What does it Take? Quantifying Cross-Country Transfers in the Eurozone*

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Abstract

We compute the implicit cross-country and within-country transfers that result from unconventional monetary policy in the Eurozone. The ECB funds the expansion of its aggregate balance sheet mostly by issuing bank reserves and cash in core countries. The national central banks (NCBs) in the periphery then borrow from the core NCBs at below-market rates to fund the asset purchases. In addition, central banks in the periphery lend more to their own banks at below-market rates. To compute the cross-country transfers, we compare the resulting cross-country distribution of NCB income to a counterfactual scenario without the ECB and without non-marketable intra-Eurozone debt. We document significant and persistent transfers from the core to the periphery.

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1 Introduction

The Eurozone is a monetary union, but not a fiscal union. The Eurozone member countries are fiscal sovereigns. The national central banks (NCBs) are fiscally backed only by their own national governments, but not by the governments of other Eurozone countries. As a result, the transfers between different NCBs matter for taxpayers in the Eurozone.

Our paper quantifies the intra-Eurozone transfers between NCBs that result from substituting non-marketable debt for bonds when the European Central Bank (ECB) engages in large-scale asset purchases. Over the past decade, the Eurosystem's balance sheet had grown to 56% of GDP in the Eurozone by the end of 2021. Most of this growth has happened through an expansion of the NCB balance sheets, which has been asymmetric across the Eurozone. As the ECB funds its asset purchases mostly by issuing bank reserves in core countries instead of periphery countries, the NCBs of core countries have accumulated claims on the periphery NCBs. These intra-Eurozone claims are referred to as Target2 assets and liabilities within the Eurosystem.[1]

More precisely, whenever the ECB expands its balance sheet, the Eurozone periphery borrows from the core through the Eurosystem at the short-term policy rate, which is below the market interest rate. As these balance sheet expansions are concentrated in times of stress in bond markets, taxpayers in core countries like Germany are exposed to credit and currency risk on the asset side of the Bundesbank, but they are not compensated for this risk.

This core-periphery pattern is particularly important when investors impute a non-zero probability to a break-up of the Eurozone. All else equal, Eurozone banks will strictly prefer to hold reserves in the core countries, because core currencies would be expected to appreciate against periphery currencies in case of a Eurozone exit or break-up. As a result, bank reserves in the core and the periphery should not trade at par. If they do, banks strictly prefer to hold core reserves in equilibrium. Similarly, households strictly prefer to hold cash in the core countries.

The ECB implements an income pooling arrangement. It pools a selected set of national central banks' income and expenses, and redistributes the pooled income back to national central banks based on their capital key shares. These pooled income and expenses are related to claims between the national central banks arising from cross-country transactions, cross-country distribution of bank notes, as well as imbalances due to implementation of monetary policy. One exception to this rule is each central bank's holding of its domestic sovereign debt. While it is still subject to the

[1]For example, between 2014 and 2021, the Bundesbank has funded its balance sheet expansion mainly by issuing bank reserves, while the Banca d'Italia has done so by issuing bank reserves and by issuing Target2 IOUs.

pooling formula, the calculation of interest income is set up such that the income from sovereign debt is mostly retained by the local central bank.

To quantify the implicit transfers due to income pooling, we compare the cross-country distribution of income from pooling arrangement to a counterfactual scenario without the ECB pooling arrangements and without non-marketable debt. In this counterfactual scenario, NCBs do not pool the income, and assets earn market rates of return. Importantly, we assume that the Eurozone governments borrow from other Eurozone governments at the prevailing market rates. We impute central bank incomes and expenses based on these assumptions.

This counterfactual calculation is conservative in that the bond market yields include explicit and implicit price support provided by the ECB.[2] Without these interventions, the market rates that liabilities of peripheral countries' governments and central banks could be even higher. We conduct a robustness analysis with respect to the core-periphery spreads to show how much this consideration further magnifies the cross-country transfer estimate.

In the counterfactual scenario, there is no Eurozone, but the member countries are part of a fixed exchange rate regime. The Bundesbank would buy assets denominated in Italian Lira and Spanish pesetas to defend the peg whenever there is flight to safety. Safe asset demand for German assets would put upward pressure on the Deutsch Mark. A real-world example that corresponds to the counterfactual is the case of Switzerland. To defend the peg with the Euro, the SNB was forced to massively buy Euro-denominated assets, mostly government bonds. The balance sheet of the SNB is 112% of Swiss GDP in 2022.

As the ECB balance sheet has grown, the intra-Eurozone transfers that are implied by the ECB's management of its balance sheet have become larger. Our paper quantifies the intra-Eurozone transfers. We believe we are the first to do so. Quantitatively, we find that countries like Germany and France pay a cumulative subsidy of 12.5% and 2.4% of their GDP from 2014 to 2023, respectively, to the Eurosystem, whereas countries like Italy and Spain receive a cumulative subsidy of -2.6% and -2.1% of their GDP in the same period.

In our counterfactual scenarios, we not only reprice cross-country IOUs but also those within individual countries. Since the onset of the European sovereign debt crisis, the ECB, through its national central banks, has provided long-term funding to euro area banks. The so-called Long-

[2]For example, in 2022, the ECB rolled out the TPI (Transmission Protection Intiative) which allowed the ECB to intervene whenever spreads between the periphery and the core were not fully justified by the macro fundamentals. The gap between the actual and the counterfactual income of the NCBs is our measure of the implicit transfers in the Eurozone.

Term Refinancing Operations (LTROs) can be understood as long-term loans extended to banks at highly favorable rates—often below the short-term lending rates, such as EONIA or the €STR. The loans are extended by national central banks and therefore consists of within-country transfers from the central bank to the banking sector.

We therefore decompose the total subsidy into a *within*-country component, which arises from bank lending, and a *cross*-country component, which originates from cross-border lending. This decomposition reveals substantial within-country subsidies to the banking sector for Italy and Spain, with cumulative subsidies of 3.3% and 5.1%, respectively. These figures are significantly higher than those observed for Germany (1.5%) and France (2%). The gap between peripheral and core countries emerges due to the large volume of bank lending (LTROs) extended by the Italian and Spanish central banks. Italy receives 6% of GDP in cross-country subidies but it spends 3.3% on its own banks. As a result, the net subsidy received is 2.7%.

The cross-country subsidies reveal that Germany has cumulatively paid subsidies amounting to 11% of GDP, respectively, while Italy and Spain have received subsidies of 6% of GDP. When accounting for all national central banks (NCBs), cross-country subsidies should sum to zero. However, total subsidies do not necessarily sum to zero, as commercial banks across different countries also benefit from these subsidies.

It is important to emphasize that, as previously discussed, our counterfactual economy relies on historical yields of marketable instruments, such as bank borrowing costs and sovereign bond yields. However, the reason these assets (e.g., LTROs) or government bond holdings are on the ECB balance sheet is precisely because the ECB aimed to reduce market bond yields and other interest rates. This naturally implies that the observed rates are distorted relative to an equilibrium where such policies were absent. These effects could be large (see, e.g., Haddad et al., 2025). As a consequence, our own subsidy estimates are also distorted— onstituting a lower bound compared to the true subsidies.

In this paper, we do not take a stance on the magnitude of the distortion. Instead, we do sensitivity analysis by recomputing cross-country subsidies with a 100 basis point increase in yields for peripheral countries. Under this scenario, we find that Germany's cumulative subsidy rises to 14% of GDP, which is 4 percentage points higher than in the baseline scenario. Meanwhile, the cross-country subsidies received by Italy and Spain increase to 8.8% and 11% of GDP, respectively. The difference between the baseline and this alternative scenario with higher spreads illustrates the sensitivity of these subsidies to changes in sovereign bond yields.

We also find it useful to draw a comparison to the U.S. system, which is a currency and fiscal union. In the U.S., market participants are indifferent between holding reserves at the Federal Reserve Bank of New York and the Federal Reserve Bank of San Francisco, because there is no risk of these districts leaving the dollarzone. However, in the Eurozone, they are not. When the ECB implements large-scale asset purchases, it replaces marketable debt with non-marketable debt that trades at par in all Eurozone countries. The ECB treats reserves held at the Bundesbank and the Banca d'Italia as equivalent. But financial market participants do not think of these as equivalent, presumably because they impute a non-zero probability to a break-up of the Eurozone or Eurozone exit. As a result, banks obviously prefer to hold reserves in the core countries. We see large asymmetries between the core and the periphery balance sheets.

As a result, quantitative easing has different public finance implications in a monetary union that is not a fiscal union. In the U.S., a monetary union that is also a fiscal union, quantititative easing really amounts to a shortening of the consolidated government's maturity structure, transferring interest rate risk from the private sector back to taxpayers. The Fed buys back long-term bonds from the private sector and issues short-term reserves. In the Eurozone core, the consolidated governments in core countries take on credit risk on the asset side of the NCBs, but they are not compensated for this risk. In the periphery, the consolidated governments borrow at below-market rates from the core. Large-scale asset purchases thus transfer credit risk from the private sector to taxpayers in the core countries. This can be interpreted as a form of financial repression. The ECB thus lowers the cost of funding for periphery countries by imposing hidden taxes on core countries.

Literature.

Governments often seek to borrow at below-market rates. Economists collectively refer to this as financial repression (McKinnon (1973) and Shaw (1973)). One mechanism is the issuance of non-marketable debt that earns rates of return below the market rate of return (Reinhart et al., 2011). In a monetary union that is not a fiscal union, the market rate of return varies across countries, but the policy rate does not. As a result, the incidence of financial repression varies across countries.

There is large literature on the economics of financial repression in emerging market economies. The literature on financial repression in advanced economies is smaller. Reinhart and Rogoff (2009) document that financial repression was used in advanced economies after WWII to reduce the debt overhang. Hall and Sargent (2011) decompose the variation in the debt/output ratio. Acalin and Ball (2022) focus specifically on the US experience after WW-II, and argue that finan-

cial repression was instrumental in decreasing the debt/output ratio. Payne and Szőke (2025) also explore the role of financial repression in lowering the funcing costs of the US, while Chien et al. (2023) examine the Japanese case.

In the last decades, large-scale asset purchases have been studied as a tool of monetary policy to be used mainly when the policy rates hits the zero lower bound. However, large-scale asset purchases have often been used as an instrument of fiscal policy, especially during and in the aftermath of wars, in the US, the UK and other European countries (Sargent et al., 2019; Hall and Sargent, 2022). Our work studies the impact of these purchases in the context of a monetary union that is not a fiscal union.

Typically, changes in Target2 imbalances do not change the net claims of one country on another country (De Grauwe and Ji, 2012). For example, in the case of QE, the claim of a German financial intermediary on the Italian government, in the form of an Italian bond, is simply replaced by a claim of the German NCB on the Italian NCB. However, this swap of one type of debt for another is not irrelevant, because the latter is not a market transaction, and the rate of return on that claim is lower than the rate of return on equivalent claims.

2 Core vs. Periphery Imbalances

We start by analyzing the balance sheets of Banca d'Italia and the Bundesbank. Table 1 offers a snapshot of the balance sheets of these two national central banks (NCBs) at the end of 2014, 2021 and 2023. These dates mark respectively the start of asset purchasing program (APP) in 2015, the peak year of APP in 2021, and the most recent one in 2023. All numbers are expressed as percentages of the country's GDP in that year.

Over the past few years, we observe a significant expansion of central bank balance sheets. For example, the Bundesbank's balance sheet grew from 26% in 2014 to 83% in 2021. Similarly, the Banca d'Italia's balance sheet grew from 33% in 2014 to 84% of GDP. These balance sheet expansions are driven by the purchase of debt securities, which increased from 2.1% to 38% of GDP in the Bundesbank's balance sheet and from 2.2% to 37.9% of GDP in the Banca d'Italia's balance sheet. These debt securities are mostly national debt securities, which increased from 0% to 21.6% of GDP in the Bundesbank's balance sheet and from 0% to 28.7% of GDP in the Banca d'Italia's balance sheet.

Next, we discuss a few items on central bank balance sheets in greater details.

Target2. In the Euro area, payments arising from the Eurosystem's monetary policy operations, as well as interbank and commercial transactions, are processed through Target2. The Target2 balances of each national central bank (NCB) reflect its net claims on the ECB. Across all Eurozone countries, these claims should sum approximately to zero.[3]

The balance sheet data suggest that the Bundesbank holds a net claim in its Target2 account, while the Banca d'Italia has accumulated Target2 liabilities. These imbalances have expanded over time, driven by asset purchase programs and bank-lending initiatives. Between 2014 and 2021, Germany's Target2 claims grew from 16% to 35% of German GDP, while Banca d'Italia's liabilities increased from under 13% to over 32% of Italian GDP.

Figure 1 illustrates the evolution of Target2 balances in the Eurozone, emphasizing the major creditor and debtor countries. The secular increase in Target2 imbalances since the global finance crisis is mostly driven by capital flows instead of the current account (De Grauwe and Ji (2012), Whelan (2014), Perotti (2020) and Eisenschmidt et al. (2024)). The first notable expansion, from 2009 to 2012, coincides with the European sovereign debt crisis. During this period, peripheral countries, heavily affected by the crisis, experienced significant capital flight to safer core coun-

[3]Since there are small amounts of Target2 clams held by participates outside of the Eurosystem, the actual aggregate amount of net Target2 claims with the Eurosystem is close to zero but not exactly zero.

Table 1: Balance Sheet of Banca d'Italia and Bundesbank

	Deutsche Bundesbank			Banca d'Italia		
% of GDP, Year End	2014	2021	2023	2014	2021	2023
Assets						
Bank Lending	2.24%	11.67%	1.75%	11.95%	24.89%	7.18%
National Debt Securities	0%	21.64%	18.63%	0%	28.74%	25.18%
Other Debt Securities	1.72%	6.77%	5.85%	2.18%	7.81%	6.32%
Gold, FX and Others	6.64%	8.34%	8.41%	17.10%	20.22%	19.25%
IntraEurosys-Target2	15.73%	34.85%	26.41%	0%	0%	0%
IntraEurosys-Banknotes	0%	0%	0%	1.37%	2.76%	2.17%
Liabilities						
Banknotes	8.22%	10.35%	9.15%	10.11%	13.25%	11.65%
Bank Reserves	3.08%	31.45%	26.93%	0.95%	22.22%	9.05%
Capital and Others	5.88%	27.36%	11.78%	8.73%	16.69%	14.37%
IntraEurosys-Banknotes	9.15%	14.09%	13.19%	0%	0%	0%
IntraEurosys-Target2	0%	0%	0%	12.82%	32.26%	25.03%
Sum	26.33%	83.27%	61.05%	32.61%	84.42%	60.10%

Unit: % of GDP. Source: ECB, Euro Stat, Bundesbank annual reports, Banca d'Italia and authors' calculation

tries, resulting in a sharp increase in Target2 imbalances.

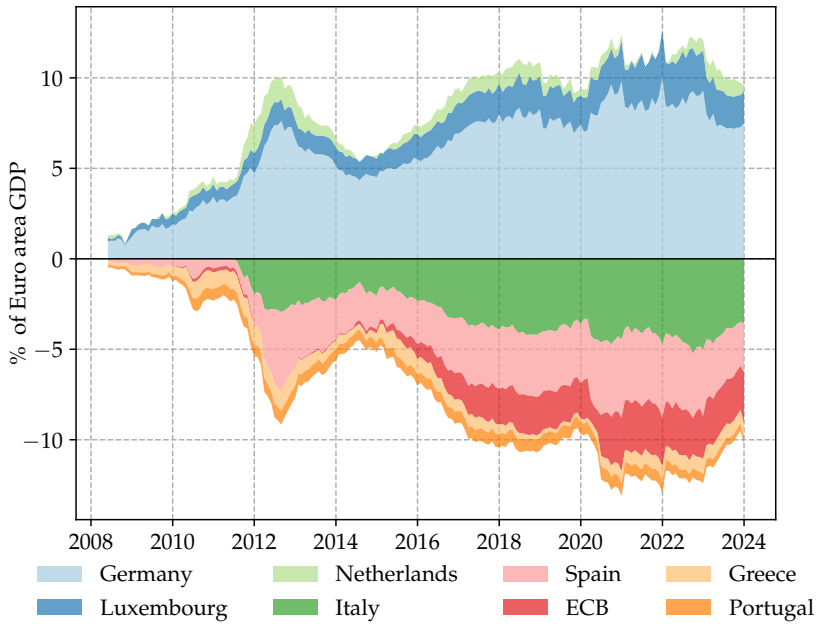
We also see a persistent rise in these imbalances beginning in 2014, which is related to the Eurosystem's large-scale asset purchase programs. As part of these programs, national central banks buy significant amounts of debt securities, often by private financial institutions located in core countries. For instance, consider the Banca d'Italia repurchasing €100 worth of Italian government bonds from Commerzbank in Frankfurt. As part of the sale, Commerzbank receives €100 in reserves, held at the Bundesbank. On the asset side, the Bundesbank registers a Target2 claim on the Eurosystem, while the Banca d'Italia acquires the bonds on its asset side and records a corresponding Target2 liability. These asset purchases lead to a larger expansion of bank reserves as well as Target2 claims of the core NCBs, in this case the Bundesbank. Asset purchases in the periphery are largely financed by the Target2 liabilities of their NCBs, such as the Banca d'Italia. As a result, the Target2 imbalances tend to grow during the asset purchases programs. As pointed out by De Grauwe and Ji (2012), this transaction swaps one German claim (i.e., Commerzbank holding Italian government bonds) on Italy for another one (i.e., Bundesbank holding Target2 claim on Banca d'Italia), but the total net German claims have not increased. However, we have substituted non-marketable debt for marketable bonds.

Figure 1 also shows the net position of the ECB, which is not zero. The ECB conducts its purchases under the Asset Purchase Programme (APP) by issuing reserves through the NCBs. This process leads to an increase in the Target2 balances of the NCBs, while the ECB records a corresponding negative Target2 balance on its own balance sheet.

Banknotes. Banknotes listed on the balance sheet of each NCB reflects its capital key share of total banknotes issued by Eurosystem instead of the actual amount of banknotes held in each country. Depending on the local households' preference for holding cash, the actual amount of currency held may be higher or lower than the amount implied by the capital key. The difference, which could be an asset or a liability position, is recorded as IntraEuroSys-Banknotes. By construction, the total sum of net claims on IntraEuroSys-Banknotes has to be zero for the Eurosystem. The actual amount of cash holding for each country is then the sum of the two balance sheet items: Banknotes and IntraEuroSys-Banknotes.

For example, the Bundesbank carries a significant amount of IntraEuroSys-Banknotes on its liabilities, around 14.1% of GDP in 2021, reflecting the higher than preference for cash in Germany. In contrast, the amount of banknotes circulated in Italy is less than its capital key share resulting

Figure 1: Target2 Imbalance among ECB and Selected NCBs



The figure plots the Target2 balances of major creditors and debtors in the Euro area, scaled by Eurozone GDP.

in a claim in IntraEurosys-Banknotes on the asset side of Banca d'Italia. This claim was 2.8% of GDP in 2021. The Banknotes and IntraEurosys-Banknotes are identical assets. The distinction between these two items on the balance sheet serves the purpose of redistributing the seigniorage income across the Eurosystem. Currently, the IntraEuroSys-Banknotes are remunerated at MRO (main refinancing operations) rate. The positive remuneration rate of IntraEuroSys-Banknotes not only redistributes seigniorage income among NCBs but also transfers the seigniorage income from NCBs to ECB. In our view, the redistributional seigniorage income can be regarded as a type of cross-country transfer.

Other Securities. The asset holdings due to APP (asset purchase programmes) and PEPP (pandemic emergency purchase programme) as well as earlier purchase programs such as SMP (securities markets programme) and CBPP (covered bond purchase programme) are divided into two sub-categories: National Debt Securities and Other Debt Securities. The National Debt Securities capture domestic government debt acquired by its own NCB under APP and PEPP. Other Debt Securities is the residual, which is the sum of all other security holdings due to the SMP, CBPP, as well as non-government securities such as supranational bonds and corporate securities pur-

chased under APP and PEPP. The separation of these two sub-items is motivated by their different income-pooling rules, which we clarify in Section 3.

Both Italian and German central banks hold a large amount of public debt in terms of their GDP share. From 2014 to 2021, the Bundesbank's national government debt asset increased from 0% to 21% of GDP, and Banca d'Italia's debt asset increased from 0% to 29% of GDP. Other than the national government bonds, the amount of bank lending also increased. It went up by about 9.8% of GDP in Italy and rose 12.8% in Germany between 2014 and 2021. Overall, the balance size of expansion due to the APP, PEPP, and bank lending are about 30% to 40% of GDP for both countries during the active-APPs periods.

In 2021, the German NCB also carried more than 20% of GDP in other liabilities, which include two major items: liabilities to German general government, 6.82% of GDP, and liabilities to non-euro area central banks, 10.58% of GDP.

Asymmetry. The evolution of NCBs' balance sheets is asymmetric. In the case of the Bundesbank, the overall rise in its liabilities, including banknotes, bank reserves and other liabilities, actually exceeds the amount of asset purchases and bank lending combined. The excess liabilities are absorbed by the Target2 claims on the periphery. In contrast, the rise of the currency and bank reserves in Banca d'Italia is insufficient to fund its bank loans and asset purchases. The shortage is made up by the increase of its Target2 liabilities owed to core countries. That is, a significant fraction of the Banca d'Italia balance sheet expansion is financed by issuing non-marketable debt through its Target2 account. More generally, the periphery borrows from the core at below-market rates as the ECB expands its balance sheet.

Table 2 aggregates across core and periphery national central banks' balance sheets. We use Eurosystem data whose sample starts from 2016. By comparing the composition of assets and liabilities, we can see that the national central banks in the core countries tend to be net holders of Target2 assets, whereas the national central banks in the periphery countries tend to be net sellers of these claims. To the extent that (1) these claims do not earn market rates of return, and (2) monetary income from these claims are first collected by the ECB and redistributed to national central banks in ways that are different from the actual ownership, which we show in detail in the next section, the Eurosystem generates a significant amount of implicit cross-country subsidies and transfers between core and periphery countries. As a result of these transfers, monetary policies in the Eurozone have important fiscal implications.

3 Income Pooling and Implicit Cross-Country Transfers

In the Eurosystem, a portion of the income earned by National Central Banks (NCBs) is pooled and then redistributed based on their capital keys. Specific rules govern how income is pooled for each asset and liability item. In this section, we first present a general accounting formula that applies to all income-pooling items. Following that, we examine the pooling rules for specific balance sheet items.[4]

3.1 Income before and after Pooling

For each asset, we use $r_{c,i}^{Book}$ to denote the book rate of asset i for the central bank of country c. The book rate represents the actual interest rate the NCBs charge for the asset. This interest rate may differ from $r_{c,i}^{Remun}$, the remuneration rate that the ECB uses for income pooling.

Let $A_{c,i}$ denote the value of asset i held by the central bank of country c. We define the book

[4]See Table 2 in Belhocine et al. (2023) for a detailed discussion on income pooling by the ECB.

Table 2: Balance Sheet of Synthetic Core vs. Periphery NCB

	Core			Periphery		
% of GDP, Year End	2016	2021	2023	2016	2021	2023
Assets						
Bank Lending	2.24%	13.49%	1.60%	10.09%	21.32%	3.76%
National Debt Securities	8.88%	21.77%	18.73%	12.40%	30.83%	26.34%
Other Debt Securities	2.87%	5.51%	4.74%	8.14%	10.50%	8.93%
Gold, FX and Others	6.59%	7.88%	8.23%	10.75%	11.84%	10.87%
IntraEurosys-Target2	25.09%	32.98%	26.01%	0.00%	1.75%	1.71%
IntraEurosys-Banknotes	1.23%	1.58%	1.27%	4.93%	6.55%	6.65%
Liabilities						
Banknotes	8.25%	9.99%	8.77%	10.58%	12.33%	10.18%
Bank Reserves	17.37%	37.23%	29.10%	5.44%	26.47%	15.68%
Capital and Others	11.23%	23.15%	11.33%	8.89%	14.05%	11.56%
IntraEurosys-Banknotes	10.05%	12.37%	11.39%	0.71%	0.42%	0.43%
IntraEurosys-Target2	0.00%	0.46%	0.00%	20.69%	29.53%	20.83%
Sum	46.89%	83.21%	60.59%	46.30%	82.79%	58.77%

The synthetic core NCB includes Germany, Luxembourg, the Netherlands, and Finland. The synthetic periphery NCB consists of Belgium, Ireland, Greece, Spain, Italy, Austria, and Portugal. The synthetic core and periphery countries have roughly equal NGDP sizes. Their NGDP, as a share of the total Eurozone, ranges between 38% and 39%. Unit: % of GDP. Source: ECB (Disaggregated balance sheet of Eurosystem), Euro Stat and authors' calculation

income $\pi^{NoPool,Book}$ using the book interest rate as

$$\pi_{c,i}^{NoPool,Book} = r_{c,i}^{Book} A_{c,i}, \tag{1}$$

which measures the income that the national central bank directly receives from the asset. The book income is what is reported by the NCBs in their annual accounts. The ECB then collects $r_{c,i}^{Remun} A_{c,i}$ based on the imputed remuneration rate and redistributes $\alpha_c \sum_k r_{k,i}^{Remun} A_{k,i}$ as rebate back to the national central bank, where α_c represent the capital key share of the NCB in country c. The after-pooling income $\pi_{c,i}^{Pool}$ is therefore

$$\underbrace{\pi_{c,i}^{Pool}}_{\substack{\text{After-Pooling}\\ \text{Income}}} = \underbrace{r_{c,i}^{Book} A_{c,i}}_{\substack{\text{Book}\\ \text{Income}}} - \underbrace{\left(r_{c,i}^{Remun} A_{c,i} - \alpha_c \sum_k r_{k,i}^{Remun} A_{k,i} \right)}_{\text{Pooling}}, \tag{2}$$

which is the NCB's actual net inflows of monetary income for asset i.

Table 3 shows the income after pooling for each balance sheet item according to Equation (2). For most items, the book rate is equal to the remuneration rate, i.e., $r_{c,i}^{Book} = r_{c,i}^{Remun}$, so that the income after pooling simplifies to

$$\pi_{c,i}^{Pool} = \alpha_c \sum_k r_{k,i}^{Remun} A_{k,i},$$

where α_c represents the share of total income received by all NCBs allocated to country c. For example, in the case of income from Target2, the final income accruing to each central bank is $\alpha_c r_{MRO} \sum_k A_{k,T2}$. As discussed in Section 2, the sum of all NCB net positions equals the ECB's

Table 3: NCB Income after Pooling

Balance Sheet Items	Book Rate	Remuneration rate	Income after pooling
Lending to Banks	Actual Rate	Actual Rate	$\alpha_c \sum_k r_{k,BL} A_{k,BL}$
National Debt Securities	Actual Rate	MRO Rate	$r_{c,ND} A_{c,ND} - r_{MRO} \left[A_{c,ND} - \alpha_c \sum_k A_{k,ND} \right]$
Other Debt Securities	Actual Rate	Actual Rate	$\alpha_c \sum_k r_{k,OD} A_{k,OD}$
Bank Reserves	Actual Rate	Actual Rate	$\alpha_c \sum_k r_{k,BR} A_{k,BR}$
IntraEurosys-Target2	MRO Rate	MRO Rate	$-\alpha_c r_{MRO} A_{T2,ECB}$
IntraEurosys-Banknotes	MRO Rate	MRO Rate	$-\alpha_c r_{MRO} A_{IB,ECB}$

final net position, $\sum_k A_{k,T2} = -A_{ECB,T2}$, where $A_{ECB,T2}$ represents the ECB's position. Since the ECB has a negative net balance, i.e., $A_{ECB,T2} < 0$, all NCBs receive positive income from Target2, distributed according to their capital key share. For example, in 2024, the ECB's net balance was -€382 billion, implying a total income accruing to NCBs of approximately €13 billion.

The only exception is the holdings of national debt securities. For these assets, the book rate is the actual interest rate received on debt holdings, while the remuneration rate is the MRO rate. This implies that each central bank receives an amount proportional to the overall Eurosystem holdings $\alpha_c r_{MRO} \sum_k A_{k,ND}$. Furthermore, NCBs also keep the spread between the sovereign bond yields of their country and the MRO:

$$\pi_{c,ND}^{Pool} = \underbrace{(r_{c,ND} - r_{MRO})}_{\text{Bond Spread}} A_{c,ND} + \alpha_c r_{MRO} \underbrace{\sum_k A_{k,ND}}_{\text{Eurosystem Holdings}}.$$

In the data, it is approximately true that the domestic national debt holding equals the Eurosystem holding times the capital key share, i.e., $A_{c,ND} \approx \alpha_c \sum_k A_{k,ND}$, which simplifies this expression to $\pi_{c,ND}^{Pool} \approx r_{c,ND} A_{c,ND}$. In this case, the central bank keeps the entire income from its national debt holdings.

The total after-pooling income $\pi_c^{Pool} = \sum_i \pi_{c,i}^{Pool}$ is the sum across all assets and liabilities. Similarly, the total book income is $\pi_c^{NoPool,Book} = \sum_i \pi_{c,i}^{NoPool,Book}$. The difference between these two concepts of income, $\pi_c^{NoPool,Book} - \pi_c^{Pool}$ is reported in the annual accounts of each central bank as net result of pooling of monetary income.

Likewise, it is useful to define the effective balance sheet item $A_{c,i}^{Pool}$ to reflect the effective stock of its holdings after pooling adjustment:

$$A_{c,i}^{Pool} = A_{c,i} - A_{c,i} + \alpha_c \sum_k A_{k,i} = \alpha_c \sum_k A_{k,i}. \tag{3}$$

3.2 Counterfactual Market Income

The main objective in this paper is to ask how each central bank's after-pooling income π_c^{Pool} that it receives in reality compares to a counterfactual scenario in which the NCB is paid or paying the market rate and faces no income pooling by the ECB. The market rate, which we denote as $r_{c,i}^{Mkt}$, could be different from both the book rate $r_{c,i}^{Book}$ and the remuneration rate $r_{c,i}^{Remun}$. Using this

market rate, we define the counterfactual market income as

$$\pi_{c,i}^{NoPool,Mkt} = r_{c,i}^{Mkt} A_{c,i}. \tag{4}$$

We define the subsidy that the central bank in country c receives for asset i as the difference between the counterfactual market income and the actual after-pooling income:

$$\pi_{c,i}^{NoPool,Mkt} - \pi_{c,i}^{Pool} = r_{c,i}^{Mkt} A_{c,i} - \left(r_{c,i}^{Book} A_{c,i} - r_{c,j}^{Remun} A_{c,i} + \alpha_c \sum_k r_{k,i}^{Remun} A_{k,i}. \right),$$

which is positive if the central bank pays out a subsidy and negative if it receives a subsidy. The subsidy can be decomposed into two components:

$$\pi_{c,i}^{NoPool,Mkt} - \pi_{c,i}^{Pool} = \underbrace{(r_{c,i}^{Mkt} - r_{c,i}^{Book}) A_{c,i}}_{\text{Mark to Market}} + \underbrace{r_{c,j}^{Remun} A_{c,i} - \alpha_c \sum_k r_{k,i}^{Remun} A_{k,i}}_{\text{Pooling}},$$

which are the effect due to the difference between the market rate and the book rate, and the pooling effect due to the ECB's redistribution of income.

We sum across all assets and liabilities of each central bank to obtain the overall subsidy for central bank of country c:

$$\pi_c^{NoPool,Mkt} - \pi_c^{Pool} = \sum_i \left(\pi_{c,i}^{NoPool,Mkt} - \pi_{c,i}^{Pool} \right), \tag{5}$$

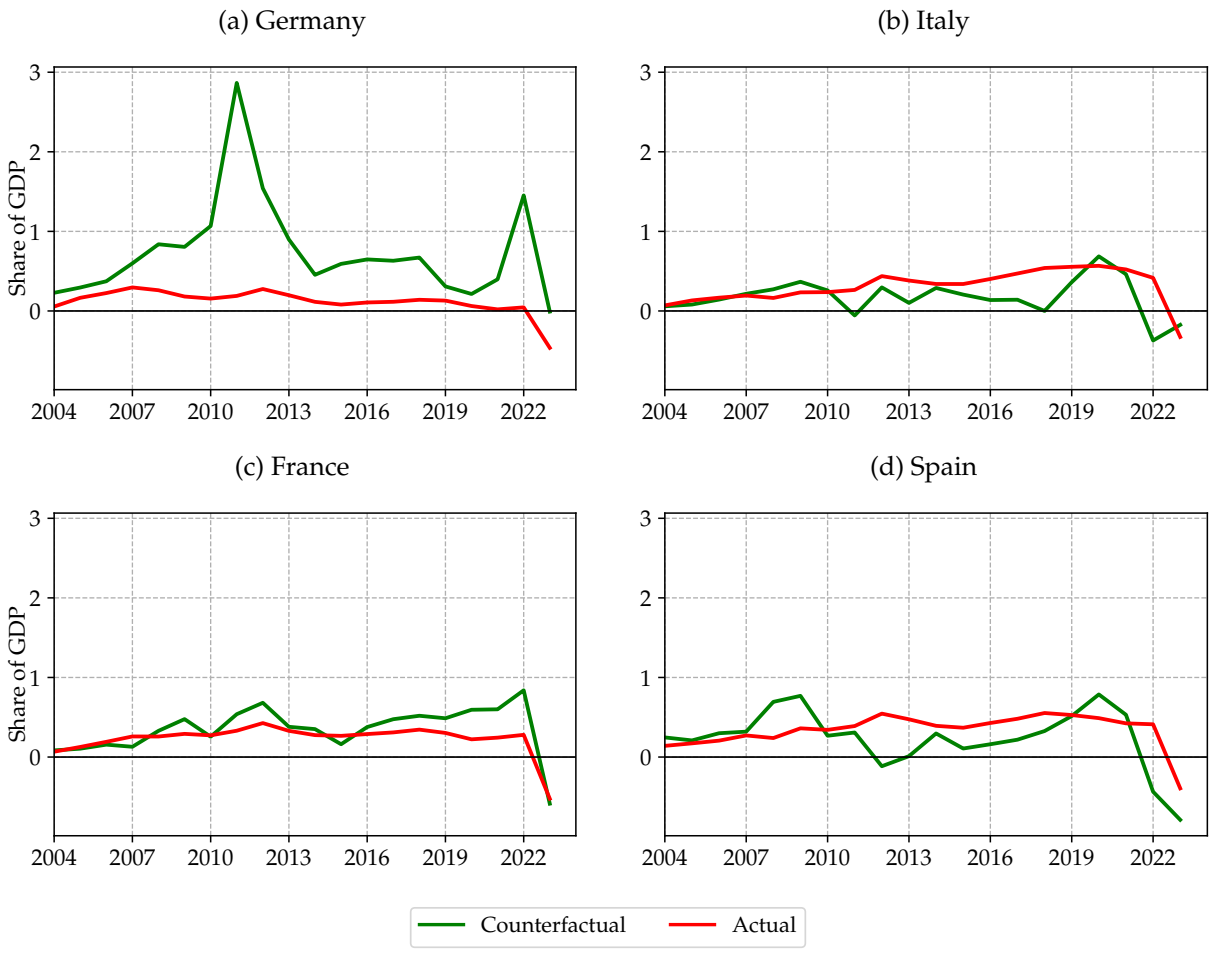
which reflects the income the central bank would have earned had it applied the market interest rate and not pooled income with other central banks.

While calculating income without pooling is a relatively straightforward accounting task, determining appropriate return rates for non-marketable instruments is more complex and depends on various underlying assumptions. To clarify the impact of these assumptions, we first present counterfactual income based on a set of baseline assumptions, referred to as the baseline scenario. For Target2 balances, we use the national government bond yields as the market interest rate. For the long-term portion of bank lending (LTROs, T-TLROs), we apply the prevailing yields on bank holdings of corporate bonds. For Eurosystem banknotes, we assign a market rate of zero.

3.3 Baseline Counterfactual Scenario

We report the actual (post-pooling) and counterfactual (market rates and no-pooling) income in Figure 2. Our sample covers the time series of Germany, Italy, France, and Spain. In all of these countries, we find non-trivial gaps between the actual and counterfactual incomes.

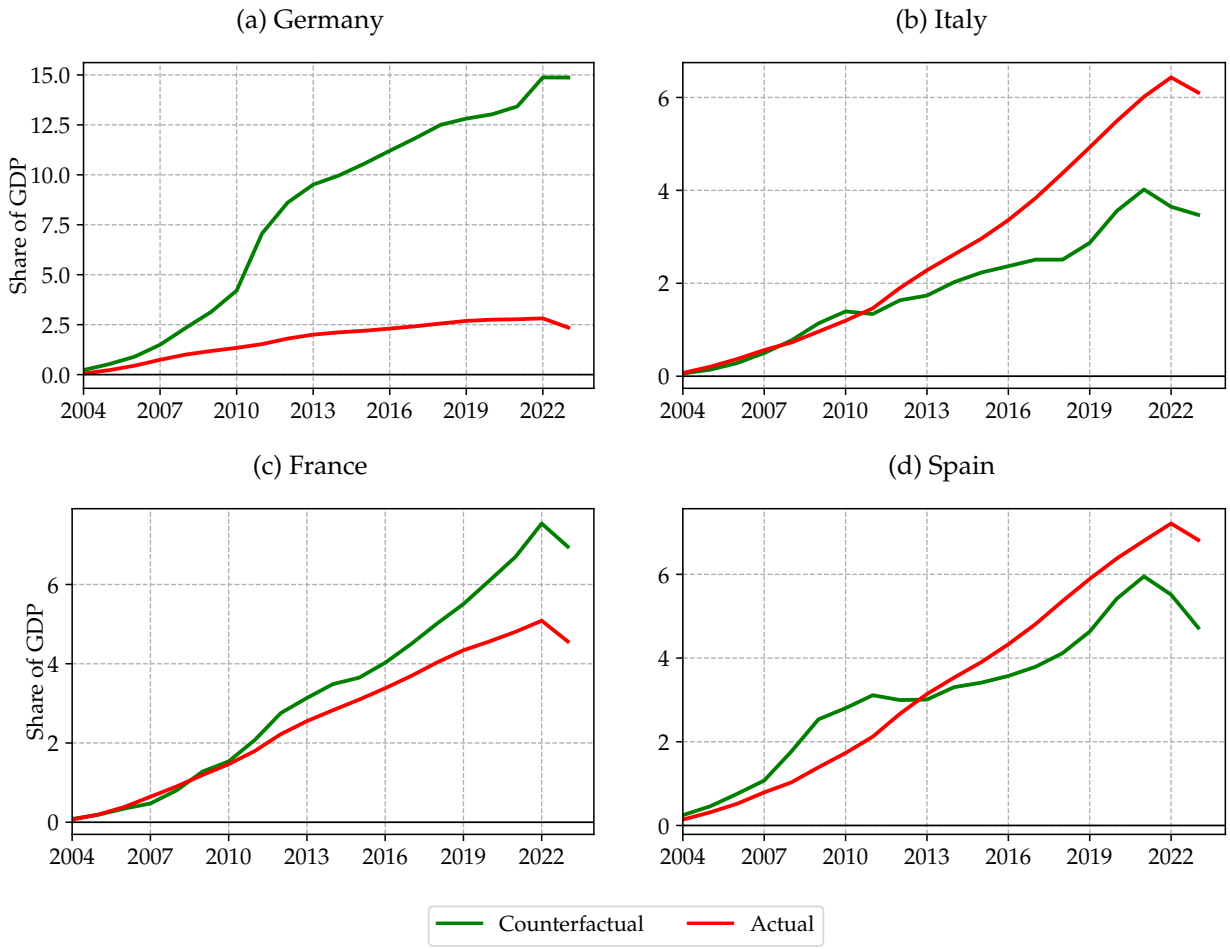
Figure 2: Net Income of Central Banks



NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

Figure 2a reports the net income of the German central bank. The counterfactual income is persistently higher than the actual (post-pooling) income by a large margin, which averaged to 0.63% of German GDP per annum from 2004 to 2023. This gap also widened during the 2012 European sovereign debt crisis and the 2022 interest rate hike when the spreads between periphery and core bond yields increased.

Figure 3: Cumulative Net Income of Central Banks



NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

In contrast, Figure 2b reports the net income of the Italian central bank. We see the opposite pattern since early 2010: the counterfactual income is persistently lower than the actual (post-pooling) income. The gap averaged to 0.12% of Italian GDP per annum from 2004 to 2023.

Figure 2c and Figure 2d show the net income of the French and Spanish central banks, respectively. The French central bank has a similar pattern to the German central bank, while the Spanish central bank has a similar pattern to the Italian central bank. On average, the counterfactual income is higher than the actual income by 0.12% of GDP for France, indicating that France is implicitly subsidizing the Eurosystem. In contrast, the counterfactual income is lower than the actual income by 0.1% of GDP for Spain, indicating that Spain is implicitly receiving a subsidy from the Eurosystem.

Figure 3 plots the cumulative actual and counterfactual income of the NCBs. The figure clearly shows that while the subsidy may appear small on an annual basis, its persistence over time results in a quantitatively significant subsidy. Table 5 presents the average and cumulative actual and counterfactual income, along with the total subsidy. The table further decomposes the subsidy into within-country and cross-country components, which we explain in greater detail below.

Quantitatively, we find that Germany and France pay a cumulative subsidy of 12.5% and 2.4% of their GDP, respectively, from 2004 to 2023, whereas Italy and Spain receive cumulative subsidies of -2.6% and -2.1% of their GDP over the same period. These figures are non-trivial when compared to the interest expenses incurred by their respective governments.

Within-Country vs. Cross-Country Subsidy. To interpret these subsidies, we find it useful to look into a central bank balance sheet in detail. Take, for example, the Banca d'Italia. Table 4 presents the item-by-item breakdown in 2014, 2021 and 2023. The middle panel shows the current-case net-income as percentage of GDP from the annual reports. Under the current scenario, the income of each balance sheet item is listed before pooling as the book income. Most of the NCBs, including the Banca d'Italia, do not report the net result of pooling of monetary income for each item. Instead, their annual reports only show the aggregate net result across all balance sheet items, which is listed as "Pooling Monetary Income".

In 2022, the Banca d'Italia ran an after-pooling income surplus at 0.42% of GDP, whereas the counterfactual income before pooling was -0.15% of GDP, resulting in a net subsidy of 0.57% of GDP. The main item that explains this subsidy is IntraEuroSys-Target2: the Banca d'Italia had a large liability under this category. If it were to pay a market interest rate on this liability, which we assumed to be the government bond yields, then, it should have paid 0.92% of GDP on this liability. In reality, its book income was 0.20% of GDP before pooling when we evaluate the income using the book interest rate, which results in an implicit subsidy.

Having said that, another item stands out with the opposite sign: the Banca d'Italia has a claim against domestic banks. If it were to receive a market interest rate on this claim, it should have received an interest income of 0.20% of GDP. However, it received -0.10% of GDP before pooling, which results in a subsidy from Banca d'Italia to Italian domestic banks.

This discussion suggests that we need to distinguish the subsidy estimate between its *within-country* and *cross-country* components. Target2, Intra-Eurosystem Banknotes, and debt securities involve transactions between countries, while bank lending is a within-country transaction with

Table 4: Net Interest Income of Banca d'Italia

	Current (Pooling)			Counterfactual (Non-Pooling)		
% of GDP, Year End	2014	2022	2023	2014	2022	2023
Income						
FX	0.01%	0.03%	0.10%	0.01%	0.03%	0.10%
Lending to banks	**0.02%**	**−0.10%**	**0.38%**	**0.06%**	**0.20%**	**0.28%**
Bonds	0.34%	0.57%	0.69%	0.34%	0.57%	0.69%
Other assets	0%	0%	0%	0%	0%	0%
IntraEurosys-Banknotes	**0%**	**0.02%**	**0.10%**	**0%**	**0%**	**0%**
Sum	0.38%	0.52%	1.27%	0.41%	0.80%	1.07%
Expenditure						
Bank reserves	0%	0.02%	0.38%	0%	0.02%	0.38%
Other liabilities	0.01%	0%	0.07%	0.01%	0%	0.07%
IntraEuroSys-Target2	**0.02%**	**0.20%**	**1.09%**	**0.35%**	**0.92%**	**0.97%**
Sum	0.03%	0.22%	1.54%	0.36%	0.95%	1.42%
Pooling Monetary Income	**0.01%**	**0.12%**	**−0.05%**			
Net Income	**0.36%**	**0.42%**	**−0.33%**	**0.05%**	**−0.15%**	**−0.35%**

Unit: % of GDP. Source: ECB, Euro Stat, Banca d'Italia and authors' calculation

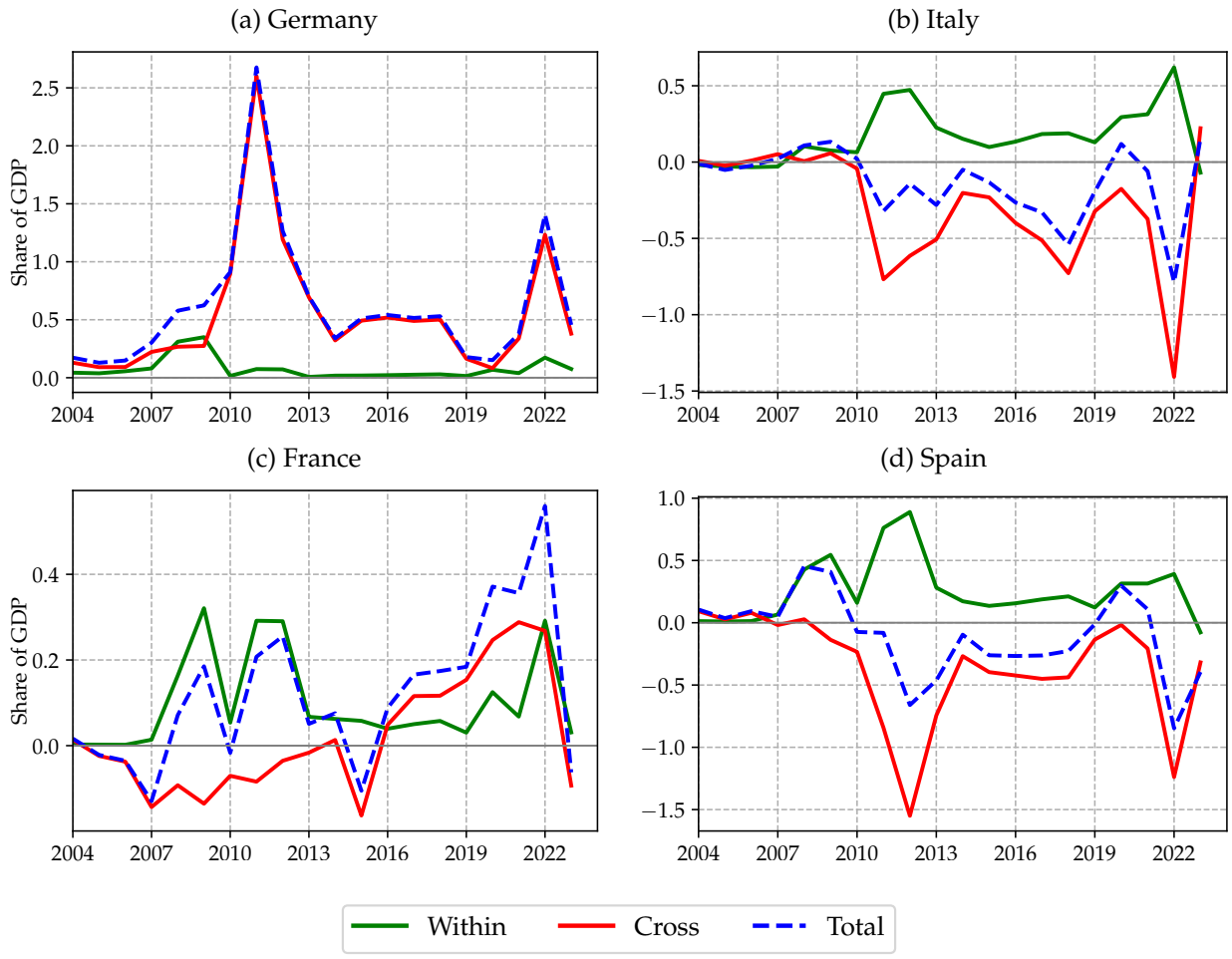
domestic banks. As the central bank provides loans to domestic banks at favorable interest rates that are significantly below market levels, the mark-to-market adjustment also reflects a within-country subsidy. That said, the bank lending is also subject to income pooling between countries. Therefore, we should decompose the subsidy for the bank lending item into two components:

$$\pi_{c,BL}^{NoPool,Mkt} - \pi_{c,BL}^{Pool} = \underbrace{(r_{c,BL}^{Mkt} - r_{c,BL}^{Book})A_{c,BL}}_{\substack{\text{Mark to Market} \\ \text{Within-Country Subsidy}}} + \underbrace{r_{c,BL}^{Remun}A_{c,BL} - \alpha_c \sum_k r_{k,BL}^{Remun}A_{k,BL}}_{\substack{\text{Pooling} \\ \text{Cross-Country Subsidy}}}.$$

The first term on the right-hand side represents the within-country subsidy, which is proportional to the difference between the counterfactual market rate and the book rate. The second term captures the cross-country subsidy, reflecting the disparity between the income generated through bank lending by an individual country and the final pooled income, which corresponds to a share α_c of the total income generated by all NCBs through bank lending. Bank lending is the only balance sheet item that includes both within-country and cross-country components. Therefore, we compute the total cross-subsidy income by summing the subsidies generated from various balance sheet items, along with the cross-country component of bank lending.

We decompose the within-country and cross-country transfers for all NCBs in our sample.

Figure 4: Within and Across Country Subsidies



NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

Figure 4 reports this decomposition for the time series of Italy, Germany, Spain, and France. Take Italy in panel (b) as an example. The Banca d'Italia has a large and positive within-country transfer towards its domestic banking sector. As a result, its total subsidy in dashed blue understates the cross-country subsidy it receives from the Eurosystem, which is reported in the solid red line. The cross-country subsidy is approximately twice the size of the total subsidy in our calculation. This is because the Banca d'Italia has significantly expanded its bank lending through LTROs and T-LTROs since the onset of the sovereign debt crisis. These are Eurosystem operations that provide funding to credit institutions under favorable conditions. During this period, the counterfactual interest rate, estimated using corporate bond yields of similar maturity, was particularly high,

leading to a large $r^{Mkt}_{c,BL} - r^{Book}_{c,BL}$ spread and, consequently, a substantial within-country subsidy.

In comparison, panel (a) shows that the German central bank has a relatively small transfer to its domestic central bank, and it pays out a large cross-country transfer to other NCBs. From this decomposition, we can see that the cross-country transfer from the core to the peripheral countries in the Eurozone is also more substantial.

Table 5: Actual vs. Counterfactual Income of NCBs in Baseline Scenario

		Panel A: Average			
	Actual	Counterfactual			
	Total	Total	Subsidy	Within	Cross
Germany	0.12	0.74	0.63	0.08	0.55
Italy	0.31	0.17	-0.13	0.17	-0.3
France	0.23	0.35	0.12	0.1	0.02
Spain	0.34	0.24	-0.1	0.25	-0.36
		Panel B: Cumulative			
	Actual	Counterfactual			
	Total	Total	Subsidy	Within	Cross
Germany	2.35	14.87	12.52	1.53	10.98
Italy	6.1	3.47	-2.63	3.32	-5.95
France	4.56	6.95	2.39	2.02	0.37
Spain	6.82	4.73	-2.1	5.1	-7.19

Panel A shows the average of actual income, counterfactual income, the subsidy, the within-country subsidy and cross-country subsidy. Panel B shows the cumulative actual income, cumulative counterfactual income, cumulative subsidy, cumulative within country subsidy and cross country subsidy. Numbers expressed as % of GDP. Source: ECB, Euro Stat, Annual reports of central banks and Authors' calculation.

3.4 The Contribution of Sovereign Spread

So far, our discussion centers on how the below-market rates on assets such as Target2 on national central banks' balance sheets imply cross-country transfers in the Eurozone. In our baseline calculation, we use actual historical market sovereign debt yields as the counterfactual interest rates.

However, in our counterfactual scenarios, marking these central bank assets to market could lead investors to anticipate additional liabilities on central bank balance sheets, which could further increase the sovereign spreads.

In addition, the main reason why the ECB engaged in policies such as quantitative easing is precisely to reduce bond yields and the spread of government bonds. For this reason, the historical bond yields we used are necessarily distorted and lower than a counterfactial scenarions with no

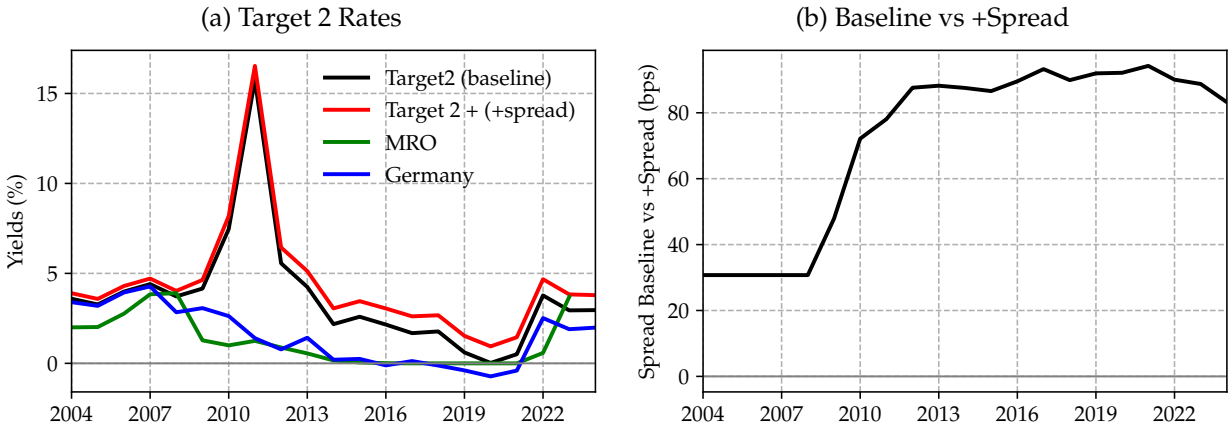
policies. In this paper, we do not take a stance on the magnitude of these distorgtions. Instead, to understand the sensitivity of the subsidies to the sovereign spreads, we conduct a counterfactual analysis by increasing the spreads of the peripheral countries by 100 basis points.

We calculate an adjusted Target2 rate by increasing the spreads for peripheral countries (Greece, Italy, Portugal, Spain, and Ireland) by 100 basis points, which we refer to as the counterfactual Target2+Spread. Importantly, we use each country's bond yield to represent Target2 liabilities and the weighted average of Euro area country yields (where the weights reflect the share of net debtors in Target2) to represent Target2 assets. Figure 5 displays various rates: the MRO rate, the baseline Target2 rate (representing Target2 assets), the representative yield for Germany, and the Target2+Spread rate. Figure 5b illustrates the spread between the baseline Target2 rate and the Target2+Spread rate.

Then, we compute the cross-country transfers with the new Target2 rates. The results are displayed in Figure 6. The cross-country subsidies increase significantly as a result of the higher spreads. The average subsidy paid by Germany increases from 0.5% to 0.7%, while the average subsidy received by Italy increases from -0.3% to -0.44%. As for France, the average subsidy remains stable at 0.02%, while Spain's average subsidy increases from -0.36% to -0.56%.

Once we account for the the increased bond yields , we find that Germany's cumulative subsidy rises to 14% of GDP, which is 4 percentage points higher than in the baseline scenario. Meanwhile, the cross-country subsidies received by Italy and Spain increase to 8.8% and 11% of GDP, respectively. The results are summarized in Table 6.

Figure 5: Target2 Rates

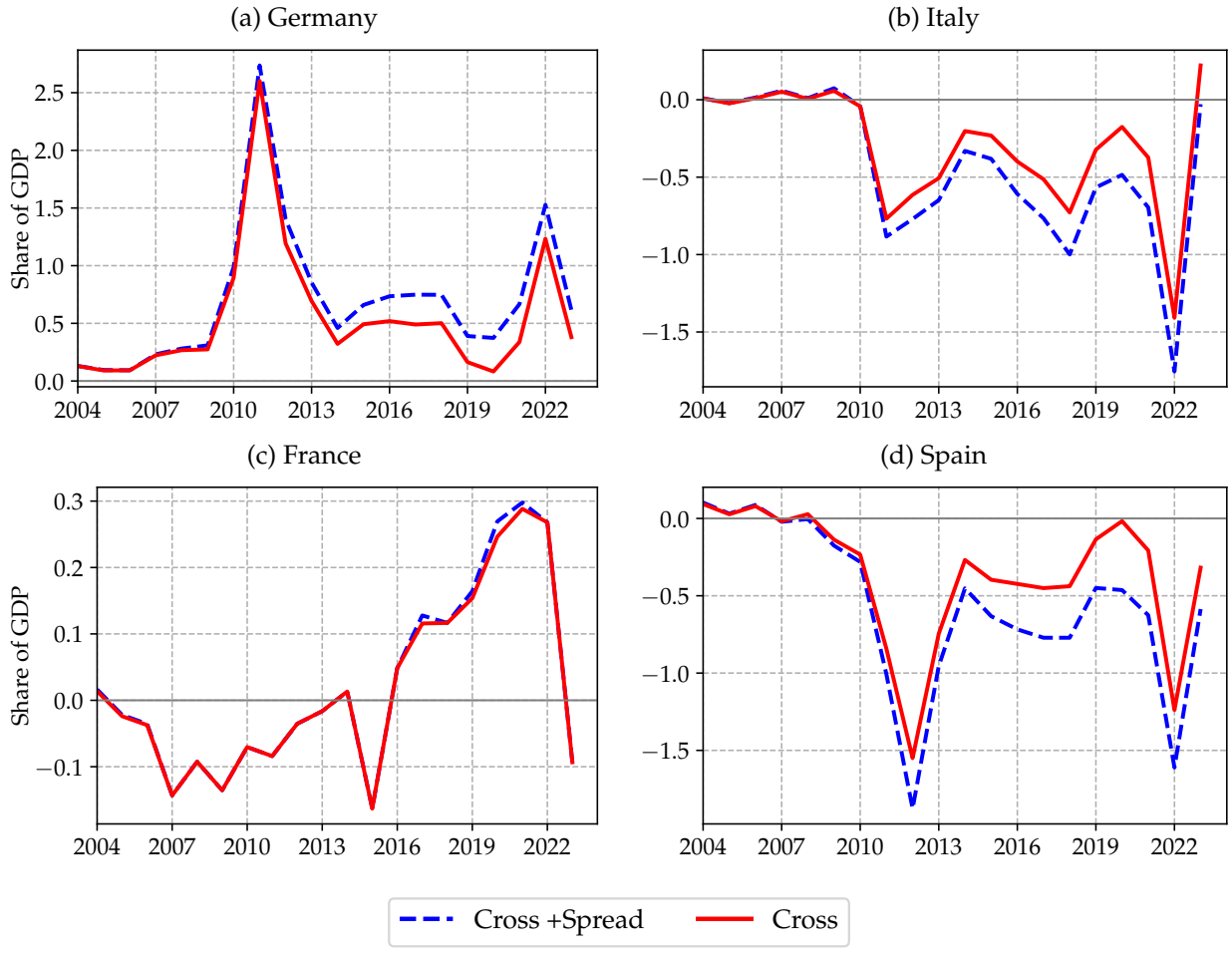


NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

This counterfactual highlights the sensitivity of the subsidies to the bond yields. The magnitude of the cross-country subsidy suggests that, if peripheral countries' sovereign issuers were unable to issue non-marketable debt at favorable rates, the funding cost of their government liabilities would be much higher.

Note that for France, the additional spread has a limited effect. This is because, in the first part of the sample, France was a net borrower in Target2. Since we do not alter its borrowing rates, this does not impact the cross-country subsidy. In the second half of the sample, France becomes a lender through Target2; however, the size of its position remains small relative to its GDP, resulting in a minimal effect.

Figure 6: Cross Country Subsidies, with Target2+Spread



NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

Table 6: Cross-Country Subsidies in Baseline vs High Spread Counterfactual.

	Panel A: Average		*Panel B: Cumulative*	
	Baseline	High Spread	Baseline	High Spread
Germany	0.55	0.70	10.98	14.04
Italy	-0.30	-0.44	-5.95	-8.82
France	0.02	0.02	0.37	0.43
Spain	-0.36	-0.56	-7.19	-11.18

Panel A shows the average of the cross-country subsidy in the baseline counterfactual and high spread counterfactual. Panel B shows the cumulative numbers. Numbers expressed as % of GDP. Source: ECB, Euro Stat, Annual reports of central banks and Authors' calculation.

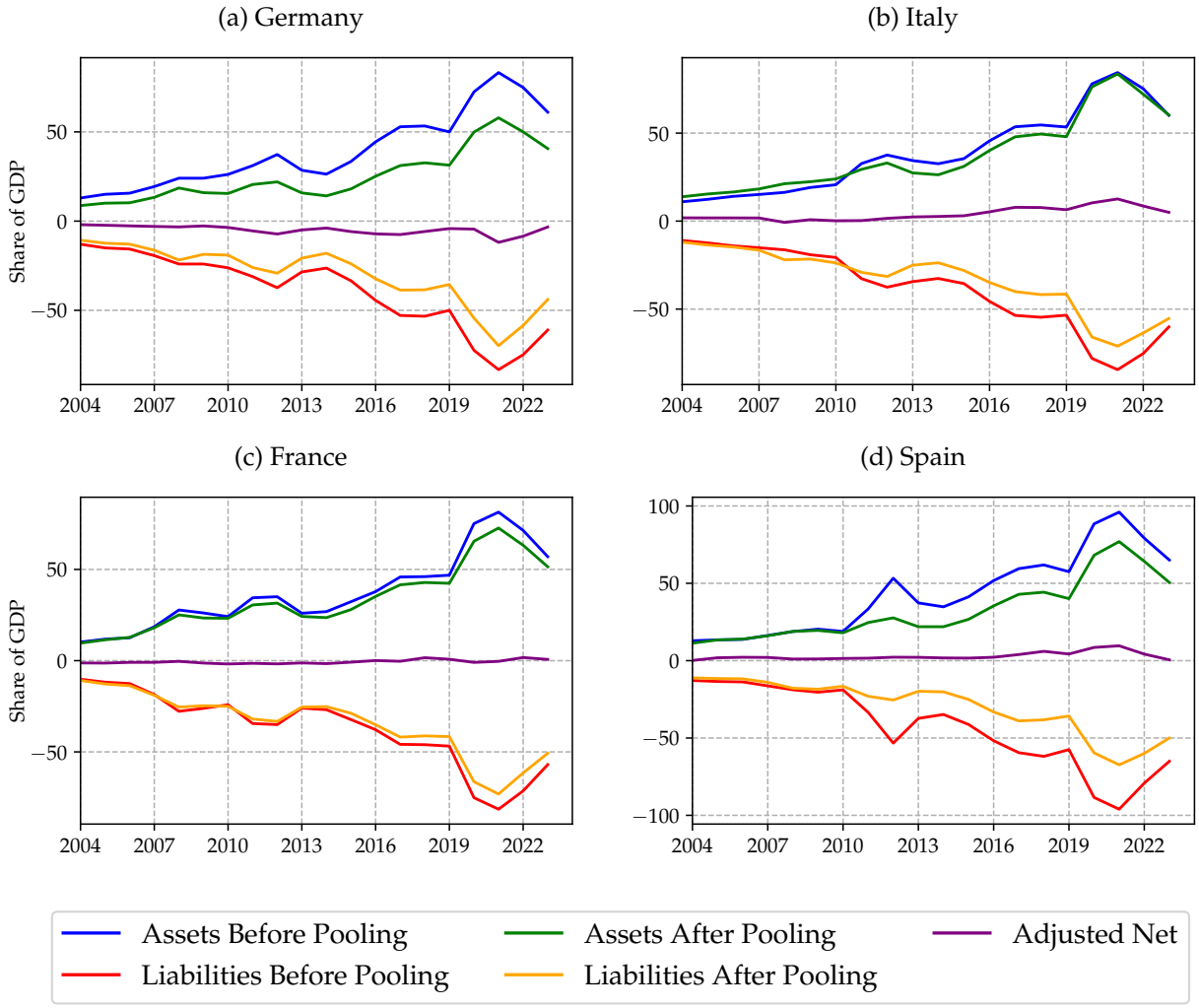
3.5 Effective Balance Sheet Size

In addition to our analysis of the central bank income, we also analyze the effect of income pooling on the central bank balance sheet. Eq. (3) offers a simple perspective: for balance sheet items subject to income pooling, their after-pooling sizes are determined by the aggregate balance sheet of all NCBs multiplied with the capital key. Figure 7 reports this calculation for the countries in our sample. There are two main takeaways.

First, if we compare the assets and liabilities of each national central bank before and after pooling, we can see that the pooling adjustment always reduces the size of the balance sheet. This is a result of netting due to pooling: for example, Banca d'Italia has a net asset in IntraEurosys-Banknotes and a net liability in IntraEurosys-Target2, whereas Bundesbank has the opposite positions. After netting, these assets and liabilities offset each other and result in a smaller gross position in the balance sheet.

Second, while the actual assets and liabilities of each national central bank are balanced before pooling, the pooling adjustment can result in a positive or negative balance. For example, the Bundesbank's net balance is negative, while reflects the fact that it contributes more assets to the ECB for pooling than the pooled assets it receives according to its capital key share. In contrast, the Banca d'Italia has a positive net balance, which reflects the fact that it gives more liabilities to the ECB for pooling than the pooled liabilities it receives according to its capital key share. In this sense, the pooling adjustments on balance sheet sizes lead to similar conclusions: the core countries such as Germany and France are net contributors to the Eurosystem subsidy, whereas the periphery countries such as Italy and Spain are net recipients of the Eurosystem subsidy.

Figure 7: Adjusted Balance Sheet



NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

4 Conclusion

Our findings highlight the significant intra-Eurozone transfers that arise from the European Central Bank's management of its balance sheet. By replacing marketable debt with non-marketable debt through large-scale asset purchases, the ECB redistributes financial risks across member states without compensation for these risks. These redistributions are particularly evident in the core-periphery divide, where core countries like Germany effectively subsidize periphery countries like Italy and Spain through the Eurosystem. This redistribution is driven by the structure of the Eurozone, which, unlike the U.S., is a monetary union of fiscally sovereign countries which

can default and exit the Eurozone. As a result, market participants strictly prefer bank reserves held in the core, implying that the EXC tends to fund its balance sheet expansions in the core, not the periphery. As a result, the periperhy is borrowing from the core at below-market rates.

Comparisons with the U.S. monetary and fiscal system further illustrate the distinct nature of the Eurozone's structure. Unlike the U.S. Federal Reserve system, where reserves are treated equally across all districts, the Eurozone's financial system reflects investors' concerns about potential fragmentation. This contributes to the core-periphery divide in reserve holdings, reinforcing financial disparities within the union. Ultimately, our results suggest that the ECB's monetary policies, while aimed at stabilizing financial markets, also serve as a mechanism of implicit fiscal redistribution across Eurozone member states.

Our quantification of these transfers underscores the scale of the implicit subsidies involved. The cumulative subsidies paid by Germany and France amount to 12.5% and 2.4% of GDP, respectively, while Italy and Spain benefit from negative subsidies of -2.6% and -2.1% of GDP over the period from 2014 to 2023. These estimates are conservative. These transfers are further amplified when considering alternative scenarios with higher sovereign bond spreads, illustrating the sensitivity of our estimates to variations in market conditions. Notably, we find that when sovereign bond yields increase by 100 basis points, Germany's cumulative subsidy rises to 14% of GDP, while the cross-country subsidies received by Italy and Spain grow to 8.8% and 11% of GDP, respectively.

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A Line by Line Analysis of Pooling

A.1 Target2

Income Pooling. For Target 2 the book yield and the remuneration rate (MRO rate) is identical for all country c, namely $r^{Book} = r^{Remun} = r_{MRO}$. Then, according to equation (2), the pooling income of IntraEurosys-Banknotes can be rewritten as

$$\pi^{Pool}_{c,T2} = r^{Book}_{c,T2} A_{c,T2} - \left(r^{Remun}_{c,T2} A_{c,T2} - \alpha_c \sum_k r^{Remun}_{k,T2} A_{k,T2} \right) \tag{6}$$

$$= \alpha_c r_{MRO} \sum_k A_{k,T2} = -\alpha_c r_{MRO} A_{ECB,T2}, \quad \text{for } i \tag{7}$$

where the last equality utilizes the property that the sum of net claims including ECB is zero, $\sum_k A_{k,i} + A_{ECB,i} = 0$. Since the net claims can offset each other among NCBs, the NCBs' pooling incomes only depend on the income paid or received by ECB. This implies the after-pooling income of each NCB is independent of its asset or liability position and only depends on the amount owned by the ECB. Consider the extreme case where ECB holds zero amount, then the after-pooling income must be zero by construction regardless of the remuneration rate. For Target2, the sum of net claims and liabilities of NCBs is minimal, $\sum_k A_{k,i}$, indicating that the overall post-pooling income is negligible. Consequently, even if a central bank holds a net position in Target2, the effective yields paid or received on this item are close to zero.

Counterfactual Target2 claims are currently remunerated at the prevailing ECB MRO rate. We mark-to-market Target2 claims by assuming that these claims are remunerated in the same way as cross-country government claims, i.e., at the current yields on government bonds. For countries with positive Target2 claims (lenders), their returns are imputed as a weighted average of sovereign bond yields from Target2 debtor countries, with weights based on each country's share of Target2 liabilities. Conversely, a Target2 debtor country pays a rate equivalent to its own government bond yield.

For instance, consider a simplified Eurozone with only three countries: Germany, Italy, and Spain. Both Italy and Spain have Target2 liabilities owed to Germany, with each holding an equal share of 50% of the total liabilities. In this case, the Target2 remuneration rate for Germany is assumed to be the equally weighted average of the Italian and Spanish bond yields. Italy and Spain, in turn, pay for their Target2 liabilities at the rate of their respective sovereign bond yields.

Since Target2 claims do not have a defined maturity, we assume the remuneration corresponds to the weighted average yield of all outstanding government bonds.

A.2 IntraEurosys-Banknotes (IB)

For IntraEurosys-Banknotes (IB) the book yield and the remuneration rate (MRO rate) is identical for all country c, namely $r^{Book} = r^{Remun} = r_{MRO}$. Then, according to equation (2), the pooling income of IntraEurosys-Banknotes can be rewritten in the same way as in for Target 2 in Equation 7:

$$\begin{aligned}\pi_{c,i}^{Pool} &= r_{c,i}^{Book} A_{c,i} - \left(r_{c,i}^{Remun} A_{c,i} - \alpha_c \sum_k r_{k,i}^{Remun} A_{k,IB} \right) \\ &= \alpha_j r_{MRO} \sum_k A_{k,i} = -\alpha_j r_{MRO} A_{ECB}^i, \quad \text{for } i = \text{IB}\end{aligned}$$

where the last equality utilizes the property that the sum of net claims including ECB is zero, $\sum_k A_k^i + A_{ECB}^i = 0$.

Counterfactual The remuneration rate on the Intra-Eurosystem banknotes and banknotes are both zero. A country is able to issue more domestic currency indicating its greater seigniorage revenue. This revenue is not shared among NCBs in our baseline scenario. Note that the ECB's 8% share of seigniorage revenue remains unchanged.

A.3 Bank Lending

Income Pooling. Bank lending (BL) consists of short-term bank lending (SBL) and long-term bank lending (LBL). Short-term bank lending primarily includes Main Refinancing Operations (MROs), while long-term lending comprises LTROs and T-LTROs. The remuneration rates for both short-term and long-term bank lending correspond to their respective book yields. The corresponding equation (2) is then simplified as

$$\begin{aligned}\pi_{c,i}^{Pool} &= r_{c,i}^{Book} A_{c,i} - r_{c,i}^{Remun} A_{c,i} + \alpha_c \sum_k r_{k,i}^{Remun} A_k^i \\ &= \alpha_c \sum_k r_{k,i}^{Book} A_{k,i}, \text{ for } i = SBL \text{ and } LBB\ ,\end{aligned}$$

which indicates that the income of these items are fully and truly shared among NCBs. The credit risk associated with bank lending programs (TLTROs) is fully shared according to their capital key.

Counterfactual For short-term bank lending, we assume that the MRO rate represents the actual market rate, implying $r^{Mkt}_{c,SBL} = r^{Book}_{c,SBL} = r^{Remun}_{c,SBL} = r_{MRO}$. For long-term bank lending, we use the yield on euro-denominated corporate bonds issued by banks. This serves as an alternative financing option for banks, comparable to long-term borrowing, and can be benchmarked against corporate bond yields.

A.4 National Debt Securities

Income Pooling. We then turn into the national debt securities (ND) held by NCBs. First, the remuneration rate is identical for all NCBs and is set to the MRO rate. Its pooling income is then

$$\begin{aligned}\pi^{Pool}_{c,ND} &= r^{Book}_{c,ND}\, A_{c,ND} - r^{Remun}_{c,ND} A_{c,ND} + \alpha_j \sum_k r^{Remun}_{c,ND}\, A_{c,ND} \\ &= r_{i,ND} A_{c,ND} - r_{MRO} \underbrace{\left[A_{c,ND} - \alpha_j \sum_k A_{c,ND} \right]}_{\text{excess holdings}}\end{aligned}$$

where the excess holdings are defined as the national debts netting out of its capital key share of NCBs' aggregate. Given the purchase of national debts of each NCB roughly mirrors its capital key, we should expect that the exceeding holdings is relatively small. Hence, the net nation-debt-income transferred from NCB to ECB is small if the excess holdings are approximately zero. This shows that most of the national debt income stays with each NCB and the effect of income pooling is limited on the holdings of sovereign debts. As $r^{Book}_{c,ND}$ is already a market yield, we have: $r^{Book}_{c,ND} = r^{Mkt}_{c,ND}$. In the APP and PEPP programs, the risk of the national debts held by NCBs is not shared while the risk associated with all other debts is fully shared.

A.5 Other Assets and Liabilities

We now examine the income pooling properties of bank reserves (BR), and other debt securities (OT). For these assets, we assume that the market rate is equal to the book rate, meaning that in our analysis, we focus solely on the effects of income pooling, excluding any mark-to-market

effects.

The remuneration rates for bank reserves (BR) and other debt securities (OT) are their corresponding book yields. The corresponding equation (2) is then simplified as

$$\begin{aligned}\pi_{c,i}^{Pool} &= r_{c,i}^{Book} A_{c,i} - r_{c,i}^{Remun} A_{c,i} + \alpha_c \sum_k r_{k,i}^{Remun} A_k^i \\ &= \alpha_c \sum_k r_{k,i}^{Book} A_{k,i}, \text{ for } i = BR, \text{and } OT\ ,\end{aligned}$$

which indicates that the income of these items are fully and truly shared among NCBs.

B Implicit Transfers within Eurozone

The ECB's monetary policy framework results in implicit transfers through two primary channels: income pooling and non-marking-to-market. Based on the preceding discussion, we now quantify $\pi_c^{NoPool,Mkt}$ and π_c^{Pool}, and the corresponding subsidies for each central bank.

The asset and liability base for incoming pooling might not be equal for each NCB. In order to correct this, there is one additional rule that if the value of an NCB's asset base exceeds or is less than the value of its liability base, the difference will be offset by applying to it the most recent MRO rate. (See the Bank of Spain Annual Report[5])

C Actual Allocation of Public Debt Purchases

C.1 Background Information regarding Public Debt Purchases

PSPP The European Central Bank (ECB) introduced the asset purchase programme (APP) in mid-2014 as part of a broader set of unconventional monetary policy tools, which also included targeted longer-term refinancing operations. These measures were designed to enhance the transmission of monetary policy and to provide the necessary level of policy accommodation to maintain price stability. On March 9, 2015, the ECB began purchasing public sector securities through the public sector purchase programme (PSPP).

Purchases under the PSPP were generally guided by the ECB's capital key, which allocates shares to each national central bank (NCB) based on its economic size and population. However,

[5]The 2022 annual accounts of the Bank of Spain is available at https://doi.org/10.53479/29690

the programme allowed for monthly flexibility, meaning that strict adherence to the capital key was not required each month. This flexibility facilitated the smooth execution of the programme.

Additionally, the timing of reinvestments of principal redemptions, and the option to stagger these reinvestments over time, could influence a jurisdiction's share of the monthly purchase volume. Consequently, this might also affect the purchase volumes of other jurisdictions.

Principal redemptions were reinvested within the same jurisdiction where the repayments occurred, while adjustments to the portfolio allocation across jurisdictions aimed to better align the PSPP portfolio with each NCB's capital key subscription. These adjustments were made within the constraints of issuer and issue limits, the principle of market neutrality, and other programme guidelines.

PEPP On March 18, 2020, the Governing Council of the European Central Bank (ECB) introduced the pandemic emergency purchase programme (PEPP) in response to the significant threats the COVID-19 pandemic posed to the euro area's economic outlook and the effectiveness of monetary policy transmission (as outlined in the Governing Council's decisions on that date). The Eurosystem began executing purchases under the PEPP on March 26, 2020.

The PEPP is a temporary asset purchase initiative that includes both private and public sector securities. Initially set at €750 billion, the programme's funding was first increased by €600 billion on June 4, 2020, and later by an additional €500 billion on December 10, 2020, resulting in a total of €1,850 billion. All asset types eligible under the pre-existing asset purchase programme (APP) were also incorporated into the PEPP, with the eligibility criteria for Greek Government securities being specifically waived.

For the acquisition of public sector securities within the PEPP, the allocation across jurisdictions is generally guided by the Eurosystem capital key. However, the programme is implemented with considerable flexibility, allowing adjustments based on prevailing market conditions to prevent an unwarranted tightening of financing conditions that could undermine efforts to counter the pandemic's downward pressure on inflation. This flexibility, applied over time and across different asset classes and jurisdictions, is set to maintaining the effective transmission of monetary policy according the ECB.

ECB The purchase share of public debt executed by the ECB, which is around 10% of total public debt purchases, does not need to mirror the capital keys of member countries. As a result, even

if the country shares of public debt purchases executed by NCBs follow exactly their capital key share. The overall purchase share of the Eurosystem could still deviate the capital key share as a result of the ECB's discretionary purchase power.

TPI Finally, in 2022, the ECB rolled out its Transmission Protection Instrument (TPI) program, allowing the Eurosystem to buy government bonds of specific member countries that experience unwarranted increases in borrowing costs. The TPI program effectively allow the purchases of public debt departing from the capital key guideline.

C.2 Actual Purchase Allocation

Need to think about the purpose of showing the actual allocation

As discussed above, while the guiding principle for the allocation of purchases across countries is the capital key, the actual net purchases of the ECB may result to be different. We collect data from the ECB and compute the actual allocation of purchases across countries. We gather data from the European Central Bank (ECB) website[6] and analyze it to calculate the distribution of purchase shares allocated to various countries. The capital key share data are obtained in two different ways. First, we use the annual-report data of NCBs and ECB and calculate the ratio of banknotes to total banknotes for each NCB. Second, we use the press release from the ECB to reconstruct the capital key ratio.[7].

Figure 8 plots the shares of PSPP and PEPP purchases of various countries. The shares are calculated as the cumulative net purchases in a country divided by the total cumulative net purchases (net of purchases of supranational bonds). We also plot the capital key share of each country.

In Germany, the PSPP share shows significant fluctuations over the observed period. Starting around 26.5% in 2016, the share experiences a general upward trend, peaking above 27.25% around 2021. However, this peak is followed by a sharp decline in 2022, where the share drops back to approximately 26.25% by 2024. The PEPP share, introduced in 2020, initially fluctuates but then stabilizes around 26.5% by 2022. There is a period of volatility in both shares between 2021 and 2022, reflecting shifts in the allocation strategy.

[6] We download data for the PSPP programme at this link https://www.ecb.europa.eu/mopo/implement/app/html/index.en.html#pspp. We download data for the PEPP at this link https://www.ecb.europa.eu/mopo/implement/pepp/html/index.en.html.

[7] There are three waves of capital key changes. The change from 2013 to 2014, from 2018 to 2019, and from 2023 to 2024, which are available, respectively, in the following: https://www.ecb.europa.eu/press/pr/date/2014/html/pr140101_1.en.html, https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.pr231221~173a7ba501.en.html, and, https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.pr231221~173a7ba501.en.html

For Italy, the PSPP share starts near 18% in 2016 and initially trends upwards, reaching just under 19% by 2020. However, from 2021 onward, the share declines steadily, falling below 18% by 2024. The PEPP share, introduced around 2020, rapidly increases to over 21%, showing a significant deviation from the PSPP share. However, by 2022, the PEPP share begins to decline, stabilizing near 19% by 2024.

In France, the PSPP share begins close to 20% in 2016 and gradually increases, reaching around 22% by 2020. The share remains relatively stable around this level until 2024, with only minor fluctuations. The PEPP share, which starts around 2020, sees a rapid increase, aligning closely with the PSPP share by 2021 and then stabilizing around 20% by 2024. The stability in both shares indicates a consistent allocation strategy throughout the period.

In Spain, the PSPP share begins around 12.0% in 2016 and rises steadily, peaking around 13.4% by 2020. However, from 2021 onwards, the share declines, dropping below 13.0% by 2024. The PEPP share, introduced in 2020, shows a steep initial decline, reaching near 12.4% before recovering and stabilizing around 12.8% by 2024. The fluctuations in the PEPP share, particularly in 2021, indicate significant adjustments in the purchase program during that period.

Purchases as Share of GDP We compute the total net purchases in each country as share of the national GDP. The results are reported in Figure 9a. We also use data from SHS and download the total stock of holdings of government bonds by the ECB and compute the value as share of GDP for each country. This is a notion of stock. The data are only available starting in 2021 and are presented in Figure 9b.

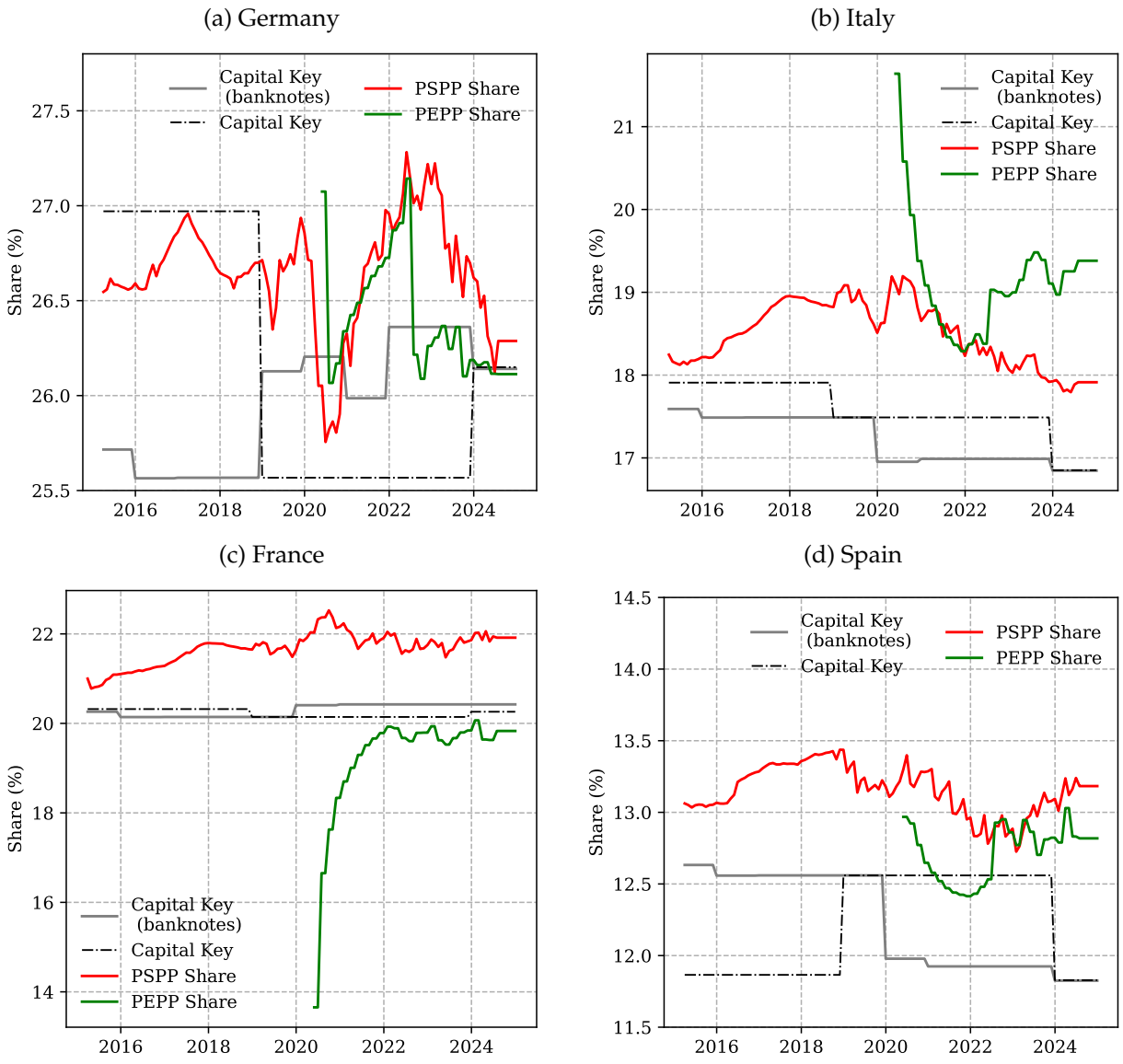
By comparing the SHSS data and the balance sheet data, the debt securities holdings under ECB's balance sheet consists of more than 50% of Italian debts. The ECB's holding of German public debt should be minimal if not zero.

D Consolidated Balance Sheet

I do not think we need this section anymore

For a comprehensive view, consider the consolidated balance sheet in major countries in Euro Area (EA). The consolidated balance sheet include central government, local government, public pension (social security) and central bank. Other than the balance sheet of NCBs, the balance sheet data can be obtained from the flow of funds in Euro Stat. The Euro-Stat flow of funds does

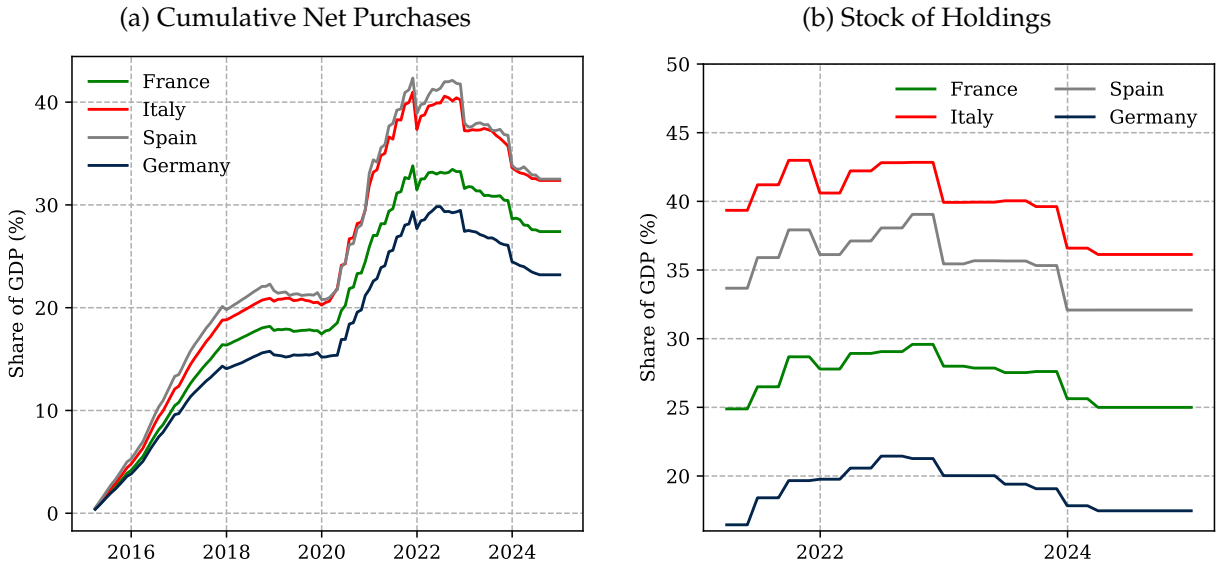
Figure 8: Purchases versus Capital Key



NOTE: Source: Bloomberg, ECB, Annual reports of central banks and Authors' calculation

provide the balance sheet data for NCBs. However, the information of several specific items involving lending and borrowing among NCBs and ECB in the Intra-Eurosystem is missing in the flow of funds data. Two of the largest items are claims related to Target2 and "other operational requirements within the Eurosystem". These specific items are lumped into the category of "currency and deposits". Moreover, the balance sheet of ECB is missing in the flow of funds data. As explained in the main context, the Target2 balance can be thought as the foreign reserve within Eu-

Figure 9: Purchases as Share of GDP



rosystem, reflecting the cumulative balance of current account as well as financial account given the nominal exchange rate is fixed at 1. The claims related to "other operational requirements within the Eurosystem" can be view as banknote.

We then separate these two terms from F2 in the flow of fund data when we consolidate the balance sheet. The F2 in the asset side item includes:

- central bank long term lending : Lending to euro area credit institutions related to monetary policy operations denominated in euro
- Target2 account assets and claims related to other operational requirements within the Eurosystem

The F2 in the liability side item includes:

- central bank long term lending : Lending to euro area credit institutions related to monetary policy operations denominated in euro
- Target2 account assets and claims related to other operational requirements within the Eurosystem

E Data

E.1 The Primary Surplus

- Look at the primary surplus or deficit among Euro area, especially in the Spain, France, Germany and Italy.

E.2 The Data Source

- Available both at ECB and Euro Stat.
- The Euro Stat one in Euro Stat is easier to access and have more complete information. It covers more countries, longer time span and more details.
- The data reported from ECB and Euro Stat are consistent to each other, which indicates the same data source.
- the Euro Stat data is available at https://ec.europa.eu/eurostat/databrowser/explore/all/economy?lang=en&subtheme=na10&display=list&sort=category
- There are additional Data for central bank balance sheet from ECB
  - Starting year 2016, ECB reported tow additional balance sheet data among the national central banks (NCBs) and ECB in Euro Area
  - One is called "accounting balance sheet" or "ECB and NCBs contributions to the consolidated financial statement of the Eurosystem", which is available at https://www.ecb.europa.eu/press/pr/wfs/dis/html/index.en.html
  - The other is called "statistical balance sheet" or "ECB and NCBs contributions to the Eurosystem statistical balance sheet", which is available at https://data.ecb.europa.eu/publications/money-credit-and-banking/3031819
  - Documents for the relationship between accounting balance sheet and statistical balance sheet: https://www.ecb.europa.eu/pub/pdf/other/bridgingtables201607.en.pdf and https://www.ecb.europa.eu/press/pr/wfs/shared/pdf/disaggregated_explanatory_note.en.pdf

F Consolidated Balance Sheet Appendix

However, the format of financial statements among ECB and NCBs differs from the structure of the balance sheets of general government presented in the flow of fund data. This difference impose some difficulties to consolidate these balance sheet. In addition, there are some other methodological differences, such as the net position versus gross positions (see https://www.ecb.europa.eu/press/pr/wfs/shared/pdf/disaggregated_explanatory_note.en.pdf)

Luckily, we are still able to identify and match the items between these two data set. The detailed mapping rule between these two data set are reported in the Appendix F

We reclassified the balance sheet items from the financial statement of ECB and NCBs into the categories of financial asset in the flow of fund data. On the asset side, here are the mapping rules we adopted.

1. Gold and SDR: Gold and gold receivables and Receivables from the IMF
2. Loans: Lending to euro area credit institutions related to monetary policy operations denominated in euro
3. Currency and deposits: Foreign Assets and Intra-Eurosystem assets, which include claims equivalent to the transfer of foreign reserves, claims related to TARGET2 and correspondent accounts (net) and claims related to other operational requirements within the Eurosystem.
4. Debt Securities: Securities held for monetary policy purposes, which is decomposed into national debts and other debts.

On the liability side, here are the mapping rules we adopted.

1. Currency: Banknotes in circulation
2. Transferable deposits: Lending to euro area credit institutions related to monetary policy operations denominated in euro
3. Currency and deposits: Liabilities to euro area credit institutions related to monetary policy operations denominated in euro, Liabilities to other euro area residents denominated in euro (includes general government), and Intra-Eurosystem liabilities, which include liabilities equivalent to the transfer of foreign reserves, liabilities related to TARGET2 and

correspondent accounts (net) and liabilities related to other operational requirements within the Eurosystem.

4. Equity: Revaluation accounts and capital and reserves

G Validation of our Income Pooling Formula

Many NCBs such asBundesbank and Banca d'Italia do not offer an item-by-item decomposition for net income transfer as a result of pooling. In general, income statements of these NCBs only list the item-by-item income before pooling. The net result of income pooling is only reported in an aggregate level, the one summing across all balance sheet items. Hence, we cannot verify our formula for these countries because of the lack of details in public available data. One exception is Banco de Espana, which does report a breakdown of the pooling of monetary income by different balance sheet items. Table 7 offers a snapshot of the income pooling decomposition in 2022. The first panel lists the before-pooling income for each item, which are generally available for most NCBs. The net income result of pooling, shown in the middle panel, are often not available for other NCBs. The sum of the first and second panel is then the income after pooling. Hence, we can then compare Table 7 item-by-item to our income pooling formula, equation (2).

The comparison shows that Table 7 is consistent with the prediction of our formula. The after-pooling income on Target2 and IntraEurosys-Banknotes are relatively small, approximately 8% of the before-pooling income. The 8% roughly matches the capital key of ECB and confirms our formula that the non-zero pooling income is the result from the income payment or expense from ECB to NCBs and not among NCBs. The Banco de Espana does not decompose national debt securities and other debt securities, which apply different pooling rules. Instead, it only reports the pooled and unpooled debt securities income. As shown in the Table 7, most of the debt security income is non-pooled. This is also consistent with the fact that most debt securities held by NCBs are their own national debt and the associated income is barely pooled. The income of debt securities other than national debt, such as Supranational bonds and non-public debt securities, are fully pooled according to our formula. Nevertheless, the purchase share of other securities is relatively small. For the bank lending and bank reserves, their income is fully pooled. The sign of the net pooling result indicates its net position relative to its capital key share of the aggregate NCB position. The negative net pooling result of bank reserves, 197 million euro, implies that the Banco de Espana issue less than its capital key share on bank reserves and hence need to chip in

Table 7: Banco de Espana Income Pooling Decomposition

2022 Year End	Before Pooling	Net Result of Pooling	After Pooling
Pooling Items			
Bank Lending	−1453.51	197.18	−1256.34
Pooled Debt Securities	926.13	−219.71	706.42
Bank Reserves	−530.01	−248.28	−778.29
IntraEurosys Banknotes	1007.95	−1095.67	−87.73
IntraEurosys Target2	−2771.29	3019.95	248.67
Non-Pooling Item			
FX	1052.83		1052.83
Non-Pooled Debt Securities	5613.53		5613.53

Unit: Million Euro. Source: Banco de Espana 2022 annual report.

the cost of bank reserves held by other NCBs. The negative income generated by bank lending can be viewed as part of the subsidy to the Spanish banking sector from Banco de Espana, which is classified as within-country transfer. However, because of the income pooling, part of the subsidy can be transferred to or from other NCBs. In the case of Spain, the bank lending subsidy came from other NCBs since its net pooling result is positive.

H Calculation of Target2 Rate

We calculate the Target2 interest rate through a series of steps. First, we download par yield rates for various maturities for each country from Bloomberg. For each country and maturity, we then compute the average yield for each year. Next, we determine the weighted average duration of outstanding bonds for each country on an annual basis. To do this, we use the duration data from the ECB's PSPP programme, which are publicly available on their website. The PSPP programme is designed to be market-neutral, with purchases reflecting the outstanding bond amounts. Since these data are only available starting in 2015, we assume that the duration for the earlier years in the sample matches the duration observed in 2015. We then interpolate the yield curve for each country in each year and compute the implied yield at the calculated duration.

We download the Target2 balances from the ECB website. We then sum the negative balances across all countries to calculate the total amount of negative balances. For each country with a negative balance, we determine the share by dividing the country's balance by the total negative

balances.

In the final step, we compute the weighted average of bond yields, using the shares in the negative balance as weights. The yield used is the annual representative bond yield for each country.