The term structure of interest rates in a heterogeneous monetary union

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Large-scale asset purchases have been a crucial monetary policy tool in recent years, when many central banks' policy rates were close to their effective lower bound, with limited space to provide further support for the economy. The ECB launched its asset purchase programme (APP) to address the risks of a prolonged period of low inflation, and its pandemic emergency purchase programme (PEPP) in response to the Covid-19 crisis. While net purchases under the APP and PEPP have now ended, it is important to draw lessons for the future from this recent experience. This note calibrates a structural model of sovereign yield curves in a heterogeneous monetary union, to shed light on the PEPP's transmission channels and to analyze how its flexible design affected its impact.[1]

MODELLING DURATION RISK AND DEFAULT RISK

The model extends the term-structure model of Vayanos and Vila (2021), which underpins much recent analysis of quantitative easing programs.[2] Their framework assumes that financial market participants include both *preferred-habitat investors,* who demand bonds of a specific maturity and/or issuer, and risk-averse *arbitrageurs,* who invest wealth across all bond markets, trading off expected returns versus risk. In this environment, net bond issuance by the government raises yields, while bond purchases by the central bank lower them, by expanding or shrinking the term premium, respectively.

Extending the Vayanos-Vila model to the euro area requires us to consider *default risk* as well as the term risk emphasized in US analyses. We endogenize the default probability under the assumption that some member state governments may be hit by debt rollover crises. A government may decide to default in order to relieve the near-term fiscal pressure it faces when creditors refuse to roll over its bonds.[3] A higher deficit or a higher flow of bond redemptions raises fiscal pressure, increasing the default probability. However, bond redemptions to the Eurosystem generate less fiscal pressure than those of privately held bonds, since redemptions paid to a national central bank largely return to the corresponding government as dividends. In this way, Eurosystem asset purchases reduce future fiscal pressure, and thereby the default probability.

Allowing for default risk, the model implies that the yield on a bond of residual maturity τ incorporates two familiar terms – the *expected future interest rates* component and the *term premium* – plus two additional components:

— the *expected default loss,* which is the expected loss of yield due to possible default over horizon τ;

— and the *credit risk premium,* which is the additional return required, beyond the expected default loss, to compensate arbitrageurs for the risk in realized yields due to the possibility of default over horizon τ.

CALIBRATION

To understand the channels of asset purchase transmission, it suffices to study a monetary union with just two member states. Here we calibrate the model to Germany and Italy, allowing for default risk on Italian but not German bonds.[4] Therefore the last two yield components mentioned above are zero for German bonds, which allows us to estimate arbitrageurs' risk aversion by matching the mean German term premium over the pre-pandemic period 2013-2019.

1 See J. Costain, G. Nuño, and C. Thomas (2022), "The term structure of interest rates in a heterogeneous monetary union", Documento de Trabajo 2223, Banco de España.

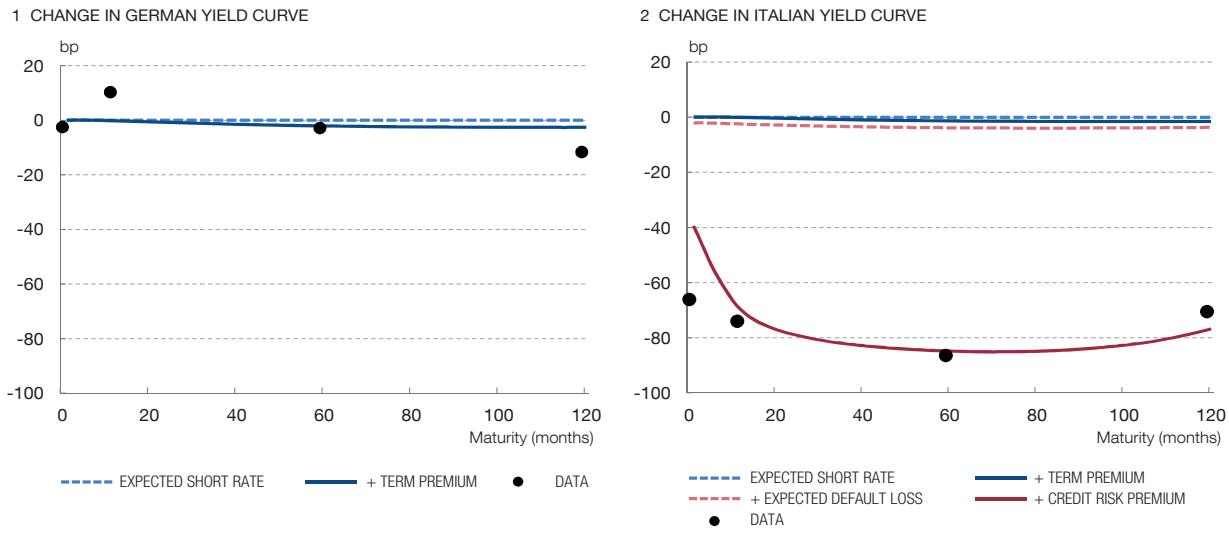
2 D. Vayanos and J.-L. Vila (2021), "A preferred habitat model of the term structure of interest rates", *Econometrica,* 89 (1), pp. 77-112.

3 The model implies that the government's default probability depends on its expected net outlays over the duration of a rollover crisis, which we call *fiscal pressure.*

4 Parameter estimates and model fit are similar if the model is instead calibrated to Germany and Spain.

Figure 1

DECOMPOSITION OF THE IMPACT OF PEPP ANNOUNCEMENT BETWEEN 18-20 MARCH



SOURCE: Datastream.
NOTES: Change in yields after PEPP announcement, in basis points: data and model.
DOTS: Change in annual yields on zero-coupon bonds, from March 18 to March 20, 2020, for 1m, 1Y, 5Y and 10Y maturities.
LINES: Model-generated decomposition of shift in yield curves. Source: Costain et al. (2022).

To match Italian yields we must estimate two more key parameters, namely, the level and slope of the default probability, as a function of fiscal pressure. We jointly identify these parameters by matching the average Italian yield curve over the pre-pandemic period, and the shift in Italian yields when PEPP was announced. Given these parameters, together with arbitrageurs' risk aversion, we can then ask how much of Italy's sovereign spread actually reflects expected losses due to default, as opposed to the market's required compensation for the risk associated with default (the *credit risk premium)*.

A central finding of this exercise is that a tiny quantity of default risk suffices to generate a large sovereign premium. The reason is that German bonds are very safe, so explaining the 50bp term premium that we find on ten-year Bunds over 2013-2019 implies that arbitrageurs are fairly risk averse. Applying our risk aversion estimate to the Italian market, an expected default loss of only 10bp on Italian ten-year bonds suffices to explain the observed 200bp sovereign premium on those bonds.

THE DEFAULT RISK EXTRACTION CHANNEL

With this calibration in place, we can simulate the impact of the initial PEPP announcement, on March 18, 2020, which allocated a total envelope of €750 billion for asset purchases up until December of that year. Figure 1 shows how the model fits the impact of the PEPP announcement (the change in yields from market close on March 18 to market close on March 20). Following the announcement, the German term premium decreased slightly, and the Italian yield curve shifted downwards in a roughly parallel but slightly convex fashion, which the model matches well.

The model decomposition shows that the credit risk premium accounts for the largest share, by far, of the decline in Italian yields. Hence, term premium movements caused by duration risk extraction, emphasized in US studies, were not the main transmission channel for the PEPP announcement. The relevant channel is better described as *default risk extraction.* Under this mechanism, Eurosystem peripheral purchases reduce the quantity of defaultable

bonds that private investors must absorb; at the same time, they reduce future fiscal pressure on peripheral governments, decreasing the default probability itself. These two effects reinforce each other to jointly shrink the credit risk premium.

The tiny decrease in the expected default loss – just three basis points – is seen in the right panel of Figure 1 as the distance between the dashed and dashed-dot lines. But the expected loss from default was already small *ex ante,* and the associated risk is highly priced, so a small reduction in this component contributes materially to the much larger decrease (around 70 to 80bp) in the credit risk premium.

FLEXIBILITY AND EFFECTIVENESS OF ASSET PURCHASES

Our structural model also helps assess possible changes in the design of asset purchase programmes. A novelty of the PEPP's design was that purchases were allocated flexibly over time and across jurisdictions. In contrast, the APP stipulated a constant pace of purchases, to be allocated in proportion to national central banks' shares in the ECB's capital. Simulating a hypothetical programme with the envelope of the PEPP but the design of the APP, we find that PEPP's flexibility generated an additional 15bp decrease in Italian yields, attributable both to frontloading over the first months, and reallocation towards Italy. Meanwhile, for German yields, following the PEPP design rather than the APP design is quantitatively irrelevant.

Given the quantitative importance of the default risk extraction channel, reallocating purchases towards jurisdictions that are vulnerable to sovereign default enhances their impact, both on those jurisdictions' sovereign yields, and on average euro area yields. But this does not imply that the Eurosystem actually faces a large expected sovereign credit loss in its balance sheet. On the contrary, by absorbing a small credit risk that would otherwise remain in private hands, asset purchases improve market functioning, both by endogenously decreasing the default probability on sovereign bonds, and by reducing the large credit risk premium that risk-averse private investors would demand to hold those bonds themselves.

The default risk extraction channel implies that flexible asset purchases are more effective. Flexibility may be particularly useful to combat unwarranted fragmentation, that is, disruption to the smooth transmission of the single monetary policy to all euro area jurisdictions, as occurred in the early stages of the pandemic crisis. This lesson may prove valuable going forward, during the unwinding of the Eurosystem's existing balance sheet.