2016 the United States confirmed itself as the main economy in the world. In the same period, the Euro Area enjoyed increases but also suffered from losses in its gross domestic product, revealing an economy much more sensitive to the shocks that occurred. Comparing the rates of growth in 2017 with those prior to the Great Recession, we see at once that neither the US nor the Euro area (not to speak of Italy) reached the pre-crisis peak.

Figure 2: Unemployment Rate as % of total labor force (2002-2006)

Source: Author's elaboration of IMF's WEO Database (July 2017)

In Figure 2, the unemployment rate in 2002-2006, 2007-2011 and 2012-2016 is graphed. At a first look, it clearly appears that in the first of the three periods, the seven countries grouped all exhibited a rather stable labor market, with dis-homogeneous trends. While Italy, Japan, the US and especially Spain's unemployment rate steadily decreased, France and Germany's performance was the opposite.

In 2007-2011, the years in which the economic crisis exploded in the US subprime mortgages market and quickly expanded into Europe, it can be seen that unemployment grew in all these countries, apart from Germany, which extensively reformed the labor market in the previous period. The downturn was particularly harsh in Spain, Greece and Ireland.

Figure 3: Unemployment Rate as % of total labor force (2007-2011)
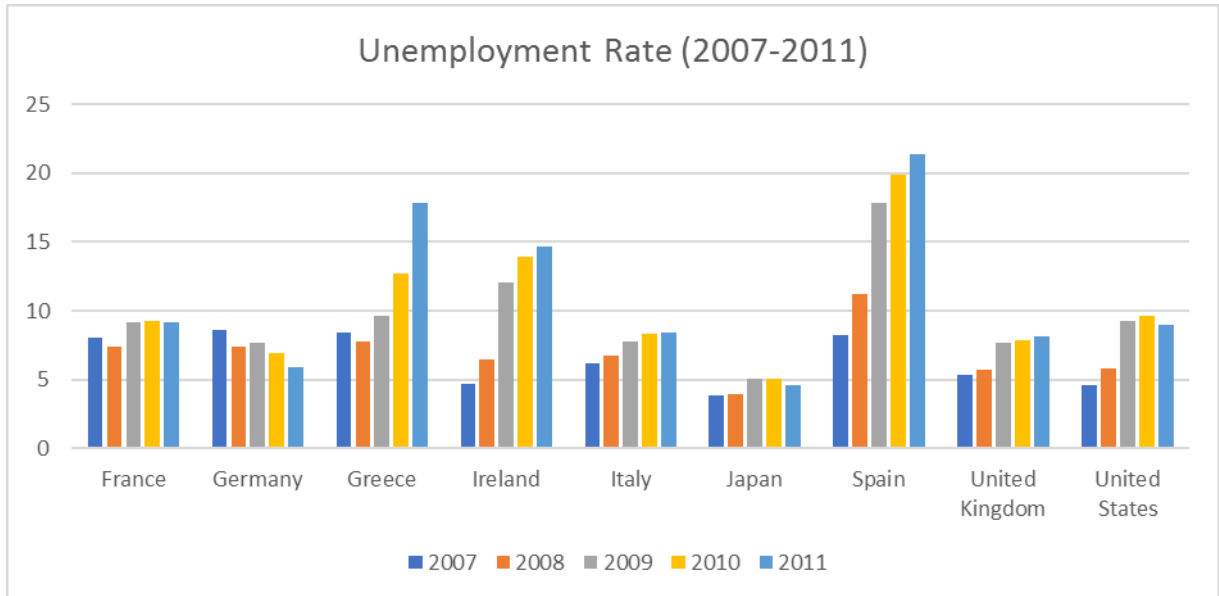
Source: Author's elaboration of IMF's WEO Database (July 2017)

Figure 4: Unemployment Rate as % of total labor force (2012-2016)

Source: Author's elaboration of IMF's WEO Database (July 2017)

In the last five years considered, shown in Figure 4, in this subset of economies, the unemployment rate stopped increasing. While Italy, France and Germany don't display significant trends (a small overall improvement in Germany's labor market, a slight improvement in Italy's starting from 2015, a little worsening in France's), the US, the UK Spain and Ireland show a very strong path towards reduction in unemployment. Greece, instead, does not exhibit a lower unemployment rate, which peaked in 2012, 2013, the worst years in its sovereign bond crisis, with the various austerity packages passed by the Greek

Parliament. In Europe, the weaker countries still have unemployment rates which are significantly higher than the pre-crisis values.

In short, the distinction in these three five-years periods seems to be characterized by different paths in the economies of interest. The following paragraph will provide more details on the relationship between GDP, the government debt and the deficit.

2.1. Debt and deficit

Having seen how the panel of economies reacted to cycles in 2002-2016, the following focus will be on their debt. As pointed out in Figure 5, the the stock of government debt grew in almost all of these countries. Greece, Italy and Japan were the three countries that had a debt above 100% of GDP in 2002. The increase of debt for Greece (+73% from 2002 to 2014) and Japan (+53% from 2002 to 2014) is astonishing.

Figure 5: General government gross debt in % of GDP
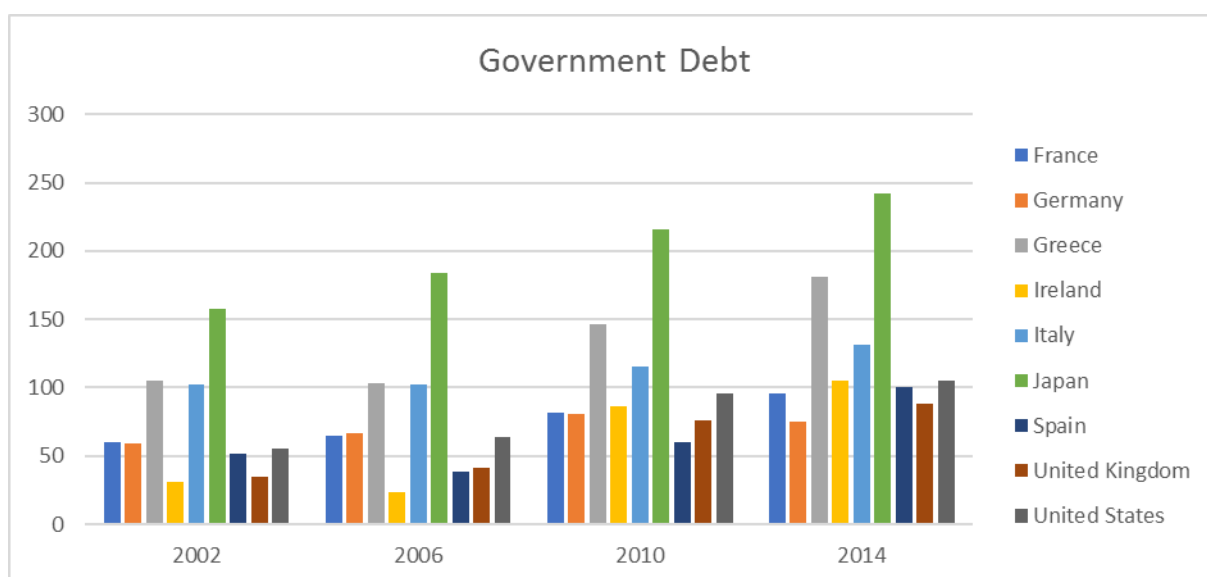
Source: Author's elaboration of IMF's WEO Database (July 2017)

However, the Italian government debt also increased (+29%) even if at a less scary pace. But also the other countries exhibit a strong growth of debt: France (+59%), Germany (+26%), Ireland (+245%), Spain (+96%), the UK (+154%) and the US (+90%). Spain's was lowering

but exploded after 2006; the UK, the US and Ireland boosted their debt after the crisis as well, because of the huge State interventions and takeovers of national banking institutions.[6]

Of course, evaluating data about government debt immediately raises the issue of debt overhang: in some of the above-mentioned countries, the debt stock of a nation may be close to the point in which it would exceed its future capacity to repay it. This point cannot be precisely estimated because of the many variables that influence sovereign bond markets, in particular the government and the State's credibility, which is almost impossible to proxy. Although it is not the purpose of this paper to expand such an issue, it could be important, as to correctly infer any conclusion from the previous data on debt, to recall Reinhart and Rogoff's explanation that "GDP growth slows to a snail's pace once government debt levels exceed 90% of GDP".[7] Almost all the countries that have been presented in Figure 5 have a debt level higher (in some cases much higher) than 90% of GDP.

However, rather than on the relationship between debt and growth, this paper focuses on fiscal policy's responses to crises. Being fiscal policy, in the end, the allocation by the public sector of its scarce resources, debt levels may be interesting in this setting because they influence the cost of borrowing for the State. It is much easier to finance a deficit if cost of borrowing is low. This has been a very relevant problem for some of the Euro Area countries starting from 2011, when yields on bonds for some of the "peripherical" countries (Portugal, Ireland, Italy, Greece and Spain, unfortunately known as "PIIGS") sky rocketed. Figure 6 gives an idea of how sizeable the break after 2011 was, by plotting the spread of 10-year government bonds of some of the Euro Area countries relative to the yield of the 10-year German Bund, usually considered to be the "risk free" benchmark. With cost of borrowing so high, no monetary nor exchange rate policy on the table, supranational rules on debt and deficit to be respected, these countries had no other alternative than shrinking, even considerably, their deficit.

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[6] For a complete list of US bailed out banks (updated in 2009):
http://money.cnn.com/news/specials/storysupplement/bankbailout/
[7] Reinhart, C.M., Rogoff, K.S., "Growth in a Time of Debt", NBER Working Paper No. 15639, January 2010, http://www.nber.org/papers/w15639
As cited by The Economist:
https://www.economist.com/news/finance-and-economics/21576362-seminal-analysis-relationship-between-debt-and-growth-comes-under

Figure 6: 10-years government bonds: yields and spreads relative to that of the German Bund for some Euro Area countries (2002-2012)
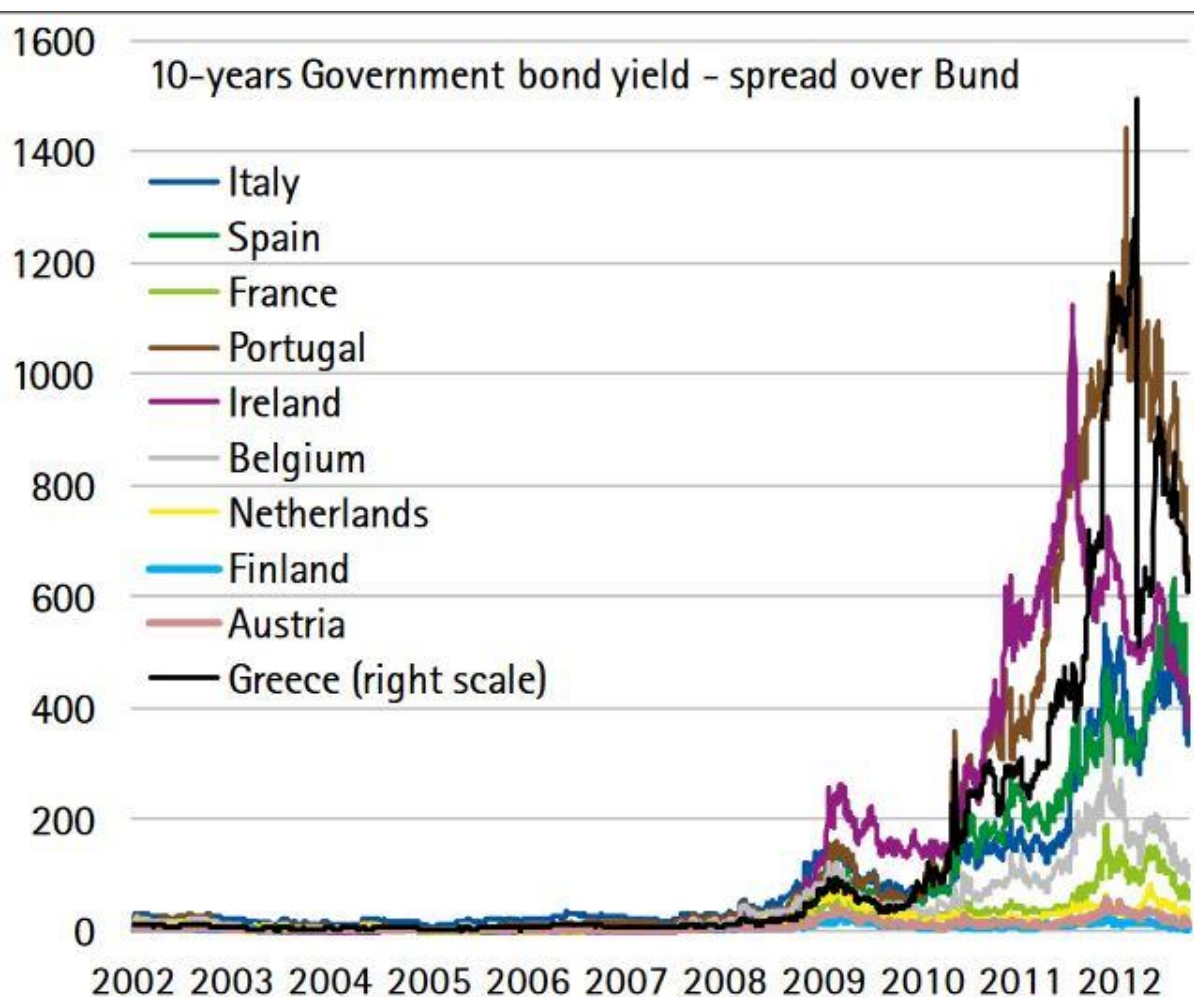
Source: Giordano, L., Linciano, N., Soccorso, P., The determinants of government yield spreads in the euro area, CONSOB, Quaderni di Finanza, October 2012

In such a critical situation, Parliaments approved austerity measures, to reduce the impact of the huge cost of borrowing on their deficit and to restore credibility. As a result, primary deficit for many of these countries was reduced (and, on the other hand, primary surplus increased), being the primary balance none other than government spending less current income from taxes, excluding interest paid on government debt.

Figure 7: General government primary net lending/borrowing
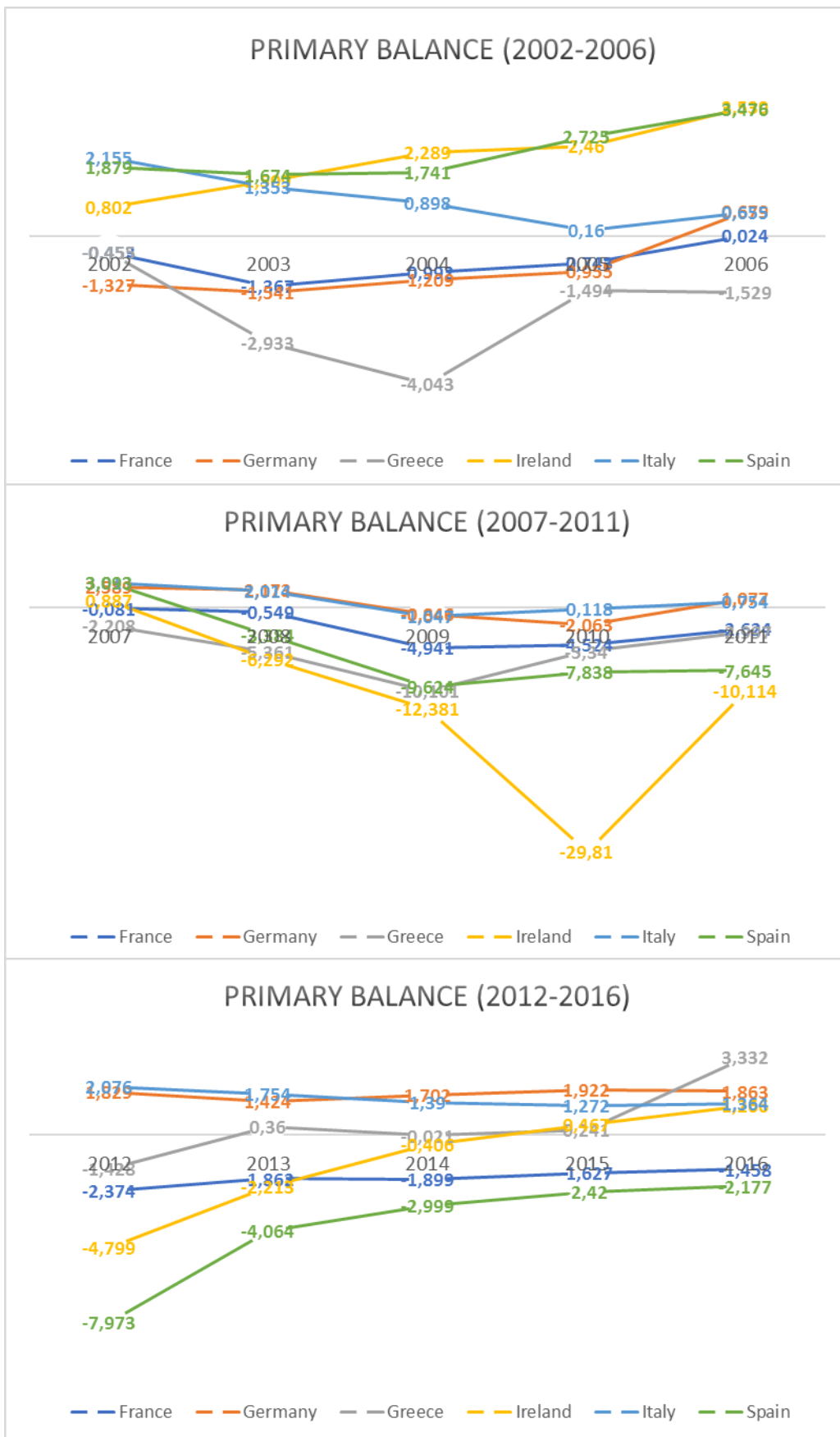
Figure 7 signals some long-term paths. France and Germany maintain a stable primary balance: France with a deficit, Germany mainly in the surplus area. Greece is in a net lending position, and a considerable one, until 2013, when it finally reaches the zero value. Ireland, after years of primary surplus, falls in 2008 in primary deficit, from which it will only recover around 2014-2015. The same holds for Spain, with the exception that Spain still hasn't recovered from the deficit. Italy, notably, is the only country which almost never (only in one year, 2009, but close to the zero) is among the primary deficit countries. Unfortunately, as will be developed in the following paragraph, the problem for Italy is its huge debt stock, on which it has to pay interests.

Since the aim was to search for years of strong fiscal restriction, the major events in this sense can be summarized as follows: for Germany, 2006 and 2011 were years in which its primary surplus increased by a sizeable percentage. Greece shrunk its primary deficit steadily and importantly from 2010 to 2013, and again in 2016. Similarly, Ireland reduced its deficit from 2011 to 2016. Italy, in 2012, and Spain, in 2013, exhibit their stronger improvement of their primary balances.

Figure 8: Ranges for the fiscal stance
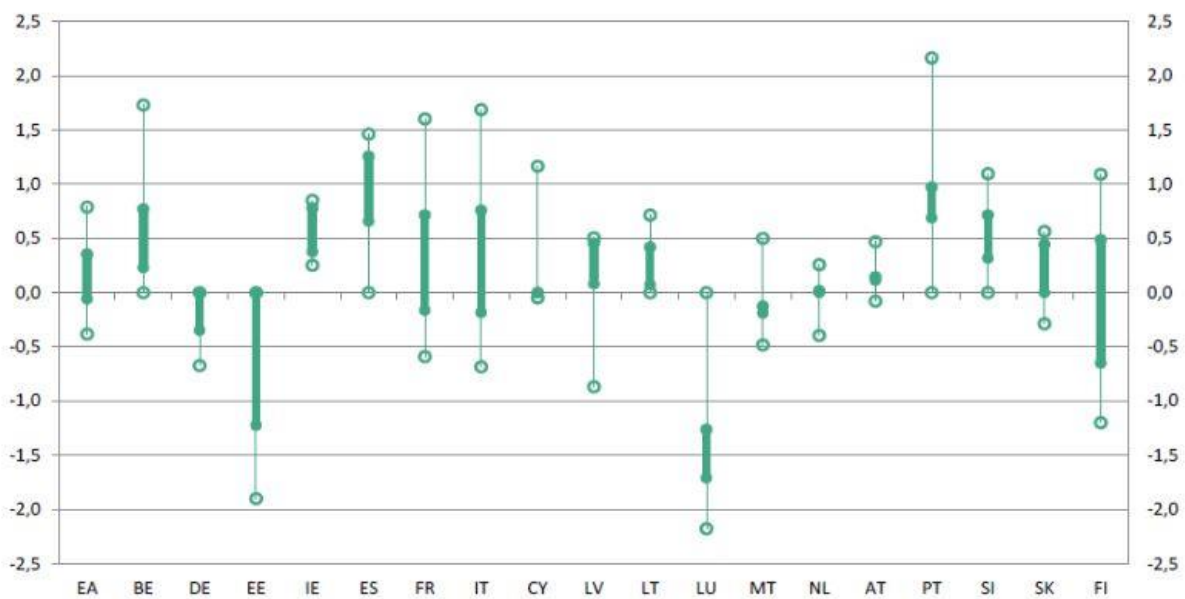
In Figure 8, the lower (upper) bounds indicate full priority to stabilization (sustainability). The thick lines indicate restrictive ranges, within which the fiscal stance accommodates both stabilization and sustainability needs, while the thin lines indicate broad ranges, within which the fiscal stance addresses one objective at the expense of the other.

As the Italian Ministry of Finance stated in 2017, "given the risk that low investment and high unemployment could eventually become structural with long-lasting detrimental effects on potential growth, promoting an increase in demand appears to be desirable, in general, because of the high efficiency of fiscal policy to attain stabilization goals in such a context. Indeed, in the current low interest rate environment, where the European Central Bank accommodative monetary policy is maintaining interest rates near the zero floor, an expansionary fiscal policy can exert major impact on employment and real GDP as fiscal multipliers are proved to be particularly large".[8] Once again, this statement clearly identifies the substantial role of the topics of interest of this paper.

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[8] Ministero dell'Economia e delle Finanze, Dipartimento del Tesoro, *Relevant Factors Influencing Debt Developments in Italy*, February 2017

2.2. A further detail on Italy

Having quickly glimpsed at the evolution of a relevant group of advanced economies in 2002-2016, it seems useful to go more in depth on the Italian situation.

Figure 9: Log of Gross Domestic Product per Capita, chain-linked values, (1995-2015), Italy
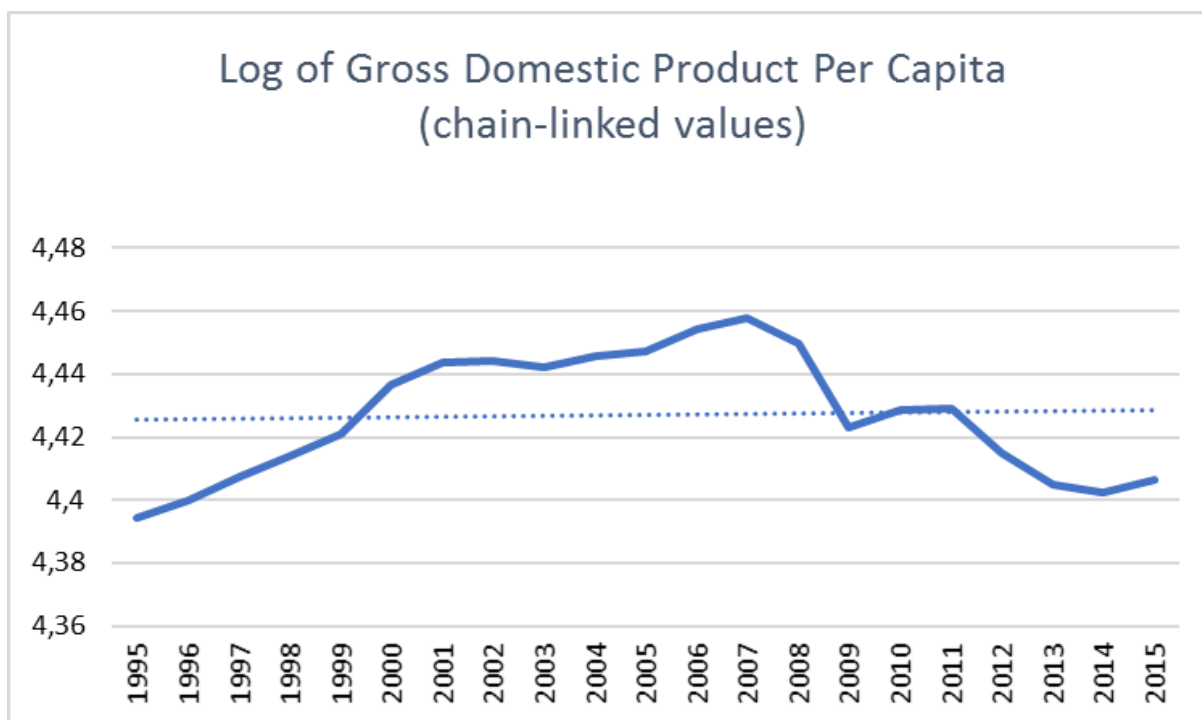
Source: Author's elaboration of ISTAT, Conti Economici Nazionali

Italy got into our period of interest, which starts in 2002, after about a decade of stability and growth. Following the social and political turmoil which exploded in 1992, the year in which the ruling parties crumbled because of the corruption scandal "Tangentopoli" and the war with the mafia and organized crime reached its peak in violence, the Italian economy enjoyed a quite solid period of growth. This was mainly due to the strong credibility the Maastricht Treaty and its ambitious programs in terms of public finance and building of the European Union gave to the country. As can be seen in Figure 9, the year 2000 was a change of pace, with an increase – yet, still moderate – in the GDP growth rate. Such pace slowed down 2007 and started declining in 2008, reaching lower levels of GDP per capita, from which the country has not recovered ever since.

Figure 10: Total Revenue, Primary Balance, Net Borrowing, Italy
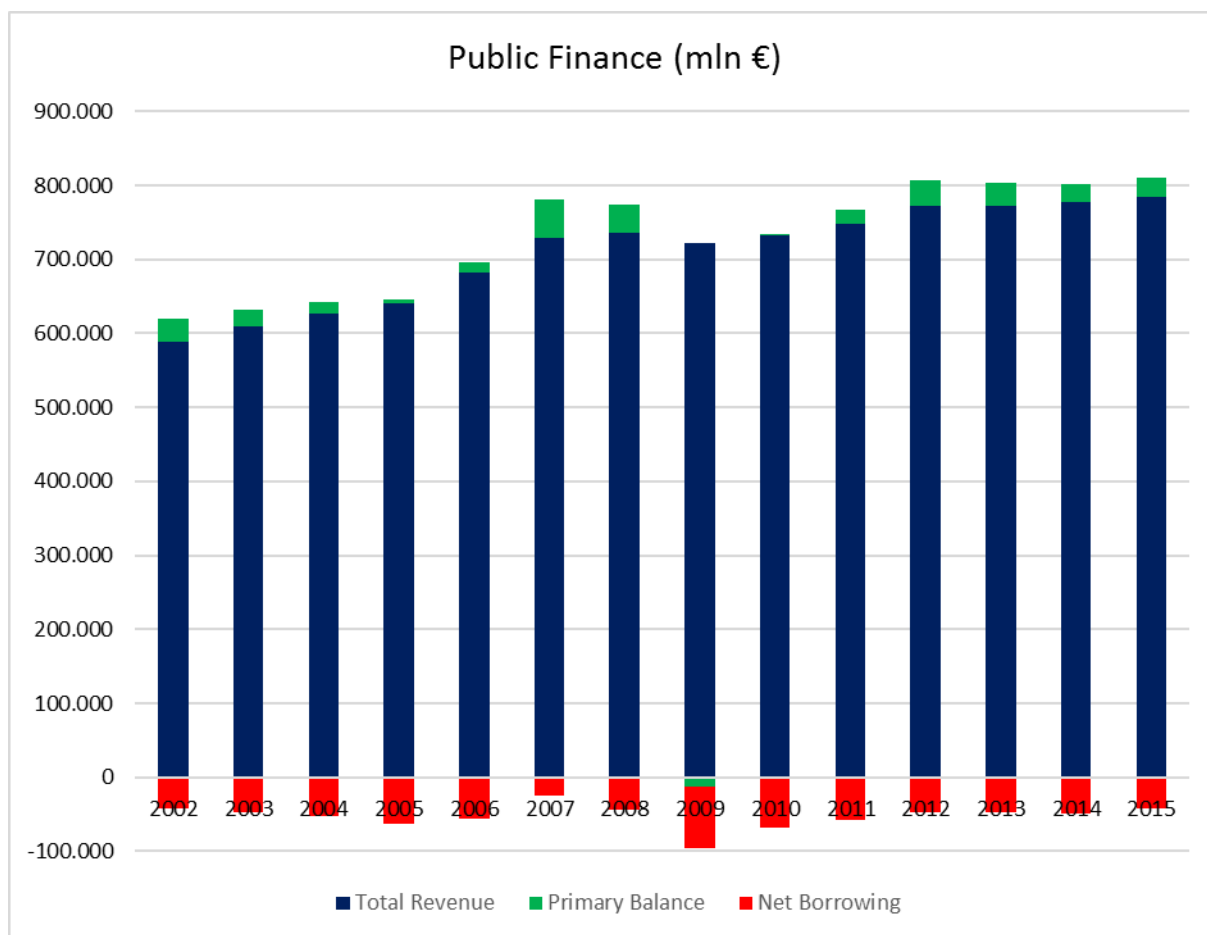
Source: *Author's elaboration of ISTAT, Conti Economici Nazionali*

Figure 10 depicts the level of public finances from 2002 to 2015. Until 2007, Italian government revenues steadily increased, while the deficit was slightly reduced. The recession caused total revenues to fall in 2009, the primary balance to shrink (resulting in a primary deficit of € -13.424 mln, the only year among the last two decades of primary deficit) and, consequently, the overall deficit to worsen. However, the following years have not been a true recovery but rather years of stagnation. In fact, revenues reflect such immobility of the economy, with a very limited reduction in the net borrowing from 2013 onwards.

Therefore, the context in which policy decisions were made was one of a country with institutional, political, social and economic processes which are very slow in adapting and responding to external factors, particularly the one of the international recovery post-2012. The time path of the Italian GDP clearly shows that the losses due to the great recession are still far from being compensated by growth and one may wonder whether the crisis left a

permanent burden on the Italian potential output and whether the need for a fiscal consolidation aggravated this situation. It is in such context that our analysis on the presence of hysteresis aims at clarifying if the economic possibilities of the Italian economy have *permanently* worsened after the crisis.

In other terms, the goal of this paper is to focus on the dynamics of the key economic drivers and to try to evaluate how resilient the Italian economy can be said. Following (Hallegatte, 2014), economic resilience can be said to be <<the ability of the economy to cope, recover, and reconstruct and therefore to minimize aggregate consumption losses>> following, for instance, a natural disaster or an external shock.

2.3. The output gap

Potential output is a widely-used concept in economics, being the measurement of the highest level of production that an economy can reach without generating inflationary pressures. The output gap is the difference between real and potential output. From a methodological point of view, the concepts of potential output and output gap enable to separate the real output of an economy into a long-term trend (identified with the potential output) and a short or medium economic cycle.

Output gap estimates in economic analysis and fiscal policy are important in order to quantify the nature of the economic cycle and to identify the actual economic situation within the cycle, as well as to suggest counter-cyclical economic policies aimed at influencing the length and the effects of the cycle itself.

While the objective of using potential output estimates and related concepts is to enable a counter-cyclical economic policy (i.e. avoiding further inflationary pressures in boom times and support demand in contractionary periods), weaknesses exist, linked to uncertainties regarding the measurement of the potential output and of related indicators.

The potential output is not observable, but instead is estimated on the basis of models and assumptions. As pointed out by Ciucci, Zoppè (2017), this means that different models and assumptions produce different estimates. Economists evaluate the performance of the applied methodologies by looking at revisions of the estimated values over time. The size of output gap revisions applied to past years, in particular after the recent economic crises, has

generated discussions on the weakness of output gap models and the fragility of the fiscal measures based on them.

Table 1 below presents recent estimates of the output gaps for the Euro area as a whole, as published by the European Commission (COM), the IMF and the OECD. It shows that all institutions identify an economic performance below its potential for the period 2011-2017.

Table 1: Estimates of euro area output gaps for 2011-2017 by different institutions

Institution	2011	2012	2013	2014	2015	2016	2017
COM - Autumn Economic Forecast 2016	-1.1	-2.2	-2.9	-2.4	-1.6	-1.0	-0.7
IMF - World Economic Outlook October 2016	-0.6	-1.9	-2.7	-2.5	-1.8	-1.2	-0.8
OECD - Economic Outlook, November 2016	-1.4	-2.9	-3.7	-3.2	-2.6	-1.9	-1.2

However, it can be noted that there are rather major differences between the output gap estimates of different institutions (and that persist over time) indicating a high degree of uncertainty.

Figure 11 might help realize how the concept of resilience, mentioned in the previous paragraph, is central to this discussion. The picture graphs the evolution of the output gap in the countries already used as group of interest. A positive output gap, i.e. when real output is above potential output, depicts a system producing more than its equilibrium capacity: as a result, unemployment decreases and inflation increases. A negative output gap, i.e. when real output is below potential output, describes a system producing less than its equilibrium capacity: as a result, unemployment increases and inflation decreases (ceteris paribus).

Figure 11: Output Gap in % of Potential GDP
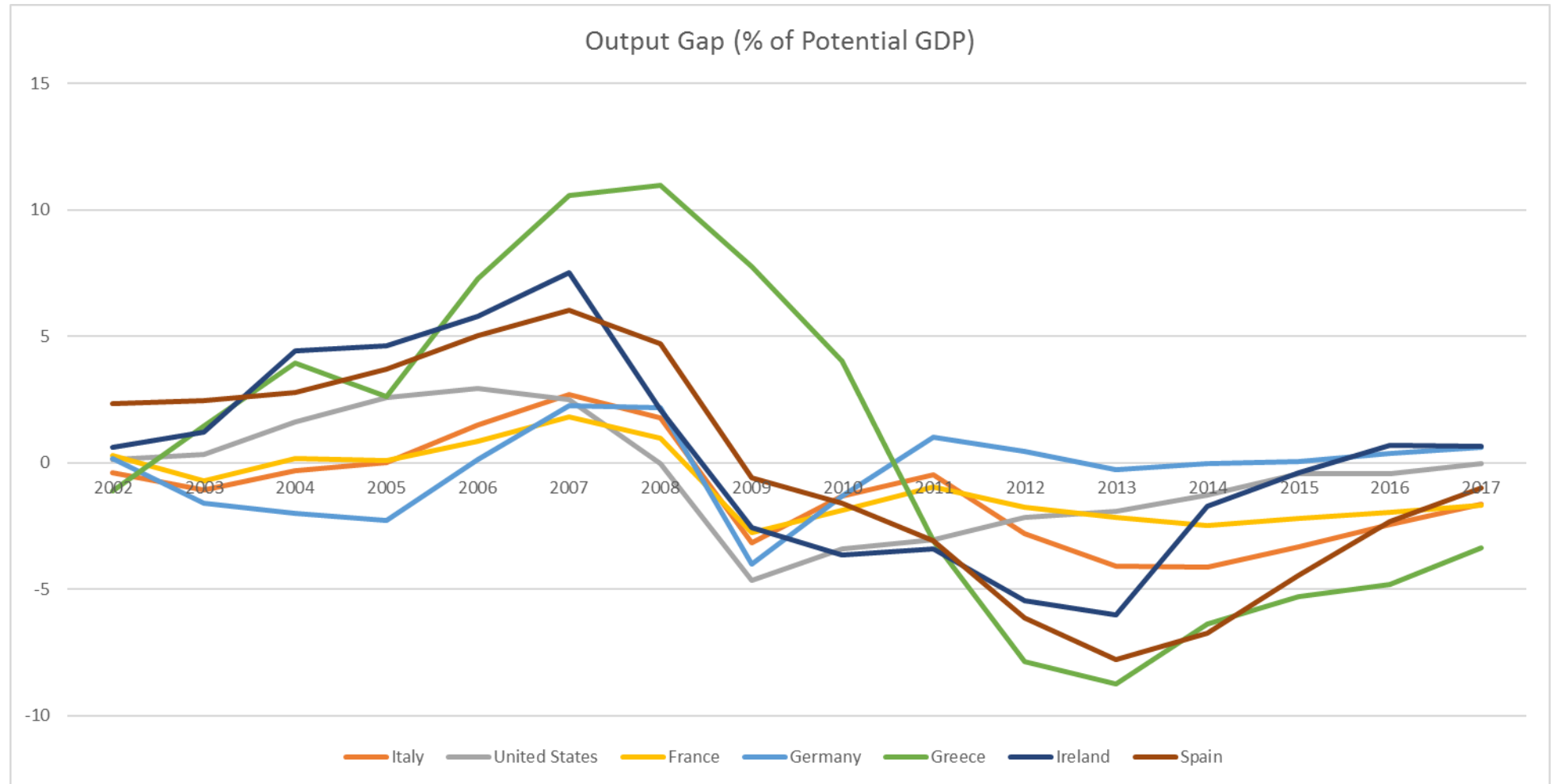
Source: Author's elaboration of IMF's WEO Database (July 2017)

From Figure 11, it can be seen that Spain, Greece and Ireland had a very similar trend, of significantly positive output gaps until 2008-2009, when they became significantly negative and very slowly returning towards zero. France and Germany had much smaller variance, maintaining a much more stable output gap, apart from Germany in 2003, 2004 and 2005, in which its output gap was the most negative among these countries of interest. As for the United States, Italy does not exhibit a very large output differential in these 14 years. The Italian output gap was quite consistently around zero from 2002 to 2006, positive in 2007-2008, then dropped to negative in 2009, reached a quasi-zero value in 2011 and then fell back into negative area from 2012 onwards.

This means that, simplifying, it can be said that the Italian economy was very close to its equilibrium from the entry in circulation of the Euro until 2006. Then, it was growing more (yet, not enormously) than it should have in 2007-2008, collapsing in 2009, after the crisis spread out from the United States to Europe. Thus, in 2009 Italy's production levels were well below its equilibrium levels, raising unemployment and bringing about deflation. A couple of years after, equilibrium capacity was almost regained, although this did not last long, since in 2012 the system collapsed again: from then until 2015, Italy never managed to reach the zero-differential level.

This paper's analysis is particularly interested in the first drop in 2009 and the subsequent stability in significant negative output gaps from 2012 to 2015. This prolonged period of production levels lower than equilibrium, may have distorted the Italian fundamentals in various ways: they might have changed the labor market, both in its supply and its demand side, they might have reduced participation in the labor force, especially in its least protected subgroups (women, over 55, under 30, for instance), they might have changed the education and training levels, they might have changed the public and private sector investment levels. All of these potential negative changes could be signals of a latent hysteresis effect in the Italian economy. This is the reason why the following chapter will focus on this element.

3. Hysteresis

This chapter will deepen the focus on Italy and the other countries previously mentioned, trying to filter economic cycles from potential output analysis. It will briefly explain some of the issues undermining estimations, especially as they get closer and closer to real time, and raising the issue of classifying our economies of interest with respect to their supposed level of resilience. The purpose of this chapter is in fact to define the environment in which the effects of fiscal policies of the recent years are studied.

The previous chapter mentioned hysteresis. Deriving from ancient Greek, the term means "a deficiency", and it is used to define systems, organism and fields that have memory, in the acceptation coined by Sir James Alfred Ewing, physicist and engineer (1855-1935). According to Webster, it is "a retardation of an effect when the forces acting upon a body are changed", i.e. when the effects of a certain input are experienced with a lagged time, delayed.

In economics, Blanchard and Summers (1986), although stating that "strictly speaking, the word hysteresis should be used only in the case where there is path dependence of steady state equilibrium unemployment", use it more loosely in order to "denote cases where actual unemployment affects equilibrium unemployment for a long time". Hysteresis occurs when the economy is altered by a disturbance. For example, as unemployment grows, there may be groups of people getting used to lowering their standard of living. Thus, they may internalize the lower standard of living, lowering their expectations for the future. This may cause, for instance, lower wage bargaining and lower labor market participation. There is a hysteresis effect when such social and labor market behavior continues when the economy returns to grow.

Ball (2009) believes that "the natural rate can be influenced by the path of actual unemployment. If U rises above U^*, for example, there exist mechanisms that pull U^* upward. Since aggregate demand influences U, hysteresis means that demand also influences U^*".

There is a broad consensus that deep recessions can have persistent effects on the level of potential output. The latter "falls because a recession reduces capital accumulation, leaves scars on unemployed whose skills, motivation and attachments to labor markets erode and slows technological progress. These long-term effects reflect what is usually called "hysteresis", whereby a transitory shock can have a permanent effect through a memory process. As a result, the path of potential output depends not only on current inputs, but also on the history of past outputs." (Mourougane, 2017)

Citing Delong, Summers (2012), "Whereas many economists have assumed that the path of potential output is invariant to even a deep and prolonged downturn, the available evidence raises a strong fear that hysteresis is indeed a factor". Various elements could be proposed to explain why hysteresis arises: there can be human capital factors, like higher school dropout rates, lower enrolment at Universities and other tertiary education (in fact, it has been observed that from 2007-08 to 2013-14, enrolment in Italian universities has dropped by 13.2 percentage points, i.e. 40,000 units) or lower skills because of lower labor market participation and less training by firms for workers (labor market participation in Italy decreased from 62.64% in 2006 to 62.01% in 2010, whereas it increased from 74.99% to 76.64% in the same period in Germany); there can be structural factors, like a generalized fall in private and public investment, or a persistent high youth unemployment level (as it looks to be the case, with unemployment in the age range 15-24 soaring from 20.3% in January 2008 to 28.3% in January 2011 to 43.2% in January 2014 and to 37.1% in January 2017); moreover, there can be labor supply effects: people become used to unemployment and may remain counted as unemployed, but aren't really looking for work (or putting downward pressure on wages); bargaining effects, i.e. when prolonged unemployment causes members to leave unions, and so they aren't represented in bargaining; labor demand effects, i.e. if firms don't want to hire the long-term unemployed, discouraging the unemployed, so the employed worry about losing their job and thus moderate wage demands.

Indeed, it is very complicated to link these elements in a causal relation. Yet, it seems of great interest to develop this topic, to better understand how economies have reacted to the most recent periods of crisis.

However, it must be born in mind that hysteresis may not only have negative effects on the potential output: there may also be circumstances in which certain expansive fiscal policies can have a positive impact on potential output. This is the case of so-called reverse hysteresis and in this paper's analysis it must not be discarded as nonessential

3.1. Cycles and potential output

Having quickly seen what hysteresis is, it seems useful to insert this concept in the framework of growth and fiscal policy. First of all, something about potential output estimation must be said: as previously pointed out, one of the main problems that arise when considering potential output or its derivation, the output gap, is dissimilarity among different estimated

values. Each study uses different methods and uneven models to provide such evaluations, thus generating variations which, if very large, may cause estimations to be inconsistent with one another. This is an extremely important lesson to bear in mind when discussing results that rest on potential output data. And it is especially true as estimations get closer and closer in time, i.e. as the margin of error gets larger and larger. Notice that fiscal policy decisions reflect the 'real time' estimate of the output gap. For a more in-depth assessment of the real-time reliability of the output gap estimates see (Bundesbank, 2014).

In addition, another issue regarding estimations is their relationship with the economic cycle. In particular, when focusing on short run estimations the economic cycle may divert estimations away from the predicted values, changing the sign of the output gap as the estimate becomes more accurate. As presented by the previously cited Mourougane (2017) and De Long, Summers (2012), such diversion can be significant and substantial, depending on how hard the economic shocks hit.

It is in this framework that this paper tries to develop an argument concerning the interaction between hysteresis and fiscal policy, not only by distinguishing the conjuncture from the potential output (distinguishing between short and long run effects of fiscal policy; long run effects may incorporate hysteresis), but also by providing an idea of which major countries can be said to be resilient and which ones cannot.

The ultimate challenge of this reasoning is to answer the focal questions "which role did austerity policies have in slowing and diminishing the post-crisis recovery in Europe? Did they entail hysteresis effects on the EU countries? Did they reduce the EU economies' potential output?".

3.2. Comparing economic cycles

Having in mind the concepts and the arguments introduced in the last section, it is interesting to compare some other elements of the economic cycle of the past two decades in some of the countries already considered. When building a discourse about hysteresis, one of the main drivers is the fluctuation of the level of investments. Investments can be by the private sector, through families or firms, and by the public sector. Clearly, the presence of hysteresis can be hypothesized when the variations in investments get stuck on recent past values, as if the economy "memorized" the preceding period and cannot respond in a totally autonomous manner.

The following Figure 12 covers the evolution of investment, using the concept of gross fixed capital formation (GFCF), which is the acquisition (purchases of new or second-hand) and creation of assets by producers for their own use, minus disposals of produced fixed assets. Data are taken from OECD, Aggregate National Accounts, SNA 2008 (or SNA 1993): Gross domestic product.

As can be seen, the annual growth rate of this indicator (i.e. GFCF) exhibits somehow common trends among the countries of the sample, with the exception of Greece. In particular, from 2003 to 2012 France, Germany and Italy all increase or decrease together, although with different paces, especially regarding the widening gap from 2010 onwards (although in 2015 the path would suggest that the indicator may be reconverging. Also the United States roughly followed the same fluctuations, with substantial divergences after 2010: from thereafter, the USA's investment growth rate always remained positive, on average about 5% yearly, and with no major variation.

In this frame of reference, Greece's path sticks out. In the years 2000, while the other countries were relatively homogeneous, Greece enjoyed three years of strong increase in the rate of growth in investment (2003, 2006, 2007) and a big fall in 2005. These huge shifts (more than three times larger than the other ranges) did not track a consistent, durable trend and were most certainly influenced by external factors, such as the Athens Olympic Games in 2004. Starting from 2008, Greek investment levels will shrink in the following seven years, stopping their reduction only in 2015 (-0.2% with respect to 2014), with values around 20 percentage points in 2010, 2011, 2012. Considering the Greek case as an outlier in this setting is interesting also in order to compare it to the country of special focus of this paper, Italy.

If it is true that in 2010, after the crisis lowered the level of Italian investments (as in all these other countries), this investment indicator recovered with values in line with the USA and France, it is also true that such recovery did not last long, since the following year and especially in 2012 investment shrunk by larger and larger percentages, starting to reduce the rate of loss only in 2013. It is precisely in this period that the similarities with Greece, rather than the other European countries considered, emerge. In fact, although the order of magnitude in investment losses is radically smaller for Italy than for Greece, it appears as in 2011-2015 these two economies were driven by some relevant common factors that did not affect that much the USA, France nore Germany, possibly the evolution of the sovereign debt crisis, which strongly linked the two countries.

Figure 12: Investment Annual Growth Rate
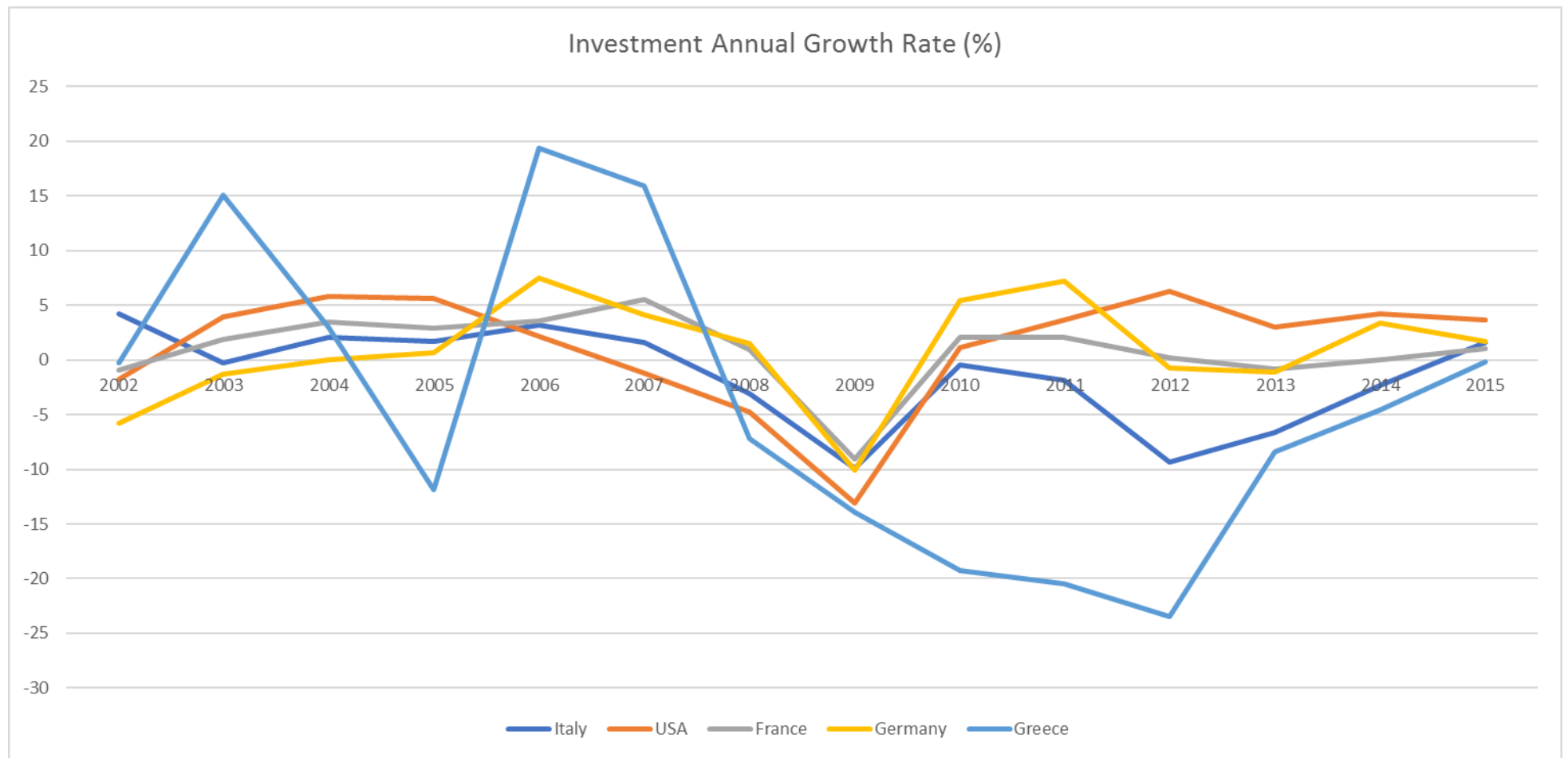
Source: Author's elaboration of OECD, Aggregate National Accounts, SNA 2008 (or SNA 1993)

Decomposing investment in its three parts, i.e. households, firms and public sector, it can be seen that Italy had an extremely stable partition among them. Family investment stayed from 2002 to 2015 roughly around 30%, corporate investment above 50% and government investment about 15% of total investment. The only significant development was in 2009, when almost 5% of the total was substituted from firms to the public sector, which intervened to cover the imbalance.

This is surprisingly remarkable, because it means that, notwithstanding the (even substantial) variations in total investment levels in Italy, its

Investment (Household)

Investment (Corporate)
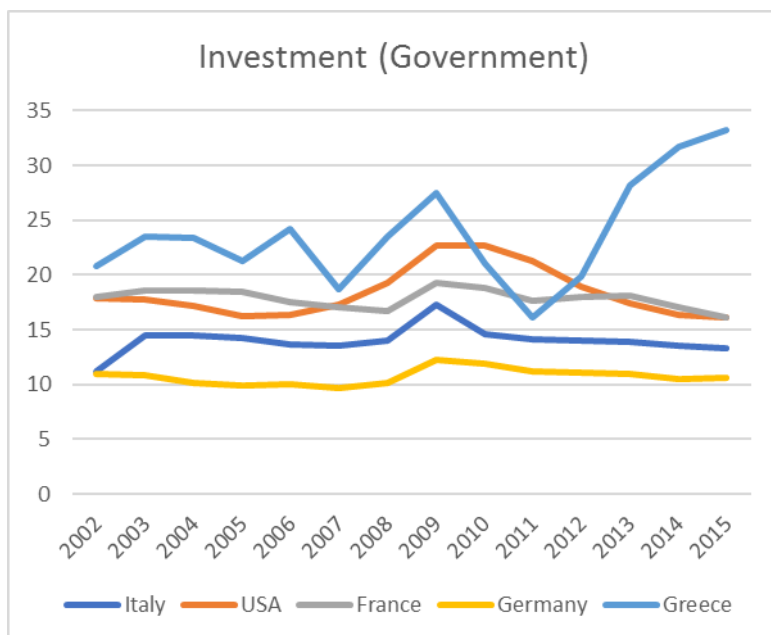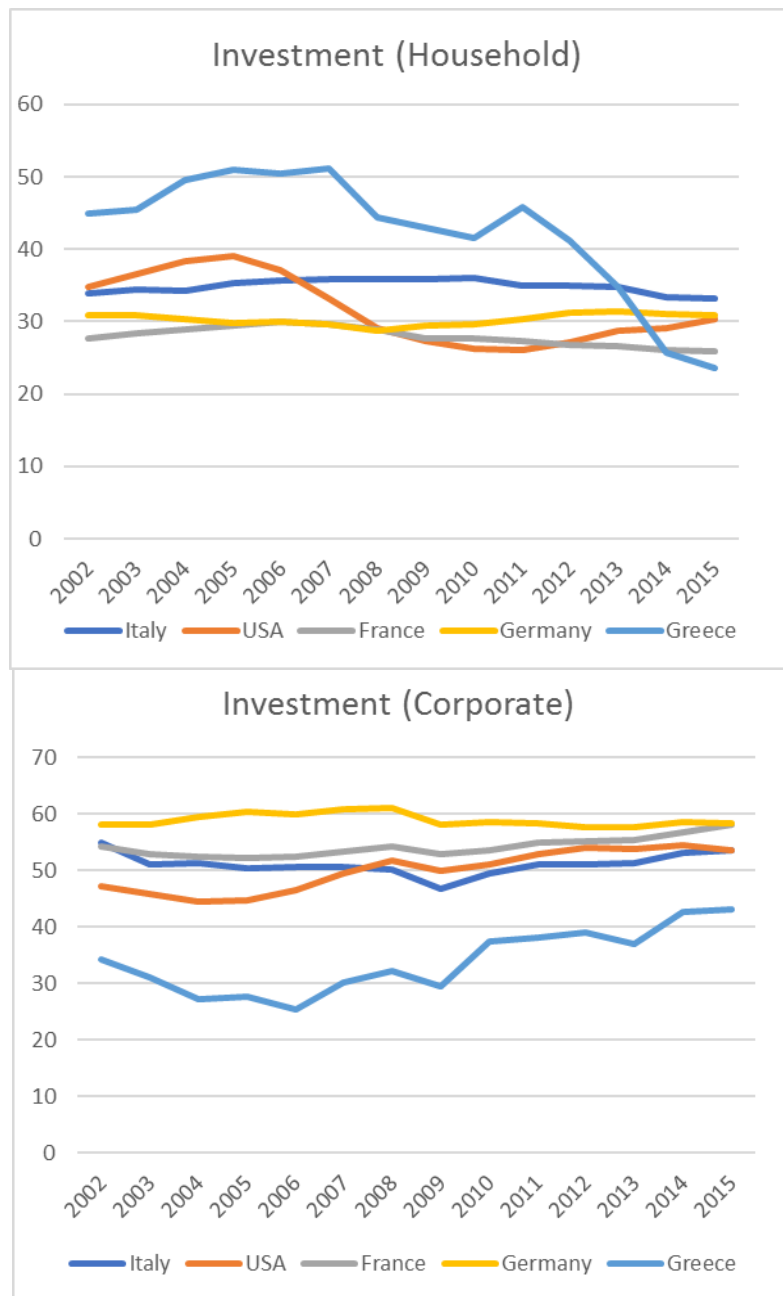
three components have proceeded in a perfectly balanced manner, as stable as Germany.

Once again, the least stable subdivision of investment components is in the Greek economy, although also the United States exhibit significant (but much smoother than in Greece) movements. It will be

Investment (Government)

27

of great importante to bear in mind these trivial comparisons when considering the results in the following chapters.

4. A model for hysteresis

Before presenting the model used as baseline for this paper's model, it may be useful to summarize in a short paragraph the state of the art in the current literature, which has been relevantly updated and redefined in the past decade, especially after the Great Recession.

4.1. State of the art

There is no general consensus on how to deal with analyzing data, while searching for hysteresis effects. Ball (2014) looks at a group of 23 countries, comparing the potential output estimates available in that year from the OECD with the IMF's estimates computed in 2007. Losses in potential output range from almost nothing in Australia and Switzerland to more than 30% in Greece, Hungary and Ireland. The average loss, weighted by economy size, is 8.4%. Moreover, "the countries with the largest current losses of potential output also have bad prospects going forward. (..) absent sharp accelerations in potential growth, the countries damaged most by the Great Recession will do worse and worse over time relative to other countries as well as to their own pre-crisis trajectories." (Ball, 2014)

Howard et al. (2011) calculate that long and severe recessions lead to a permanent loss from 8 to 10% after 10 years. According to Bordo *et al.* (2001), instead, by comparing peaks during the recession period it can be shown that losses amount to 6.2% of GDP for banking crises, 18.6% for twin crises (exchange rate and banking crises).

Bordo, Meissner and Stuckler (2009) construct an ECM model with data from 18 countries between 1880 and 1913 and 45 countries between 1973 GDP per capita. They conclude that crises are followed by an output loss of about 1.5% in the long term for the most recent period and of 4% for the first wave of globalization. As for Haltmaier (2012), growth rate decreases on average by 0.5% two years after the peak, while half of this loss is recovered in the years that followed. The cumulated loss is estimated to 1.5 percentage points 4 years after the peak. This loss is bigger for developed countries than for emerging-market economies.

Hall (2014) focuses on the United States, by using a counterfactual: the post-crisis shortfall is the difference between the 1990-2007 trend and actual data. From the end of 2007 to 2013, American output fell by a cumulative 13.3% below pre-crisis trend, with most of the shortfall occurring before the end of 2010. By looking at OECD countries, Haugh *et al.* (2009) argue that Japan is the only country for which a banking crisis would have a persistent impact on potential growth.

Barro (2001) estimated a dummy variable model in a panel of 67 developed and developing Economies, with data on 1965-2000 GDP per capita. His point is that twin crises lead to a reduction by 2 percentage points in GDP per capita over a five-year period (1.3 point for an exchange rate crisis and 0.6 for a banking crisis) and that there is no effect after 5 years. Finally, for Reinhart and Rogoff (2009), analyzing both OECD countries and a few emerging market economies, Banking crises are followed by a recession that lasts on average 2 years and leads to a cumulated loss of GDP per capita. Production would decline from peak to through on average by 9%.

4.2. A complex analysis

As outlined in the previous chapters, there are various issues undermining any identification, valuation and calculation strategy when considering potential output and the possible presence of hysteresis effects in the Eurozone.

The following Chart 1 and Chart 2 depict the higher uncertainty brought about by the crisis, with a remarkable growth in the margin of error, in volatility and ranges of potential output estimates. "Misjudging the size of the output gap can lead to significant policy mistakes. The perception of having more spare capacity than is actually available in the economy can lead to a more accommodative monetary or economic policy than needed, fuelling inflation and potential bubbles. In fact, in 2007, prior to the crisis, all euro area countries were perceived to have significantly less favourable output gaps than their ex post assessments have shown". (Anderton et al., 2014)

(annual percentage changes)

— potential
····· average (2000-07)
---- average (2008-13)

— actual
····· average (2000-07)
······ average (2008-13)

(annual percentage changes; standard deviations)

— potential
····· volatility (2000-07)
---- volatility (2008-13)

— actual
····· volatility (2000-07)
······ volatility (2008-13)

Sources: European Commission estimates (CIRCABC) and ECB calculations.

Chart 2 Uncertainty of euro area potential output estimates, pre-crisis and crisis ranges of estimates

(annual percentage changes)

— range
····· mid-point
---- average

(i) Pre-crisis
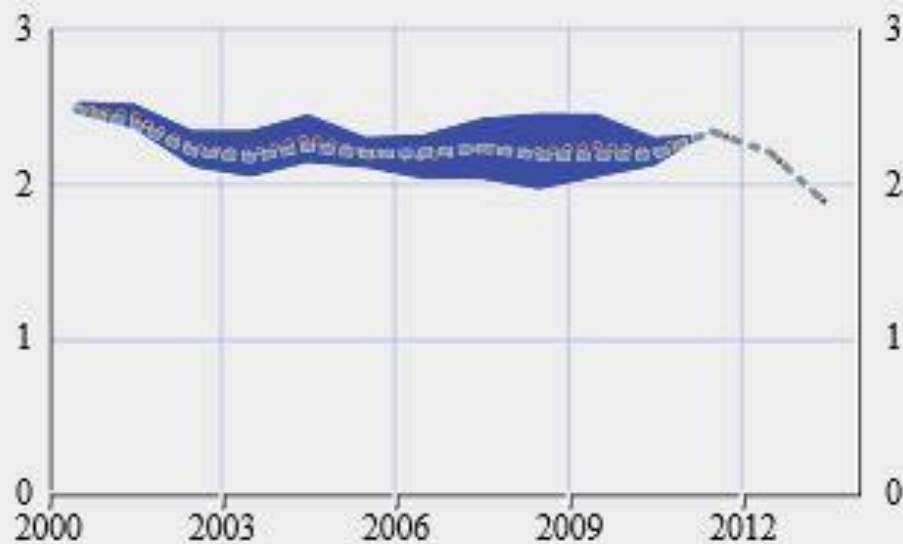
(ii) Crisis
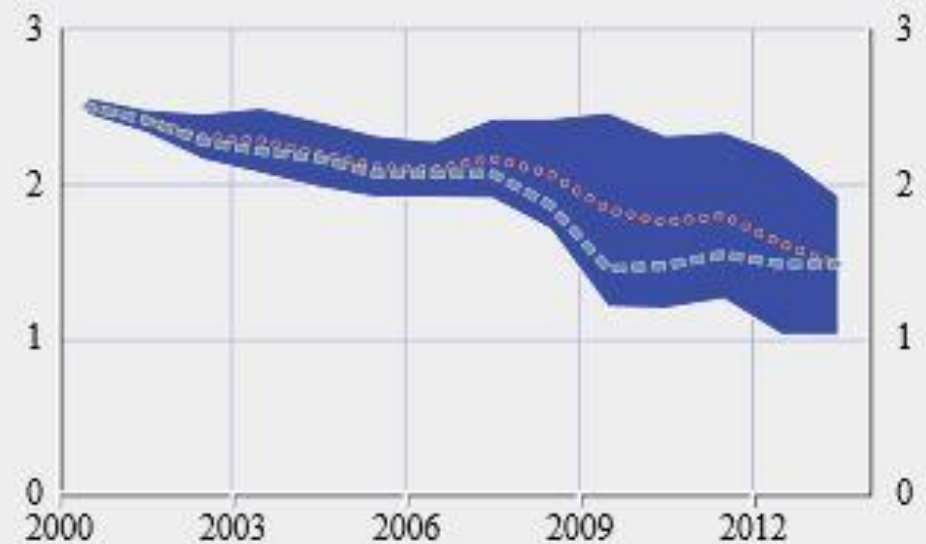
Sources: Eurostat data, European Commission estimates (CIRCABC) and ECB calculations.
Notes: For panel (i), "pre-crisis", vintages are from 2002 to 2007. For panel (ii), "crisis", vintages are from 2008 to 2013, where available. The number of vintages varies from year to year, which accounts to some extent for the different widths of the range over the sample. The methodology underlying different vintages is subject to small modifications.
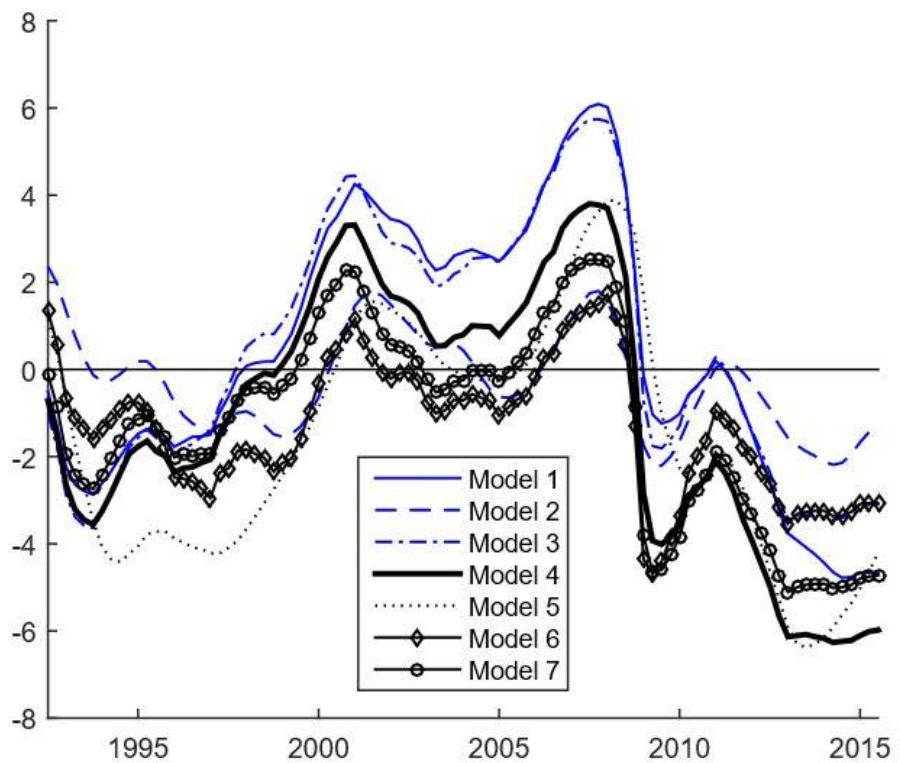
Jarocinsky and Lenza (2016), moreover, remind that it is "important to discriminate among modelling assumptions. In fact, while the alternative estimates agree about the timing of peaks and troughs, they disagree about the level of the output gap. Such differences are economically relevant: the output gap in 2014 and 2015 was, on average, close to -2% according to some estimates, and -6% according to others", as can be seen in Chart 1.

Therefore, this paper will try to develop a very simple econometric model to analyze the relationship among potential output and the periods of crisis in the Euro area from 2007/2008 and from 2011/2012.

Many commentators and a substantial portion of the European countries' political leaders state that the Eurozone's potential output was permanently reduced after 2008, but what is less certain is the long-term impact on the growth rate of potential output (see e.g. European Commission, 2009; ECB, 2009; and ECB, 2011). Potential output has likely been limited by a reduction in capital reserves, caused by capital scrapping, i.e. when assets are withdrawn from the capital stock at the end of their service lives. This type of reconstruction seems reasonable, as many sectors were particularly hit by the financial and economic crisis, which persistently downsized their industries. Also, structural unemployment could have rose. Data are unambiguous: in the Eurozone, unemployment has increased since the crisis hit Europe; what is instead still surrounded by ambiguity is the longer term effect on potential growth. Indeed, it has been argued that while, in general, recessions tend to have only a temporary effect on potential growth, i.e. are limited to a one-time shift in the level of potential output, a prolonged recession may have hysteresis-type

effects that are longer-lasting, especially when recessions are associated with financial crises (Reinhart and Rogoff, 2009).

However, in this paper we follow Annabelle Mourougane's view, according to whom hysteresis effects are so hard to quantify that in 2014, i.e. six years after the collapse of Lehman Brothers, output is still depressed in many countries, suggesting that the extent of hysteresis and/or its impact on the economy may have been underestimated. One reason may be that most empirical models which estimate the effects of financial crises do not explicitly account for hysteresis. When the latter is incorporated in the analysis it is in an ad hoc and partial way, most of the time through an autoregressive process. This simplifying assumption stems from the difficulty of quantifying the degree of hysteresis. First, it is difficult to disentangle the effects coming from hysteresis from those reflecting trend changes due to a technological or a population shock. Second, stabilization policies are likely to affect hysteresis (Mourougane, 2017).

4.3.   The model in Mourougane, 2017

The baseline model of Mourougane seeks to estimate the impact of crises on potential output by regressing the latter on a dummy capturing the beginning of a crisis period. The effect of any crisis is independent of the lags of potential output (otherwise, the model would be sensitive to the choice of the number of lags, and as a result would tend to be unstable) because lagged changes in labor force participation enter only as control variables and are not used to derive the impulse response functions, and because the structure of the equation does not impose permanent effects.

More specifically, the dynamics of potential output is given by:

$$y_{i,t+k}^* - y_{i,t}^* = \alpha_{i,k} + \sum_{j=1}^{l} \beta_{j,k}\Delta y_{i,t-j}^* + \delta D_{i,t} + \varepsilon_{i,t+k} \qquad (1)$$

Where

y_t^* is the log of potential output, with l the number of lags in the process

$D_{i,t}$ is a dummy which is equal to 1 at the start of a financial crisis

$\alpha_{i,k}$ is a country fixed effect

the parameter δ_k gives the impact at period k.

This specification was amended in two ways, in order to improve it. Firstly, to test if crisis impact potential growth levels, the model allowed for possible changes in the constant, when potential and actual growth differ for more than 1 point, i.e. when supply can be altered by the fall in demand. For significant ruptures, crisis will affect potential output, hence a future lower potential growth could be experienced.

$$(2) \qquad y^*_{i,t+k} - y^*_{i,t} = \alpha_{i,k} + \theta_k C_{i,t} + \sum_{j=1}^{l} \beta_{j,k} \Delta y^*_{i,t-j} + \delta D_{i,t} + \varepsilon_{i,t+k}$$

Where $C_{i,t}$ equals n for n banking crises before year t.

Even further, hysteresis was included in (2) following Kapadia (2005), according to whom a deviation of actual growth from potential growth leads to a permanent change in potential growth:

$$(3) \quad y^*_{i,t} = a_i + \rho_a y^*_{i,t-1} + \mu(y_{i,t-1} - y^*_{i,t-1}) + u^a_t = a_i + (\rho_a - \mu)y^*_{i,t-1} + \mu(y_{i,t-1}) + u^a_t$$

Where

y_t is the actual output log

μ is the hysteresis level ($\mu > 0$)

u is a productivity shock of zero mean and variance σ_a

ρ_a is the productivity shock's past impact

The combination of (2) and (3) gives $\forall k = 1 \dots T$

$$(4) \quad y^*_{i,t+k} - y^*_{i,t} = \alpha_{i,k} + \theta_k C_{i,t} + \sum_{j=1}^{l} [\beta_{j,k} \Delta y^*_{i,t-j} + \mu_{j,k}(\Delta y_{i,t-j} - \Delta y^*_{i,t-j})] +$$

$$\delta D_{i,t} + \varepsilon_{i,t+k}$$

Where $\delta_k + \theta_k$ is the impact of the crisis, $\mu_{j,k}$ the hysteresis effect and l is the length of the memory process. It must also be noted that

$$\Delta y_{i,t-j} - \Delta y^*_{i,t-j} = (y_{i,t-j} - y_{i,t-j-1}) - (y^*_{i,t-j} - y^*_{i,t-j-1})$$

$$(y_{i,t-j} - y_{i,t-j-1}) - (y^*_{i,t-j} - y^*_{i,t-j-1}) = OG_{i,t-j} - OG_{i,t-j-1}$$

With $OG_{i,t-j}$ being the output gap at time t-j. Hence, in (4) potential output growth is a function of, among the others, output gap growth.

The specification in (4), however, has a major disadvantage: hysteresis is modelled as a linear process, but it could be nonlinear. This must be kept in mind when analyzing the results.

4.4. The adapted model

The focus of this paper is on hysteresis in relation to effects of fiscal policy. The above-detailed model will be readjusted to a slightly different framework. In particular, the initial specification will be:

$$\forall k = 1...T \qquad y^*_{i,t+k} - y^*_{i,t} = \alpha_{i,k} + \sum_{j=1}^{l} \beta_{j,k} \Delta y^*_{i,t-j} + \delta_k FR_{i,t} + \varepsilon_{i,t+k}$$

(5)

Where $y^*_{i,t}$ is the log of potential output, with 1 the number of lags in the process

$FR_{i,t}$ is a dummy, equal to 1 in a year of fiscal restriction

$\alpha_{i,k}$ is a country fixed effect

introducing $FR_{i,t}$ as the new dummy, not linked to the start of a financial crisis, but instead to the presence of fiscal restriction in that very same year. However, whether such dummy is independent of the error term is questionable: $FR_{i,t}$ and $\varepsilon_{i,t+k}$ may be correlated. For instance, in a system providing specific thresholds to sovereign States in managing their budgets, such as the Stability and Growth Pact in the European Union, the presence of an economic shock would pose the problem of endogeneity. In the event of an exogenous economic downturn, government expenditure increases through automatic stabilizers and government revenues drop. Due to such supranational rules, the deficit must be maintained relatively unchanged, so it is very likely that governments need to enact restrictive fiscal policies to keep the system balanced.

Following this reasoning, to overcome such dependence mechanism, equation (5) must take into account the presence of financial crises in a strategy similar to that adopted by Mourougane and described in the previous section, which reasonably holds: inserting a variable $C_{i,t}$, which equals 1 if there was a crisis in year *t-1*, the previous year, and captures previous crises.

$$\forall k = 1...T$$
$$y^*_{i,t+k} - y^*_{i,t} = \alpha_{i,k} + \theta_k C_{i,t} + \sum\nolimits_{j=1}^{l} \beta_{j,k} \Delta y^*_{i,t-j} + \delta_k FR_{i,t} + \varepsilon_{i,t+k} \qquad (6)$$

$C_{i,t}$, is constructed following the approach by Laeven and Valencia (2012), in identifying all systemic banking, currency, and sovereign debt crises.

Furthermore, it is crucial to provide a definition of fiscal restriction, as meant when referring to the dummy variable $FR_{i,t}$ in the model. Fiscal restriction is intended to be the increase in the cyclically-adjusted primary surplus by at least 1.5% of GDP on an annual basis (following Alesina, 2009).

This approach of considering only major differentials in deficit management is another response to the previously outlined matter of endogeneity: fiscal policy clearly depends on economic and financial situations. A critical assumption is that "at least up to a point the decision of whether or not to act on the spending side or the revenue side of the government is dictated by political preferences and political bargain which is, at least to a point, exogenous to the economy and generated by ideological or policy preferences. Looking at the debates proceeding major fiscal

changes, and considering the high degree of uncertainty about the size of fiscal multipliers this assumption holds some water." (Alesina, 2009)

4.5. Crisis effects across countries and over time

Equation (6) presents some other issues to be dealt with. It would assume that hysteresis effects do not vary to a great extent from country to country, but in reality, it is evident that the resilience of the labor markets depend on country-specific structural differences. These are certainly accounted for by country fixed effects, but country fixed effects capture many other differences that are not specified in the notation, such as the quality of institutions, the legal system, etc. In an ideal setting, the best solution would be to estimate country-specific hysteresis coefficients, but in this case the little degree of freedom (due to data availability) does not allow to proceed in such way. The alternative path chosen by Mourougane (2017) is to introduce an interaction term through which the crisis impact will also depend on the extent of hysteresis experienced by individual countries.

$$\forall k = 1...T$$

$$y^*_{i,t+k} - y^*_{i,t} = \alpha_{i,k} + \theta_k C_{i,t} + \sum_{j=1}^{l} [\beta_{j,k} \Delta y^*_{i,t-j} + \mu_{j,k}(\Delta y_{i,t-j} - \Delta y^*_{i,t-j}) +$$
$$\rho_{k,j}(\Delta y_{i,t-j} - \Delta y^*_{i,t-j}) FR_{i,t}] + \delta FR_{i,t} + \varepsilon_{i,t+k} \quad (7)$$

Where the crisis effect on potential growth is in part independent on the country (δ_k) and in part country-specific $\rho_{k,j}$ ($\Delta y_{i,t-j}$ - $\Delta^* y_{i,t-j}$). Furthermore, the proposed estimation relies only on one lag ($l = 1$) and provides only one prediction ($k = 1$) due to the scarceness of data. The main drawback to such a major simplification is the impossibility to comment the impact of the variables over a longer time span, i.e. $k = 2, 3, ... T$.

However, as will be seen in the following paragraph, the available framework still allows to conclude on some significant results.

5. Results

Regressing equation (7) leads to various interesting results. As can be seen in the summary statistic in Annex A, the R^2 is not so large (32%), indicating quite highly volatile, noisy data. However, even highly volatile, noisy can have a significant trend. This is the case: θ_k, $\beta_{j,k}$, $\mu_{j,k}$ are all significant at the 95% confidence level and δ_k is significant at the 90% level, while $\rho_{k,j}$ is definitely not significant.
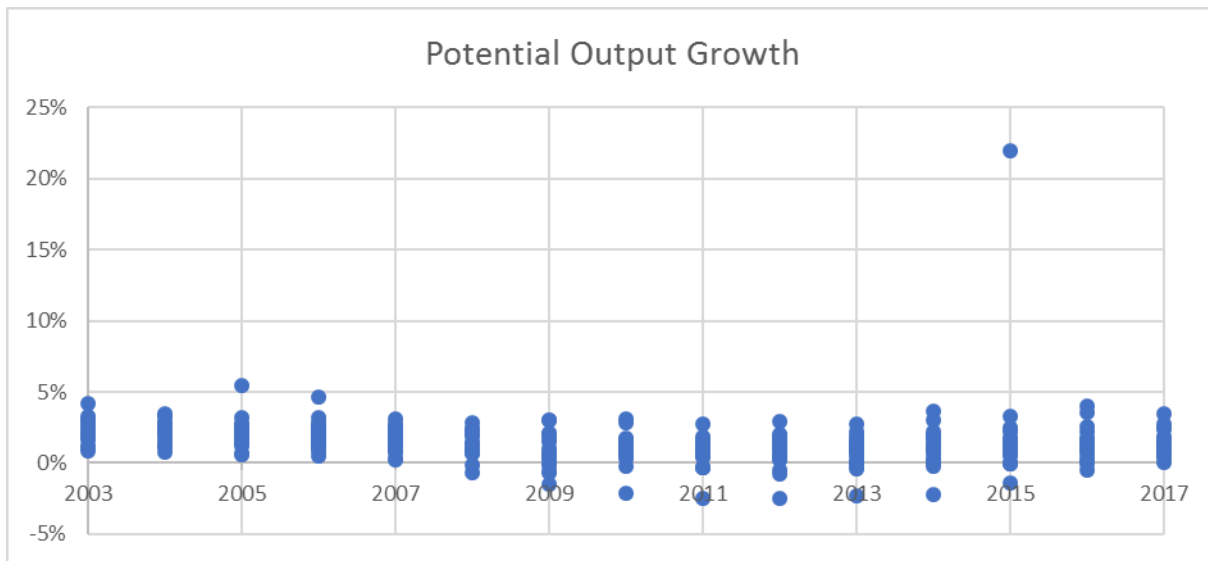
This means that, with 95% confidence, having had a major systemic banking, currency, sovereign debt crisis ($C_{i,t} = 1$) does have a significant impact on potential output growth. Similarly, potential output growth is significantly dependent on its first lag. Also, potential growth is significantly correlated with the growth in the previous year of the output gap. $FR_{i,t}$, i.e. a year of strong (at least 1.5% of GDP) fiscal restriction, instead is significant only at the lower 90% confidence interval.

Looking more in detail into the variation of potential GDP growth over time, some important conclusions can be drawn. First of all, by considering the group of countries in the dataset as a whole. This way, in the period 2003-2017 presented in Figure 13, it can be seen that data are very compact and variability is limited. There is only one remarkable outlier, i.e. Ireland in 2015, when the country's GDP grew by a remarkable 26.3% with respect to 2014, due to the inclusion in the country's corporate private sector of a set of foreign companies that switched their base to Ireland.[9] Obviously, such a momentous rate of growth in output, also affected the rate of growth of potential output.

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[9] For more details about Ireland's 26% GDP growth rate in 2015:
https://www.theguardian.com/business/2016/jul/12/irish-economic-growth-revised-figures-foreign-investment-aircraft

**Figure 13: Potential output growth in the dataset countries (2003-2017)**

Source: Author's elaboration of IMF's WEO Database (July 2017)

Another outcome that is easily visible in Figure 12 is that in this period potential GDP mostly increased. Even in the harsher years of the Great Recession and of the Eurozone sovereign bond crisis, most countries had a positive variation in potential output. Whether this is feasible and logical, it is a matter of evaluation, since, it is noteworthy to repeat, potential GDP and the output gap are estimates, not hard data.

Abandoning a yearly-based analysis and adopting a country-based one for the very same data, allows to infer some other interesting facts. The picture is provided by Figures 14 and 15 and permits to compare in the various histograms, in one case the growth of potential output, and in the other case the output gap growth, between countries.

The largest variations in potential output growth can be seen for Greece, Ireland and Spain, with Italy and Portugal very close to zero, and Greece even negative. On the other hand, Australia seems to have the most compact (and among the highest) data for potential GDP growth.

Figure 14: Potential Output Growth Rates per Country (2003-2017)
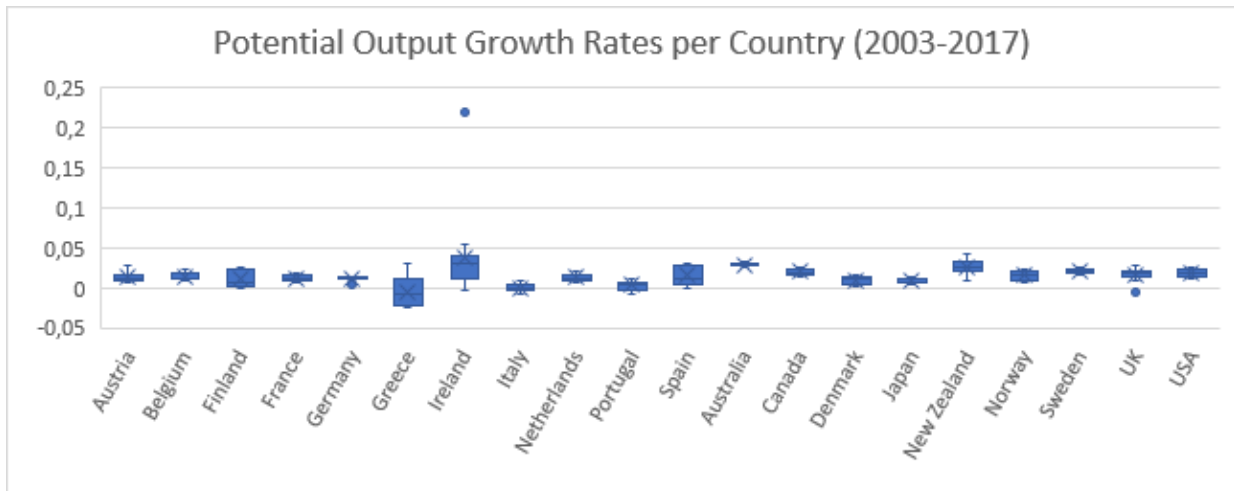
Source: Author's elaboration of IMF's WEO Database (July 2017)

Figure 15: Output Gap Growth Rates per Country (2002-2016)
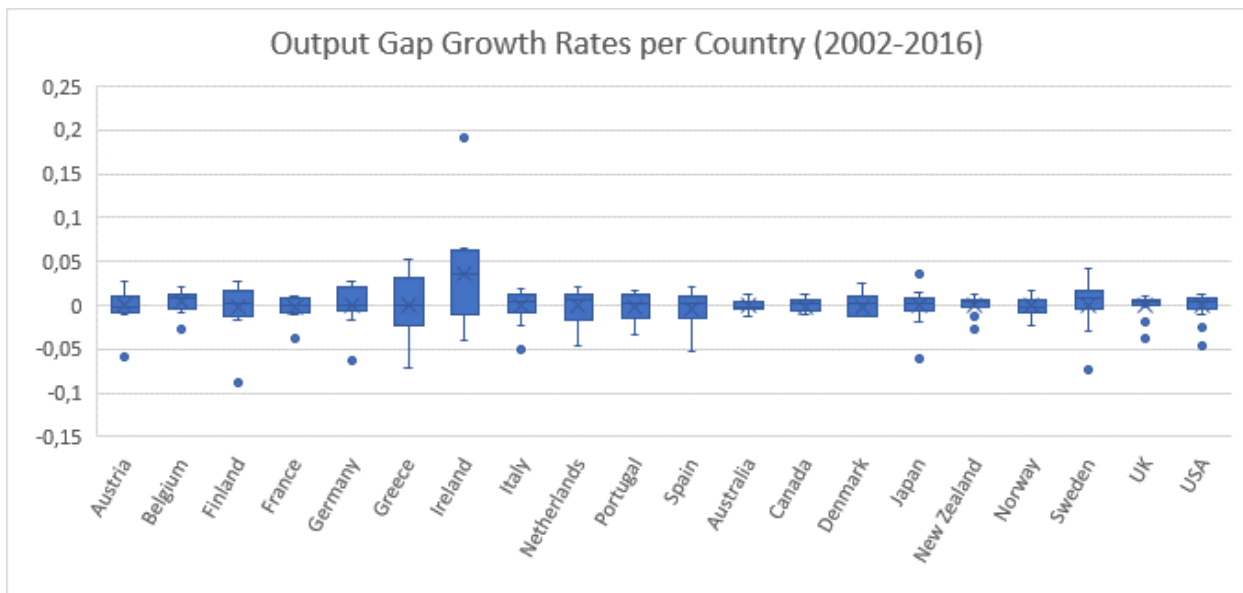
Source: Author's elaboration of IMF's WEO Database (July 2017)

Evidently, output gap growth is most variable for Greece and Ireland. Once again, it is Australia that sees the least variation in variability.

If Going back to the regression of equation (7), a graphical interpretation of the impact of $\mu_{j,k}$ is provided by Figure 16.

Figure 16: Potential GDP growth vs. Output gap growth (2003-2017)
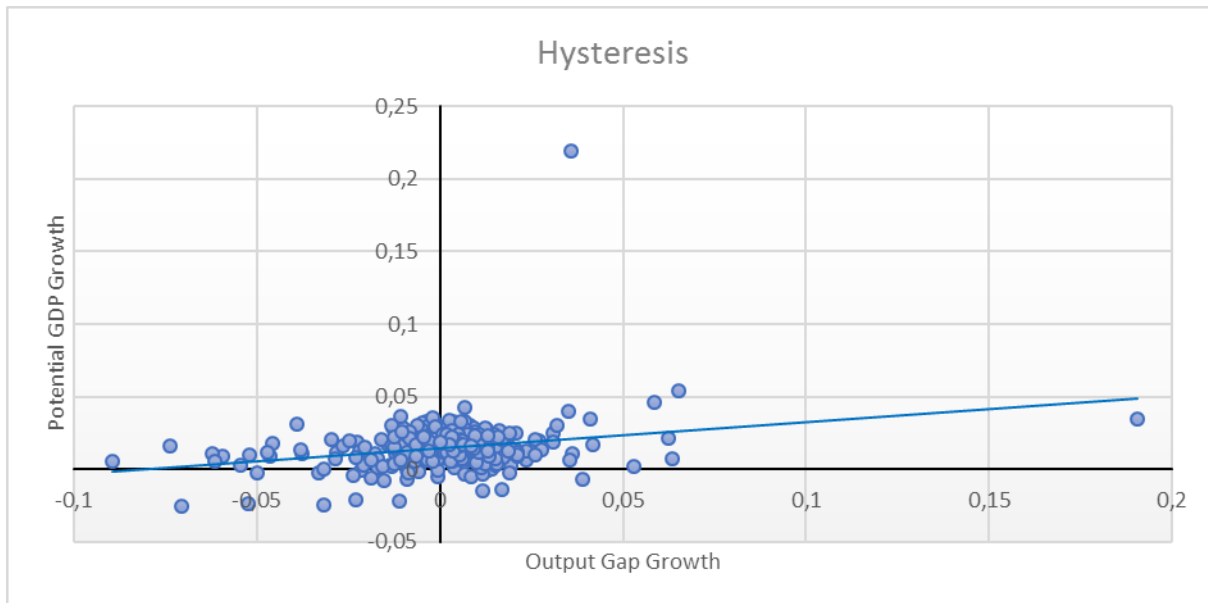

Source: Author's elaboration of IMF's WEO Database (July 2017)

The figure plots the level of output gap growth on the x-axis versus the level of potential output growth on the y-axis. As highlighted by the blue fitted line, there is a positive correlation, which the regression output shows to be significant, among the two variables. The slope of the fitted line is positive and smaller than 1. Since values are quite small, they are all concentrated around the origin; however, the above-mentioned outlier given by Ireland is present and evident also in this plot as the most unpredictable value.

In short, it seems reasonable to state that, since both the descriptive statistic deriving from the observation of the plot in Figure 16 and the results cited in Annex A denote a correlation, the hysteresis effect $\mu_{j,k}$ is a significant, positive coefficient in equation (7).

Hysteresis, as modeled in this framework, thus has a significant, positive impact on the rate of growth of potential output. In other words, an increase in the output gap will impact positively the potential GDP growth rate one year from now. Holding the assumption that endogeneity, as expressed in previous chapters, does not affect the causal relationship at the basis of equation (7).

Such results should be considered with caution, together with the setting the model was built in and with all the previously explained limits of estimates and datasets used. Still, they provide a tentative model with a series of interesting implications, in a yet-to-be-developed field of economics.

6. Conclusions

The perspective of this paper is to try offer a tentative contribution to the studies on the effects of strong crises on potential growth. It is a crucial topic for today's economics, since all major political decisions on fiscal policy depend on the answer that could be given to such an issue. The starting point has been the model developed and used by Annabelle Mourougane in 2017 through which she confronted hysteresis and its effects on potential output growth. The model has been slightly redefined with the use of a different dummy variable and of a different dataset. The dummy variable introduced is whether the country experiences a fiscal consolidation of at least 1.5% of GDP, as defined by Alesina and Ardagna in 2009. The dataset is a group of 20 developed countries – 11 in the Eurozone and 9 with non-Euro currencies – with data taken from the IMF's World Economic Outlook Database, as updated in July 2017.

What can be said, keeping in mind the limitations due to the lack of thorough, completely credible data, their short time span, their availability only in annual form, is that strong crises impact the growth of potential output. Also, hysteresis is present and part of the impact in a significant way.

Because of the above-mentioned concerns regarding data, a relevant assumption has been made: Mourougane's model and this paper's setting would allow for various lags for growth in potential output.

A very important part of the argument in favor of strong fiscal consolidation, even in times of economic downturn, not only in response to automatic stabilizers, but also for reputational and credibility purposes in presence of highly indebted sovereign countries, is that crises do not impact potential output. Crises would reduce output, which would shortly recuperate and readjust itself to potential output levels. However, it has been suggested that this is not the case and that, even in a very reduced time frame, also potential output growth is significantly affected. Clearly, it would be important to further assess the way through which this happens.

A second noteworthy conclusion is that, in order to have a better understanding of these relationships, data collection and availability should be enhanced. Output gaps and potential output are estimates. This however does not mean they should not be improved. Provision of semestral or trimestral data, in addition to annual ones, would be very helpful in order to restrict timing and having a clearer picture of responses to crises or harsh fiscal restrictions. There is no general consensus on how to deal with analyzing data, searching for hysteresis effects. However, it seems

more than reasonable to deepen the knowledge on the topic. The effects can be overwhelmingly relevant for fiscal policy decision makers.

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Annex A

Summary Statistic of the regression model from equation (7)

$$y^*_{i,t+k} - y^*_{i,t} = \alpha_{i,k} + \theta_k C_{i,t} + \sum_{j=1}^{l} [\beta_{j,k} \Delta y^*_{i,t-j} + \mu_{j,k}(\Delta y_{i,t-j} - \Delta y^*_{i,t-j}) + \rho_{k,j}(\Delta y_{i,t-j} - \Delta y^*_{i,t-j})FR_{i,t}] + \delta FR_{i,t} + \varepsilon_{i,t+k}$$

```
Number of obs =      300
F( 5,   294) =    27.37
Prob > F      =   0.0000
R-squared     =   0.3176
Adj R-squared =   0.3060
Root MSE      =   0.0136
```

```
      Source |      SS         df         MS
-------------+------------------------------
       Model |  0.02533235     5   0.00506647
    Residual |  0.05442669   294   0.00018513
-------------+------------------------------
       Total |  0.07975904   299
```

```
------------------------------------------------------------------------------
   potgrowth |    Coef.    Std. Err.     t      P>|t|    [95% Conf. Interval]
-------------+----------------------------------------------------------------
      crisis | -.006112     .002470    -2.48    0.014    -.010980    -.001256
    potgrlag |  .4670662    .050128     9.32    0.000    .3684113    .5657209
      outgap |  .0804227    .038779     2.07    0.039    .0041037    .1567417
    outgapfr |  .0560331    .0949027    0.59    0.555    -.130742    .2428079
          fr | -.003738     .0021576   -1.73    0.084    -.007985    .0005084
       _cons |  .0087719    .0012493    7.02    0.000    .0063132    .0112307
------------------------------------------------------------------------------
```