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**"THE DYNAMICS OF THE ITALIAN TREASURY AUCTION  
MECHANISM: A THEORETICAL AND EMPIRICAL ANALYSIS"**

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## Introduction

The treasury auction mechanism represents the very basis for stability in financial and general economic health in any given country. In Italy, the auction process of government bonds is of primary importance in the management of public debt and the maintenance of financial market stability. Efficiency and optimality of the auction mechanism, however, continue to remain subjects of ongoing debate in a scenario of dynamic economic conditions and regulatory frameworks. The purpose of this thesis will be to delve into the details of how the mechanism of Italian treasury auctions works and try to provide an analysis of the dynamics involved. This work will seek to explore the main factors influencing the bond transactions within this framework by integrating a review of the existing literature with the examination of mechanisms of auction in use. A central focus is therefore placed on understanding how this mechanism works in terms of cost and demand dynamics, as well as how it responds to external economic shocks, such as those triggered by quantitative easing policies. The knowledge of these dimensions, especially how the auction operates and how it works out in the stabilization of the markets and its sensitivity to macroeconomic interventions, provides critical insights into possible ways that the Italian Treasury might adopt in order to improve the issuance process.

In particular, the first chapter offers an in-depth examination of the operational framework of the Italian Treasury auctions. It details the key characteristics and processes involved in bond allocation, providing a description of the functioning of this mechanism. This chapter provides also a short overview of the role of the specialists and the dynamics of the primary and secondary markets, with the aim of facilitating a more exhaustive understanding of the processes associated with bond issuance and sale. Furthermore, it presents the mechanisms adopted by other countries offering a brief international overview of the auction process for government bonds. Finally, it presents the price determination mechanisms used in Italian government securities auctions, providing illustrative examples of the two different types of auction processes: a competitive auction for the issuance of 12-month BOTs and a marginal auction for the issuance of 10-year BTPs.

The second chapter provides definitions of the variables used in this analysis, along with the methodologies for the main indicators adopted to evaluate the efficiency and effectiveness of the auctions in the subsequent sections.

The third chapter shifts the focus to a data-driven examination of the Italian Treasury auctions. Employing historical auction data, this chapter presents a brief description of the ratios computed aiming to analyze the performance of the auction mechanism adopted based on the definitions presented in the previous chapter. In particular, the bid-to-cover ratio, which is a key indicator of demand for government debt, the evolution of the gross yield at issuance, which

provides information on the cost of borrowing for the Treasury and on the return for investors, and the analysis of debt dynamics, with a focus on the average life of debt and the debt-to-GDP ratio, all contribute to the provision of a general picture of the functioning of the mechanism adopted for the issuance of government securities on the primary market.

The fourth chapter explores the indirect effects of the European Central Bank's quantitative easing (QE) programme on Italian treasury auctions, focusing on how unconventional monetary policy interventions in the secondary market influence primary market conditions for sovereign debt issuance. By examining dynamic responses of some critical variables, such as yields, bid-to-cover ratios, and investor demand, the model estimated seeks to investigate the transmission mechanisms through which quantitative easing policies affect the issuance strategies in the primary market. This type of analysis opens an engaging pathway for future research.

In conclusion, the objective of this thesis is to give an overview of how Italy approaches debt management in an increasingly complicated financial environment. More precisely, this analysis tries to shed light on the auction mechanism supporting the issuance of Italy's public debt, providing some insights about its efficiency and its operational features through the key performance indicators previously outlined. This work also attempts to take a first step toward a model that will analyze how the auction process responds to exogenous shocks, therefore providing evidence on the robustness and flexibility of Italy's debt issuance system in different market conditions. Therefore, this thesis tries to contribute meaningfully to the discussion on primary auctions management of the Treasury by incorporating literature review and data analysis.

# **1. Structure of the Italian treasury auction mechanism**

## **1.1 Government bond issuance methods**

The issuance of government bonds can be conducted through different methods, each one selected to achieve a specific objective and align with prevailing market conditions. One common method is that of public auction, which aims not only to guarantee a high level of competition and transparency in the process, but also to facilitate widespread access for a diverse group of investors. An alternative option is for bonds to be placed through a syndicate of banks, selected from Government Bond Specialists, who are responsible for collecting and managing final orders from investors. This is often referred to as a placement syndicate. Another option involves the use of electronic trading platforms, which provide a more streamlined and accessible process for issuing bonds (Ministry of Economy and Finance, (B) <sup>1</sup>). The Italian Treasury tends to prefer public auctions, which are considered an efficient method to guarantee transparency and wide investor participation, but it typically relies on a placement syndicate for the issue of bonds in the domestic market. For instance, syndicates are often utilized when new financial instruments are being introduced, such as the first issuance of BTP€is in 2003 and CCTeus in 2010. Furthermore, the use of a syndicate may be warranted when a more comprehensive assessment of market conditions is required, particularly regarding the evaluation of investor interest, the determination of the optimal quantity of bonds to offer, or the establishment of the most suitable issue price. This approach is commonly adopted for long-term BTPs and BTP€is, where the complexity of the instruments and the need for precise market assessments make this method more suitable (Ministry of Economy and Finance, (B)). In the next sections, public auctions will be the focus since this thesis aims to provide a better understanding of their mechanisms and to present a data-driven examination of the Italian Treasury auctions for government bonds.

## **1.2 Main types of treasury auctions**

Treasury securities are issued through two different types of auctions: the multiple price auction, also known as competitive or American auction, and the uniform price auction, also called Dutch auction (Public Debt Management Office Department of The Treasury, 2000). The competitive auction provides that each bid is satisfied at the price offered and the first bids to be accepted are those with the highest prices while all the others are subsequently satisfied in

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<sup>1</sup> Note that (A), (B), (C), (D), (E), (F) and (G) are adopted to distinguish the references from different pages of the Ministry of Economy and Finance's website. Please refer to the section "online sources" of the references to ascertain which web page the corresponding citation pertains to.

descending order until the total quantity of accepted bids matches the amount offered by the Treasury. For what concerns the uniform price auction, all the bids are auctioned at the same price, known as “marginal price”, which is determined by fulfilling bids starting with the highest price, continuing until the total accepted bids equal the amount offered. In the following table (Table 1), there is a summary of the two types of auctions with the names adopted for each one and their main features.

**Table 1 - Summary of competitive and marginal auctions**

	<b>Competitive auction</b>	<b>Marginal auction</b>
<b>Other names</b>	Discriminatory, Multiple, American	Uniform, Non-competitive, Dutch
<b>Allotment price</b>	Each bid is satisfied at the price offered	All the bids are auctioned at the same price (the marginal price)
<b>In Italy is adopted for...</b>	BOTs	CTZs, BTPs, CCTeus and BTP€is

From the two previous descriptions and based on the information provided by Milton Friedman in an interview with the Wall Street Journal (Friedman, 1991), it can be deduced that a uniform price auction proceeds in a manner analogous to that of a discriminatory one, with the crucial difference being that in the former, all bidders pay the same price, which is also referred to as the "cut-off price" (Monostori, 2014). To evaluate the effectiveness of the auction mechanism employed by Italy, which is a principal objective of this analysis, it is essential to recognize that a uniform price auction and a discriminatory auction cannot be ranked based on their efficiency. As argued by Viswanathan and Wang (2000), the optimal auction format for the auctioneer's expected revenue is contingent upon the circumstances. In the event of non-competitive bids being submitted for considerable sums, the elevated aggregate demand increases the expected revenue from uniform price auctions. Conversely, in other scenarios, the discriminatory-price format is more lucrative for the Treasury (Viswanathan and Wang, 2000).

The recognition that uniform price auctions and discriminatory auctions cannot be definitively ranked in terms of efficiency marks a substantial advancement in the research field. This challenges the long-standing Friedman argument, which asserted the superiority of the uniform-price format due to the “winner's curse”. In a discriminatory price auction, smaller participants may be concerned that their valuations and bids could significantly exceed the market valuation, potentially resulting in substantial losses on their winning bids due to the winner's curse.

Conversely, in uniform price auctions, the final auction price is typically aligned with the post-auction secondary market price, which can provide smaller participants with greater assurance in participating in this type of auction (Monostori, 2014). Overall, as stated by Monostori (2014) in his paper “Discriminatory versus uniform-price auctions”, the primary argument against discriminatory price auctions is that the fear of the winner's curse may lead participants with limited analytical capacities to shade their bids or even avoid the market, thereby reducing demand. Conversely, discriminatory price auctions provide less opportunity for dominant market players to exert their market power compared to uniform price auctions, leading to steeper bid curves. These claims reinforce the idea that it is not possible to rank uniform price and discriminatory price auctions based on theoretical models using the expected revenue of the seller as a criterion. The format that is more advantageous in each situation is likely to depend on different factors, including the bid-to-cover ratio, the number of participants, and the market uncertainty (Monostori, 2014).

Furthermore, it is relevant to highlight that a review of global data reveals that a greater number of government bond issuers employ a discriminatory price format, while the exclusive use of the uniform price format is less prevalent among countries (Monostori, 2014). Table 2 summarizes a few countries and the mechanisms they use as an example, based on the responses to a survey conducted by Brenner, Galai and Sade (2009) in their paper "Sovereign debt auctions: Uniform or discriminatory?".

**Table 2 - Countries using various auction mechanisms**

<b>Country</b>	<b>Treasury auction mechanism</b>
Belgium	Discriminatory
France	Discriminatory
Germany	Discriminatory
Greece	Discriminatory
Italy	Both
Portugal	Discriminatory
Spain	Both
Switzerland	Uniform
United Kingdom	Both
United States	Uniform

For what concerns our analysis, it is important to emphasize that the Italian treasury makes use of two kinds of auctions: a competitive yield auction for BOTs, as previously mentioned, and a marginal price auction for CTZs, BTPs, CCTeus and BTP€is.

To gain a deeper comprehension of the Italian treasury auction mechanism, it is essential to have a clearer understanding of the distinctions between the different categories of government securities.

### **1.3 Italian marketable securities**

The Italian government finances its expenditures in excess of tax revenues through the issuance of debt securities, a responsibility that falls within the purview of the Department of the Treasury. The overwhelming majority of public debt is in the form of marketable securities that are issued via scheduled auctions, which are collectively referred to as "primary market". The Italian Ministry of Economy and Finance determines the regular issuance, on the domestic market, of eight categories of government securities available for both private and institutional investors: Treasury Bills (BOTs), Treasury Certificates (CCTeus), Treasury Bonds (BTPs), Treasury Bonds Green (BTP Green), Treasury Bonds Linked To Euro-Zone Inflation (BTP€is), Treasury Bonds Linked To Italian Inflation (BTP Italia), Treasury Bonds Step-Up For Retail Investors (BTP Futura) and Treasury Bonds For Retail Investors (BTP Valore) (Ministry of Economy and Finance, (B)). The last three categories are mainly dedicated to retail investors. These include both families (individual savers, natural persons) and small/medium enterprises that do not carry out financial intermediation activities (and fall within the definition of retail clients under MIFID II). In particular, BTP Italia can be held by any operator, but its purchase was typically reserved for retail investors in the first days of placement. A concise overview of the characteristics of each bond type is essential to facilitate the understanding of the underlying dynamics of their issuance mechanisms.

BOTs are financial instruments with a maturity period of one year or less, which are traded on regulated retail and wholesale markets. Those intending to purchase Treasury Bills through an auction are required to reserve the desired amount via an authorized intermediary on the preceding business day. Since April 2009, this type of government securities has been placed through competitive auctions in which dealers' bids are expressed in yield rather than price terms. Authorized intermediaries are permitted to place up to five bids, each of a minimum value of 1,5 million euros. They must indicate the nominal value to be subscribed and the relative yield (Ministry of Economy and Finance, (F)).

Treasury Certificates indexed to Euribor (CCTeus), as all floater bonds, offer a yield that is in line with market yields. Moreover, due to their linkage to the Euribor, CCTeus provide an effective means of risk management (hedging) for investors, both institutional and retail, whose liabilities are contingent upon the Euribor trajectory (Ministry of Economy and Finance, (F)). Similarly to other government bonds, they are traded on a regular basis on the electronic government bond market (MOT) in limited quantities and on the electronic wholesale spot market of Government Bonds (MTS) (Ministry of Economy and Finance, (F)). Additionally, they can be traded on all other non-regulated electronic platforms and on over-the-counter (OTC) markets (Ministry of Economy and Finance, (F)).

BTPs are medium- to long-term securities featuring fixed coupons, making them particularly suitable for investors seeking consistent semi-annual payments. They are issued with maturities from 18 months to 3, 5, 7, 10, 15, 20, 30 and 50 years. This range of maturities allows investors to strategically plan regular cash flows throughout the year. Additionally, BTPs are highly valued for their liquidity. Prior to maturity, institutional investors can buy or sell BTPs in regulated secondary markets (MTS) for transactions starting from €2.5 million, as well as in over-the-counter markets. Retail investors can engage in similar transactions in the regulated secondary market MOT (Government Bond and Securities Electronic Market) with a minimum trade size of €1,000 (Ministry of Economy and Finance, (F)). These government securities are offered through a marginal auction, whereby the price and quantity issued are subject to discretionary determination. A mechanism of speculative bid exclusion is in place and is described in detail in each issuance decree. The same decree sets supplementary placement terms, which are reserved for specialists in government bonds. The quota reserved to Specialist is equal to 30% of the amount allocated in the ordinary auction for the first tranche and 15% for further tranches. Only specialists who took part in the last auction, have access to this supplementary placement (Ministry of Economy and Finance, (F)).

Green BTPs are the new sustainable finance government bonds designed to support public expenditures with positive environmental impact (Ministry of Economy and Finance, (F)). This is achieved through the utilization of the proceeds derived from the issuance of these bonds, which in turn facilitate the country's ecological transition. They are medium- and long-term government bonds with the same features of the other nominal BTPs: consequently, they guarantee fixed semi-annual coupon payments, the amount of which is determined by the coupon rate and the reimbursement of the face value at maturity (Ministry of Economy and Finance, (F)). At the discretion of the Italian Treasury and based on market conditions, these securities can be issued through syndicated placement or marginal auction with discretionary determination of price and quantity issued (Ministry of Economy and Finance, (F)).

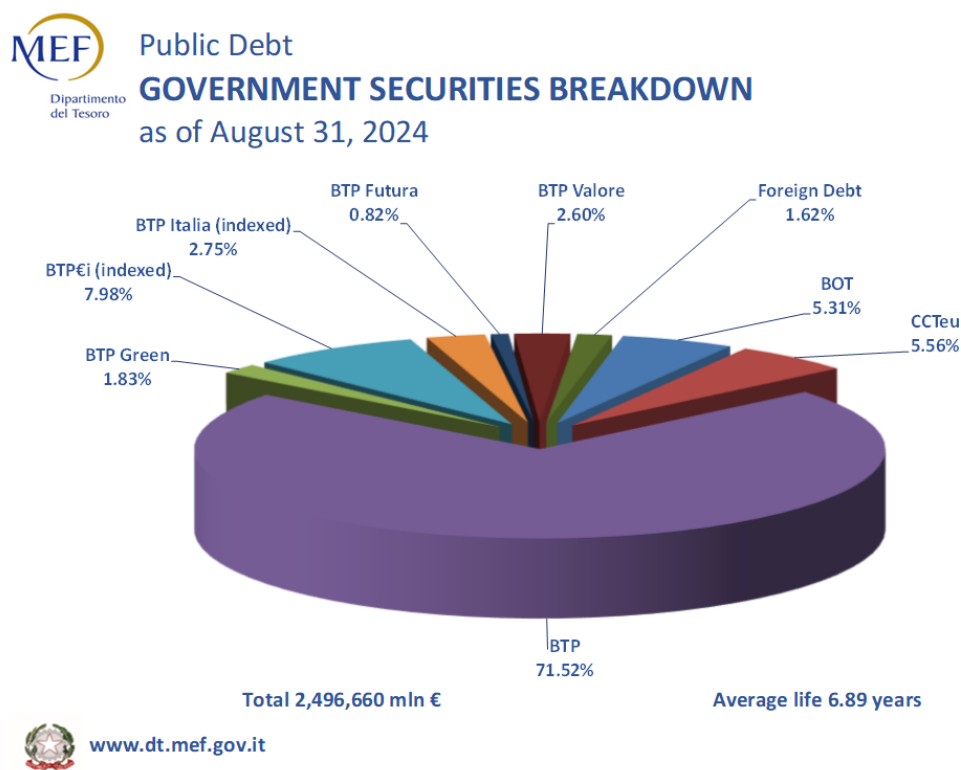
Treasury Bonds linked to Euro-zone inflation (BTP€is) are securities that offer investors a degree of protection against the risk of price increases. The principal to be redeemed at maturity and the coupons, paid semiannually, are adjusted for inflation in the Eurozone. BTP€is are issued with maturities 5, 10, 15 and 30 years. These are medium- to long-term floating-rate bonds, specifically designed for investors seeking semi-annual payments tied to inflation rates, particularly within the euro area, and aiming to maintain the real value of their invested capital over time. Until September 2004, BTP€is were issued exclusively through placement syndicates that had been established for this specific purpose. Subsequently, these bonds have also been issued via a marginal auction, in which both the auction price and the nominal amount issued are determined at the discretion of the relevant authorities within a pre-announced range. A maximum issuance limit is set, along with a mechanism to exclude speculative bids, which is detailed in each issuance decree (Ministry of Economy and Finance, (F)).

The BTPs Italia represents a new government security offering that provides investors with protection against an increase in the level of prices in Italy (Ministry of Economy and Finance, (F)). Both the coupons, which are paid semi-annually, and the principal are indexed to the Italian inflation rate. Because of the indexation mechanism deployed, the principal subscribed is revalued every six months, thereby enabling the holder of the security to recuperate any loss of purchasing power that may have occurred during this period. Moreover, the coupons, which are also paid on a semi-annual basis, yield a constant minimum return in real terms (Ministry of Economy and Finance, (F)).

BTPs Futura are government bonds specifically designed for individual savers and similar investors, targeting the retail market. They are named "Futura" to emphasize their dual purpose: safeguarding savings while also contributing to the "future of the country," particularly in terms of addressing the health and economic challenges brought about by the COVID-19 crisis. These securities are offered on the MOT platform, Borsa Italiana's electronic market for bonds and government securities, and investors can purchase them through banks, post offices, or online via internet banking, provided they have access to trading functions (Ministry of Economy and Finance, (F)).

Finally, BTP Valore is a newly introduced series of government bonds, with initial emission occurred in 2023, designed specifically for individual investors and other similar retail market participants, offering various maturities and periodic coupon payments. The BTP Valore is placed on the market via the MOT electronic platform, which is the Italian stock exchange's electronic market for bonds and government securities. This placement is conducted through the dealer banks (Ministry of Economy and Finance, (F)).

Provided the description of the main Italian government securities, it is relevant to observe that, as evidenced by Figure 1, the public debt can be breakdown by government security. From the latest data provided by the Department of the Treasury, it can be assessed that more than half of the marketable Treasury debt outstanding is in the form of BTPs (71,52%), whereas BTP€is, CCTeus and BOTs represent respectively the 7,98%, the 5,56% and the 5,31%.



**Figure 1** - *Public Debt: government securities breakdown (as of August 31, 2024).*

*(Source: Ministry of Economy and Finance, (E))*

The aforementioned government bonds are issued by the Treasury in the primary market, in accordance with the methods delineated in the initial paragraph. After their issuance, they can be traded in the secondary market. The following paragraph will therefore provide an overview of these two markets, with a particular focus on the primary market, which is the main subject of the analysis conducted in the subsequent chapters.

#### **1.4 Primary and secondary markets and the role of specialists**

Primary dealers may purchase government bonds at either the primary market, which is where bonds are first issued, or the secondary market, where they are traded on a daily basis. Indeed, the participation of dealers in auctions is restricted to a selected group, designated as primary

dealers, who are required to meet minimum participation standards in the auction and minimum quoting obligations on the secondary market (Beetsma, Giuliadori, Hanson and de Jong, 2020). Private investors cannot participate directly to the public auctions, so they are required to engage with a banking institution or a duly qualified financial intermediary in order to buy the debt securities from them (Ministry of Economy and Finance, (G)). To ensure transparency, it is a legal requirement for banks to clearly display the dates on which auctions of the various types of government bonds will take place and, above all, the dates within which investors will be permitted to book them. Consequently, clients need to be well-informed to make conscious investment choices (Ministry of Economy and Finance, (G)).

Government bond auctions offer primary dealers a unique opportunity to acquire securities with minimal transaction costs. For most government bond types, these investors benefit from the absence of fees, except for BOTs. To participate in these auctions, they must adhere to specific procedural requirements that aim to facilitate efficient market operations and allow for proper allocation planning. To promote transparency and accessibility, detailed information regarding these bond auctions is made publicly available. This includes an auction calendar, which provides a chronological overview of upcoming offerings. Indeed, at the conclusion of each calendar year, the Treasury prepares and publishes the subsequent year's annual auction calendar, together with the public debt management guidelines (Ministry of Economy and Finance, (B)). This is done to provide dealers with sufficient advance notice of the frequency of auction placements and the quality profile that will inform the issuance policy during the forthcoming year. The "Annual auction calendar" provides details regarding the dates of all scheduled issue press releases, auctions, and settlements, classified according to bond category. Additionally, the "BOT auction calendar" is published, delineating the specifics pertaining to bonds within this segment for the year, including issue and maturity dates (Ministry of Economy and Finance, (B)). Furthermore, a press release is published prior to each auction, typically two business days in advance. In addition to disclosing the bonds to be issued and their attributes, it also specifies the quantities to be offered in the auction and provides a comprehensive list of relevant dates, including the bond settlement date (Ministry of Economy and Finance, (B)). Following each auction, the results are promptly published, allowing market participants and observers to analyze the outcomes. Table 3 provides a summary of the timeline of the issuance and publication process, along with the corresponding documents. The dissemination of this information through official channels ensures that all citizens, regardless of their level of financial knowledge, can easily access and comprehend the intricacies of government bond issuances. This commitment to transparency not only fosters an informed investor base, but also

contributes to the overall efficiency and integrity of the government securities market (Ministry of Economy and Finance, (G)).

**Table 3 - Summary of government bond auction documentation**

<b>Document</b>	<b>Content</b>	<b>Publication date</b>
<b>Annual auction calendar</b>	Dates of all scheduled issue press releases, auctions, and settlements, classified according to bond category	End of previous year
<b>BOT auction calendar</b>	Specifics pertaining to BOTs for the year, including issue and maturity dates	End of previous year
<b>Press release</b>	Bonds to be issued and their attributes, quantities to be offered in the auction and a list of relevant dates	Two business days before auction date
<b>Auction results</b>	Outcomes of the auction	Auction date

Additionally, investors can buy outstanding government bonds on the secondary market. In the context of secondary market transactions for government bonds, financial institutions, including banks and other intermediaries, are permitted to impose fees on their services (Ministry of Economy and Finance, (G)). However, these institutions are bound by regulatory requirements to disclose such fees transparently to their clients. This transparency enables investors to engage in negotiation regarding fee structures, potentially leading to more favorable terms. Moreover, the secondary market guarantees the liquidity of government securities that allows bondholders the flexibility to divest their positions prior to the bond's maturity date, with the sale price determined by prevailing market conditions. In Italy, the secondary market for government securities is overseen by Borsa Italiana S.p.A., which operates the MOT (“Mercato Obbligazionario Telematico”, or Electronic Bond Market). This platform serves as the primary venue for retail investors to engage in the buying and selling of government bonds and other fixed-income securities. Access to this market is typically mediated through financial intermediaries, who execute trades on behalf of their clients (Ministry of Economy and Finance, (G)). It is worth noting that the secondary market for Italian Government Bonds ranks as the third largest globally in terms of both size and trading volume. Government bonds constitute 84% of the total bond market in Italy, with fixed-rate bonds (BTP), inflation-linked bonds (BTP€I and BTP Italia), and floating rate notes (CCT) accounting for nearly 90% of outstanding government debt securities (Association for Financial Markets in Europe, 2015).

Specialists, also known as primary dealers, play a critical role in the wholesale electronic government securities market, acting as key intermediaries and market makers. These individuals, typically major international or national commercial banks, are granted exclusive rights to participate in government bond auctions and supplementary placements (Ministry of Economy and Finance, (C)). In return, they are subject to specific obligations, such as purchasing a minimum amount of debt during auctions and providing liquidity in the secondary market by consistently quoting prices for these bonds. Subsequently, primary dealers sell the purchased debt to other market participants, including institutional investors such as pension funds. Notwithstanding the aforementioned obligations, primary dealers are afforded certain privileges, including financial incentives from Debt Management Offices (DMOs). For instance, in Italy, they receive a commission that ranges from 0,20% to 0,40% of the allotted amount. This may exert an influence on both the primary and secondary market prices for the same instrument (Beetsma, Giuliadori, Hanson and de Jong, 2020). To apply for enrolment in the List of Specialists, market makers in Italian government bonds must satisfy several conditions. They must reside in the European Union, they must be a bank or an investment company, they must operate on regulated markets and/or on wholesale multilateral trading systems whose registered office is in the EU and, finally, they must meet some additional requirements (Association for Financial Markets in Europe, 2015). Specialists in government bonds are assessed, monitored, and ranked by the Treasury Department according to decrees that outline the specific criteria and methodologies used for their evaluation. The selection of leaders among specialists is based on several criteria, including the performance of specialists over a specified period, the contribution of a specialist to the analysis of the market by the Treasury, and the specialist's specific expertise in a particular segment or geographical area (Association for Financial Markets in Europe, 2015).

Candidate specialists who have demonstrated proficiency in line with the Treasury's expectations and who are perceived as having the potential to markedly enhance the outcomes of placement transactions may be extended an invitation to participate in syndicated transactions (Association for Financial Markets in Europe, 2015). While a satisfactory and consistent operational performance by the Specialist is a necessary condition for selection, it is not a sufficient condition itself. The Treasury considers the levels and continuity of the Specialist's role, but its choices are based also on the following criteria: the Specialist's advisory activity related to the specific transaction, the possession of an adequate distributional structure with respect to the operation, and the ability to achieve the targets set by the issuer (Association for Financial Markets in Europe, 2015).

In order to gain a more nuanced understanding of the efficiency of the mechanism employed in Italy, it would be beneficial to undertake a comparative analysis of the alternative approaches adopted by other countries and the key distinctions between these various types of auctions.

## **1.5 Differences in auction types across countries**

Examining the global context can provide valuable insights into the factors that lead to the adoption of the two different pricing mechanisms. The paper of Brenner, Galai and Sade (2009) shows that most countries use the discriminatory method, while fewer countries use the uniform pricing approach. The study also finds that market-oriented economies are more likely to use the uniform pricing mechanism. Countries that use this mechanism are also more likely to be "common law" jurisdictions and, on average, rank higher in terms of "ease of doing business" and economic freedom, and have lower levels of corruption (Brenner, Galai and Sade, 2009).

In this paragraph, the different auction mechanisms of three countries will be presented. In particular, Germany adopts mainly a discriminatory auction system with some exceptions, Spain uses a hybrid system of discriminatory and uniform price auctions similar to the Italian one, and the US chose to adopt the uniform price format in 1998 for two- and five-year notes while keeping the discriminatory auction for the other securities. The selection of these three countries is driven by the objective of illustrating a diverse range of mechanisms adopted. Germany was selected for its predominantly discriminatory framework, which stands in contrast to the more hybrid system observed in Spain, which in turn shares similarities with that of Italy. Lastly, the United States was included to represent a predominantly uniform approach which is the one, as previously said, less common among countries. The United States, given its considerable size, extensive research, and the intriguing evolution of its legal framework, represents a valuable case study for analysis.

### **1.5.1 Germany**

The German Finance Agency, acting on behalf of the Deutsche Bundesbank, is responsible for the sale of a range of financial instruments, including Federal bonds, inflation-linked Federal securities, five-year Federal notes, Federal Treasury notes and Treasury discount papers. These are sold through an auction process. The German Finance Agency is authorized to conduct auctions and other debt management transactions on behalf of the German Federal Government. The range of potential buyers is not subject to any restrictions. Nevertheless, only those who are members of the Bund Issues Auction Group are permitted to participate in the auctions directly (Association for Financial Markets in Europe, 2015).

The one adopted by Germany is a discriminatory auction mechanism or multi-price auction process, where the Federal Government's acceptance of bids is contingent upon the price quoted in the respective bid, which is not subject to a single settlement price (Association for Financial Markets in Europe, 2015). Indeed, the process takes place as follows. The bidders are obligated to honor their bids until the allotment is finalized. Bids for Federal bonds, five-year Federal notes, Federal Treasury notes, and Treasury discount paper that are accepted by the Federal Government will be allotted at the price specified in the bid. Bids submitted at prices above the minimum price accepted by the Federal Government will be fully allotted, while bids below this threshold will not be considered. Non-competitive bids will be allotted at the weighted average price of the accepted competitive bids. The Federal Government retains the discretion to reject all bids, to proportionally reduce bids quoting the lowest accepted price, and/or to scale down non-competitive bids. Bidders will be notified of the allotment immediately, and the allotted securities will be settled on the value date specified in the invitation to bid (Association for Financial Markets in Europe, 2015).

### **1.5.2 Spain**

Bonos and Obligaciones del Estado are the Spanish treasury securities which are characterized by a maturity period exceeding two years. While both Bonos and Obligaciones have identical characteristics, the exception is their respective maturity periods. Indeed, Bonos have a maturity period ranging from two to five years, whereas Obligaciones have a maturity period exceeding five years (Association for Financial Markets in Europe, 2015).

The issuance of these government bonds may follow one or a combination of different procedures, including competitive auction or a competitive process involving a restricted number of authorized institutions. In the latter case, these institutions agree to underwrite the issue or act as counterparties in the secondary market. The Treasury may formalize the arrangements and contracts it deems appropriate with the selected institutions, specifying allocation procedures that differ from the standard auction system and determining the way the issues will be placed. The selection of agent institutions may prioritize financial criteria, commercial capacity, or performance in the debt market. In contrast, Letras del Tesoro are issued exclusively through a competitive auction process (Association for Financial Markets in Europe, 2015). The format of auctions is typically based on a modified Dutch auction structure, which incorporates aspects of the single-price format (or uniform price auction) with elements of the conventional multiple-price auction (or discriminatory price auction). Submitted bids are then classified in descending order of price. As explained in the paper by the Association for Financial Markets in Europe (2015), the General Secretariat of the Treasury, at the proposal of

a committee comprising two representatives from the Bank of Spain and two from the General Secretariat of the Treasury and Financial Policy, determines the nominal amount to be issued and, based on the last bid admitted, the stop-out price or rate, which is used to calculate the marginal interest rate. All bids, at or above the minimum, are accepted, unless the pro-rata formula is being employed. Furthermore, non-competitive bids are accepted in their entirety (Association for Financial Markets in Europe, 2015).

### **1.5.3 The United States**

The United States Department of the Treasury utilized a discriminatory format until 1998, when, following experimentation with its two- and five-year note auctions in 1992, the uniform price format was adopted as the method of sale (Malvey and Archibald, 1998). The competitiveness of the Treasury auction process and the design of the auction system have been the subject of scrutiny on numerous occasions.

Before this change, extensive research had been conducted in support of the uniform mechanism for bond sales in the United States. One of these studies is the one conducted by Chari and Weber (1992) in their work “How the U.S. Treasury Should Auction Its Debt” that highlighted how a switch to either an ascending price open outcry auction or a uniform price auction for US Treasury debt was likely to raise Treasury revenues and reduce excessive resources devoted to information-gathering. The aforementioned paper presents two primary arguments in favor of implementing a uniform price auction for the U.S. Treasury. Firstly, the uniform pricing mechanism is argued to reduce bidders' incentives to gather information about other participants' willingness to pay. This reduction in information-seeking behavior is considered socially beneficial. Secondly, the uniform price auction structure is argued to offer advantages to short traders who are concerned about potential squeezes. Under this system, these traders would likely be able to acquire securities at the auction at a lower cost compared to the current methodology. This advantage stems from the fact that in a uniform price auction, short traders' high-price bids are unlikely to significantly impact the final price they pay for the security. These arguments collectively suggest that the uniform price auction could enhance market efficiency and fairness in the US Treasury auctions (Chari and Weber, 1992).

The transition from the preceding multiple-price format constituted a significant revision of the auction process, prompted by the occurrence of several infractions of the established auction rules in 1991. The 1990s saw a few significant alterations to the structure of auctions. These included the aforementioned change, a notable expansion in the restrictions placed on auction awards, and an increase in the numerical precision with which bids were expressed. Each of

these changes was driven by the Treasury's objective of fostering competitive bidding and liquid secondary markets (Garbade and Ingber, 2005).

Considering the current mechanism in place, it can be noticed that the federal government presently auctions three categories of marketable securities: bills, notes, and Treasury Inflation-Protected Securities (TIPS). Bills are single-payment securities issued at a discount, with a fixed face value payable at maturity. Notes are interest-bearing obligations that disburse interest semiannually, with both interest payments and principal repaid at maturity. TIPS are interest-bearing securities with payments that are indexed to inflation (Garbade and Ingber, 2005).

A participant in the US auction market may submit one or more competitive bids, each indicating the minimum yield they are willing to accept for a specified quantity of notes, or the minimum discount rate for a specified quantity of bills. Alternatively, the participant may submit a single noncompetitive bid, specifying the quantity of securities they wish to purchase at the final price determined by successful competitive bidders (Garbade and Ingber, 2005).

As already mentioned, the US Treasury conducts note auctions in a single-price format, also known as uniform price auction. Once the bidding process has concluded, the total quantity of securities available is first reduced by the amount allocated to non-competitive bids. Subsequently, competitive bids are accepted in accordance with the order of increasing yield until the offering has been fully exhausted. The highest accepted yield is referred to as the "stop." Bids that specify yields below the stop are filled in their entirety, while bids that exceed the stop are rejected. Bids that align with the stop are filled on a pro-rata basis. All auction awards are made at a single price, calculated from the yield at which the auction ceased. The final stage of the auction process entails the delivery of new securities to successful bidders and the collection of payment (Garbade and Ingber, 2005).

Overall, the objective of this section is to reinforce the assertion that, as previously stated, an analysis of the efficiency of an auction mechanism should not be conducted objectively but must instead consider numerous influencing factors. Indeed, as can be observed from the three countries presented, each State has different needs and therefore employs different auction mechanisms for the issuance of its government bonds.

## **1.6 Price determination in government securities auctions**

Following the examination of the mechanisms and the context of the primary market, the main objective of this section is to present and analyse the pricing formulas for government bonds within the context of primary market auctions. It is crucial to gain an understanding of the

pricing mechanisms of both the competitive auction and the marginal auction to evaluate the efficiency of these mechanisms employed for bond issuance and their role in public debt management. This section will examine the mechanisms that are typically employed to determine the price of government securities in the two different auction types. The objective is to provide a broad understanding of the manner in which the variables involved in the computations interact to determine the final auction price. The following explanation of the two auction mechanisms is derived from the illustrative examples presented on the Ministry of Economy and Finance's website (Ministry of Economy and Finance, (B)).

In a competitive auction, each bidder submits a bid that specifies both the quantity and the price they are willing to pay. In the context of an auction, the role of the auctioneer, in this case the government, is to rank the bids in descending order, from the highest price downwards. The objective is to allocate securities starting with the highest bids until the total amount of securities on offer is fully assigned. This process is designed to incentivise bidders to submit competitive prices, as higher bids improve the likelihood of receiving an allocation (Ministry of Economy and Finance, (B)). A defining feature of the competitive auction mechanism is that each successful bidder is required to pay the price they have submitted, rather than a uniform clearing price. Consequently, this mechanism can result in a diverse range of accepted prices, reflecting the varying valuations of the bidders (Ministry of Economy and Finance, (B)). The auction is considered complete when the total supply of securities has been allocated, and the price of the last successful bid, the so-called cut-off price, becomes a critical threshold. To ensure market stability and to mitigate the impact of speculative or artificially low bids on the outcome of the auction, an exclusion mechanism has been implemented. This mechanism establishes a minimum acceptable price, referred to as the exclusion price, under which bids are automatically rejected (Ministry of Economy and Finance, (B)). As it can be observed from the example proposed by the Ministry of Economy and Finance (B), the exclusion price is generally calculated by determining the weighted average yield of the upper half of accepted bids, to which a fixed margin, commonly 100 basis points, is added.

The exclusion price, denoted as  $P_e$ , can be mathematically represented as follows:

$$P_e = \frac{100}{1 + (r_m + 1\%)}$$

where  $r_m$  represents the weighted average yield of the accepted bids.

The establishment of this threshold serves to guarantee the exclusion of bids that fall below a reasonable market valuation, thus safeguarding the integrity of the price discovery process (Ministry of Economy and Finance, (B)).

The final weighted average price of the auction is then calculated by taking the sum of the product of accepted quantities and prices, divided by the total quantity allocated. This weighted average price serves as an important benchmark for market participants and reflects the overall cost of the issuance for the government. The formula for the weighted average price (*WAP*) extracted from the Ministry of Economy and Finance's example (B) is given by:

$$WAP = \frac{\sum p_n \cdot q_n}{\sum q_n}$$

where  $p_n$  and  $q_n$  are respectively the accepted prices and quantities.

In sum, the competitive auction mechanism encourages aggressive bidding behaviour and facilitates efficient price discovery. However, it may result in a greater divergence of accepted prices, reflecting the disparate expectations of participants regarding the fair value of the securities being auctioned.

In contrast to competitive auctions, marginal auctions operate under a uniform pricing rule. All successful bidders receive their securities at the same price, which is referred to as the marginal price. This price is equivalent to the lowest bid that is sufficient to meet the total quantity of securities offered in the auction (Ministry of Economy and Finance, (B)). The auction process begins similarly to a competitive auction, with bids arranged in descending order according to price. Subsequently, the securities are distributed to the highest bids until the total supply is exhausted. Once the supply has been fully allocated, the marginal price is determined as the price of the last successful bid. In the event of multiple bids being submitted at this marginal price, a proration is conducted based on the quantities requested, with the objective of ensuring that the total quantity does not exceed the supply (Ministry of Economy and Finance, (B)). This proration introduces a degree of fairness, as all participants at the marginal price are allocated an equal share of the remaining allocation.

The marginal price  $P_{marginal}$  is typically calculated as:

$$P_{marginal} = \frac{100}{1 + r_m}$$

where  $r_m$  is the yield corresponding to the marginal bid price.

The implementation of a single clearing price streamlines the auction process, thereby reducing the variability of outcomes. This is achieved by ensuring that all successful bidders receive the same price. Like the competitive auction, the marginal auction employs a price exclusion mechanism to prevent the influence of speculative bids on the outcome of the auction (Ministry of Economy and Finance, (B)). In this case, the exclusion price is set by subtracting a fixed margin, typically 200 basis points, from the weighted average price of the accepted bids. This

exclusion price ensures that only bids above a certain threshold are considered, thereby safeguarding the auction's integrity as stated by the Ministry of Economy and Finance (B).

The formula for the exclusion price  $P_e$  in a marginal auction is:

$$P_e = \frac{100}{1 + (r_m - 2\%)}$$

Consequently, any bids that fall below the exclusion price are disregarded. This process is designed to minimize the possibility of speculative or non-competitive bids exerting an undue influence on the outcome of the auction, thereby maintaining an orderly market. One of the principal advantages of the marginal auction is its tendency to encourage a more conservative approach to bidding. Given that all successful participants pay the same price, there is a reduced incentive for bidders to inflate their bids with a view to securing an allocation, which is a common occurrence in competitive auctions (Ministry of Economy and Finance, (B)). Therefore, the marginal auction mechanism promotes price stability and can result in lower average yields for the issuer, as participants adopt a more cautious approach to their bidding strategies.

## **1.7 Examples of auction allocations**

In this section, the Italian Department of the Treasury's example contained in the paper "Example of BOT auction allocation" (Ministry of Economy and Finance, (B)) will be used to provide guidance illustrating the mechanics of a competitive auction for the issuance of 12-month BOTs and a marginal auction for the sale of 10-year BTPs. This approach is designed to facilitate a more nuanced understanding of the underlying processes.

### **1.7.1 Competitive auction (12-month BOT)**

In accordance with the regulations, each duly authorized dealer is permitted to submit a maximum of five requests (Ministry of Economy and Finance, (B)). In this example, it will be considered a competitive auction for €7.000 million in one-year Treasury bills (12-month BOT), with four operators submitting bids. For convenience, each operator submits three bids, and the total demand exceeds the amount offered. The following bids are made (see Table 4), expressed in millions of euros:

**Table 4 - Requests submitted by operators (BOT competitive auction)**

Operator	Bid	Quantity Requested (€ million)	Bid Price
A	1st	750	96,15
B	1st	1.500	95,90
D	1st	1.000	95,90
B	2nd	1.100	95,88
C	1st	1.000	95,85
D	2nd	800	95,84
A	2nd	1.000	95,82
C	2nd	700	95,82
B	3rd	950	95,70
D	3rd	800	95,65
C	3rd	1.500	94,80
A	3rd	900	94,00
<b>Total bids</b>		<b>12.000</b>	

Given the oversubscription, the auctioneer calculates the weighted average price based on the bids that constitute the second half of the total amount offered (€3.500 million) presented in Table 5:

**Table 5 - Second half of the bids (BOTs)**

Bid Price	Quantity (€ million)
95,88	850
95,85	1.000
95,84	800
95,82	850

The weighted average price (WAP) is:

$$WAP = \frac{(95,88 \cdot 850) + (95,85 \cdot 1.000) + (95,84 \cdot 800) + (95,82 \cdot 850)}{3.500} = 95,85$$

After subtracting 25 basis points from the corresponding yield, the maximum acceptable price is calculated to be €96,08. Any bid exceeding this price is excluded, which in this case is the one at €96,15.

For the exclusion price, the first half of the offered amount is considered (€3.500 million), excluding bids above the maximum acceptable price (see Table 6):

**Table 6 - First half of the bids (BOTs)**

Bid Price	Quantity (€ million)
95,90	1.500
95,90	1.000
95,88	1.000

The WAP for this half is €95,89 and adding 100 basis points to the yield gives an exclusion price of €94,98.

Thus, the bids at €94,00 and €94,80 are excluded. The remaining bids are accepted, with the lowest accepted price being €95,82. Since bids at this price amount to €1.700 million, but only €850 million can be awarded, allocations are proportional, with a 50,00% distribution rate.

The allocation of BOTs can be summarized as presented in the following table (Table 7):

**Table 7 - Summary table of allocations (BOTs)**

Allocation price	Quantity allocated per allocation price				Total allocated quantity
	A	B	C	D	
95,99	750	0	0	0	750
95,90	0	1.500	0	1.000	2.500
95,88	0	1.100	0	0	1.100
95,85	0	0	1.000	0	1.000
95,84	0	0	0	800	800
95,82	500	0	350	0	850
<b>Quantity allocated per operator</b>	<b>1.250</b>	<b>2.600</b>	<b>1.350</b>	<b>1.800</b>	<b>7.000</b>

Concluding, the final weighted average price of the auction is computed as follows:

$$WAP = \frac{(2.500 \cdot 95,90) + (1.100 \cdot 95,88) + (1.000 \cdot 95,85) + (800 \cdot 95,84) + (850 \cdot 95,82)}{6.250} = 95,87$$

### 1.7.2 Marginal auction (10-year BTP)

For a marginal auction, dealers can place up to five bids, each at different prices (Ministry of Economy and Finance, (B)). In this example, it will be presented an auction of €3.500 million

in 10-year government bonds (10-year BTP) with a 5,50% coupon rate, where four operators participate making the following bids in millions of euros (Table 8):

**Table 8 - Requests submitted by operators (BTP marginal auction)**

Operator	Bid	Quantity Requested (€ million)	Bid Price
A	1st	500	104,00
B	1st	600	101,30
D	1st	700	101,30
B	2nd	800	101,20
C	1st	700	101,10
C	2nd	400	100,65
D	2nd	500	100,65
A	2nd	500	99,98
B	3rd	500	99,98
D	3rd	500	99,97
C	3rd	400	99,95
A	3rd	600	99,94
<b>Total bids</b>		<b>6.700</b>	

The maximum acceptable price is calculated from the second half of the bids (€1.750 million) presented in Table 9:

**Table 9 - Second half of the bids (BTPs)**

Bid Price	Quantity (€ million)
101,30	50
101,20	800
101,10	700
100,65	200

The Weighted Average Price is:

$$WAP = \frac{(101,30 \cdot 50) + (101,20 \cdot 800) + (101,10 \cdot 700) + (100,65 \cdot 200)}{1.750} = 101,10$$

After adding 200 basis points to the yield, the maximum acceptable price is €103,10.

The exclusion price is based on the first half of the offered amount (€1.750 million), excluding bids above the maximum acceptable price (see Table 10):

**Table 10 - First half of the bids (BTPs)**

<b>Bid Price</b>	<b>Quantity (€ million)</b>
101,30	1.300
101,20	450

The WAP for this group is €101,27 and subtracting 200 basis points from the yield gives an exclusion price of €99,27. Thus, bids below this price are excluded. The marginal price, where the total amount offered is met, is €100,65. Since bids at this price total €900 million, but only €200 million can be awarded, allocations are proportional, with a 22,22% distribution rate.

The allocation can be summarized as follows (Table 11):

**Table 11 - Summary table of allocations (BTPs)**

<b>Allocation price</b>	<b>Quantity allocated per allocation price</b>				<b>Total allocated quantity</b>
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	
100,65	500	1.400	700	700	3.300
Distributed at 22,22%			89	111	200
	<b>Total allocated</b>				<b>3.500</b>

## **2. Indicators for the analysis: definitions and methodologies**

In the analysis of government bond auctions, the estimation of certain financial indicators is crucial for evaluating both market demand and the cost of borrowing. This work focuses on the following key ratios: the bid-to-cover ratio, the gross yield, the amount of debt outstanding and the debt-to-GDP ratio. While the bid-to-cover ratio and the gross yield are direct indicators of auction performance, providing insight into investor demand and the cost of issuing debt, the amount of debt outstanding and the debt-to-GDP ratio serve as broader indicators of the sustainability of government debt and the market's ability to absorb new securities.

The bid-to-cover ratio measures the strength of demand by comparing the total bids received with the amount of bonds offered, while the gross yield reflects the rate of return investors demand to buy the bonds. Debt outstanding, on the other hand, shows trends in cumulative debt issuance and sustainability. The debt-to-GDP ratio provides further insight by comparing the government's debt burden relative to the size of its economy. As a result, it is a valuable metric for evaluating the efficiency and potential sustainability of the auction mechanism.

A summary of all the ratios adopted, their associated computation methods, and the data employed is provided in the table of Appendix A. The following section provides an overview of these indicators and their relevance to the analysis of public auctions.

### **2.1 Bid-to-cover ratio**

A crucial indicator of demand in an auction is the so-called bid-to-cover ratio. It reflects the level of investors' interest by comparing the total amount of bids received to the amount of securities available for allotment. A higher bid-to-cover ratio is indicative of robust demand, thereby suggesting that the auction is competitive. Conversely, a lower ratio may be indicative of weaker demand. As stated by Beetsma et al. (2020), the theory postulates that the bid-to-cover ratio declines in accordance with the degree of market risk aversion, market volatility, the quantity of debt to be issued, and the concentration of dealer wealth. By analyzing this ratio, those responsible for formulating economic policy and debt managers can assess the robustness of the auction process and identify potential improvements to ensure that government borrowing costs are kept to a minimum while maintaining a healthy level of investor interest. Two principal methodologies exist for calculating this ratio: the ex-post bid-to-cover ratio and the ex-ante bid-to-cover ratio. The bid-to-cover ratio is typically calculated as the total amount of bids received over the volume of securities actually allotted (Beetsma, Giuliadori, Hanson and de Jong, 2020).

This is the ratio that is commonly reported by the media and is referred to as the "ex-post bid-to-cover ratio". It can be expressed as:

$$\textit{Ex-post bid-to-cover ratio} = \frac{\textit{Amount Bid}}{\textit{Amount Allotted}}$$

However, Beetsma et al. (2020) argue that this method of calculating the ratio may be subject to influence from discretionary post-auction decisions regarding the final allotment, which could introduce a form of endogeneity into the analysis. In contrast, the ex-ante bid-to-cover ratio seeks to eliminate this endogeneity by calculating the ratio based on the amount initially planned by the Debt Management Office (DMO) to offer and announced in the press release, referred to as the ex-ante supply. The resulting formula is:

$$\textit{Ex-ante bid-to-cover ratio} = \frac{\textit{Amount Bid}}{\textit{Amount Offered}}$$

The ex-ante bid-to-cover ratio provides a less biased measure of auction performance by using the amount offered (or target volume) rather than the actual allotment. This is because the former provides a clearer indication of demand relative to the pre-announced auction size (Beetsma, Giuliadori, Hanson and de Jong, 2020). Note that the theory proposed by Beetsma et al. (2020) in their paper "Determinants of the bid-to-cover ratio in Eurozone sovereign debt auctions" posits that the bid-to-cover ratio should exhibit a decline in correlation with the degree of market risk aversion, market volatility, the amount of debt to be issued, and the concentration of primary dealer wealth. The empirical results confirm this hypothesis partially, with supply and market volatility both exerting a pronounced negative influence on the bid-to-cover ratio, the market risk aversion not exerting a significant influence and the number of primary dealers exerting occasionally a positive effect on the ratio. Overall, their results suggest that maintaining a relatively large group of primary dealers may be advantageous in terms of securing favorable pricing for debt issuance. Nevertheless, this advantage must be considered in light of the expenses associated with maintaining a more extensive network of primary dealers (Beetsma, Giuliadori, Hanson and de Jong, 2020).

In consideration of the aforementioned points, in this thesis any reference to the bid-to-cover ratio specifically refers to the second formula, namely the "ex-ante bid-to-cover ratio" as it appears to be the measure most consistent with the analysis conducted.

## 2.2 Gross yield

Analyzing the trends in the gross yields over time can be a useful preliminary indicator of the efficiency of the Italian Treasury's auction mechanism. The evolution of the gross yield can provide insights into the cost of borrowing for the Treasury and the returns for investors. However, the conclusions that can be drawn from its increase or decrease depend on various factors. Indeed, an increase in the gross yield over time may be associated, for example, to an increase in the perception of sovereign risk, a decrease in demand at primary auctions that forces the Treasury to offer higher yields to attract buyers, a higher cost of servicing public debt, or limited competition at auctions. For this reason, to gain further comprehension of the observed trends, it is necessary to conduct a comparative analysis with the objective of identifying any correlations between the aforementioned trends and the market. In the following chapter, the gross yield developments will be evaluated in comparison with the BTP-Bund spread<sup>2</sup> since this is a key indicator of market-perceived risk on Italian debt relative to the European benchmark. This indicator is computed as follows:

$$BTP\text{-}Bund\ Spread = BTP\ yield - Bund\ yield$$

A comparison of the gross yield of Italian government bonds with the BTP-Bund spread represents a highly valuable analytical tool for evaluating the efficiency of the Italian auction mechanism in the context of sovereign risk perception and market competition. The differential, or spread, between the yields of Italian government bonds and those of German bonds exhibits a trend partly connected to the movement of the general rate and partly attributable to specific profiles due to the different perception of relative risk between the two countries (Ministry of Economy and Finance, 2023). One of the Italian Treasury's primary objectives is to issue debt securities at the lowest possible cost. A comparison of the gross yield at issuance with the BTP-Bund spread enables an evaluation of the efficacy of the auction mechanism in achieving this objective. Indeed, if the gross yield of the Italian government securities is found to be in close alignment with the BTP-Bund spread, this may be taken to indicate that the auction is functioning relatively efficiently. This is on the basis that the yield demanded by investors is seen to accurately reflect Italy's sovereign risk premium over Germany. This indicates that the price established in the auction is aligned with market conditions and risk perception. Conversely, if the gross yield consistently exceeds the Spread, this may indicate an inefficiency in the auction mechanism, such as low participation or insufficient competition among

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<sup>2</sup> Note that the BTP-Bund spread referred to in this analysis is the value that measures the yield differential between the Italian 10-year government bond (BTP) and the equivalent German Bund of the same duration.

investors. This results in the country having to offer higher yields to attract demand, leading to a higher financing cost than justified by the perceived risk.

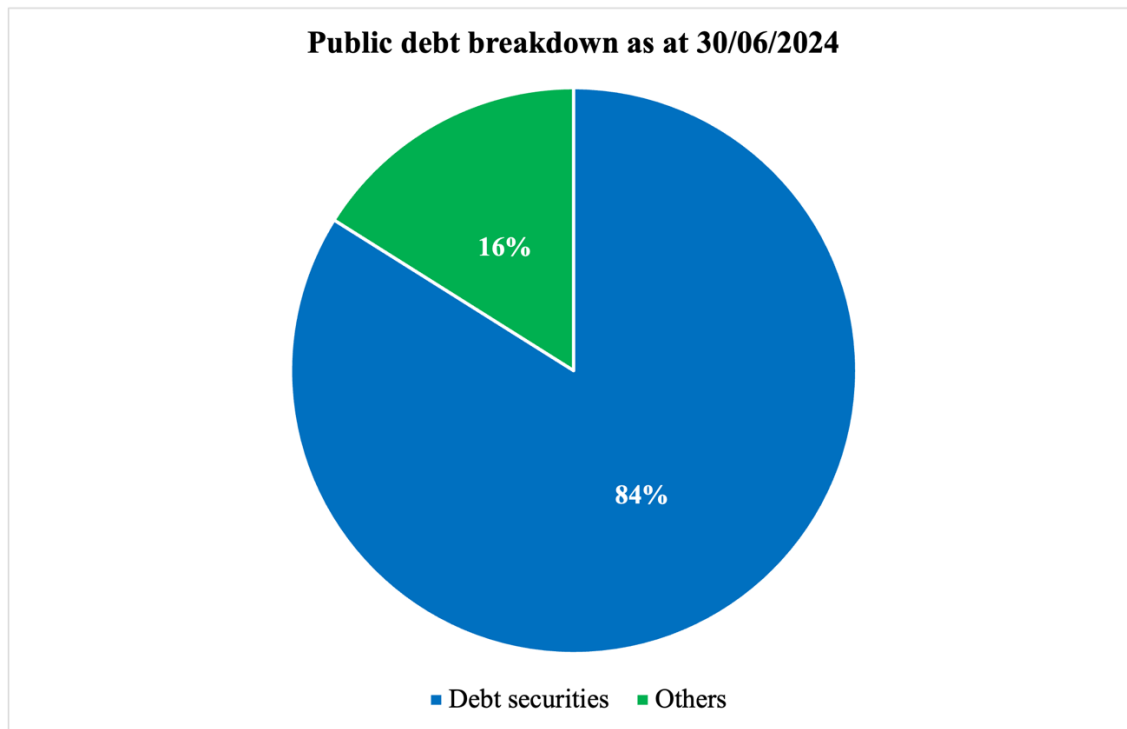
The BTP-Bund spread is typically compared to BTPs and other long-term bonds due to the structural characteristics inherent to its calculation. However, its performance can also be compared to the gross yield of Treasury Bills (BOTs), while taking into account the structural differences between these two financial instruments and what their respective yields represent. This comparison reveals the perception of sovereign risk in the short- and long-term, as well as how this perception influences the cost of debt across different maturities. For instance, if the gross yield of Treasury Bills (BOTs) decreases while the BTP-Bund spread widens, this could suggest that BOT auctions are more competitive, with strong demand from short-term investors, whereas there is weaker demand for BTPs or a heightened perception of long-term risk. The following chapter will address this issue in greater detail.

### **2.3 Debt outstanding and average life of bonds**

The term "public debt" or "general government debt" is used to describe the total amount of financial obligations held by a government, recorded at their nominal value and consolidated among institutional units belonging to the same sector (Ministry of Economy and Finance, (D)). Since it is a measure of the sustainability and financing dynamics of public debt over time, the monitoring of changes in outstanding debt enables the assessment of whether the country is increasing its debt and at what cost. In order to effectively monitor these changes, it is valuable to compare the outstanding debt with the newly issued debt. This approach provides a clearer insight into the dynamics of debt management and facilitates a more nuanced understanding of the overall debt structure. Additionally, comparisons of this type further improve the evaluation of average maturities, which is a critical factor in assessing the long-term sustainability and risk profile of the debt portfolio. By analyzing both the stock of existing debt and the flow of new issuances, it becomes possible to identify patterns in debt issuance strategies and evaluate the potential impact on future refinancing needs and interest obligations.

In the context of public debt, it is important to distinguish between the gross debt, which represents the total amount of public debt, and the portion of debt composed of treasury bonds. It is evident that most of the public debt is constituted by government securities, which are debt securities issued by the Treasury on both the domestic market (BOTs, CTZs, CCTs, CCTeus, BTPs, BTP€is and BTPs Italia) and the international capital markets (Global Bond, MTN and Commercial Paper programs) (Ministry of Economy and Finance, (D)). However, it is crucial to acknowledge that these securities do not represent the totality of the public debt.

The percentage of debt securities has consistently ranged between 78% and 84% of the gross debt between 2002 and 2024. The public debt breakdown for 30 June 2024, calculated using the data from the statistical dataset of the Bank of Italy (Bank of Italy, 2024), is presented in Figure 2. Looking at the graph, it should be mentioned that the component of debt not constituted by debt securities is primarily composed by loans, currency, and deposits.



**Figure 2** - *Public debt breakdown as at 30/06/2024.*

It should be also noted that the analysis presented in the next chapters focuses exclusively on data pertaining to bonds issued within the domestic market. This approach does not significantly impact the conclusions drawn from the results, as evidenced by the graph in the first chapter (Figure 1), which illustrates that foreign debt represents only the 1,62% of government securities outstanding as of August 31st, 2024. Consequently, it can be classified as a negligible component for the purposes of this analysis. Moreover, the average life of debt is regarded as a key indicator for evaluating the efficiency of the Italian Treasury auction mechanism, as it provides insight into the weighted average duration before public debt repayment is due. This metric assists in the evaluation of debt sustainability by indicating the frequency with which debt must be refinanced, which in turn affects exposure to interest rate volatility. An extended debt maturity profile, achieved through the implementation of efficient auctions, can serve as an indicator of lower refinancing risks and effective cost management. Furthermore, monitoring this indicator provides insight into the responsiveness of the Treasury to market conditions and

interest rate expectations, thereby reinforcing its strategic relevance in the analysis of public debt management.

## 2.4 Debt-to-GDP ratio

The ratio of government debt to gross domestic product (GDP) is a key indicator for investors, as it provides insight into a country's capacity to meet its future financial obligations. This, in turn, influences the cost of borrowing and the yields on government bonds. In this analysis this ratio is computed as follows:

$$\text{Debt-to-GDP} = \frac{\text{Gross debt}}{\text{Gross Domestic Product}}$$

The utility of this ratio lies in its ability to offer a snapshot of the sustainability of a nation's debt relative to its capacity to generate revenue. As such, it is an essential tool for evaluating the efficiency of a country's debt management strategies. The debt-to-GDP ratio provides insights into the effectiveness of Italy's Treasury in meeting its financing needs without intensifying the pressure on the country's debt burden, particularly in the context of treasury bond auctions. Since a high debt-to-GDP ratio may result in an increase in the cost of borrowing, it is very important to gain an understanding of this metric to assess the efficiency of Italy's bond issuance mechanism. This is due to the fact that it highlights the potential risks associated with the accumulation of debt against the economic growth trajectory of the country considered. It is evident that an increase in this ratio gives rise to investor apprehension regarding the sustainability of debt in these countries (Akram and Das, 2017). Consequently, the selection of this indicator allows for an examination of the Treasury's capacity to manage debt in a sustainable manner, while simultaneously addressing the challenges posed by market pressures and investor expectations.

### 3. Exploring the data

#### 3.1 Auction data collection and dataset construction

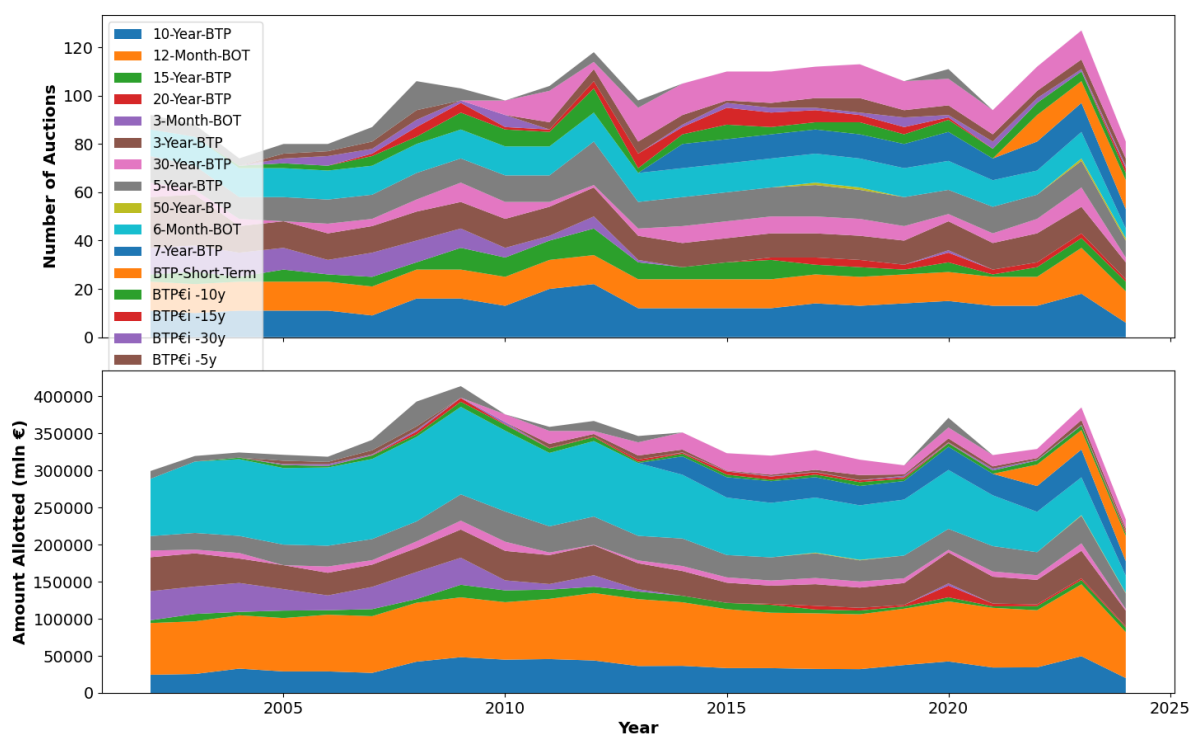
This analysis of the Italian Treasury auction mechanism begins after the adoption of the euro as the country's official currency, so the period considered covers the years between 2002 and 2024. A database of all government bonds issued during the period under study has been created. For each auction, the dataset contains the type of bond, the International Securities Identification Number (ISIN code) that uniquely identifies the transaction, the days to maturity, the auction date, the settlement date, the maturity date, the amount offered, the amount bid, the amount allotted and the gross yield. All the data employed in this analysis regarding the issuance of treasury securities have been published by the Italian Department of the Treasury in the Ministry of Economy and Finance's official website (Ministry of Economy and Finance, (A)). They have been gathered and consolidated into a unified dataset for analytical purposes using the Python programming language. The database contains 691 BOT auctions that can be considered short-term bonds with maturity of one year or less and 1.218 BTP auctions, 163 CCTeu auctions and 237 BTP€i auctions that are considered long-term bonds with maturity greater than one year. Additionally, it includes the auctions for BTPs dedicated to the retail public such as BTP Green, BTP Futura and others. It is relevant to mention that in the following analysis the bonds placed through syndicate will not be considered since the focus of this work is studying the efficiency of the auction mechanism itself while the above-mentioned method represents an alternative to it, as already explained in the first chapter. Appendix B shows, as an example, a portion of the constructed dataset.

Furthermore, this analysis will consider three distinct crisis periods to assess the performance of Italian government bond auctions under varying market conditions. In particular, an examination of other works such as "Second report on the liquidity of the secondary market of Italian government bonds, year 2023" (Catapano, Greco, Mormando, Tesserì, Iacono, Tretto and Caruso, 2023) reveals that the principal crises observed during the period under consideration were the global financial crisis of 2007-2008, the European sovereign debt crisis in the 2010-2012 period, and the outbreak of the Covid-19 pandemic in Europe in February 2020. This approach allows for a comparison between auction dynamics during periods of relative market stability and times of intensified financial stress. This will enable the identification of any significant changes in investor behavior, auction outcomes, and the effectiveness of the bid-to-cover ratio and gross yield as indicators in different market environments. The data presented has been analyzed using the definitions and formulas outlined in Chapter 2, in order to derive the indicators required to evaluate the efficiency of the Italian

treasury auction mechanism, which constitutes the central focus of this study. The key findings are discussed in the following sections.

### 3.2 Auction performance: volume and amounts allotted

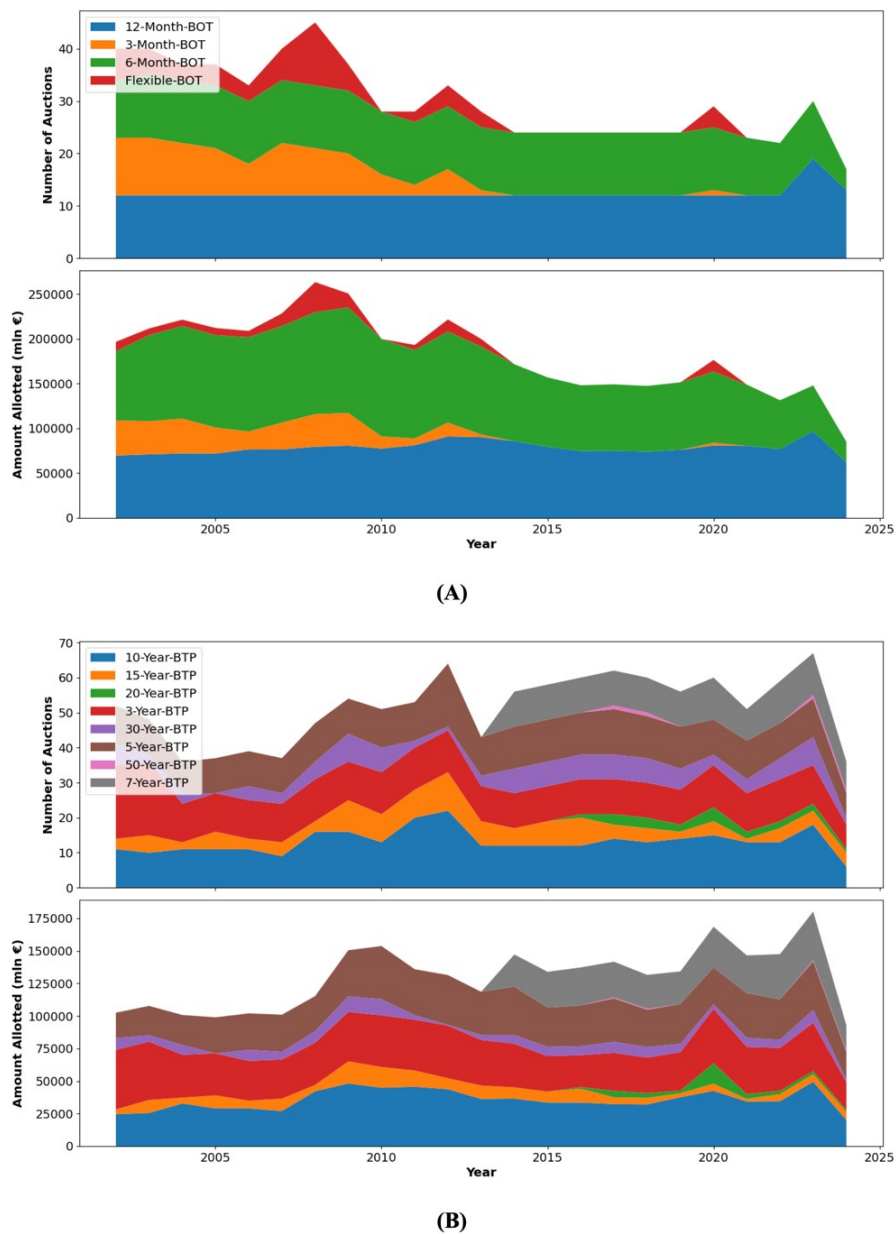
First, from the analysis conducted it is possible to assess how the number of auctions and the amount allotted for Italian government bonds changed in the considered period (Figure 3). The graphs presented in this paragraph exclude retail bonds due to their negligible contribution to the total securities issued. Furthermore, the inclusion of these bonds would not significantly impact the period under consideration, as they are newly issued and account only for a small part of the total amount of government securities.



**Figure 3** – Overview of the number of auctions and the amounts allotted (2002-2024).

The top panel illustrates the number of auctions for various types of securities, demonstrating notable fluctuations over time. A pronounced peak is discernible around 2010-2012, which is likely indicative of the European sovereign debt crisis. During this period, Italy, like numerous other European countries, increased its bond issuances with the objective of financing deficits and addressing fiscal imbalances. Subsequently, the number of auctions exhibited a tendency towards stability, although a slight upward trajectory was discernible following 2020, potentially associated with the fiscal policies implemented in response to the global health crisis caused by Covid-19. Different bond types contribute variably to the total number of auctions.

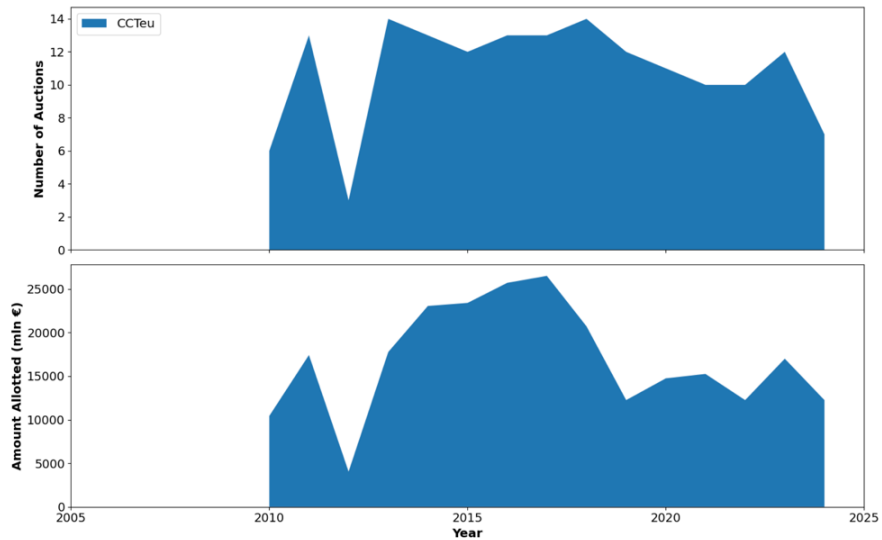
The bottom panel, which depicts the total amount allotted in millions of euros, exhibits a comparable trajectory. It is evident that the amount raised increased markedly between 2008 and 2012, a period that coincided with the global financial crisis. Thereafter, a gradual decline and subsequent stabilization were observed. Following the year 2020, a further notable increase in the amounts allocated is observed, reflecting the Italian government's requirement to finance expenditures related to the pandemic. The most substantial contributions to the total amounts raised originate from long-term securities, including the 10-Year BTP, 15-Year BTP, and 30-Year BTP. However, flexible and short-term BOTs also constitute a significant part of the issuance strategy. The relative contribution of the various security types is more evident when each category of bond is isolated and examined over the specified sample period, as illustrated in Figure 4.



**Figure 4 - Number of auctions and amounts allotted by bond types.**



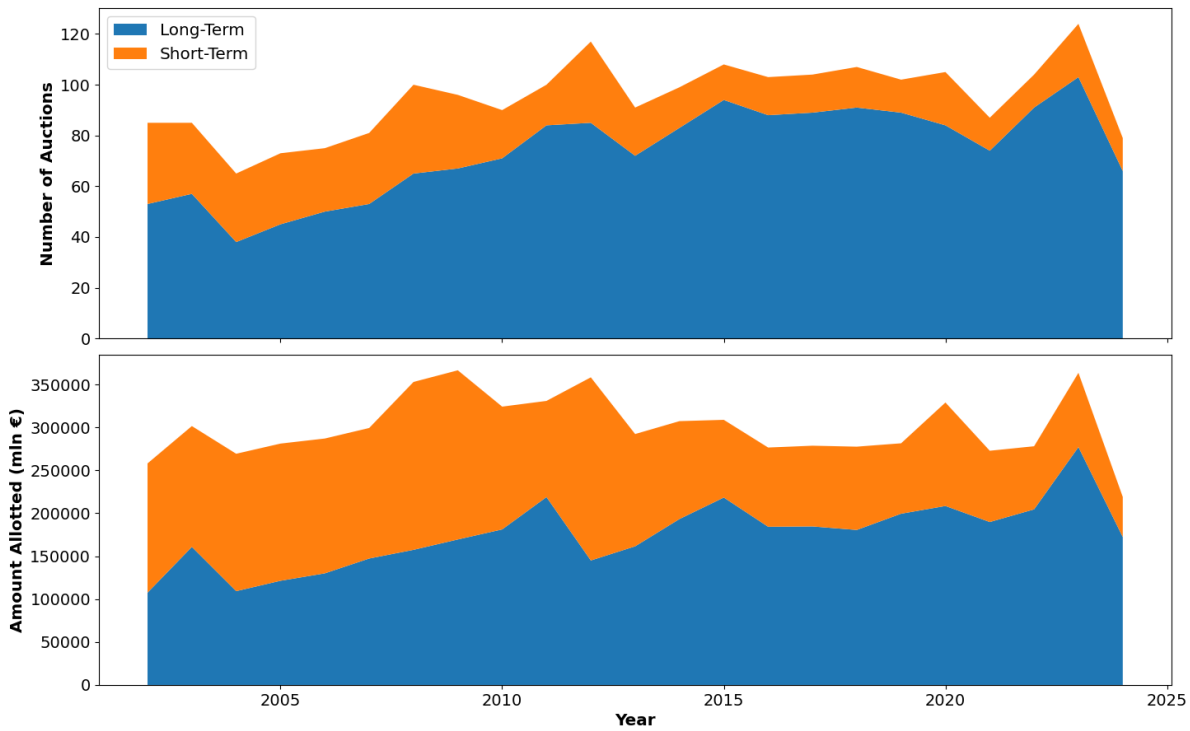
(C)



(D)

**Figure 4 - (continued).**

In particular, the first graph represents BOTs (Figure 4.A), the second one is for BTPs (Figure 4.B), the third graph corresponds to BTP€is (Figure 4.C) and, finally, in the last one the CCTeus can be observed with issuances starting from 2010 (Figure 4.D). The differentiation among bond types allows for an analysis of maturity-based distinctions. A natural extension of this classification is to examine bonds across the maturity spectrum, particularly contrasting short-term and long-term instruments, as it can be seen in Figure 5.



**Figure 5 - Long-term vs short-term bonds: number of auctions and amounts allotted.**

This approach permits a more nuanced understanding of how bond issuance varies across different time horizons. The provided graph illustrates a distinction between bonds classified as short-term (in orange), with a maturity period of less than one year, and those designated as long-term (in blue), with a maturity period exceeding one year. Upon examination of Figure 5, it becomes evident that during the 2007-2008 financial crisis there is a notable shift towards short-term auctions, suggesting a governmental preference for managing immediate liquidity concerns. This trend is persistent through the European sovereign debt crisis (2010-2012), where the volume of short-term issuances remained elevated. In contrast, the COVID-19 pandemic in 2020 prompted a significant increase in both auction frequency and allotted amounts, with a particular emphasis on long-term securities. This focus on long-term securities is not solely a consequence of the pandemic crisis, but it is also a result of a declared shift in the Department of the Treasury's policy regarding the maturity of government securities. Indeed, in recent years, there has been an effort to extend the average life of bonds, and one strategy to achieve this objective is to increase the issuance of securities with longer expirations (Ministry of Economy and Finance, 2023), as illustrated in this graph. This will be discussed in greater detail in the following sections.

### 3.3 Evaluating auction demand: bid-to-cover ratio

The bid-to-cover ratio is a key indicator of demand for government debt, and it plays an essential role in evaluating the market's appetite for sovereign debt securities. As previously mentioned, in this work the bid-to-cover ratio refers to the "ex-ante bid-to-cover ratio," which is computed as the fraction of the amount bid to the amount offered.

The graphs created illustrate the average values of this ratio for each type of bond and demonstrate how they fluctuate over the period between 2002 and 2024. As for the previous paragraph, the data for BTP Green, BTP Italia, BTP Futura and BTP Valore have been excluded from the analysis of this ratio. For the reader's convenience some graphs of the bid-to-cover ratio are reported below, as an example, while the others can be found in Appendix C.

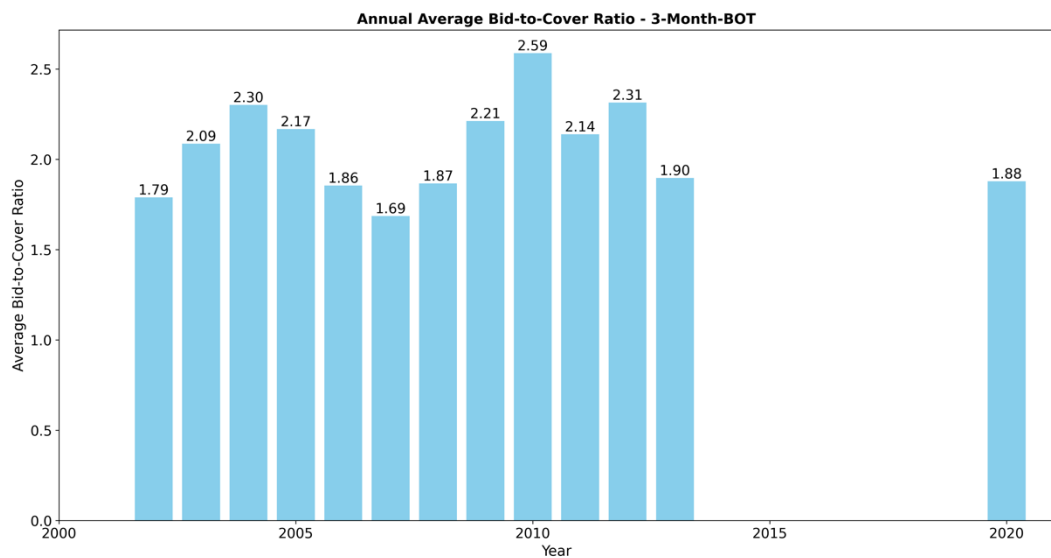


Figure 6 - Bid-to-cover ratio (3-month BOT).

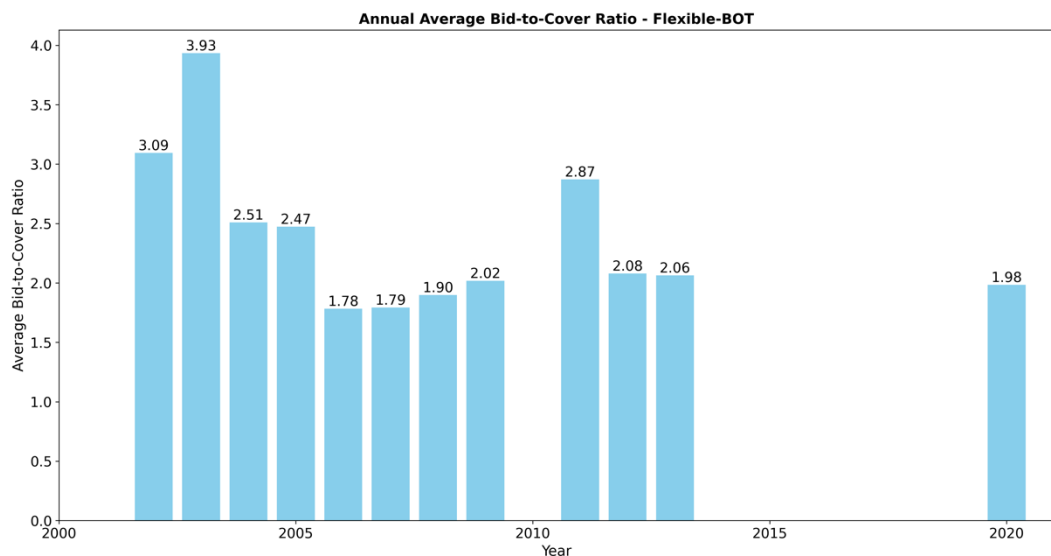
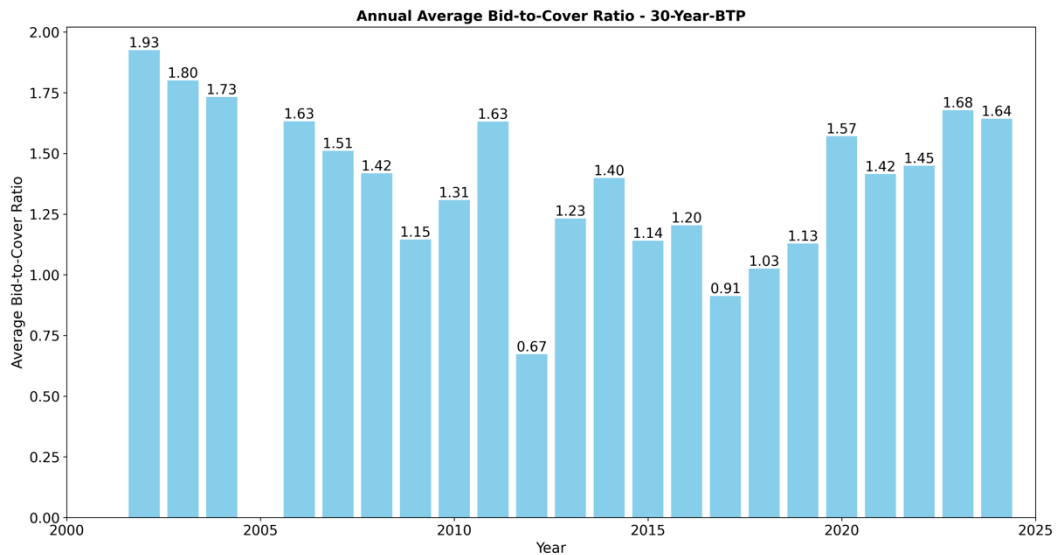
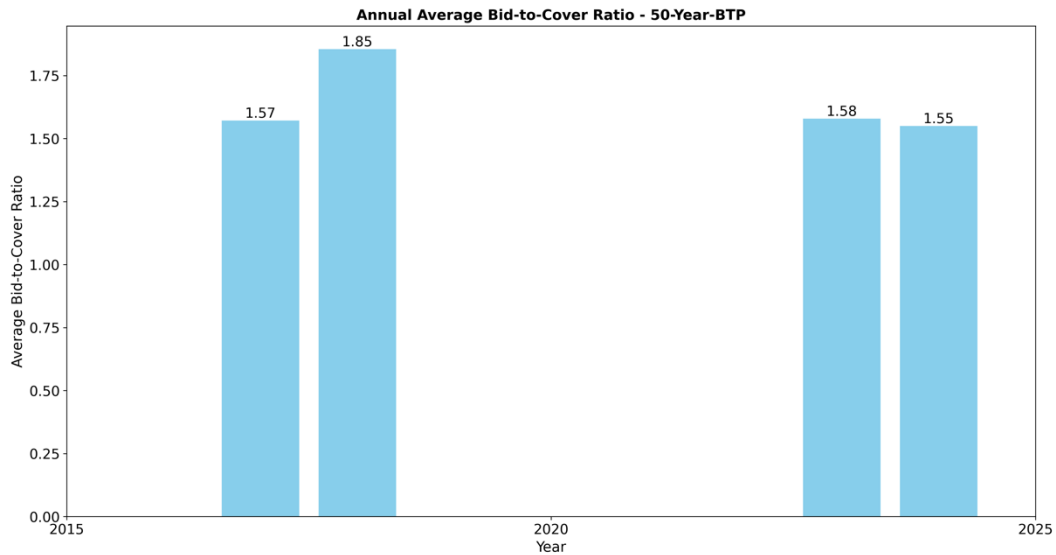


Figure 7 - Bid-to-cover ratio (Flexible BOT).



**Figure 8 - Bid-to-cover ratio (30-year BTP).**



**Figure 9 - Bid-to-cover ratio (50-year BTP).**

An examination of the bid-to-cover ratio graphs reveals that, for certain categories of government securities, the value of the ratio is absent for a few of the years under consideration. This can be explained by an analysis of the dataset collected and the nature of the bonds issued. For instance, 3-month BOTs (Figure 6) and Flexible BOTs (Figure 7) are issued contingent on cash requirements. Consequently, the Treasury is empowered to determine the issuance of these instruments on an annual basis, based on the country's financing requirements. This is the reason why, in some of the years under consideration, the issuance has been suspended. The same can be said of all the other graphs that lack certain values, because bonds such as the 30-year BTP (Figure 8), the 50-year BTP (Figure 9) and others are offered in response to the market's expressed demand. These decisions are documented annually by the Department of

the Treasury of the Italian Ministry of Economy and Finance in the "Public debt management guidelines". To illustrate, Table 12 presents a summary of the frequency of auctions for each instrument for the year 2024, as outlined in the "2024 Public Debt Management Guidelines" (Ministry of Economy and Finance, 2024).

**Table 12** – *Auction frequency for each instrument (2024)*

Type of security	Mid-month auction	Month-end auction
Flexible BOTs	Issuance subject to cash requirements	
3-month BOTs	Issuance subject to cash requirements	
6-month BOTs		x
12-month BOTs	x	
Short-term BTPs		x
3-year BTPs	x	
5-year BTPs		x
7-year BTPs	x	
10-year BTPs		x
15, 20, 30 and 50-year BTPs	Offered in relation to market demand	
CCTeus		x
BTP€is		x

From the bid-to-cover ratios computed, the following conclusions can be drawn. Firstly, the data indicates that the ratios for short-term bonds are, on average, higher than those for long-term bonds. This is evidenced by both the graphs in Appendix C and the table below (Table 13), which contains the average values of the bid-to-cover ratios for the period between 2002 and 2024, divided by type of security. As evidenced by the data, bonds with shorter maturities, such as BOTs, exhibit a marginally higher average ratio during the specified period. This observation leads to the conclusion that the demand for government securities typically declines as the duration of the bonds increases.

**Table 13 - Average bid-to-cover ratios (2002-2024)**

Type of bond	Average bid-to-cover ratio (2002-2024)
3-month BOT	2,0419
6-month BOT	1,6108
12-month BOT	1,6835
Short-term BTP	1,5560
CCTeu	1,5769
Flexible BOT	2,3303
5-year BTP€i	1,5028
10-year BTP€i	1,4568
15-year BTP€i	1,2466
30-year BTP€i	1,2697
3-year BTP	1,5758
5-year BTP	1,5176
7-year BTP	1,4584
10-year BTP	1,4282
15-year BTP	1,4169
20-year BTP	1,4491
30-year BTP	1,3589
50-year BTP	1,6388

Secondly, during periods of crisis, a general decline in this ratio is observed across all categories of securities. However, it should be noted that there are some differences between the three crises under consideration. Looking at the ratios computed for the period of the financial crisis (2007-2008), it is evident that there has been an increase in demand for sovereign debt across all maturities, with a particular preference for short-term securities. In consequence of the sovereign debt crisis (2010-2012) concerns have been raised about the long-term fiscal stability of Italy, resulting in a greater decline in the bid-to-cover ratio for longer-term debt compared to short-term debt. In contrast with the preceding two crises considered, the immediate flight to liquidity triggered by the advent of the pandemic resulted in an increase in the ratio for short-term bonds, while demand for longer-term BOTs remained relatively limited.

Overall, it can be observed that the bid-to-cover ratio shows a slight preference for short-term securities, particularly during times of crisis. This is reflected in the ratio's tendency to decrease for long-term bonds and increase for short-term instruments during these periods of uncertainty.

Investors appear to favor shorter maturities in volatile environments, likely seeking to mitigate risk exposure by reducing the duration of their holdings. Conversely, in more stable times, long-term securities might regain attractiveness as the economic outlook improves.

This aligns with previous research, including the work of Beetsma, Giuliadori, Hanson and de Jong (2020), in which, as presented also in the previous chapter, the authors developed a model supporting the theory that the bid-to-cover ratio should decline with certain factors such as market risk aversion, market volatility, the volume of debt to be issued, and the concentration of primary dealer wealth. The findings of their study partially support this hypothesis, showing that both supply and market volatility have a strong negative impact on the bid-to-cover ratio. However, they found essentially no evidence for the influence of market risk aversion, while the number of primary dealers was occasionally shown to have a positive effect on the ratio analyzed (Beetsma, Giuliadori, Hanson and de Jong, 2020).

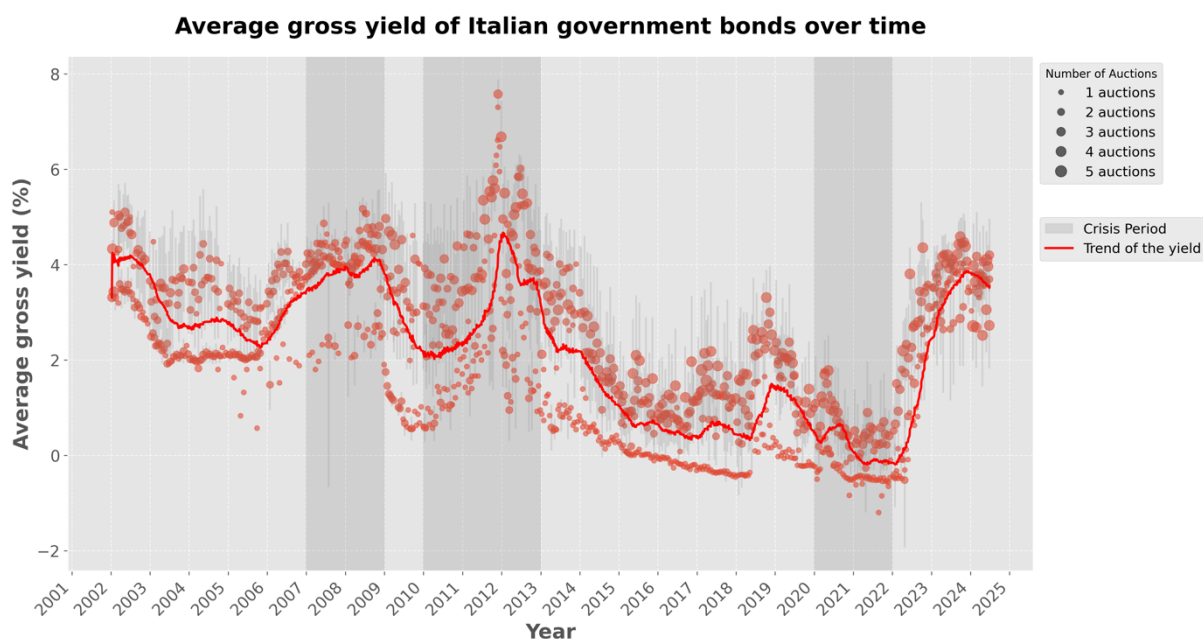
In conclusion, the behavior of the bid-to-cover ratio suggests that the auction mechanism is sufficiently responsive to changing market conditions. During periods of crisis, the preference for short-term securities and the higher bid-to-cover ratios for shorter maturities suggest that investors continue to demonstrate interest in Italian government bonds, albeit with a preference for lower-risk instruments. The auction system's ability to attract adequate demand, even in times of uncertainty, underscores its capacity to adjust to investor preferences and accommodate market volatility. Nevertheless, the observed reduction in demand for long-term bonds during crises emphasizes the need to ensure that risk is adequately priced to maintain robust demand across maturities.

### **3.4 Trends in gross yields**

As mentioned above, the evolution of the gross yield can provide information on the cost of borrowing for the Treasury and the return for investors. The graphs presented in Appendix D shows the evolution of this indicator for each type of security over the period from 2002 to 2024. Note that the blue dots indicate the auctions, and the red line shows the trend in the yield over time. For some bonds such as 3-month BOTs or Flexible BOTs, as was the case with the bid-to-cover ratios, there are some highlighted areas to indicate the years without emissions. The graphs (refer to Appendix D) demonstrate that short-term bonds exhibit greater responsiveness to market conditions and lower volatility in comparison to long-term government securities. As has been observed previously, BTPs and other long-term bonds demonstrate a higher premium for a longer duration and a greater sensitivity to periods of stress and high volatility during periods of crisis. It is particularly noteworthy that there is a significant

difference in behaviour between conventional BTPs and inflation-linked securities (BTP€i). The latter consistently demonstrated lower real yields but higher volatility during periods of inflation uncertainty, indicating the existence of distinct price discovery dynamics for different instrument types within the same auction framework. This is evidenced by the table in Appendix E, which illustrates the average annual yields for each bond type.

To gain a better understanding of these dynamics, it is particularly instructive to examine the average yield of government securities at issuance over the period from 2002 to 2024 (Figure 10). The analysis of this curve over an extended period enables the identification of significant trends, with particular attention paid to the three crisis periods under investigation.



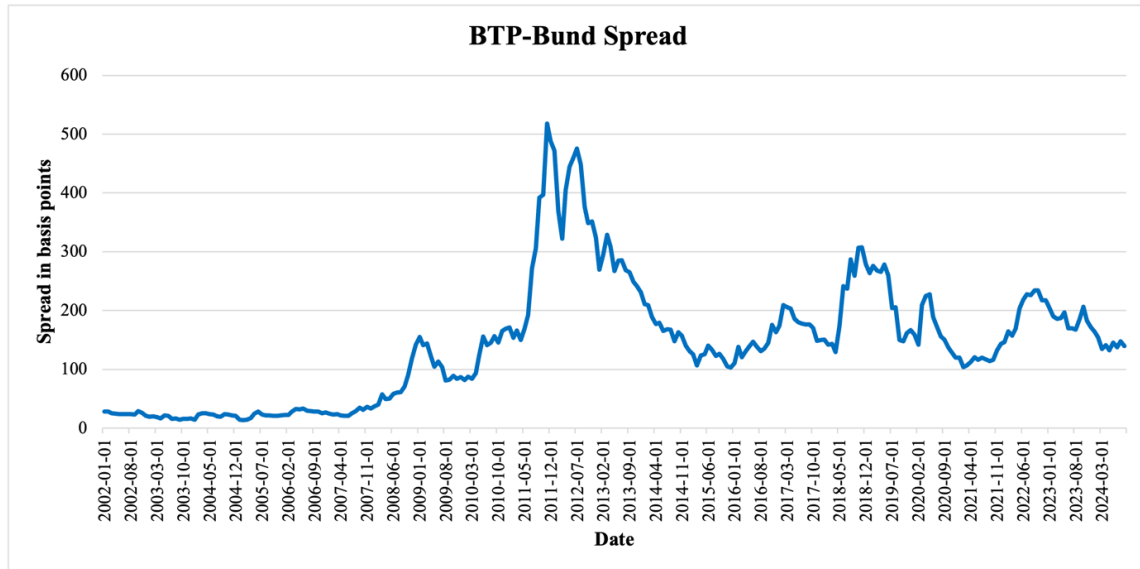
**Figure 10** - Average yield of government securities at issuance.

In the period preceding the crisis (2002-2007), the yield curve displayed a typical positive slope with limited spreads across maturities, indicating effective price discovery and sufficient market depth. However, the 2007-2008 financial crisis introduced substantial yield volatility, particularly in longer-term securities, which suggests that the auction mechanism's price discovery function was temporarily unable to perform its intended function. The sovereign debt crisis (2010-2012) constituted a significant challenge to the resilience of the auction system, with yields reaching levels that had not been previously observed. This period demonstrated the mechanism's susceptibility to significant market stress, despite its continued operational functionality under extreme conditions. The subsequent implementation of the ECB's quantitative easing programmes (2015-2019) constituted a fundamental alteration of the yield environment, with some short-term yields reaching negative territory and the curve becoming flatter. This intervention supported market stability, as evidenced by the findings of Rodriguez-

Rodriguez, Hierro, and Garzon (2024), which demonstrate that from 2015 onwards, when the ECB's QE programme was deployed, a stabilizing and countercyclical reaction to the expected inflation, the output gap, and the euro area risk premium was observed. Indeed, even though the precise mechanisms behind these effects remain poorly understood, quantitative easing (QE) has been demonstrated to be an effective means of reducing both short- and long-term interest rates, as evidenced by the findings presented in the paper by Droste, Gorodnichenko, and Ray (2024). This concept is further reinforced by the observation that, in periods of significant financial distress, the Federal Reserve and other central banks, such as the ECB, will be required to adopt an active purchasing strategy for Treasuries across the entire yield curve to successfully influence the overall term structure of interest rates. It can thus be concluded that the responses of the yield curve to unexpected movements in demand during Treasury auctions provide insight into the functioning of QE programmes implemented by central banks (Gorodnichenko and Ray, 2018). This is because, regarding quantitative easing, the impact of central bank's intervention in the bond market is double. Firstly, it increases the number of buyers in the market when it begins purchasing bonds, thereby exerting a demand effect. Secondly, it reduces the number of sellers in the market when it holds bonds on its balance sheets, exerting a supply effect (Ferdinandusse, Freier and Ristiniemi, 2020). The global pandemic of 2020 and the subsequent periods that followed have provided new insights into the maturity of the system in question. The initial rise in yields was quickly contained, exemplifying enhanced market resilience in comparison to previous crises. The recent period (2022-2024) of monetary policy normalisation has demonstrated the capacity of the auction mechanism to facilitate orderly price discovery in a rising rate environment. This is evidenced by the efficient adjustment of yields across the yield curve, while maintaining relatively contained spreads.

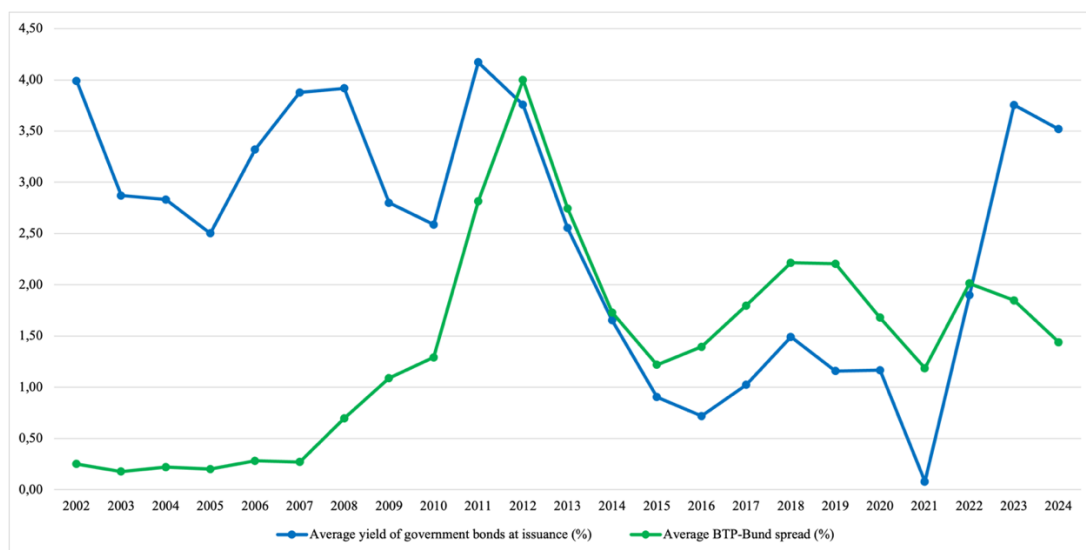
Although the development of the gross yield is informative, conclusions may be incomplete or misleading without comparison with other market factors, such as prevailing interest rates or yields of comparable government bonds. This is because gross yield is influenced by numerous external variables that do not directly affect the efficiency of the auction mechanism, including global macroeconomic trends, monetary policies and geopolitical factors. Considering the information presented, the yield trends are compared with the BTP-Bund spread, as previously stated in this work. To compute this indicator, data from the FRED website were used, specifically the long-term government bond yields, with a particular focus on the 10-year yields, for both Italy (Organization for Economic Co-operation and Development, 2024b) and Germany (Organization for Economic Co-operation and Development, 2024a). The data were expressed as a percentage on a monthly basis. The spread is defined as the difference between

the yield rates of the BTP and the Bund. To compute the spread, it was first necessary to determine these differences with the data from each month. These were then converted to basis points by multiplying by 100, as this is the common unit of measurement for this indicator. The results of these computations are illustrated in the following graph (Figure 11).



**Figure 11 - BTP-Bund spread between 2002 and 2024.**

For purposes of comparison, the data regarding yield and spread have been consolidated in Figure 12. The following graph presents a comparison between the average gross yield of newly issued Italian government bonds and the BTP-Bund spread from 2002 to 2024. The blue line represents the average yield of Italian government bonds at issuance, while the green line reflects the spread between Italian 10-year BTPs and German Bunds, which serves as a key measure of Italy's risk premium in the context of the Eurozone.



**Figure 12 - Evolution of government bond yields at issuance and BTP-Bund spread.**

From 2002 to 2007, the yield on Italian government bonds demonstrates a fluctuating pattern with notable volatility. During this period, yields experience sharp movements but remain within a relatively moderate range, reflecting changing macroeconomic conditions and investor sentiment in the early years of the Eurozone. Simultaneously, the BTP-Bund spread remains low and stable, suggesting that despite the fluctuations in yields, market confidence in Italy's fiscal stability relative to Germany remained largely intact during these early years of the Eurozone. From 2008 onward, the graph reveals a sharp increase in both the yields and the spread, coinciding with the beginning of the global financial crisis and, subsequently, the European sovereign debt crisis. The spike in yields around 2011-2012, reaching their highest point in the dataset, aligns with the peak of market fears regarding Italy's sovereign debt sustainability. During this period, the BTP-Bund spread also risen significantly, indicating increased perceptions of risk and a growing divergence between Italian and German government borrowing costs. After 2012, the graph shows a considerable decline in both the bond yields and the BTP-Bund spread, corresponding to the interventions by the European Central Bank (ECB) aimed at stabilizing financial markets after the crises occurred. From 2015 to 2019, the yields remain low, reaching historical lows between 2020 and 2021, while the BTP-Bund spread also narrows, reflecting improving market confidence and lower risk premiums for Italian debt. The following period shows renewed volatility, with bond yields rising again sharply in 2022, potentially because of inflationary pressures and global monetary tightening due to the impact of the COVID-19 pandemic. The BTP-Bund spread also widens, suggesting renewed concerns over Italy's fiscal outlook relative to Germany. The relationship between the two indicators considered suggests that the spread acts as an indicator of Italy's relative risk compared to Germany, with heightened spread levels typically accompanied by increases in bond yields at issuance.

Additionally, the increase in yields during crises and the subsequent decline during recovery periods indicate that the auction system successfully adjusts the cost of borrowing to reflect changing economic conditions and investor sentiment. While higher yields during crises reflect the necessary risk premium, the Treasury's ability to secure lower yields in periods of stability demonstrates that the auction mechanism remains effective in minimizing the cost of borrowing when market conditions improve. This responsiveness is crucial for sustaining market confidence and ensuring access to financing at manageable costs.

### 3.5 Analysis of debt dynamics

The following paragraph discusses the trends in the Italian public debt, underlining how such outstanding debt has evolved together with the average maturity of the debt portfolio. An analysis of Italy's outstanding debt, especially focusing on that portion constituted by securities, sets the ground for the study in the mechanism for an auction in the primary market. Understanding the composition and maturity structure of the public debt brings significant insight into the strategic decisions underlying debt issuance and management.

The information regarding debt have been obtained from two sources: the Bank of Italy (Bank of Italy, 2024) for data concerning the debt outstanding and the MEF website (Ministry of Economy and Finance, (E)) for all the data related to the auctions. The presented data illustrate a persistent increase in Italy's gross debt over the observed period, with a notable increase from approximately 1,2 million euros in 1995 to nearly 3 million euros by 2023, representing a significant growth of approximately 150%. This growth has been particularly pronounced in the period following the 2008 financial crisis and during the ongoing pandemic. As illustrated in the previous chapter, the proportion of debt securities has exhibited a consistent trend, oscillating between 78% and 84% of the gross debt over the 2002-2024 period. In the following graph (Figure 13), it can be observed that there has been an increase in debt during the period under consideration, and that the growth of debt securities is mostly proportional, thereby confirming that the percentage remains quite stable over time.

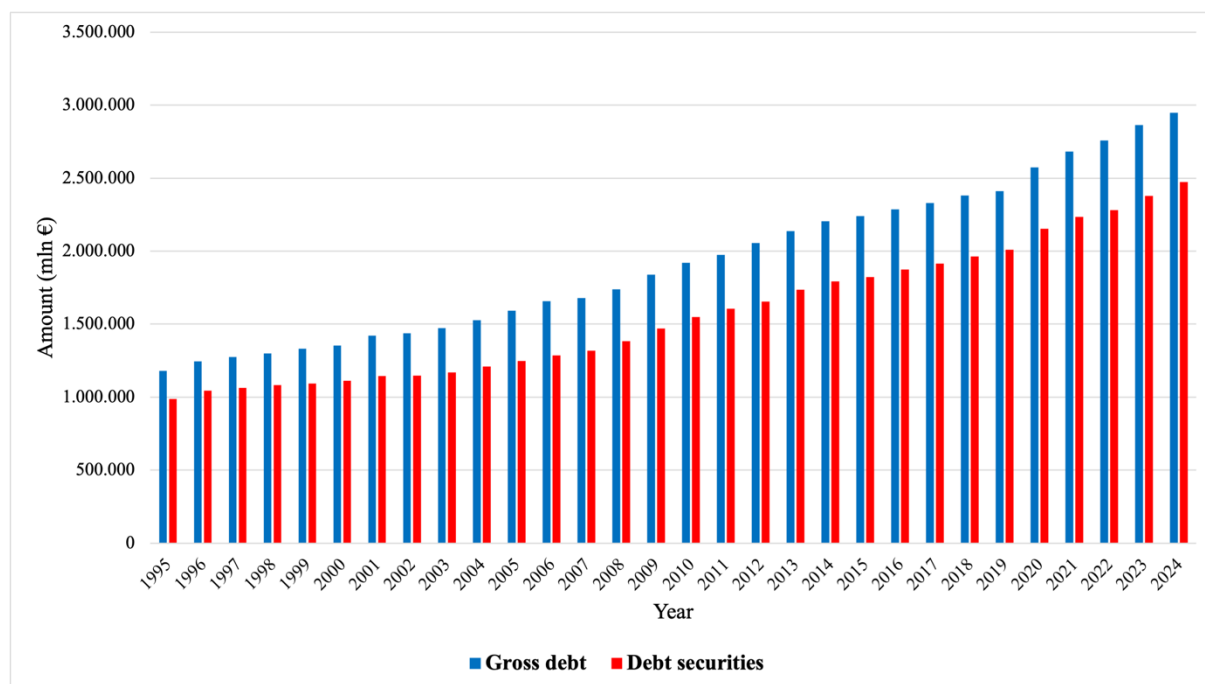
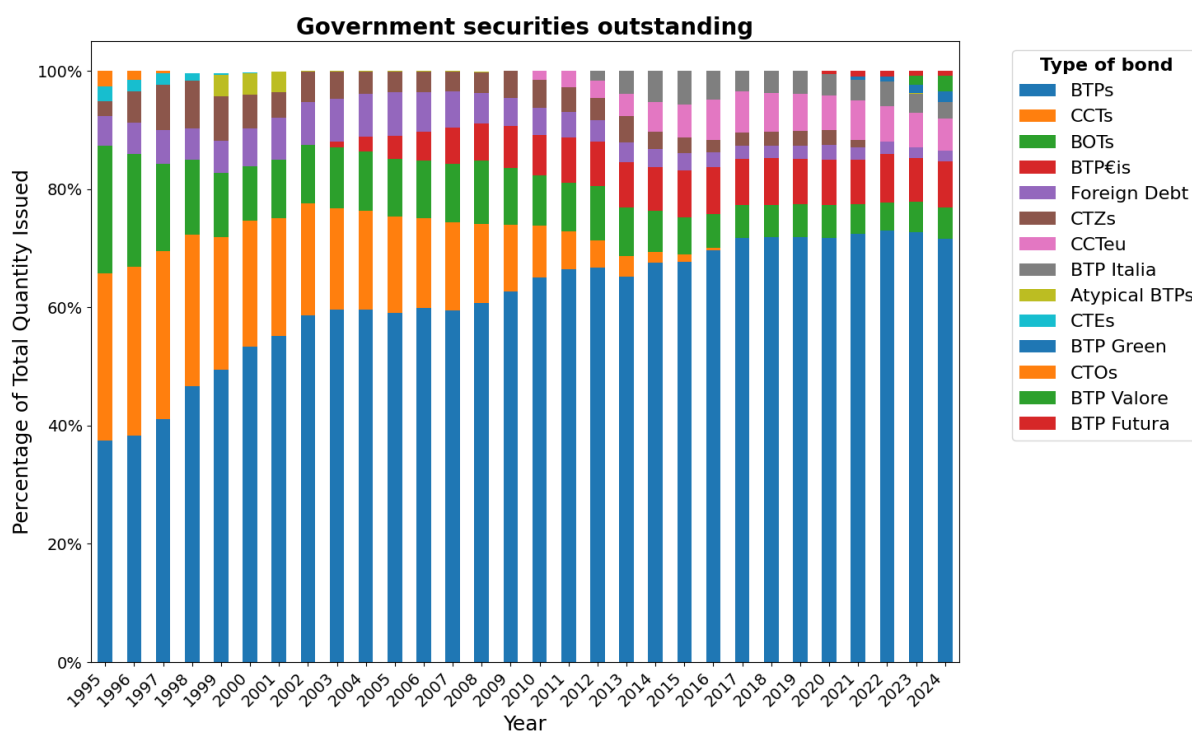


Figure 13 - Evolution of debt over time (1995-2024).

Additionally, the composition of government securities in circulation has experienced a substantial evolution over the period between 1995 and 2024, with noteworthy shifts in the relative importance of different instruments, as it can be observed from Figure 14.

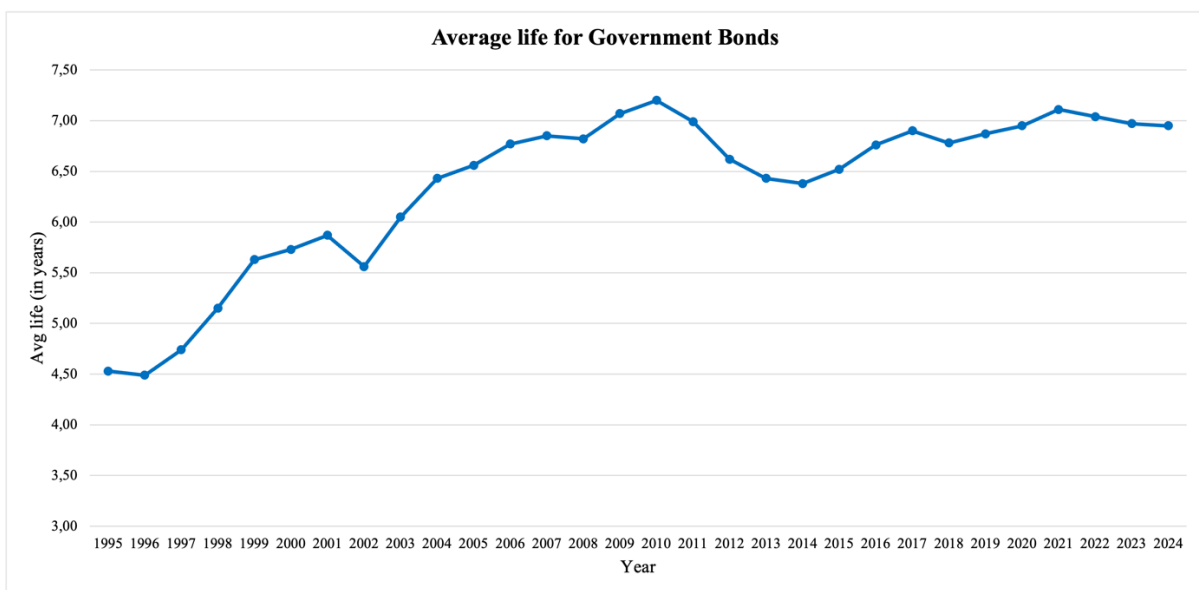


**Figure 14** - Evolution of the composition of government securities outstanding (1995-2024).

Looking at the graph above (Figure 14), it is evident that the most striking trend is the substantial increase in BTPs, which have become the dominant instrument. BTPs (in blue) have grown from representing approximately 37% of total securities in 1995 to around 75% by 2024. This shift reflects a clear strategic preference for medium- to long-term fixed-rate instruments, which are likely aimed at reducing refinancing risks and securing more stable funding costs. Conversely, there has been a notable decline in the share of CCTs and CCTeus, which have become a marginal portion of the market by 2024. Additionally, the introduction of new government securities, such as BTP Italia, BTP Futura, and BTP Green in recent years, reflects the Treasury’s efforts to diversify the investor base and respond to specific market demands, in particular those of retail investors. However, these newer instruments maintain relatively small shares of the total outstanding debt and for this reason, as previously stated, have been excluded from this analysis.

It follows that the observed evolution in debt composition is indicative of a strategic policy orientation, basically focused on risk management and market development. This would be manifested through the strategic lengthening of the average maturity period by the increased issuance of long-term financial instruments (Ministry of Economy and Finance, 2023).

In particular, the strategy focuses on enhancing stability in the market and bringing down external vulnerabilities. This framework presents a bond management policy that strikes a balance between conservative and innovative approaches, emphasizing structural resilience over immediate financial considerations. The announced change in the Department of the Treasury's policy on the maturity of government securities (Ministry of Economy and Finance, 2023), namely the strategic lengthening of the average maturity period through increased use of the long-term financial instrument, becomes even more evident when plotted on the graph in Figure 15, which represents the annual average life change of government securities between 1995 and 2024.



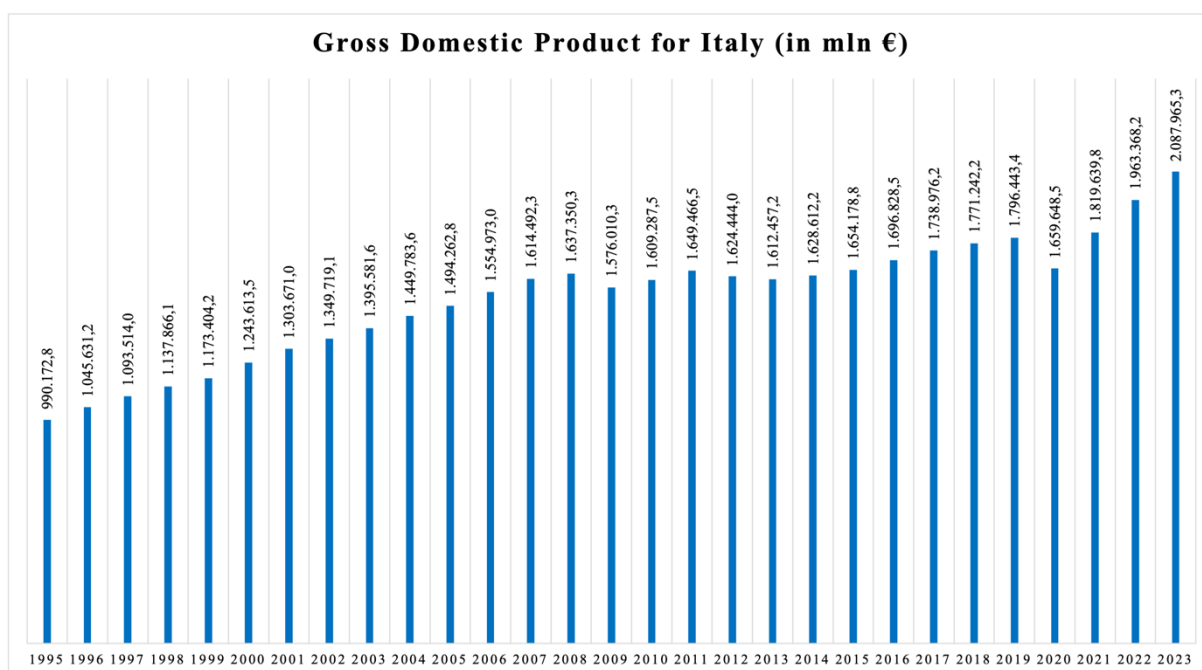
**Figure 15 - Average life of government bonds (1995-2024).**

The data (Figure 15) demonstrates a notable period of maturity extension from 1995 to 2010, during which the average life span experienced a significant expansion from approximately 4,5 to 7,2 years. This was followed by a subsequent phase of relative stability, characterized by modest fluctuations around the 7-year threshold. This structural transformation in debt composition reflects a deliberate policy shift towards enhanced fiscal resilience and reduced refinancing risk. Notably, long maturities have been sustained across various market conditions and economic cycles, showing Treasury's consistent commitment to sustainable debt management practices. The sustained higher average life observed in recent years represents a significant departure from the shorter-term orientation that was prevalent in the mid-1990s. This demonstrates a different approach to public debt management that prioritizes long-term stability over short-term cost optimization.

### 3.6 Fiscal sustainability: insights from the debt-to-GDP ratio

As mentioned in the previous chapter, the comparison between the level of government debt and the Gross Domestic Product (GDP) is a critical determinant for the financial health of a country, as it essentially reflects both its capability to meet future financial obligations and the main determinants of borrowing costs and bond yields. Understanding the Italian trends of GDP over recent decades is thus crucial to understand its debt sustainability. The following analysis outlines the GDP growth pattern of Italy, ranging from 1995 to 2023, after which a discussion of the debt-to-GDP ratio and its implications for economic stability is presented.

The trajectory of Italy's gross domestic product from 1995 to 2023 provides an illustrative analysis of periods of growth, stagnation, and vulnerability to global economic cycles, as it is demonstrated by the following graph (Figure 16). It should be noted that the graph has been constructed relying on the data published on the FRED website (Eurostat, 2024).

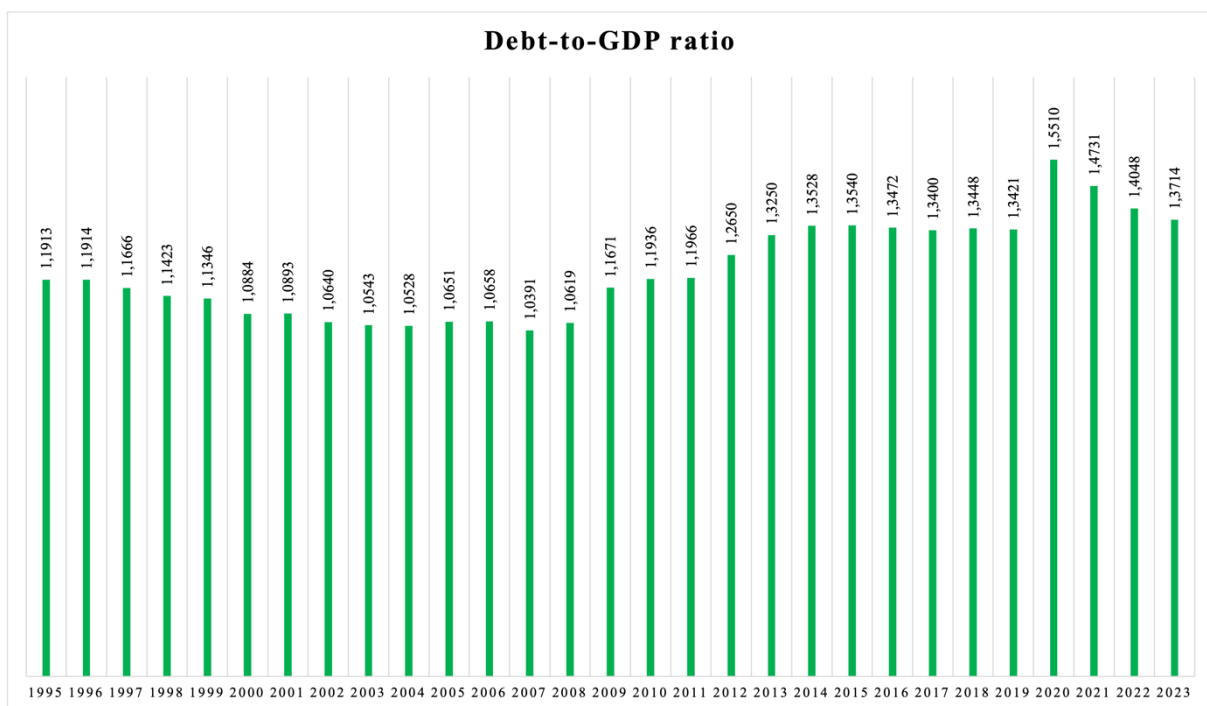


**Figure 16** - *Gross Domestic Product for Italy between 1995 and 2023.*

The gross domestic product exhibits a volatile pattern over the specified period, yet there is an overall growth trend. From 1995 to 2008, Italy experienced a moderate boost in its economy, where GDP rose from about €990 billion to €1,6 trillion in 2007 and reflected the general European growth. Then, with the financial crisis of 2008, the graph (Figure 16) shows a decrease of GDP to approximately €1,58 trillion in 2009. The following years, between 2010 and 2014, reflected stagnation. Indeed, GDP fluctuated between €1,6 to €1,63 trillion due to the European sovereign debt crisis. From 2015 to 2019, it partially recovered to reach €1,8 trillion, even though Italy grew at a relatively slower pace compared to other large European economies.

The COVID-19 pandemic caused another sharp contraction in 2020, which cut GDP to €1,66 trillion after lockdowns and restrictions disrupted key sectors like tourism and trade. However, in the period 2021-2023, Italy experienced a strong economic recovery. Its GDP reached a value of about €2,09 trillion in 2023, thanks to the recovery of economic activity and directed fiscal stimulus. Overall, this data underlines an economy able to recover, but sensitive both to domestic and international shocks.

Following the analysis of both the debt and GDP trends on an individual basis, it is now possible to gain a more accurate understanding of the debt-to-GDP ratio trends, which serve as a crucial indicator of a country's financial stability. The debt-to-GDP ratio demonstrates distinct patterns of evolution over the examined timeframe, as shown in Figure 17.



**Figure 17 - Debt-to-GDP ratio (1995-2023).**

Starting from approximately 1,19 in 1995, the ratio initially exhibited a period of improvement, declining gradually to reach one of its lowest points of about 1,05 in 2003 and 2004. This favorable trend can be explained by steady GDP growth coupled with contained debt expansion. However, this positive trend started to reverse drastically with the 2008 global financial crisis. The ratio started to increase, rising from around 1,04 in 2007 to approximately 1,27 in 2012. This worsening reflects both the GDP contraction and the increased government borrowing necessary to support the economy during the crisis. The subsequent period (2013-2019) showed a sustained elevation in the ratio, floating around 1,32 and 1,35. This persistently high level indicates that despite periods of economic recovery, Italy struggled to meaningfully reduce its

debt burden relative to economic output. Considering this situation, Italy could not significantly improve this ratio over the period, and it was thus positioned in an especially vulnerable position against exogenous future shocks. The most dramatic shift occurred with the COVID-19 pandemic, when the ratio spiked to an unprecedented 1,55 in 2020. This sharp increase resulted from the double impact of severe GDP contraction and massive fiscal stimulus measures required to address the health crisis and support the economy. The post-pandemic period (2021-2023) has seen some improvement, with the ratio declining to around 1,37, primarily driven by strong GDP recovery. However, this level is still much higher than in the pre-pandemic period, showing that the crisis has left its footprint on the debt sustainability metrics of Italy.

## **4. Analyzing variable responses to QE shocks using a VAR approach**

### **4.1 Motivation**

Based on the analysis carried out in the previous chapter on some crucial primary market indicators, this section aims to investigate the indirect effects of unconventional monetary policy, specifically the European Central Bank's (ECB) Quantitative Easing (QE) programme, on the Italian treasury auctions. While the previous chapter provided a descriptive analysis of variables such as gross yield at issuance, bid-to-cover ratios, and issuance allocation by maturity, this chapter attempts to take a more structural approach in understanding the dynamic responses of these key variables to exogenous shocks. Since QE targets the secondary market, this analysis will be directed to investigate the transmission mechanisms through which operations on that market have an impact on the conditions under which the issuance of new sovereign debt occurs in the primary market. The value of this study lies in its potential to shed light on the indirect impact of unconventional monetary policy on primary market outcomes, particularly in relation to yield spreads, investor demand and the strategic issuance selected by the Italian Treasury.

In order to comprehend the significance of examining the consequences of quantitative easing on key economic indicators, it is essential to initially examine the principles that define unconventional monetary policies, such as QE, and how these differ from conventional policy structures. As noted by Benigno, Canofari, Di Bartolomeo and Messori (2022), traditional monetary policy typically focusses on three main functions: setting a short-term policy rate to direct the short-term risk-free rate, thereby facilitating the transmission of monetary influences on inflation and economic growth; performing open-market operations to maintain sufficient liquidity for the banking sector, alongside mechanisms that manage reserves and withdrawals; and structuring the central bank's balance sheet to include mainly short-term government securities, cash, and commercial bank reserves. Plans like Asset Purchase Programmes (APPs), such as QE, diverge significantly from these functions, especially by reshaping the central bank's asset holdings. Instead of focusing primarily on short-term government debt, QE involves substantial purchases of long-term securities from both government and private sectors, and sometimes extends to corporate bonds and equities (Benigno, Canofari, Di Bartolomeo and Messori, 2022). In addition, to directly lower long-term interest rates, quantitative easing (QE) transmits itself through various channels. One of these is the signaling channel, whereby the central bank signals the fact that it intends to keep rates of interest low in the future through commitment to substantial asset purchases. This is because any premature

rate increase would reduce the value of bonds held by the central bank and result in significant losses (Delivorias, 2015). This signaling mechanism further reinforces market expectations of prolonged low rates, amplifying QE's impact on long-term borrowing costs and economic growth. By focusing on long-term assets, QE directly targets long-term market interest rates, complementing short-term rate control to improve monetary transmission and contribute to broader economic stability. The effects of QE on bond yields and sovereign spreads are very heterogeneous across asset classes and maturities.

Overall, studying a QE shock's impact on the primary market appears to be relevant because, while QE operations are conducted in the secondary market, they have indirect yet substantial effects also on the primary issuance of securities. By lowering long-term interest rates and signaling a commitment to sustained accommodative monetary policy, QE reduces the yield environment for both existing and new issuances, thereby influencing the cost of capital for issuers. Additionally, QE would work in the sense that it could affect investor demand in the primary market, since lower yields in the secondary market may drive investors towards new issuance in search of return and, therefore, improve funding conditions and pricing dynamics for issuers. Analyzing QE's indirect impact on the primary market thus provides an overview of how this unconventional monetary policy influences the entire financial system, from issuance costs to market liquidity and capital allocation efficiency.

In conducting this research, the adoption of a Structural Vector Autoregression (SVAR) framework with an external instrument for the QE shock enables the identification of causal impacts on key issuance metrics, thus representing an optimal approach for exploiting the analysis. This approach has been chosen mainly relying on the research conducted by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019) that aims to show the existence of perceived policy Target, Timing, Forward Guidance (FG), and Quantitative Easing (QE) surprises and study their effects on various financial market segments in the euro area. In particular, the Proxy SVAR model is applied to different combinations of the variables under consideration, with the objective of studying the impacts of the four distinct shocks. This is achieved by instrumenting the residuals of the VAR with a single instrument at a time. The results of their research demonstrate that, among other findings, quantitative easing (QE) influenced the rates on safe investments and those on sovereign bonds with a maturity of 10 years (Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa, 2019). Indeed, the impulse response functions estimated with this model can be employed to quantify the magnitude and persistence of adjustments to variables in response to QE-related shocks, thereby offering insights into the evolving interaction between monetary policy and sovereign debt management.

This investigation therefore adds to the existing literature on monetary policy spillovers through its specific focus on the link between secondary market interventions and primary market issuance dynamics. The analysis will also carry value for policymakers and debt managers in, among other things, comprehending how QE can potentially alter the Treasury's ability to secure favorable financing terms when formulating issuance strategies that are resilient to shifts in monetary policy regimes.

## **4.2 Theoretical foundation**

Following the credibility crisis in macroeconomics during the 1970s, a need for new methodologies to fulfill the primary tasks of macroeconomists arose. The introduction of Vector Autoregressions (VARs) by Sims (1980) provided the needed solution. Since the beginning of their application, VAR models have become a foundational econometric tool in macroeconomics, supported by a robust body of applications and advancements. This widespread adoption underscores the flexibility and effectiveness of the VAR framework across various research contexts.

To clarify the model choice, it is important to note that, even if under certain conditions Local Projections and Structural VAR models can produce equivalent response estimates, as demonstrated by Plagborg-Møller and Wolf (2021), the VAR approach appears to yield a more precise estimation of impulse response functions (IRFs) for the topic investigated. This preference aligns with the findings of Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019), who employed the VAR model to estimate variable responses to QE shock, an approach that can also be applied in this chapter, given the aim of estimating the responses of certain variables in the Italian primary market to such shock. Consequently, the VAR method is chosen for the following analysis.

Using the VAR model, there are two different approaches that can be applied: a proxy Structural VAR (Vector Autoregression) and an Internal Instrument VAR with proxy first. Comparing the two models, it arises that with the proxy SVAR approach the estimations should be more precise. Indeed, there are only four variables to model instead of five, since the proxy for the shock is added after the estimation of the model. This is in line with the principle that increasing the number of variables, given a sample, a model results in less precise estimates. On the other hand, Internal Instrument VAR with proxy first helps in estimating correct Impulse Responses even if in the model there is nonfundamentalness (Forni, Gambetti and Sala, 2018) and we do not have complete information. The theory documented good properties for this model making it a good approach to adopt in macroeconomics analysis. At the same time, estimating one

additional variable, in our case the proxy for the information shock, makes the estimates less precise than in the case of proxy SVAR for the reason above mentioned. Each model presents a set of advantages and disadvantages. A significant finding related to the use of VAR models is the proof, presented in the paper by Plagborg-Møller and Wolf (2021), that proxy SVARs are equivalent to Cholesky VARs with the instrument ordered first under certain conditions. In this analysis, the Proxy SVAR model is adopted as it is the same approach that was employed in the paper "Measuring Euro Area Monetary Policy" by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019). This analysis examined the impact of the same instrument employed for the QE shock in this chapter, so it seems appropriate to apply the same model that the authors demonstrated to be effective in this kind of analysis.

Following the strategy above mentioned, the following formula is the one applied to estimate the reduced form VAR:

$$y_t^i = \alpha + \sum_{j=i}^p A_j y_{t-j} + u_t$$

with  $\alpha$  representing the intercept (drift),  $p$  the lag-order of the VAR and  $u_t$  the vector of residuals from the OLS equation-by-equation regressions.

Then, following the methodology of a Proxy SVAR model, the residuals of the VAR estimated are instrumented with the shock in question. The instrument used as a proxy for the QE shock must satisfy the relevance and exogeneity assumptions. These conditions are respected since the proxy that has been employed in this analysis is the one proposed in the paper of Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019), where these assumptions have already been demonstrated. In their paper, the authors investigate the impact of four different instruments (Target, Timing, Forward Guidance and Quantitative Easing) on the residuals of the Vector Autoregression (VAR) model, with one instrument at a time. This approach allows them to extrapolate the component correlated with each single surprise, respectively. In light of the aforementioned findings, the following analysis will focus on the impact of the QE instrument on a selected set of variables, mainly within the primary market, over the period between 2014 and 2018, employing the proxy for the instrument that has been previously estimated by the authors (Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa, 2019).

### 4.3 Data and variables

In this investigation, Italian daily data from 2014 to 2018 on a series of variables were employed. This period was selected based on the fact that the ECB began systematic asset purchases in September 2014, following the initiatives of other central banks, including the Federal Reserve and the Bank of Japan (Benigno, Canofari, Di Bartolomeo and Messori, 2022). Subsequently, the APP (Asset Purchase Programme) was temporarily suspended in December 2018. Thereby this offers an optimal timeframe for investigating the impact of the QE shock in the euro area, and consequently, in this specific instance, in Italy.

It should be noted that, due to certain limitations that emerged during the analysis, two distinct models were estimated with the objective of achieving a more nuanced comprehension of the indirect effects of unconventional monetary policy on the Italian sovereign debt market.

While the proxy employed for the QE shock is the one provided by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019), the endogenous variables employed for the two models, together with a brief explanation of the rationale behind their selection and their sources, are presented in the following table for the reader's convenience (Table 14).

The first four variables (see Table 14) all relate to the primary market and the data used are therefore the ones collected in the dataset created and used for the analysis in the previous chapter. In contrast, the other three variables pertain to the secondary market and are derived from the data collected and analyzed, along with other variables, in the paper by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019)<sup>3</sup>. The inclusion of these secondary market variables in the second estimated model serves the purpose of controlling for potential spillovers between the two markets, with the intention of enhancing the reliability of the resulting estimates. This is done in order to address the critical issues identified in the initial model. A detailed explanation of this topic will be provided in the following section.

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<sup>3</sup> Publishing and maintaining the Euro Area Monetary Policy Event-Study Database (EA-MPD) by Altavilla et al. (2019), employed by different studies and also in this analysis, constitutes a significant contribution to the discussed topics.

**Table 14 - Variables employed for the VAR model**

<b>Variable</b>	<b>Motivation</b>	<b>Source</b>
<b>Gross yield ad issuance (%)</b>	The gross yield of securities issued on the primary market is a key variable for observing the real financing costs incurred by the Italian Treasury	Constructed dataset
<b>Bid-to-cover ratio</b>	The bid-to-cover ratio is an indicator of relative demand in government bond auctions that provides a measure of investor interest in Italian debt	Constructed dataset
<b>Amount allotted short-term</b>	The amount allocated for securities divided by their maturity period provides insight into the Italian Treasury's issuance preferences for both short- and long-term securities and it offers a measure of the Treasury's management of new issues	Constructed dataset
<b>Amount allotted long-term</b>		Constructed dataset
<b>2-year Italian bond rate</b>	The IT2Y helps to observe how QE impacts short- to medium-term financing costs	Paper by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019)
<b>Spread BTP-Bund</b>	This daily spread between the Italian BTP and the 10-year German Bund represents the perceived sovereign risk for Italy relative to Germany (benchmark for the Eurozone)	Paper by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019)
<b>2-years OIS rate</b>	The OIS2Y represents expectations for short-term interest rates in the Eurozone and, with daily data, it is a useful proxy to monitor how the market reacts to changes in expectations on monetary policy rates.	Paper by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019)

The following vectors describe the different combinations of variables used in the two estimated models:

$$y_t^i = \begin{pmatrix} YI \\ BTC \\ AAST \\ AALT \end{pmatrix} \quad (1)$$

$$y_t^i = \begin{pmatrix} IT2Y \\ SPR \\ OIS2Y \\ YI \\ BTC \end{pmatrix} \quad (2)$$

where YI = gross yield at issuance (%), BTC = bid-to-cover ratio, AAST = amount allotted short-term, AALT = amount allotted long-term, IT2Y = 2-year Italian bond rate, SPR = spread BTP-Bund and OIS2Y = 2-years OIS (Overnight Indexed Swap) rate.

Note that, since the data are daily based, this analysis employed 12 lags as suggested by the analysis conducted by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019). The following sections will present the estimated Impulse Response Functions (IRFs) of the two models, together with an explanation of the rationale behind the attempts to improve the analysis conducted following the discovery of limitations in the initial approach.

## 4.4 Estimation and results

### 4.4.1 Impulse response functions

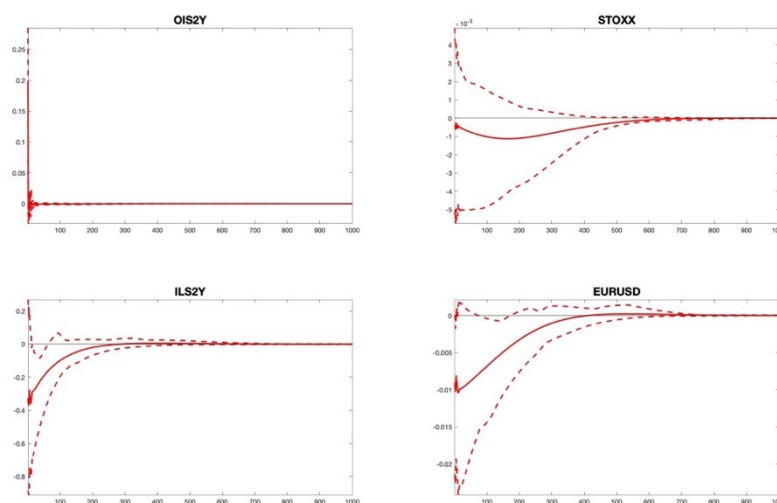
The impulse response functions (IRFs) quantify the dynamic impact of a shock over time, illustrating how the endogenous variables of the VAR respond to an innovation in the shock while holding other shocks constant at zero. IRFs are the focus of this analysis, mainly for what concerns the impulse responses of the endogenous variables employed to the QE shock as captured by its proxy. This section will present the two models estimated, providing an explanation of the rationale behind their construction and an acknowledgement of the limitations to which they are subject.

#### 4.4.1.1 Replication of the IRFs of the paper

A preliminary stage of the analysis is based on the attempt to replicate the impulse response functions proposed in the reference paper (Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa, 2019) to gain insight into the specifications employed in the model. This is necessary

in order to clarify the number of lags, the number of future steps and all the characteristics of the model used, to apply them to the primary market data object of analysis in this section.

In order to achieve this, the IRFs to the QE shock of the following variables have been estimated to replicate one of the models presented in the paper: OIS2Y, LOGSTOXX, ILS2Y and LOGEURUSD. The data employed in this estimation are drawn from the Euro Area Monetary Policy Event-Study Database (EA-MPD), constructed by the authors (Altavilla et al., 2019) and they refer to the period between 2014 and 2018. As already mentioned, the approach employed is a Proxy SVAR model at daily frequency estimated with 12 lags and projecting 1000 future steps with a wild bootstrap methodology, as retrieved from the replication code published together with the paper. Figure 18 presents the IRFs computed with this approach.



**Figure 18** - *Replication of the IRFs of the paper by Altavilla et al. (2019).*

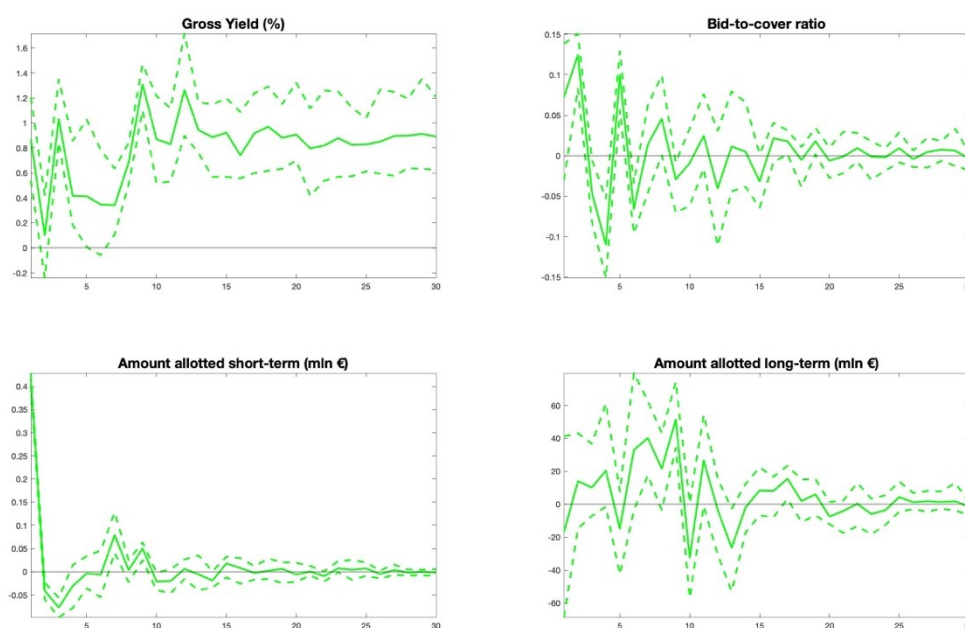
The graph above shows that the adopted model qualitatively replicates the graphs included in the paper by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019), considering the confidence interval applied (dotted lines), but with some differences in the magnitude of the effects. This discrepancy may be attributed to the use of a different frequency. While the paper references a daily VAR, the data pertain to business days. It is plausible that the authors have employed a specific procedure to address this discrepancy, which is not explicitly visible in the code. Furthermore, in this study, MATLAB is the solely adopted software for the purpose of simplification, whereas the replication codes published by Altavilla et al. (2019) demonstrate the utilization of a combination of disparate software. Specifically, R was employed for data processing and dataset creation, while Julia and Stata were used for the estimation of the different models. This may result in some discrepancies in the restrictions applied in estimating the model, given that the specific estimation procedures employed by MATLAB may be

approached and executed in a manner that differs from that of the other software programmes employed by the paper (Altavilla et al., 2019).

Overall, it can be argued that the Proxy SVAR model, despite certain limitations in the quantitative aspects of the estimates, can be adopted in the following sections to estimate the models under analysis, as the nature of the analysis is qualitatively similar to the one presented in the aforementioned paper (Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa, 2019). However, it is important to consider the potential errors in the magnitude of the estimated effects while examining the results.

#### 4.4.1.2 First model

The selected variables for the initial model were chosen with the intention of estimating the impact of the QE shock on the primary market. These variables include the gross yield at issuance, the bid-to-cover ratio, the amount allotted short-term, and the amount allotted long-term. The chosen indicators are economically relevant and are believed to capture the most crucial aspects of the functioning of the primary market for government bonds. The IRFs estimated are presented in Figure 19.



**Figure 19** - IRFs first model.

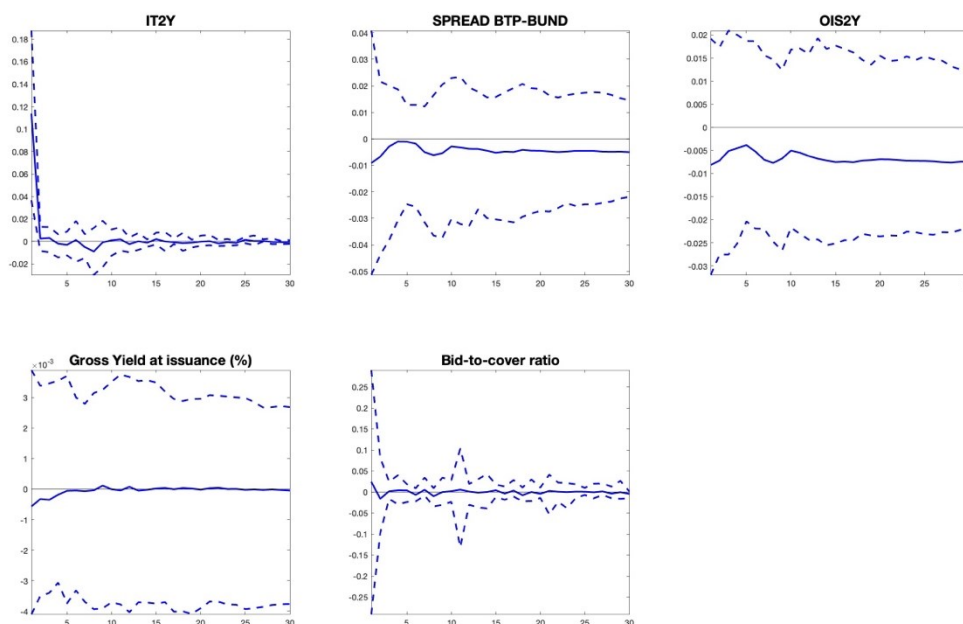
In the thirty periods analyzed, the gross yield at issuance, in contrast to the goal of lowering yields that is pursued through quantitative easing (QE), shows a slight increase. However, this can be understood in the context of the primary market, as if QE were to reduce yields in the

secondary market, the Treasury could use this context to increase supply in the primary market at higher prices. Nevertheless, the positive effect is not particularly pronounced and seems to fade rapidly over time, after some fluctuations. In addition, an initial increase in the bid-to-cover ratio followed by a decline could indicate that Italian auctions initially attract more interest due to the accommodative environment, but after that the bid-to-cover ratio immediately normalizes, just as QE does not seem to induce a substantial change in short- and long-term amount issued as the impact of the shock, also in this case, fades very quickly. Presumably, the Italian Treasury does not change the duration of its issuance strategies in response to a QE shock, preferring to maintain stability for the amount allotted at all maturities. However, the statistical significance is notably weak for the variables under examination, indicating great uncertainty in the effects of QE on these aspects of the primary market. One potential explanation for this is the estimation of the responses to the shock directly on these primary market variables. Indeed, it could be argued that QE is an unconventional monetary policy that acts on the secondary market, where the ECB purchases securities, and therefore its effects on the issuing strategy of the Italian treasury are only indirect. It can therefore be hypothesized that the inclusion of additional control variables, especially those belonging to the secondary market, could enhance the robustness of the estimates.

#### *4.4.1.3 Second model*

Based on the previous analysis, the estimation for the second model relies on the following logical framework. First, to mitigate the risk of model overestimation and to address potential issues of correlation between the variables, the number of factors pertaining to the primary market has been reduced. Second, additional control variables related to the secondary market have been introduced to account for and filter out the indirect effects of the QE shock within the primary market. The variables for the primary market included are the gross yield at issuance and the bid-to-cover ratio trying to study the impact of the QE shock both on the financing costs incurred by the Italian Treasury and the demand in government bond auctions. The variables added with a control objective are the 2-year Italian bond rate to observe how QE impacts short- to medium-term financing costs, the spread BTP-Bund to control for the perceived sovereign risk for Italy relative to Germany and the 2-years OIS rate as a proxy to monitor how the market reacts to changes in expectations on monetary policy rates.

The results of the model constructed are summarized by the IRFs quantifying the impact of the QE shock in Figure 20.



**Figure 20 - IRFs second model.**

The model is observed to be non-significant, as it is evident observing the data presented in Figure 20. Consequently, it is unable to effectively capture the impact of the QE shock on the primary variables. Furthermore, the model lacks direct information on the duration preference (short- or long-term), which is a deficiency in terms of the time structure of debt, which is one of the effects under investigation.

The lack of significance of these two models may be attributed to a number of factors. The following section seeks to elucidate these underlying causes and propose potential solutions to the challenges they present.

#### 4.4.2 Limitations of the models

The direct investigation of the actual effects of quantitative easing, especially as in this case of the effects on primary market variables that have been investigated through the use of a structural VAR with an external instrument, is challenging. However, it represents an intriguing avenue for future research.

A preliminary examination of the limitations of the two models estimated reveals that, as previously stated for the first model, estimating the direct impact of the shock on primary market variables may not be the most appropriate approach. This is because the effect on these variables is indirect and shaped by the shock's influence on certain secondary market variables. An initial attempt to address this issue has been made by incorporating some control variables of the secondary market into the second model. A further improvement would be to match the

data pertaining to the issuance of the government bond with that of the transactions on the secondary market, thus obtaining a more comprehensive dataset. Despite this, the second model has brought to light further limitations.

Another potential concern that may be raised in relation to both models is that of frequency. The model employed is a Proxy SVAR with daily frequency, in line with the preceding research of Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019). In accordance with the aforementioned reference, the QE shock proxy and all secondary market variables are observed at a daily frequency. However, while the primary market data may be adapted to a daily frequency by taking the auction date as a criterion and setting values to zero on non-auction days, they are inherently periodic. Consequently, the imposition of zeros on non-auction days may potentially compromise the accuracy of the models' estimates.

Additionally, it is pertinent to mention that, as elucidated by Altavilla et al. (2019), interest rate surprises can be decomposed into four distinct shocks: target, timing, forward guidance, and QE shocks. This is achieved through the factor rotation methodology of Swanson (2021) and the division of ECB communication into press release and press conference. However, as indicated in the paper by Gnewuch (2022), a limitation of the instrument employed is that it does not distinguish between policy and information shocks. This may have an impact on the precision of the estimates, as this proxy is unable to differentiate between the effects of the policy and those related to the information shock.

Moreover, regarding the primary market variables considered in the two models and, in particular, the amount allotted of both short- and long-term securities and the yield at issuance, there is a need for improvements to be made in order to enhance the conducted analysis and provide more precise estimates of the impact of quantitative easing on Italian treasury auctions. The proposal to maintain a distinction between the amounts allocated for short-term and long-term securities appears to be an effective approach to incorporate direct information on the maturity preference and the Italian Treasury's debt management strategy with respect to the time structure of debt in the model. Nevertheless, an examination of the immediate impact of the shock on these two variables is an inaccurate representation of the reality. This is because the amount to be issued is not determined by the shock in isolation, but rather by a number of factors, including the maturing portion of government bonds and the necessity to refinance this part of the debt. Consequently, the amount to be issued is not a variable that can be considered entirely subject to the shock under analysis. This is more evident when one considers the time-related aspects of government bond issuance. Recalling the first chapter, it is crucial to highlight that, even if at the end of each year the Treasury publishes the subsequent year's annual auction calendar, this document contains the dates of the auctions and the types of government securities

to be issued, but not their amount (Ministry of Economy and Finance, (B)). The information regarding the amount offered is published with the official press release, typically two business days before the auction. This enables the Treasury to exercise a certain degree of discretion in modifying the quantities in response to external developments that may impact the country's requirements, while maintaining the understanding that, as previously stated, the objective is to address the portion of bonds maturing, necessitating a certain quantity of issuance. This serves to clarify that, in theory, the portion of the amount allocated that is susceptible to external shocks, such as quantitative easing in this case, is the difference between the expected amount allocated, which is typically foregone at the end of the previous year, and the amount actually allocated, which is subject to eventual adjustments. One potential approach to solve this inaccuracy is to estimate a proxy for the expected amount allocated by the Treasury for the future auctions, forecasted from the bonds maturing and requiring refinancing and other public information about the new issuances. With this strategy, the impact of the shock can be estimated on the difference between this value and the amount actually allotted. In light of the preceding argument, the latter can be adjusted by the Treasury as needed up to around 48 hours before the auction, when the amount to be issued is made public. Therefore, it is evident that the difference between the proxy proposed and the amount allotted is the portion actually subject to the shocks.

Concerning yield at issuance, the problem in estimating the impact on this variable is that, looking at the data, yields on the primary market appear to be strictly related to the movements of the secondary market yields. This relation can be a possible shock propagation channel to be investigated, but it makes it harder to distinguish the impact of QE between the two variables. Indeed, quantitative easing has been shown to have an impact on secondary market yields in a variety of papers, such as Altavilla et al. (2019) and Krishnamurthy and Vissing-Jorgensen (2011). While it is plausible that this impact could influence decisions regarding primary market bond issuances, the findings from the second estimated model do not provide evidence to support this effect, failing in capturing this dynamic. Examining the relationship between primary and secondary market interest rates thus emerges as a promising avenue for future research. Indeed, several studies, such as that conducted by Beetsma, Giuliodori, de Jong, and Widijanto (2013), suggest that spillover effects exist between these two markets. An example of this phenomenon can be observed in the two graphs in Figure 21 and Figure 22, which illustrate the yields for 10-year and 3-year BTPs respectively in both markets. As anticipated, there is a clear related pattern between the yields from the primary and secondary markets of bonds of the same type, in accordance with the established framework.

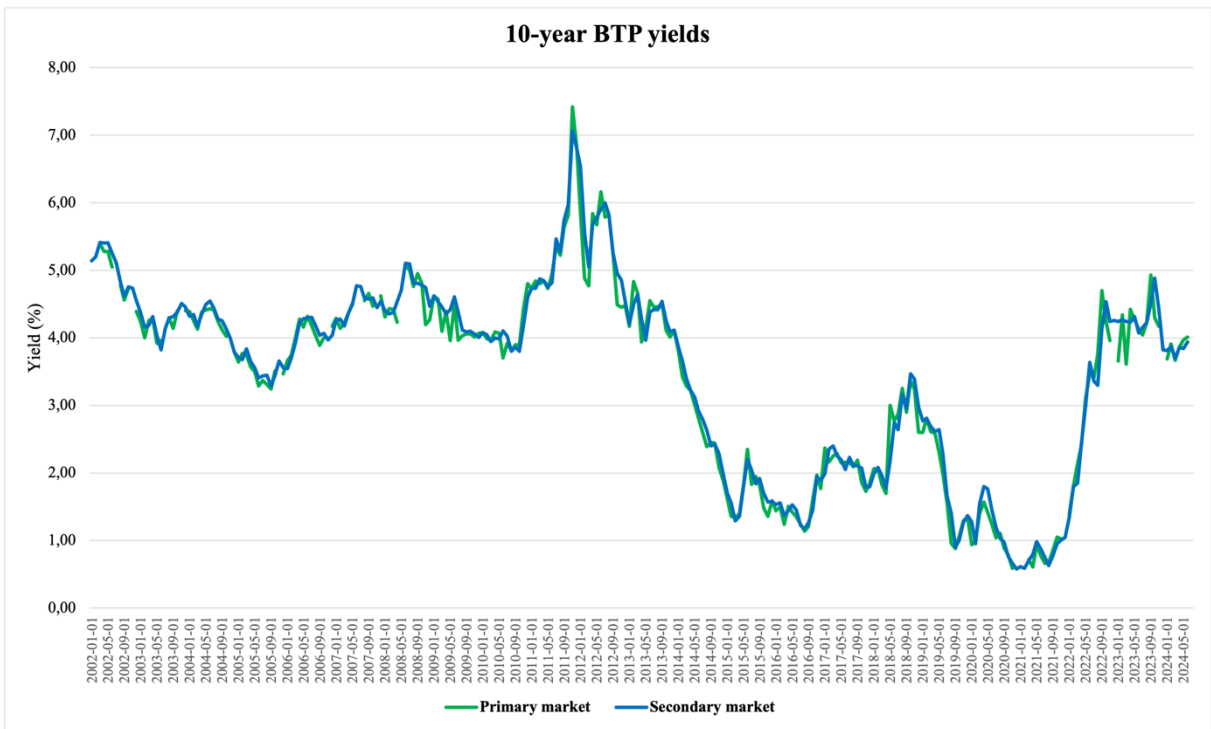


Figure 21 - 10-year BTP yields.

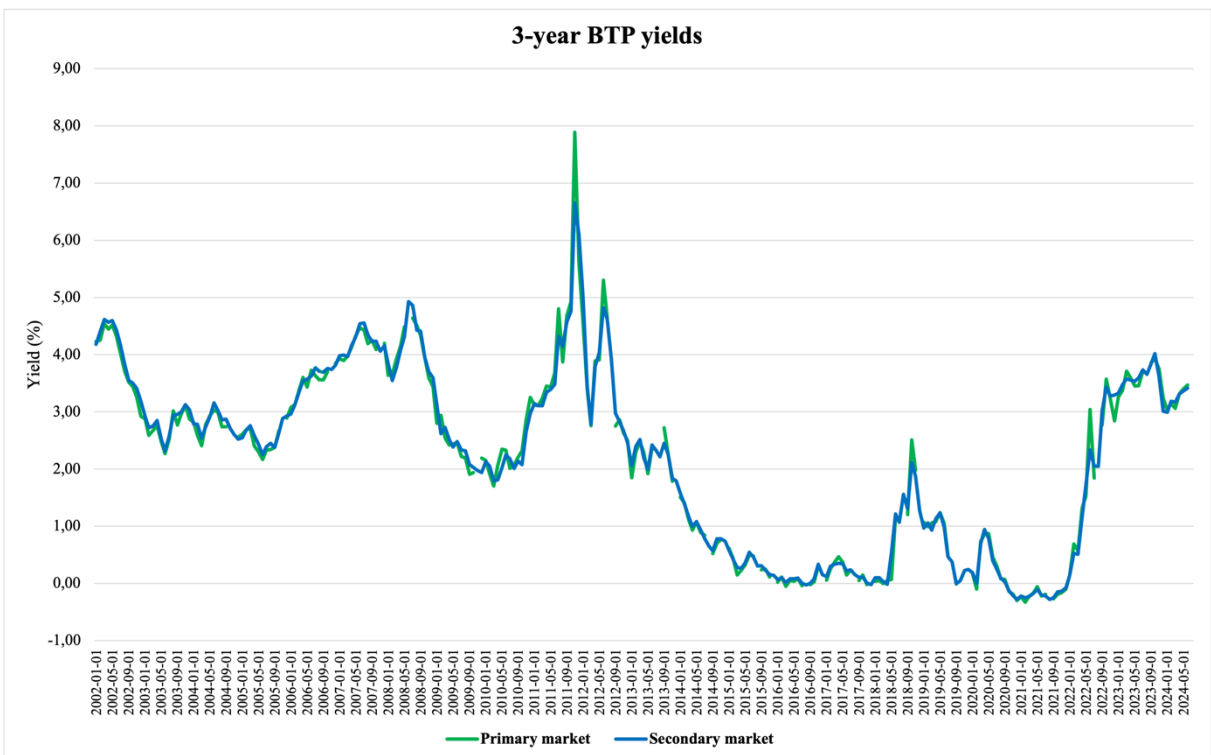


Figure 22 - 3-year BTP yields.

In conclusion, modifications can be made to enhance the precision of the estimated models. This may involve adjusting the frequency of the model by partly foregoing the accuracy of the daily secondary market data to find a match with the periodic and, hence, more irregular

frequency of the primary market. Additionally, it may be beneficial to identify the primary market variables that are most susceptible to the analyzed shock, involving different estimation techniques and studies such as the ones proposed for the amount allotted and the gross yield. Furthermore, matching the data of the primary market collected in the dataset constructed for this work with the ones of the transactions on the secondary market and incorporating the appropriate control variables for secondary market dynamics in the model could facilitate the capture of spillovers between the two markets, improving the recognizability of the actual effects of quantitative easing on primary market treasury auctions.

## Conclusion

This thesis has examined the Italian Treasury auction mechanism in depth, with a focus on its role in managing public debt and supporting financial stability in an evolving economic and regulatory landscape. This analysis provided an understanding of how Italian government bond auctions really work and, importantly, placed the Italian framework in its international context through a comparison with different mechanisms adopted. It has also been illustrated, in addition, the process of price determination both in competitive auctions and in marginal auctions, clarifying how these kinds of auctions work within the frame of a debt management strategy for Italy.

The research proceeded to the stage of data analysis, where key efficiency and effectiveness indicators were developed aiming to evaluate the Italian auction mechanism. In order to conduct this analysis, a dataset was constructed based on the data from Italian treasury auctions. Subsequently, using the data collected, historical trends in bid-to-cover ratios, gross yields, and debt dynamics were examined, with particular attention paid to the implications of average debt maturity and debt-to-GDP ratios. The findings indicate that the auction mechanism is responsive to shifting market conditions, as evidenced by fluctuations in the bid-to-cover ratio. The continuous demand for Italian government bonds, even in crisis conditions, represents the fact that the auction system may change according to investor risk appetites and absorb market volatility. The sensitivity of yields to new economic conditions, increasing during crises to reflect rising risk and then falling in recovery, also speaks to the Treasury's ability to manage borrowing costs. This dynamic approach is necessary to keep investors confident and source financing at affordable costs throughout economic cycles. Besides, the structural adjustment in the composition of debt toward longer maturities emphasizes strategic prioritization of fiscal resilience and sustainable debt management.

In addressing the broader context, this study has also had to delve into the indirect influence of the Quantitative Easing (QE) programme by the European Central Bank on auctions by Italian Treasury. Indeed, it is by analyzing the possible effects of these interventions in the context of primary market outcomes that this work has so far attempted to disclose some relevant information on the various transmission channels through which unconventional monetary policy impacts debt issuance conditions. Even though some limitations were experienced in estimating the models, this analysis stresses the most relevant issues underlying the estimation of the external shock as causes of indirect impact on the primary auction outcomes, including some recommendations for future research in this area.

In conclusion, the findings of this thesis prove that there is greater insight into the dynamics and resilience of the Italian Treasury auction process to outside influences. The work's contribution is important in relation to the general strategies that Italy applies to move through the complexities that arise from fluctuating financial conditions. Through the analyses performed, this thesis highlights the strategic importance of auction mechanisms and offers a foundation for future studies aiming to optimize public debt issuance in similar economic contexts.

## Appendix

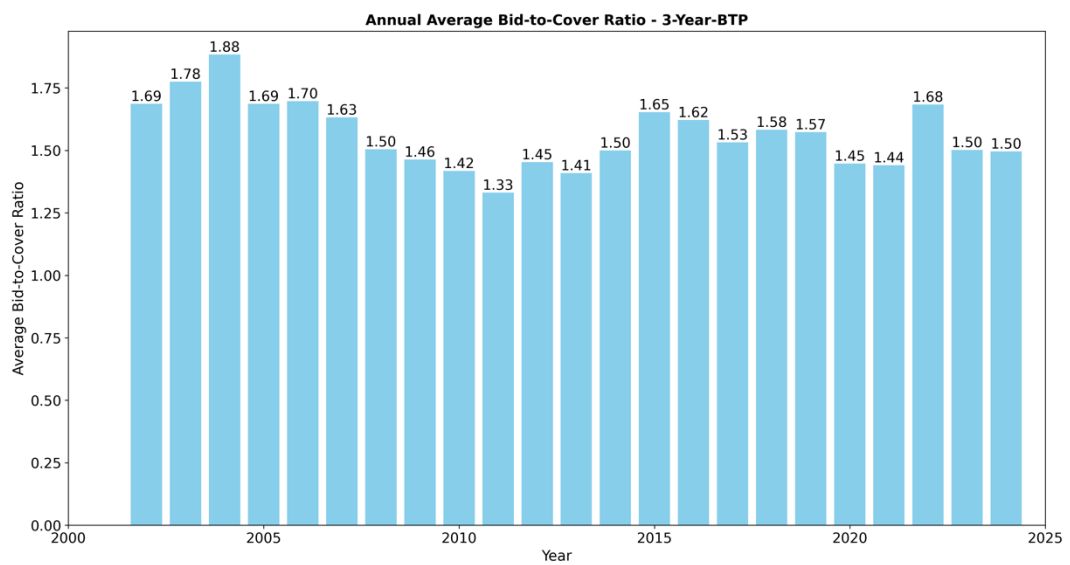
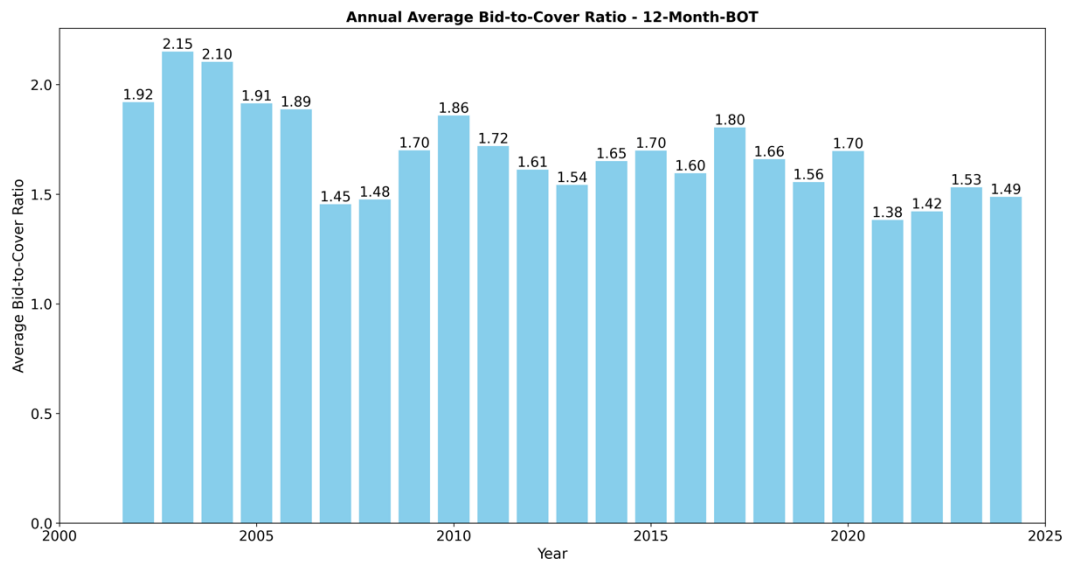
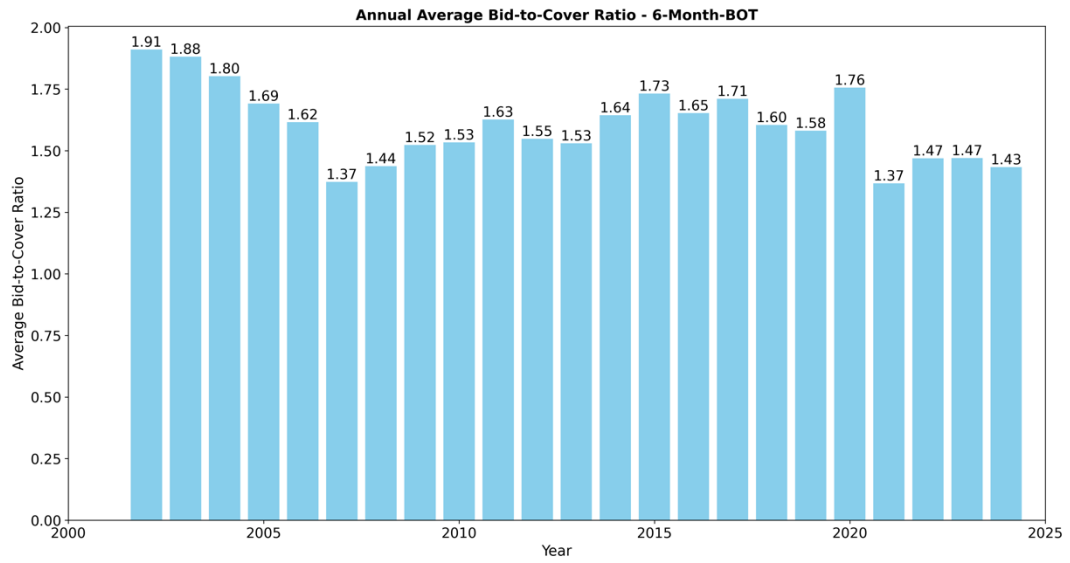
### A. Summary of ratios: definitions, formulas and data sources

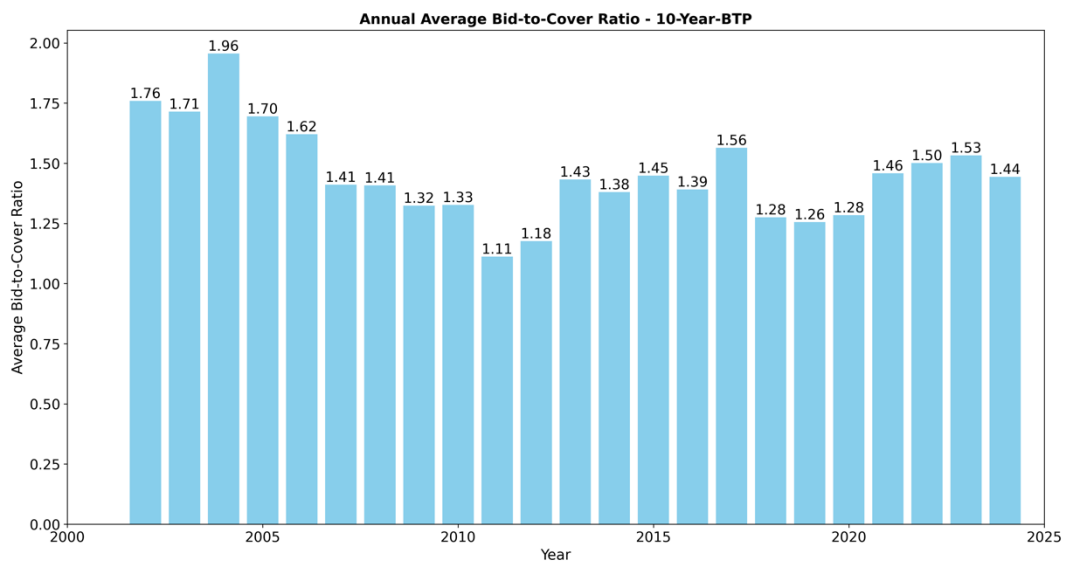
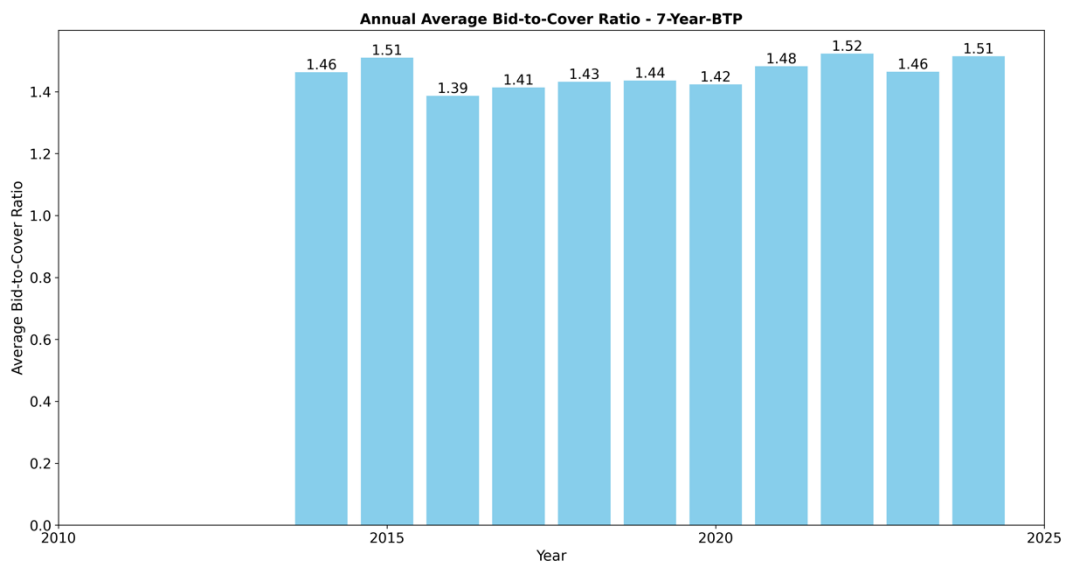
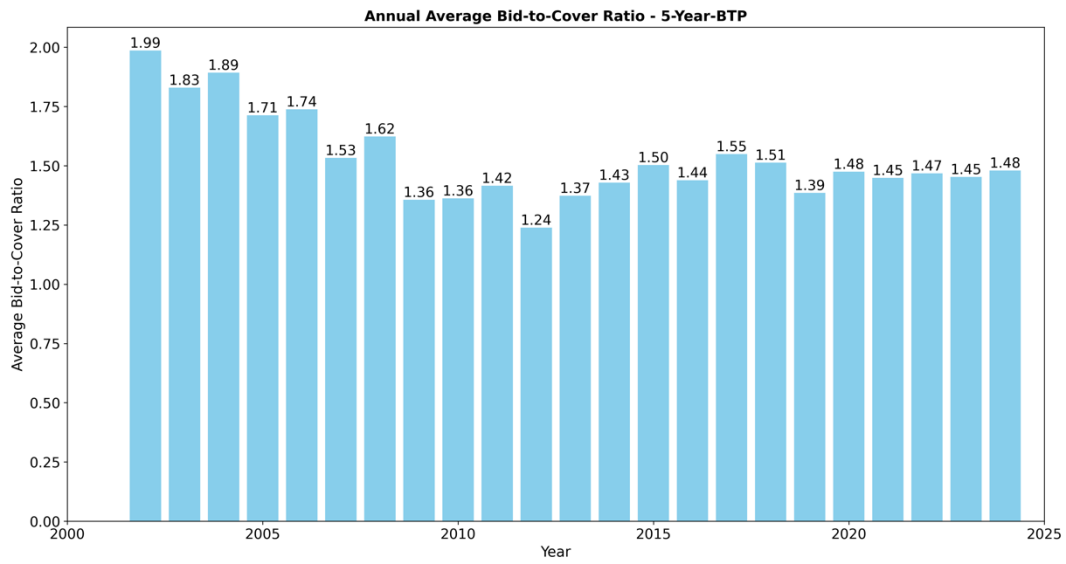
Indicator or ratio	Formula (if applicable)	Period	Source
<b>Number of auctions</b>	Data	2002-2024	Constructed dataset
<b>Amount allotted</b>	Data	2002-2024	Constructed dataset
<b>Bid-to-cover ratio</b>	Amount bid / Amount offered	2002-2024	Constructed dataset
<b>Gross yield</b>	Data	2002-2024	Constructed dataset
<b>BTP-Bund Spread</b>	BTP yield - Bund yield	2002-2024	Italy's yields FRED website
			Germany's yields FRED website
<b>Debt outstanding</b>	Data	1995-2024	Bank of Italy report
<b>Government securities outstanding</b>	Data	1995-2024	MEF website
<b>Average life for government bonds</b>	Data	1995-2024	MEF website
<b>Government securities newly issued</b>	Data	2002-2024	Constructed dataset
<b>Debt-to-GDP ratio</b>	Gross debt / GDP	1995-2023	Gross debt from Bank of Italy report
			GDP FRED website

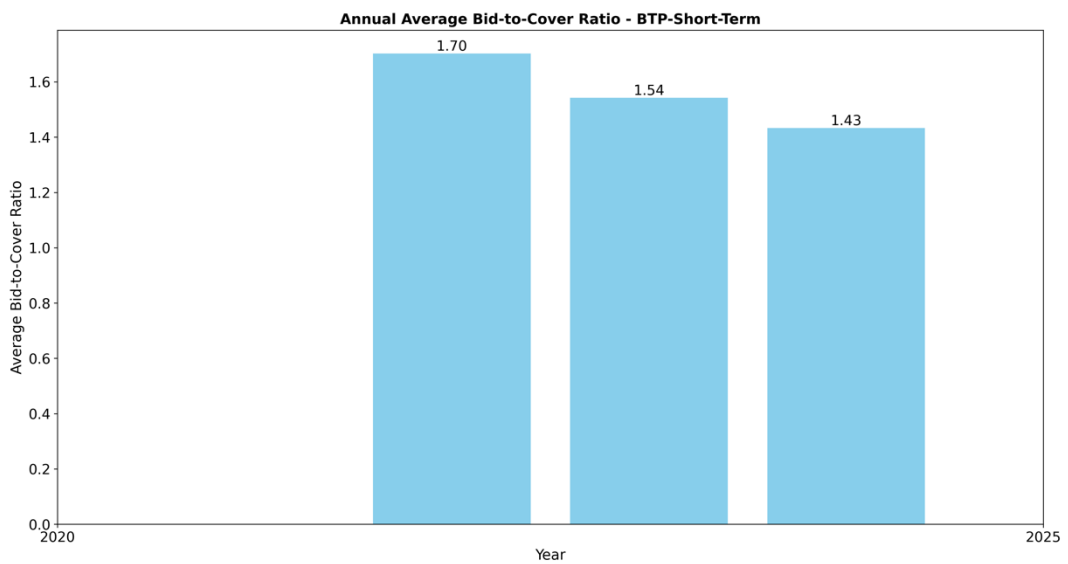
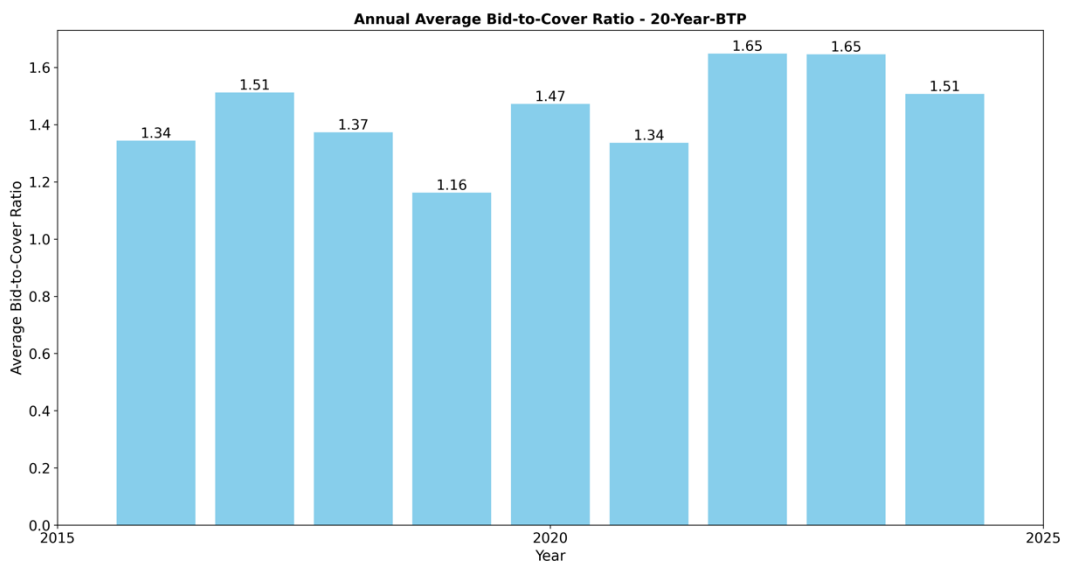
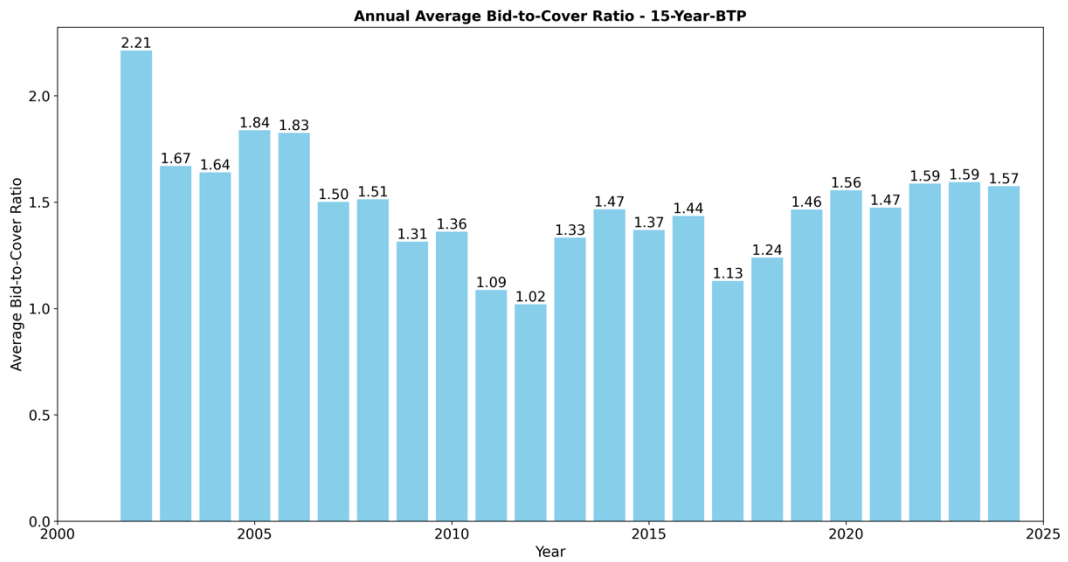
## B. Sample of the constructed dataset

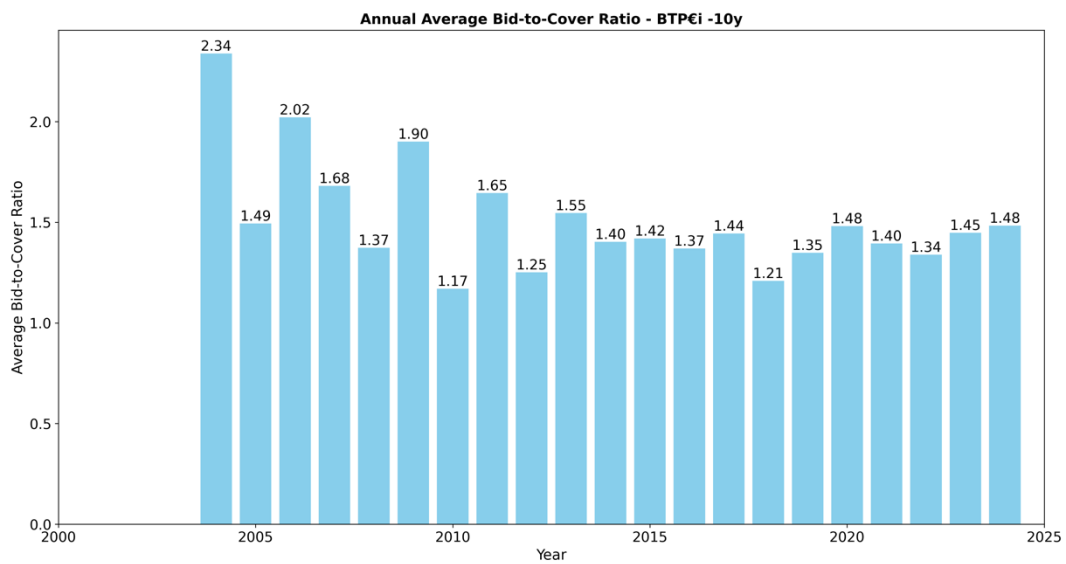
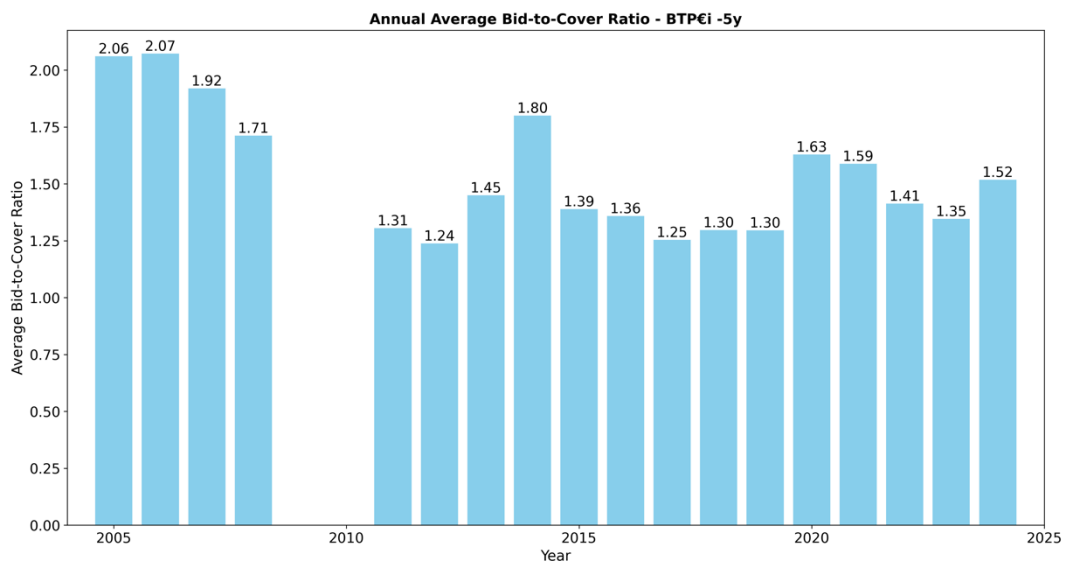
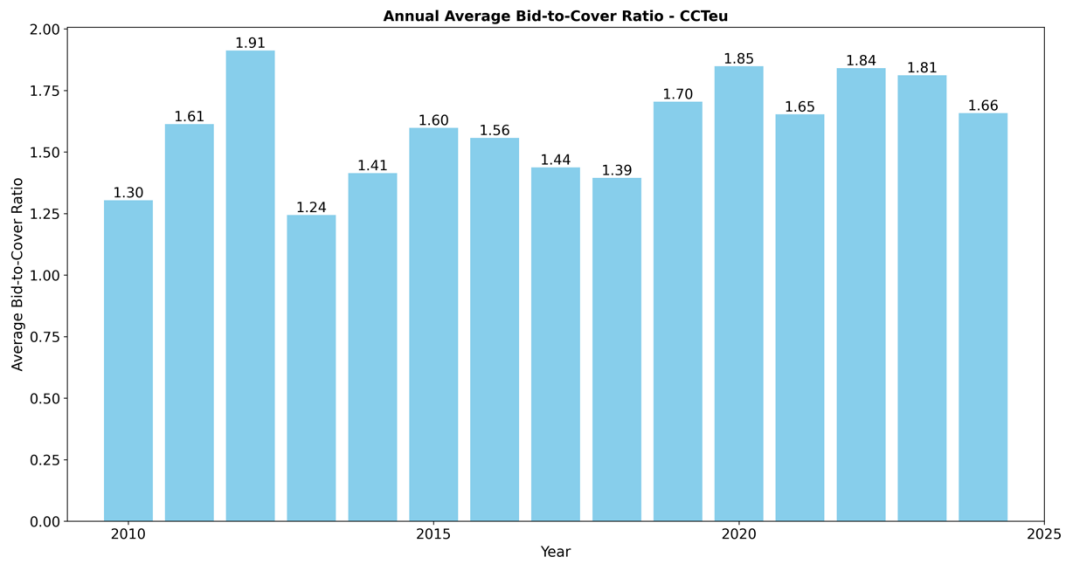
Type	ISIN Code	Tranches	Days to Maturity	Maturity Date	Auction Date	Settlement Date	Amount Offered (mln €)	Amount Bid (mln €)	Amount Allotted (mln €)	Gross Yield (%)
3-Year-BTP	IT0003231146	1st - 2nd	1.275	July 15, 2005	January 15, 2002	January 17, 2002	3,500.00	6,048.60	3,500.00	4.17
3-Year-BTP	IT0003248512	3rd- 4th	1.079	March 1, 2005	14 March 2002	18 March 2002	1,750.00	3,284.00	1,750.00	4.48
3-Year-BTP	IT0003248512	1st - 2nd	1.096	March 1, 2005	27 February 2002	01 March 2002	3,500.00	4,567.07	3,500.00	4.25
3-Year-BTP	IT0003231146	3rd- 4th	894	July 15, 2004	January 30, 2002	February 2, 2002	2,500.00	4,203.18	2,500.00	4.34
3-Year-BTP	IT0003248512	7th- 8th	1.051	March 1, 2005	11-apr-02	15-apr-02	2,000.00	3,347.49	2,000.00	4.54
3-Year-BTP	IT0003264566	1st - 2nd	1.095	September 15, 2005	September 12, 2002	September 16, 2002	3,000.00	5,149.00	3,000.00	3.65
3-Year-BTP	IT0003288864	1st - 2nd	1.096	May 15, 2005	13 May 2002	15 May 2002	3,500.00	4,620.88	3,500.00	4.56
3-Year-BTP	IT0003288864	5th - 6th	1.063	May 15, 2005	June 13, 2002	June 17, 2002	2,000.00	3,175.44	2,000.00	4.41
3-Year-BTP	IT0003264566	9th - 10th	1.032	September 15, 2005	Nov 14, 2002	Nov 18, 2002	1,750.00	3,096.71	1,750.00	3.26
3-Year-BTP	IT0003231146	1st - 2nd	1.275	July 15, 2005	January 15, 2002	January 17, 2002	3,500.00	6,048.60	3,500.00	4.17
3-Year-BTP	IT0003288864	9th - 10th	1.033	May 15, 2005	July 15, 2002	July 17, 2002	1,500.00	2,129.00	1,500.00	4.07
3-Year-BTP	IT0003264566	5th - 6th	1.064	September 15, 2005	October 15, 2002	October 17, 2002	1,500.00	2,359.38	1,500.00	3.51
3-Year-BTP	IT0003248512	5th - 6th	1.064	March 1, 2005	27 March 2002	02-apr-02	2,000.00	3,284.79	2,000.00	4.60
3-Year-BTP	IT0003288864	7th- 8th	1.049	May 15, 2005	June 27, 2002	July 1, 2002	1,500.00	2,732.62	1,500.00	4.24
3-Year-BTP	IT0003264566	3rd- 4th	1.080	September 15, 2005	September 27, 2002	October 1, 2002	2,000.00	3,839.90	2,000.00	3.39
3-Year-BTP	IT0003248512	9th - 10th	1.034	March 1, 2005	29-apr-02	02 May 2002	2,000.00	3,151.51	2,000.00	4.35
3-Year-BTP	IT0003231146	7th- 8th	1.047	July 15, 2005	August 29, 2002	September 2, 2002	2,000.00	2,120.86	2,000.00	3.71
3-Year-BTP	IT0003288864	3rd- 4th	1.077	May 15, 2005	May 30, 2002	June 3, 2002	2,000.00	3,854.00	2,000.00	4.48
3-Year-BTP	IT0003288864	11th - 12th	1.018	May 15, 2005	July 30, 2002	Aug 2, 2002	1,250.00	2,865.00	1,250.00	3.96
3-Year-BTP	IT0003264566	7th- 8th	1.049	September 15, 2005	October 30, 2002	November 1, 2002	1,500.00	2,960.46	1,500.00	3.38
3-Year-BTP	IT0003264566	11th	987	September 15, 2005	December 30, 2002	January 2, 2003	1,500.00	2,742.29	1,500.00	2.92
3-Year-BTP	IT0003424485	11th - 12th	1.023	Feb 01, 2006	April 11, 2003	April 15, 2003	2,000.00	3,082.00	2,000.00	2.79
3-Year-BTP	IT0003477111	9th - 10th	1.035	May 15, 2006	July 11, 2003	July 15, 2003	1,500.00	2,881.13	1,500.00	2.38
3-Year-BTP	IT0003477111	5th - 6th	1.064	May 15, 2006	June 12, 2003	June 16, 2003	2,000.00	3,355.67	2,000.00	2.12
3-Year-BTP	IT0003264566	13th-14th	974	September 15, 2005	January 13, 2003	January 15, 2003	1,500.00	2,629.59	1,500.00	2.89
3-Year-BTP	IT0003424485	3rd- 4th	1.080	Feb 01, 2006	February 13, 2003	February 17, 2003	2,250.00	3,836.35	2,250.00	2.65
3-Year-BTP	IT0003424485	7th- 8th	1.052	Feb 01, 2006	March 13, 2003	March 17, 2003	2,000.00	3,452.72	2,000.00	2.57
3-Year-BTP	IT00032225	7th- 8th	1.052	September 01, 2006	October 13, 2003	October 15, 2003	1,500.00	2,524.00	1,500.00	2.90
3-Year-BTP	IT000322254	11th -12th	1.019	September 01, 2006	November 13, 2003	November 17, 2003	2,000.00	3,533.00	2,000.00	3.11
3-Year-BTP	IT0003477111	1st - 2nd	1.095	May 15, 2006	May 14, 2003	May 16, 2003	3,500.00	5,596.82	3,500.00	2.53
3-Year-BTP	IT000322254	3rd- 4th	1.080	September 01, 2006	September 15, 2003	September 17, 2003	1,500.00	3,236.91	1,500.00	2.86
3-Year-BTP	IT0003424485	5th - 6th	1.066	Feb 01, 2006	February 27, 2003	March 03, 2003	2,000.00	3,268.48	2,000.00	2.53
3-Year-BTP	IT0003477111	7th- 8th	1.049	May 15, 2006	June 27, 2003	July 01, 2003	2,000.00	3,573.96	2,000.00	2.42
3-Year-BTP	IT000322254	1st - 2nd	1.096	September 01, 2006	August 28, 2003	September 01, 2003	3,500.00	6,436.90	3,500.00	3.02
3-Year-BTP	IT0003424485	9th - 10th	1.037	Feb 01, 2006	March 28, 2003	April 01, 2003	1,750.00	3,276.89	1,750.00	2.78
3-Year-BTP	IT0003424485	13th - 14th	1.006	Feb 01, 2006	April 29, 2003	May 2, 2003	1,500.00	2,866.00	1,500.00	2.73
3-Year-BTP	IT0003477111	3rd- 4th	1.078	May 15, 2006	May 29, 2003	June 2, 2003	2,750.00	4,026.64	2,750.00	2.43
3-Year-BTP	IT00032225	5th - 6th	1.066	September 01, 2006	September 29, 2003	October 01, 2003	2,000.00	3,317.00	2,000.00	2.68
3-Year-BTP	IT0003424485	1st - 2nd	1.094	Feb 01, 2006	January 30, 2003	Feb 03, 2003	3,500.00	5,011.49	3,500.00	2.87
3-Year-BTP	IT0003477111	11th - 12th	1.018	May 15, 2006	July 30, 2003	Aug 01, 2003	1,500.00	3,659.13	1,500.00	2.66
3-Year-BTP	IT000322254	9th - 10th	1.033	September 01, 2006	October 30, 2003	November 03, 2003	2,000.00	3,459.00	2,000.00	3.02
3-Year-BTP	IT000322254	13th -14th	973	September 01, 2006	December 30, 2003	January 02, 2004	2,500.00	4,970.00	2,500.00	2.87
3-Year-BTP	IT0003611156	1st - 2nd	1.095	January 15, 2007	January 14, 2004	January 16, 2004	4,000.00	6,081.00	4,000.00	2.79
3-Year-BTP	IT0003611156	5th - 6th	1.050	January 15, 2007	Feb 26, 2004	March 01, 2004	3,000.00	4,632.00	3,000.00	2.59
3-Year-BTP	IT0003674238	3rd - 4th	1.065	June 01, 2007	June 28, 2004	July 01, 2004	3,000.00	5,366.00	4,000.00	3.03
3-Year-BTP	IT0003674238	1st - 2nd	1.095	June 01, 2007	May 28, 2004	June 01, 2004	4,000.00	7,976.00	4,000.00	2.93
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3-Year-BTP	IT0003611156	9th - 10th	987	January 15, 2007	April 29, 2004	May 03, 2004	3,000.00	5,252.00	3,000.00	2.78
3-Year-BTP	IT0003674238	5th - 6th	1.033	June 01, 2007	July 29, 2004	August 02, 2004	2,000.00	5,683.00	2,000.00	3.00
3-Year-BTP	IT0003674238	9th - 10th	973	June 01, 2007	September 29, 2004	October 01, 2004	2,000.00	4,603.00	2,000.00	2.74
3-Year-BTP	IT0003611156	7th- 8th	1.019	January 15, 2007	March 30, 2004	April 01, 2004	3,500.00	5,352.00	3,500.00	2.41
3-Year-BTP	IT0003674238	7th- 8th	1.003	June 01, 2007	August 30, 2004	September 01, 2004	2,500.00	5,409.00	2,500.00	2.74
3-Year-BTP	IT0003674238	11th - 12th	879	June 01, 2007	December 30, 2004	January 03, 2005	2,500.00	4,189.00	2,500.00	2.56
3-Year-BTP	IT00038 084850	3rd - 4th	1.067	Feb 01, 2008	February 25, 2005	March 01, 2005	3,000.00	5,196.00	3,000.00	2.69
3-Year-BTP	IT00038 084850	7th- 8th	1.005	Feb 01, 2008	April 28, 2005	May 02, 2005	2,500.00	4,914.00	2,500.00	2.40
3-Year-BTP	IT00038 77708	3rd - 4th	1.049	June 15, 2008	July 28, 2005	Aug 01, 2005	3,000.00	4,941.00	3,000.00	2.33
3-Year-BTP	IT00038 77708	1st - 2nd	1.080	June 15, 2008	June 28, 2005	July 01, 2005	4,000.00	6,003.00	4,000.00	2.17
3-Year-BTP	IT00038 084850	1st - 2nd	1.095	Feb 01, 2008	January 28, 2005	February 01, 2005	4,000.00	6,877.00	4,000.00	2.61
3-Year-BTP	IT00038 77708	9th - 10th	957	June 15, 2008	October 28, 2005	November 01, 2005	2,000.00	3,528.00	2,000.00	2.67
3-Year-BTP	IT00038 77708	7th- 8th	986	June 15, 2008	September 29, 2005	October 03, 2005	2,750.00	4,849.00	2,750.00	2.38
3-Year-BTP	IT00038 77708	11th - 12th	895	June 15, 2008	December 29, 2005	January 02, 2006	3,000.00	4,335.00	3,000.00	2.89
3-Year-BTP	IT00038 084850	5th - 6th	1.036	Feb 01, 2008	March 30, 2005	April 01, 2005	3,000.00	5,027.00	3,000.00	2.71
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3-Year-BTP	IT00038 77708	5th - 6th	1.018	June 15, 2008	August 30, 2005	September 01, 2005	2,500.00	4,544.00	2,500.00	2.34
3-Year-BTP	IT000 4008121	3rd - 4th	702	Feb 01, 2008	February 27, 2006	March 01, 2006	3,000.00	4,843.00	3,000.00	3.13
3-Year-BTP	IT000 4008121	7th- 8th	640	Feb 01, 2008	April 27, 2006	May 02, 2006	3,000.00	5,049.00	3,000.00	3.60
3-Year-BTP	IT000 4085244	7th- 8th	987	June 15, 2009	September 28, 2006	October 02, 2006	2,000.00	3,390.00	2,000.00	3.56
3-Year-BTP	IT000 4085244	11th - 12th	895	June 15, 2009	December 28, 2006	January 02, 2007	2,000.00	3,364.00	2,000.00	3.85
3-Year-BTP	IT000 4085244	1st - 2nd	1.078	June 15, 2009	June 28, 2006	July 03, 2006	4,000.00	6,708.00	4,000.00	3.73
3-Year-BTP	IT000 4085244	3rd - 4th	1.049	June 15, 2009	July 28, 2006	August 01, 2006	2,500.00	4,330.00	2,500.00	3.63
3-Year-BTP	IT000 4008121	1st - 2nd	730	Feb 01, 2008	January 30, 2006	February 01, 2006	4,000.00	6,645.00	4,000.00	3.08
3-Year-BTP	IT000 4008121	5th - 6th	669	Feb 01, 2008	March 30, 2006	April 03, 2006	3,000.00	5,124.00	3,000.00	3.39
3-Year-BTP	IT000 4008121	9th - 10th	610	Feb 01, 2008	May 30, 2006	June 01, 2006	3,000.00	5,185.00	3,000.00	3.43
3-Year-BTP	IT000 4085244	5th - 6th	1.018	June 15, 2009	August 30, 2006	September 01, 2006	2,000.00	3,697.00	2,000.00	3.56
3-Year-BTP	IT000 4085244	9th - 10th	957	June 15, 2009	October 30, 2006	November 01, 2006	2,000.00	3,278.00	2,000.00	3.70
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3-Year-BTP	IT0004254352	5th - 6th	1.035	August 01, 2010	September 27, 2007	October 1, 2007	2,500.00	3,849.45	2,500.00	4.25
3-Year-BTP	IT0004196918	5th - 6th	1.034	March 01, 2010	April 27, 2007	May 2, 2007	2,500.00	6,794.18	2,500.00	4.13
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3-Year-BTP	IT0004196918	9th - 10th	973	March 01, 2010	June 28, 2007	July 2, 2007	2,000.00	3,468.13	2,000.00	4.47
3-Year-BTP	IT0004196918	3rd - 4th	1.064	March 01, 2010	March 29, 2007	April 2, 2007	3,000.00	4,578.39	3,000.00	3.98
3-Year-BTP	IT0004254352	3rd - 4th	1.063	August 01, 2010	August 30, 2007	September 3, 2007	2,500.00	3,614.50	2,500.00	4.19
3-Year-BTP	IT0004085244	13th - 14th	865	June 15, 2009	January 30, 2007	February 1, 2007	2,000.00	3,228.00	2,000.00	3.93
3-Year-BTP	IT0004254352	1st - 2nd	1.096	August 01, 2010	July 30, 2007	August 1, 2007	4,000.00	5,323.25	4,000.00	4.43
3-Year-BTP	IT0004196918	7th- 8th	1.004	March 01, 2010	May 30, 2007	June 1, 2007	2,500.00	4,242.76	2,500.00	4

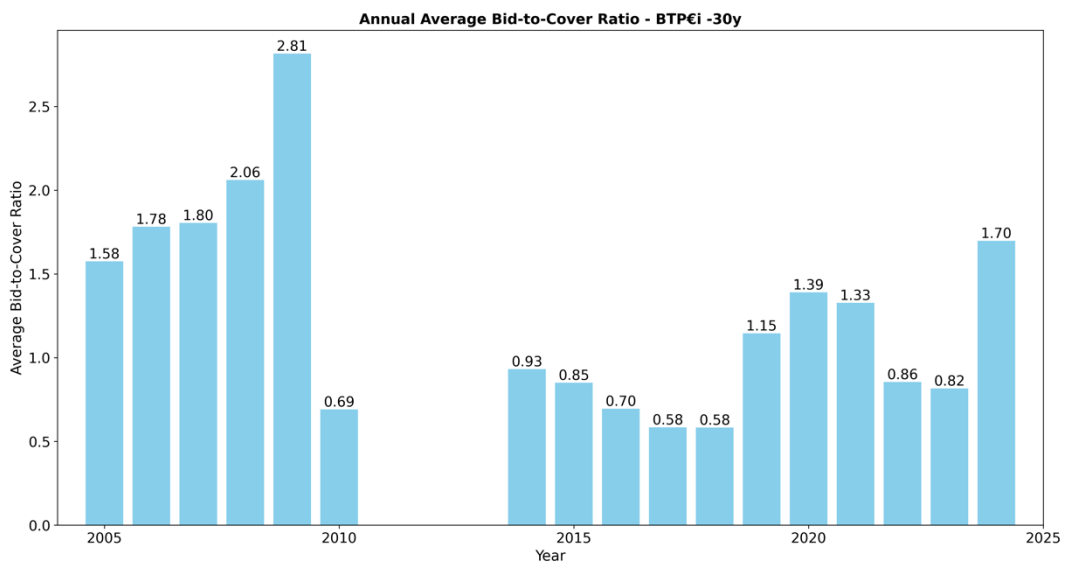
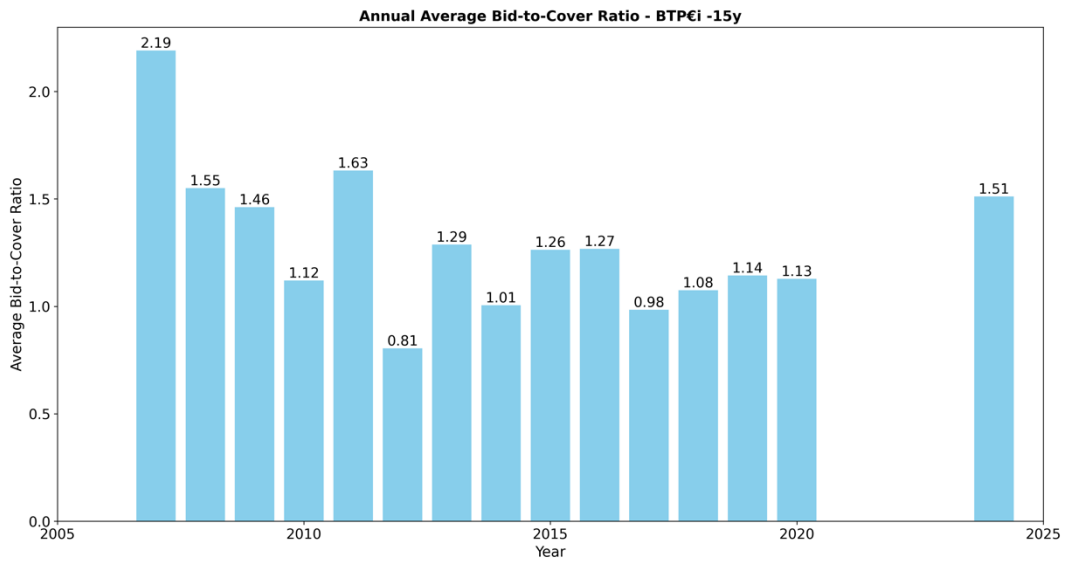
## C. Bid-to-cover ratio graphs





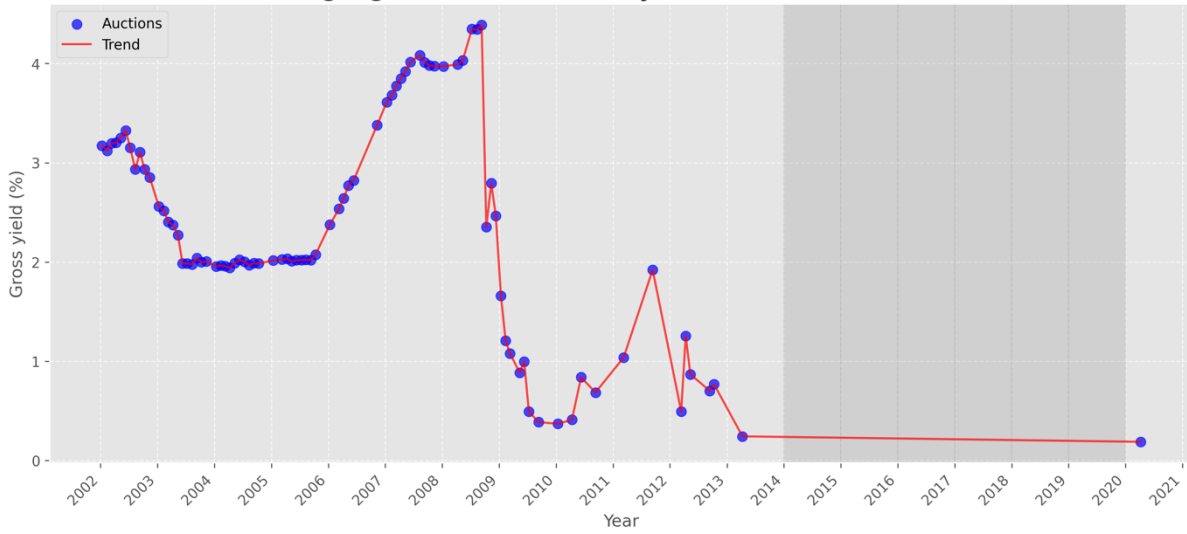




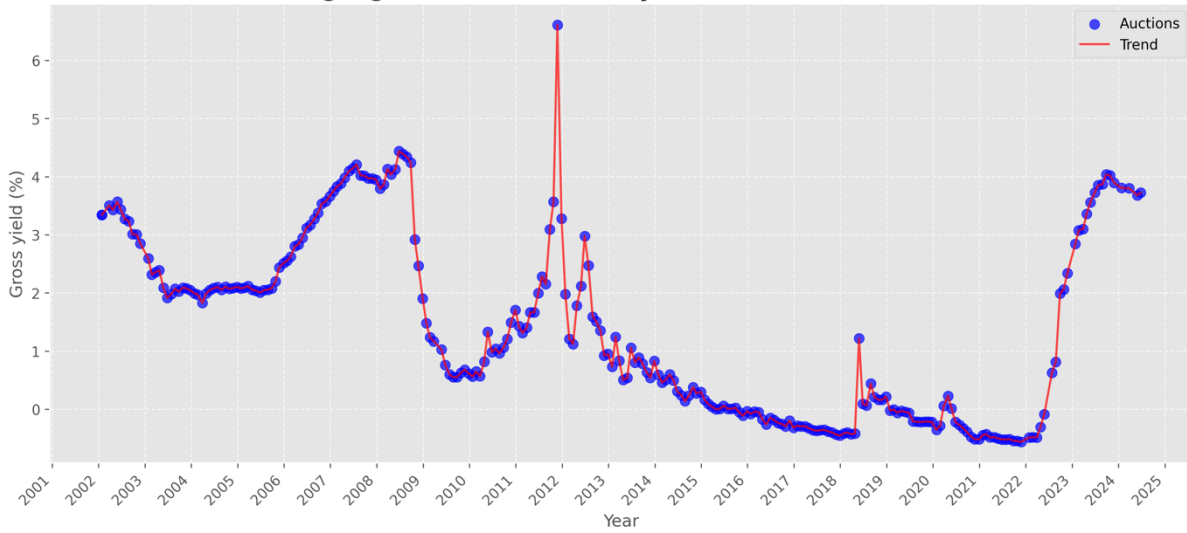


## D. Gross yield trends: a visual analysis

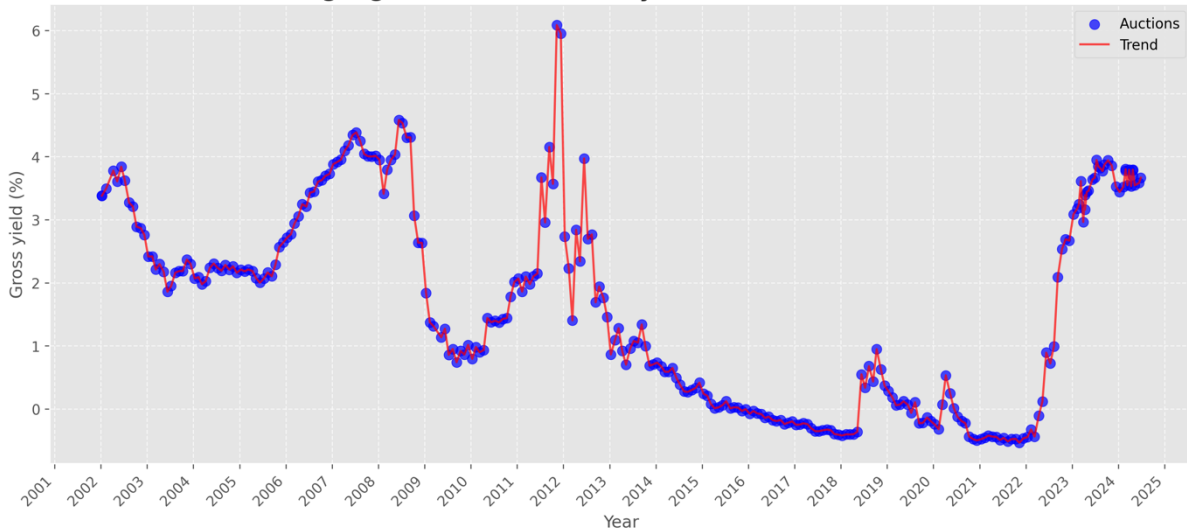
**Gross yield 3-Month-BOT**  
(Highlighted areas indicate years without emissions)



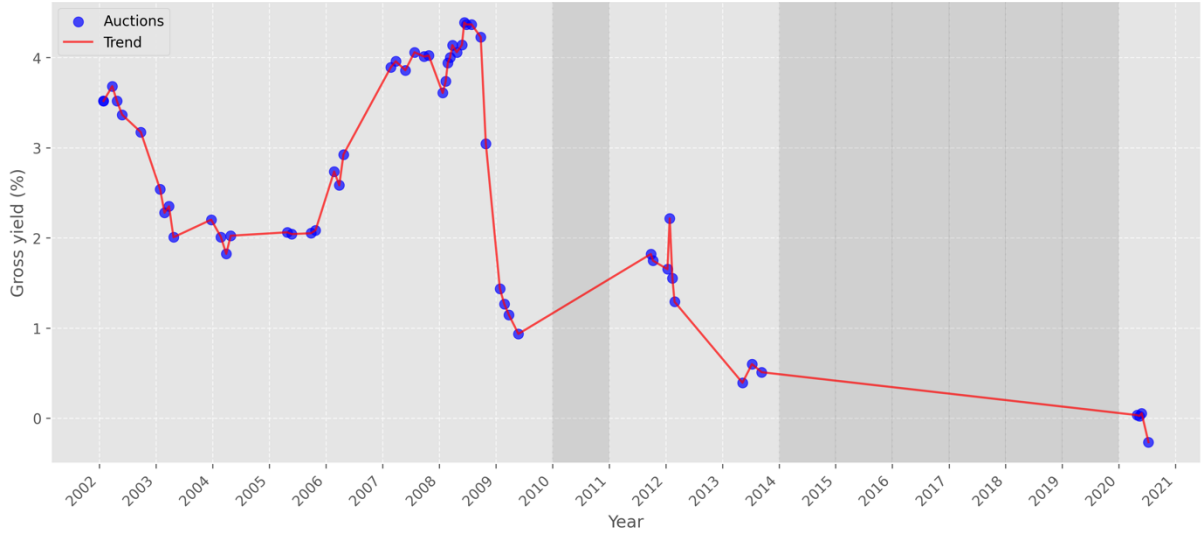
**Gross yield 6-Month-BOT**  
(Highlighted areas indicate years without emissions)



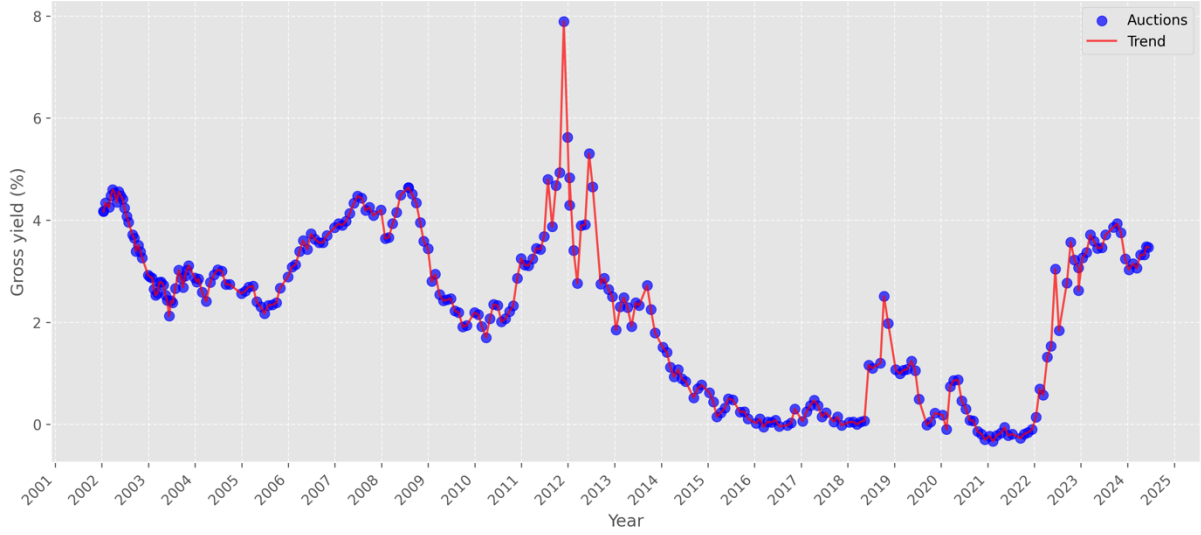
**Gross yield 12-Month-BOT**  
(Highlighted areas indicate years without emissions)



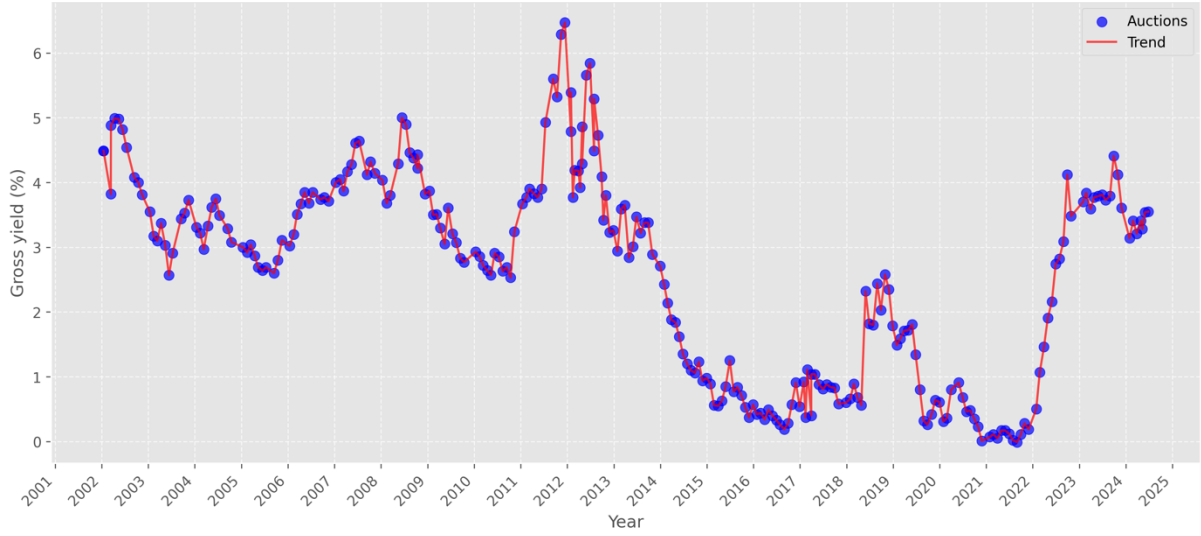
**Gross yield Flexible-BOT**  
 (Highlighted areas indicate years without emissions)



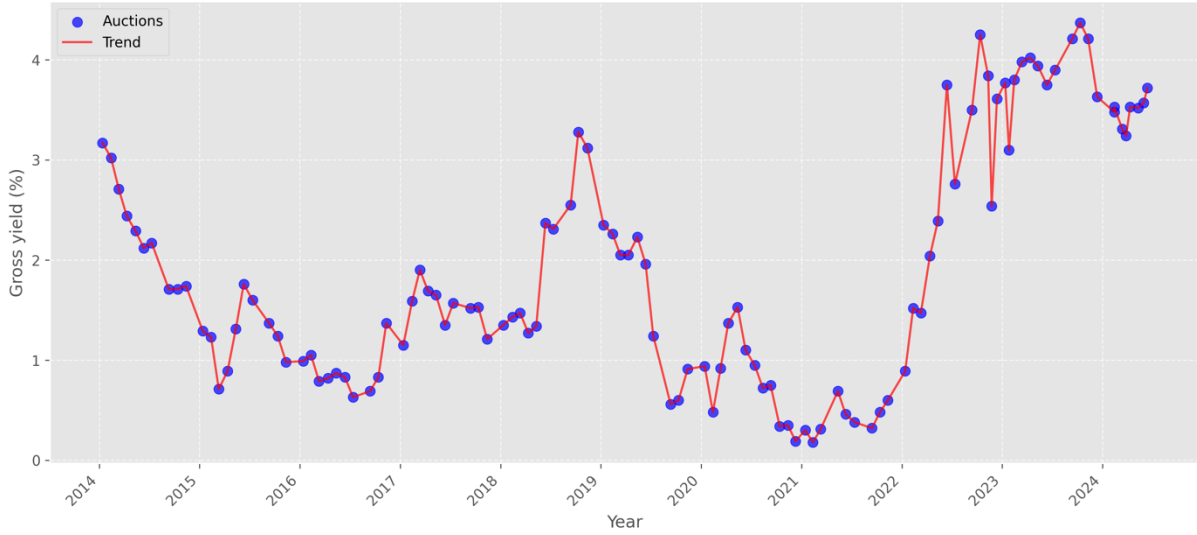
**Gross yield 3-Year-BTP**  
 (Highlighted areas indicate years without emissions)



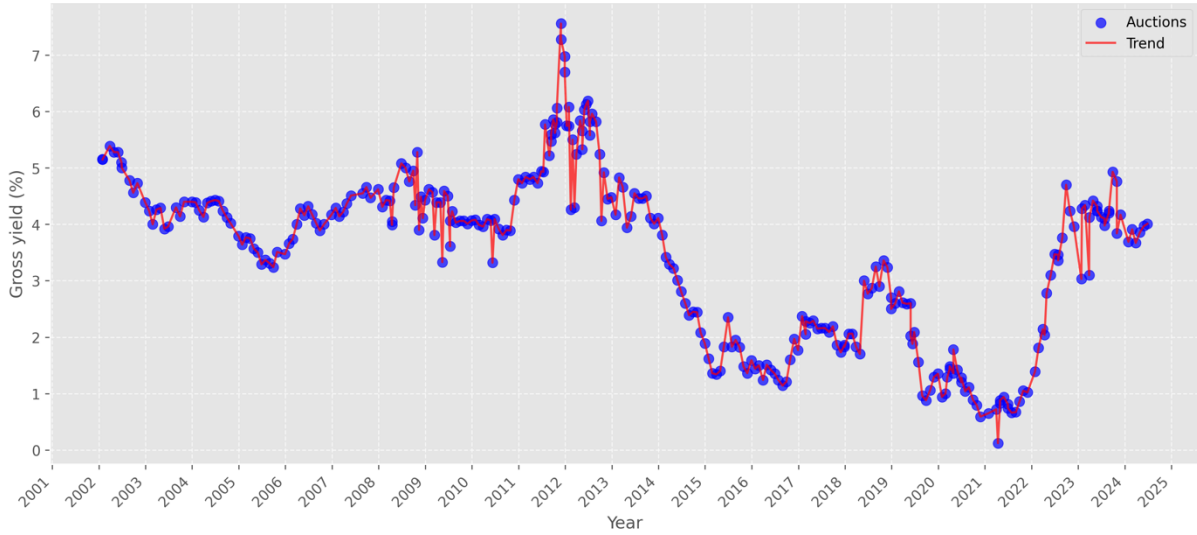
**Gross yield 5-Year-BTP**  
 (Highlighted areas indicate years without emissions)



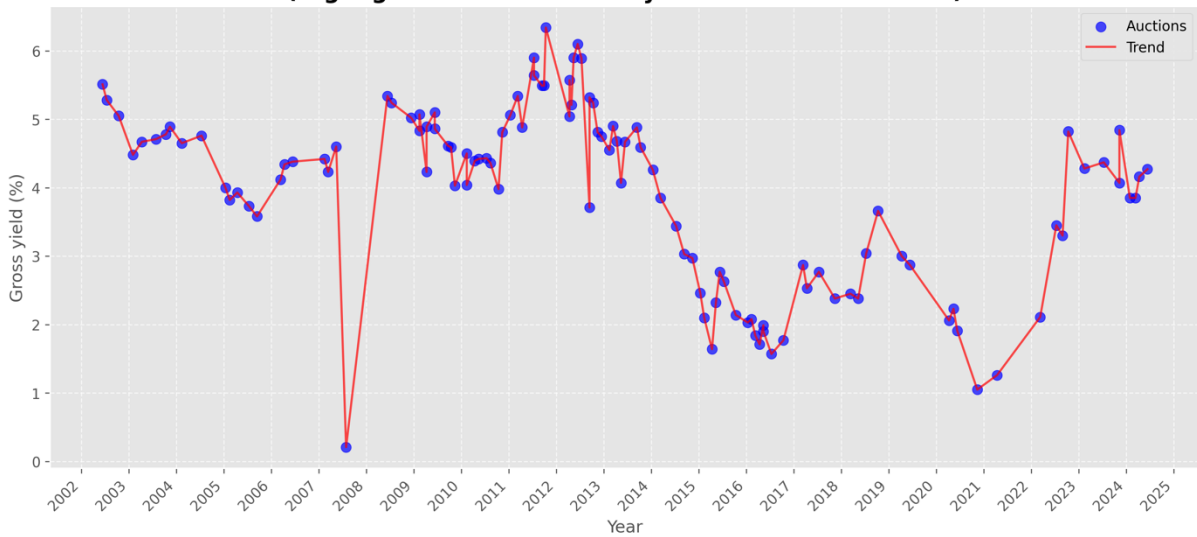
**Gross yield 7-Year-BTP**  
**(Highlighted areas indicate years without emissions)**



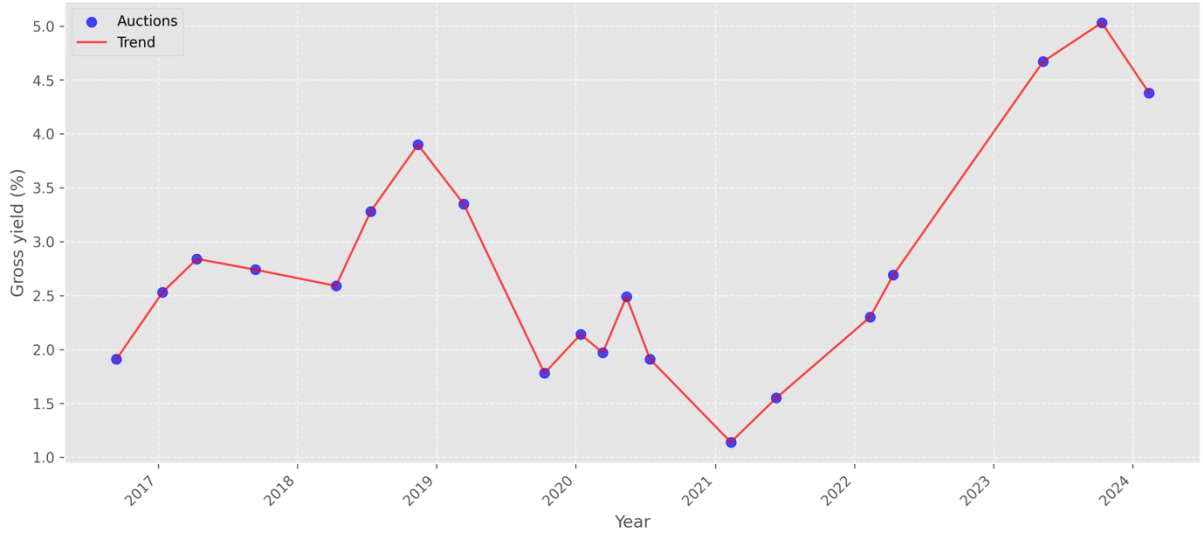
**Gross yield 10-Year-BTP**  
**(Highlighted areas indicate years without emissions)**



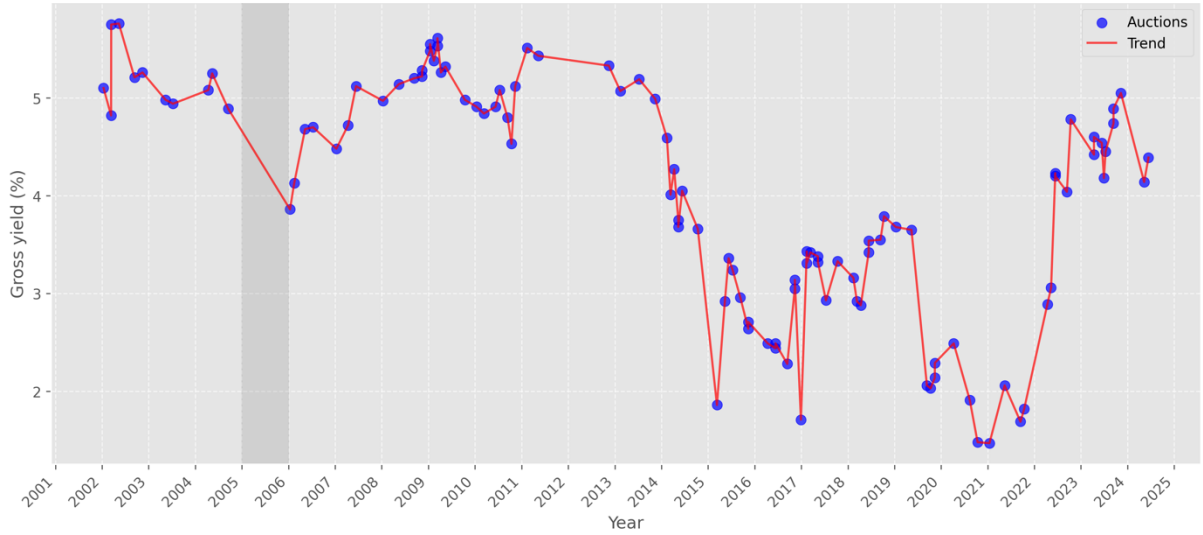
**Gross yield 15-Year-BTP**  
**(Highlighted areas indicate years without emissions)**



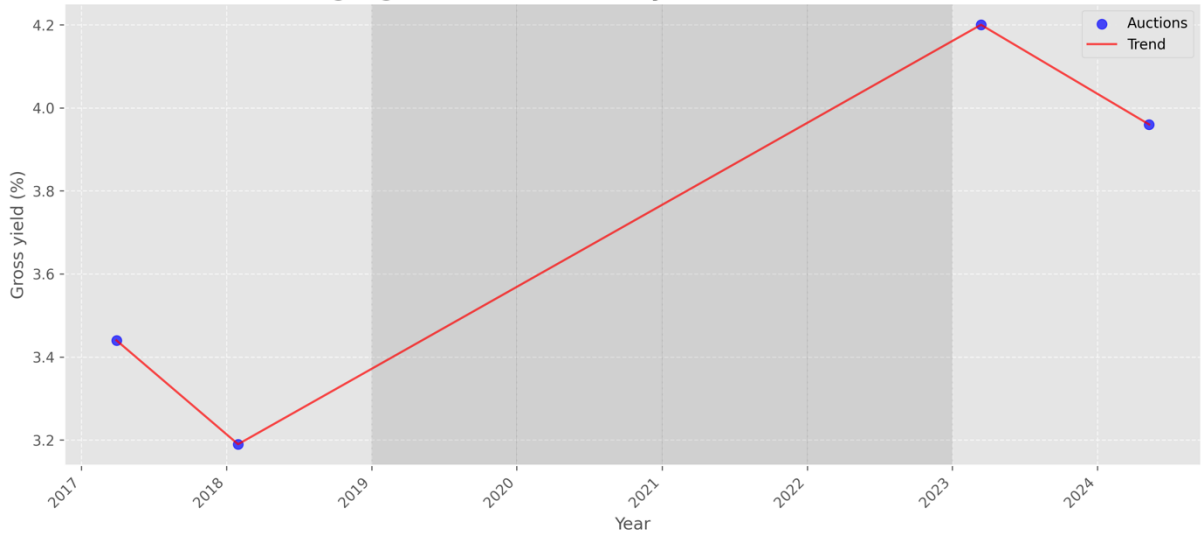
**Gross yield 20-Year-BTP**  
(Highlighted areas indicate years without emissions)



**Gross yield 30-Year-BTP**  
(Highlighted areas indicate years without emissions)

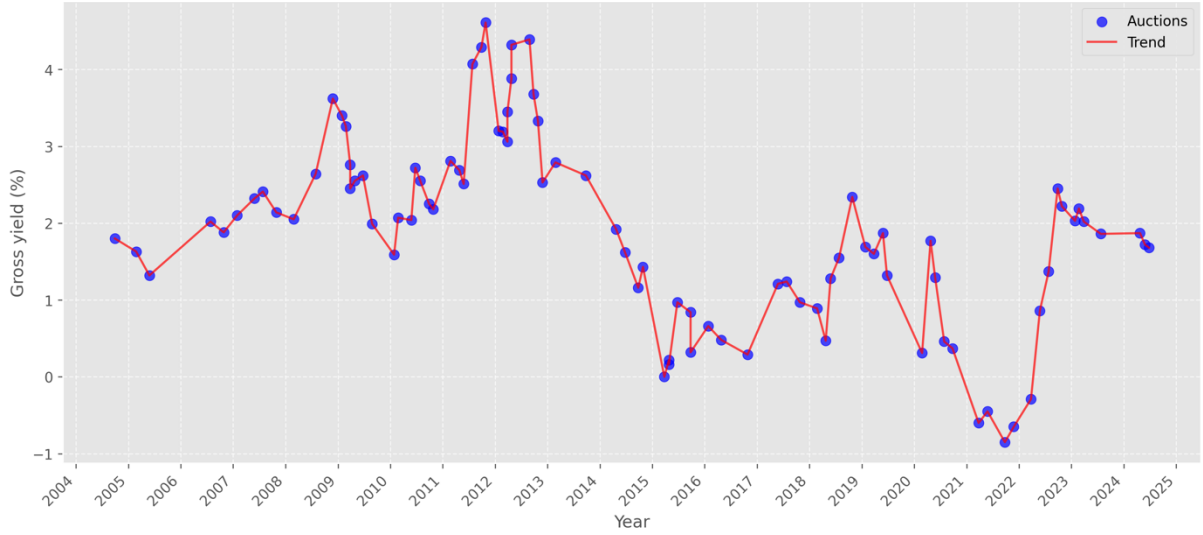


**Gross yield 50-Year-BTP**  
(Highlighted areas indicate years without emissions)

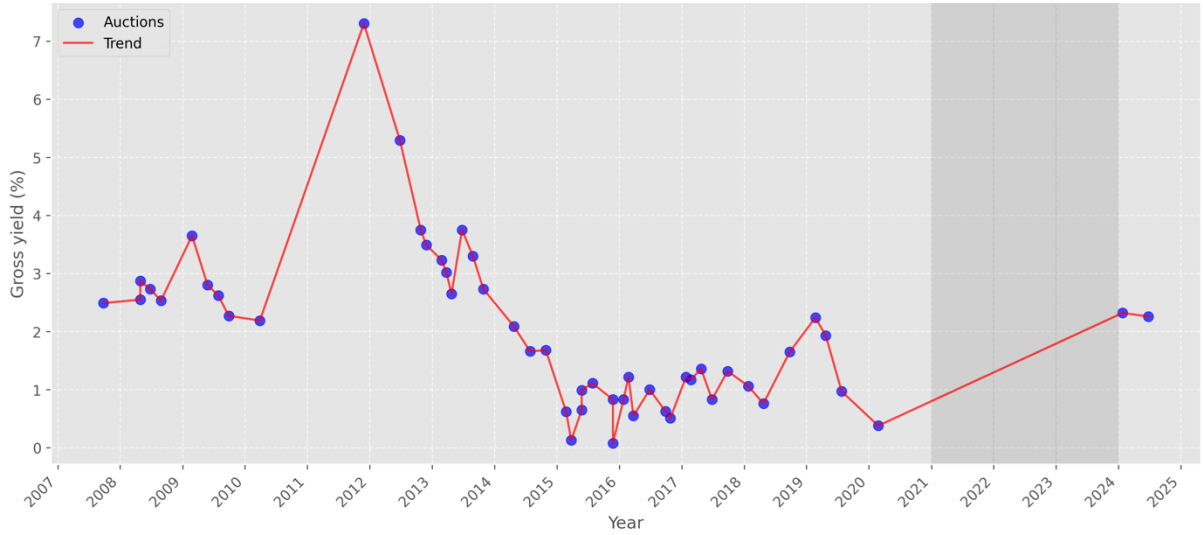




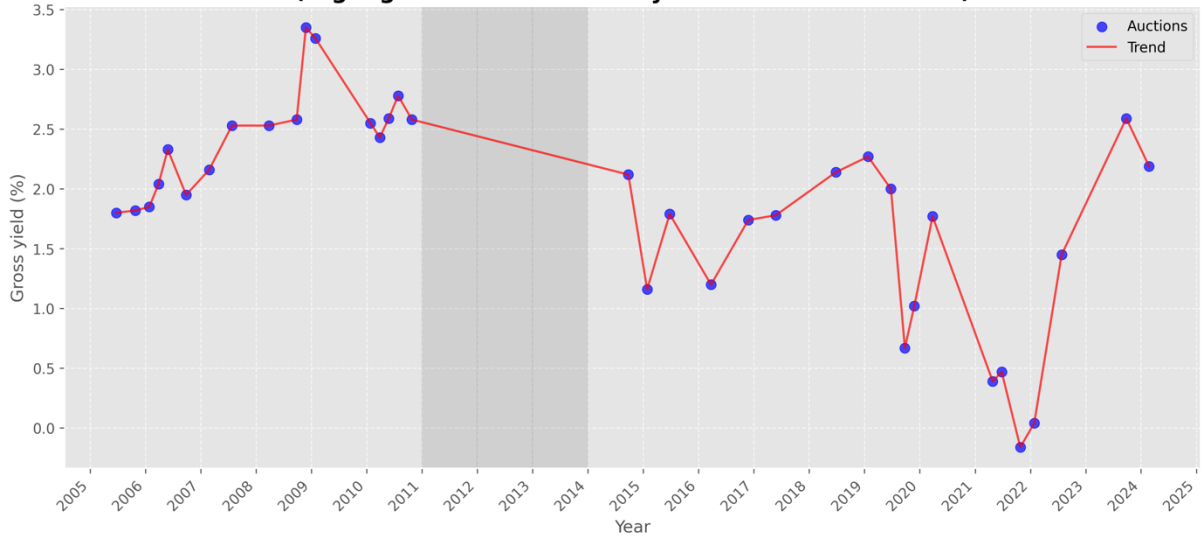
**Gross yield BTP€i -10y**  
**(Highlighted areas indicate years without emissions)**



**Gross yield BTP€i -15y**  
**(Highlighted areas indicate years without emissions)**



**Gross yield BTP€i -30y**  
**(Highlighted areas indicate years without emissions)**



## E. Average annual yields for each bond type

Years	Bond types																		
	3-Month BOI	6-Month BOI	12-Month BOI	Short-Term BTP	CCTeu	Flexible BOI	5-year BTPeI	10-year BTPeI	15-year BTPeI	30-year BTPeI	3-Year BTP	5-Year BTP	7-Year BTP	10-Year BTP	15-Year BTP	20-Year BTP	30-Year BTP	50-Year BTP	
2002	3.113	3.271	3.342			3.463					4.021	4.445		4.983	5.28		5.317		
2003	2.192	2.162	2.211			2.275					2.705	3.24		4.191	4.706		4.96		
2004	1.977	2.035	2.171			1.952					2.765	3.34		4.234	4.705		5.073		
2005	2.026	2.143	2.225			2.06	0.7	1.8		1.81	2.499	2.836		3.493	3.812				
2006	2.754	3.122	3.288			2.749	1.315	1.95		2.042	3.515	3.6		4.038	4.28		4.342		
2007	3.89	3.984	4.088			3.967	1.953	2.243		2.345	4.173	4.22		4.426	3.365		4.773		
2008	3.632	3.72	3.766			4.002	1.922	2.77		2.82	4.082	4.272		4.512	5.2		5.162		
2009	0.958	0.844	1.117			1.195		2.719		2.835	3.26	3.272		4.146	4.69		5.389		
2010	0.576	1.03	1.322		2.207			2.2		2.19	2.586	2.27		4.027	4.366		4.884		
2011	1.48	2.537	3.22		4.022	1.784	1.923	3.497		7.3	4.318	4.677		5.675	5.518		5.47		
2012	0.817	1.664	2.32		4.83	1.679	3.69	3.503		4.177	3.649	4.4		5.381	5.231		5.33		
2013	0.243	0.781	0.974		2.537	0.501	2.2	2.705		3.113	2.231	3.189		4.328	4.62		5.083		
2014		0.375	0.477		1.284		0.843	1.532		1.81	2.12	1.481	2.308	2.784	3.51		4.001		
2015		0.015	0.065		0.702		0.2	0.418		0.63	1.475	0.71	1.238	1.661	2.294		2.813		
2016		-0.187	-0.142		0.542		0.295	0.477		0.79	1.47	0.052	0.431	0.887	1.449	1.861	2.514		
2017		-0.36	-0.314		0.715		0.062	1.14		1.18	1.78	0.208	0.792	1.516	2.091	2.638	3.303	3.44	
2018		0.074	0.164		1.564		0.158	1.306		1.157	2.14	0.816	1.66	2.049	2.634	2.883	3.257	3.323	3.19
2019		-0.128	0.005		1.267		0.727	1.62		1.713	1.49	0.724	1.059	1.621	1.879	2.935	2.642		
2020	0.188	-0.257	-0.137		0.483	-0.038	-0.232	0.84		0.38	1.77	0.236	0.459	0.803	1.174	1.812	2.127	1.96	
2021		-0.506	-0.47		-0.048		-0.913	-0.637		0.233	-0.195	0.116	0.413	0.765	1.26	1.345	1.76		
2022		0.597	0.95	1.409	1.083		-0.537	1.322		0.745	2.032	2.335	2.713	3.093	3.42	2.495	3.867		
2023		3.576	3.548	3.682	3.979		1.895	2.025		2.59	3.575	3.833	3.89	4.136	4.39	4.85	4.609	4.2	
2024		3.752	3.652	3.382	4.984		1.563	1.757		2.29	3.261	3.363	3.487	3.852	4.032	4.38	4.265	3.96	

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