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Designing euro area QE: Eggertsson and Woodford meet Mundell

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"The problem with QE is it works in practice but it doesn't work in theory." (Ben Bernanke)

"…Let me start by saying that each monetary policy operation always has some fiscal implication…Usually, these fiscal implications are dealt with easily within a one-country framework, between the central bank and the treasury. But in the euro area, there is no European treasury…" (Mario Draghi)

Background: *This sketch is motivated by the decision of the ECB from January 2015 to expand its asset purchase programme to include purchases of public sector securities. The sketch addresses generic issues concerning the design of such purchases in a monetary union. Details of the decision are summarised in Appendix II at the end of this sketch.*

The recent decision of the ECB to launch large scale purchases of sovereign bonds in the euro area (for short: EA QE) is subject to an ongoing controversy. Some observers argue that owing to this decision the ECB has finally turned into a mature central bank, making full use of a tool routinely used by many central banks to avert deflationary threats. Others argue that this decision may be largely ineffective in an environment of very low – and for a sizable class of assets already negative – yields. Again others argue that the decision has detrimental long-run consequences, not least because it violates crucial incentive compatibility constraints that are at heart of the special architecture of the euro area.

This sketch argues that EA QE meets scepticism (and in some camps open resistance) for two distinct and conceptually different reasons. To disentangle them is important in order to establish a *design for EA QE* that is internally consistent and, looking ahead, compatible with a comprehensive set of tools and policy options, embracing future euro area contingencies that go beyond the narrow motivation of QE.

- First, EA QE may be *ineffective* for reasons that are not specific to the euro area. In particular, it is well known from standard macroeconomic theory for single economies that purchases of sovereign debt may precisely become ineffective when short-term nominal

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interest rates have reached the (near-zero) lower bound. This canonical general equilibrium result is due to Eggertsson and Woodford (2003), below, for short, labelled as EW-result. It is the reference point to which the above quote from Ben Bernanke alludes.[2]

- Second, EA QE may be *inacceptable* to the extent that it relies on the pooling of outright sovereign risks. If done in this way EA QE introduces, in a sense, Eurobonds through the backdoor, placed on the Eurosystem balance sheet. For many observers such policy option is not feasible, because it violates the spirit of the no-bail-out clause, one of the cornerstones of the euro area architecture.

This sketch argues that it is possible to adhere to the second criticism, without compromising on the monetary policy intention of the envisaged measures, if EA QE is designed with adequate risk-sharing. The adequate amount of risk-sharing can be naturally derived from the current allocation of fiscal responsibilities in the euro area. Currently, these responsibilities are firmly anchored at the national level. At the same time, the first criticism can be addressed in ways that are known from the literature dealing with single economy issues, provided EA QE is considered sufficiently effective at current levels of already very low yields.[3]

The reminder of this sketch is structured as follows. Section I sets the stage and summarises some (stylised) characteristics of the euro area. Section II summarises non-technically the logic of the EW result concerning the ineffectiveness of monetary policy in a single economy, once the lower bound on nominal interest rates has been reached. For simple exposition, the lower bound is assumed to be zero. Section II also briefly sketches a channel on how to overcome this result via signalling effects, mimicking forward guidance. Section III reconsiders this logic in a simple and stylised monetary union with a single monetary policy and many, non-coordinated fiscal policies, decided at the national level. Governments of member countries issue sovereign debt with potentially different characteristics. It is argued that in such stylised environment the (in)effectiveness of monetary policy, in the sense of EW, can be separated from cross-country distributional considerations if purchases of government debt are conducted according to no-risk-sharing. Section IV extends the reasoning to an environment characterised by negative yields, thereby relaxing the *zero*-lower-bound (ZLB) assumption. Section V offers some modifications and extensions, including a discussion of the appropriate portfolio composition (in terms of country-specific debt to be purchased by the common central bank). Moreover, it introduces the notion of EA QE with adequate risk-sharing. Finally, Section VI contains selected remarks on how to conceptualise EA QE from a broader

[2] To be distinguished from closed economy issues, QE has an open economy dimension, related to exchange rate effects vis-à-vis the rest of the world. Empirically, this dimension is likely to be relevant for the euro area. Conceptually, since the euro area is *not* a small open economy, it is difficult to argue, however, how this channel could be systematically used. The effectiveness of this channel relies on a beggar-thy-neighbour element, raising issues of international monetary policy coordination not covered in this sketch.

[3] In this spirit, see, for example, Woodford (2012). For a sceptical perspective on standard QE, stressing aspects related to excessive risk-taking and boom-bust-cycles in financial markets, see, in particular, various studies from the BIS, like BIS (2013/14). Moreover, euro area specifics, like the bank-based nature of the financial system, need to be covered in a comprehensive assessment. This sketch does not address these issues, i.e. pros and cons of QE in the euro area beyond the (resurrected) EW-result.

perspective. Specifically, it offers thoughts on how to complement EA QE (which is motivated by area-wide developments) with country-specific policy options and tools, taking the current degree of incompleteness of the euro area as given. The section includes remarks on country-specific accommodation, the relative competitiveness of member states within the euro area, and sovereign default. In a sense, this section indicates how Eggertsson/Woodford (2003) meets Mundell (1961). Such broader perspective is needed if one wants to see how it is possible to maintain and, in some cases, how to resurrect needed distinctions between monetary and fiscal policies in the euro area.

I Euro area QE: stylised institutional features and policy challenges at the ZLB

I.1 Architecture of the euro area

The euro area is a monetary union with a unique architecture, characterised by a single monetary policy and many largely decentralised non-monetary policies. This is particularly relevant for the fiscal policies of the 19 member countries. In the absence of strongly coordinated (let alone perfectly integrated) fiscal policies, the euro area is an incomplete monetary union, with an architecture that is prone to lead to suboptimal (i.e. Nash) equilibrium outcomes. As pointed out by Chari and Kehoe (2008), free-riding incentives in such environment are generic.[4] As a result, the single monetary policy is systematically 'invited' to mitigate suboptimal outcomes for which it is not responsible in the first place, reflecting the incomplete architecture of the euro area.

This strategic vulnerability of the euro area has long been recognised. In the area of fiscal policies the crucial framework which is supposed to provide the necessary checks and balances is given by the (various vintages of the) Stability and Growth Pact.[5]

Moreover, the no-bail-out clause acts as a complementary disciplining device, stressing the importance of marked-based discipline, since peer pressure and attempts to subject member countries to commonly agreed rules are likely to be insufficient. Ultimately, market-based discipline leads to questions concerning sovereign default.[6]

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[4] Similarly, see Uhlig (2003). The generality of the results established by Chari and Kehoe (2008) are re-emphasised by Kempf and von Thadden (2013) for a broad class of models.

[5] Evidently, this problem is not confined to fiscal policies, see, e.g., the agenda underlying the European semester, the macroeconomic surveillance procedure, and the creation of the banking union.

[6] Going back to the founding documents of EMU, it is clear that one way to make the euro area a more complete monetary union proceeds through deeper political integration, including the establishment of a fiscal union with centralised budgetary decision-making at the union level. As an alternative, advocates of a monetary union without a fiscal union claim that completeness can be established via the mechanism of sovereign default. Under current circumstances, the costs and benefits associated with the activation of this mechanism are controversially discussed, reflecting the absence of an orderly mechanism to restructure debt and in view of incomplete euro area financial markets, characterised by limited risk-sharing capacities, fragmentation along country lines, and inconsistent regulation (like the classification of government debt as a risk-free asset of banks). From either of the two perspectives, the euro area is currently an incomplete monetary union. The US is an interesting example of a complete monetary union which combines both perspectives, i.e. there exists a sizeable federal budget and a regime of binding balanced-budget rules at the level of states.

I.2 Monetary policy challenge: too low inflation for too long

Currently the euro area faces the formidable challenge that there is a risk that area-wide inflation may be too low for too long a period of time. In a worst case scenario the Eurosystem may slowly slide towards a situation in which it will not be able to deliver on its primary objective. Not because of inflation that is too high, but rather too low. This constellation is not without curiosity because the design of the EA architecture was primarily concerned with institutional safeguards related to the opposite scenario.

To maintain price stability in such environment may require the adoption of further unconventional measures, given that the ECB's policy rates have effectively reached the lower bound. In line with the (diverse) examples set by the Fed, the Bank of England and the Bank of Japan, it seems natural to argue that the adoption of large-scale asset purchases, including sovereign debt, is the dominant option that is left if the inflation outlook does not improve. For short, QE is on the agenda.

I.3 Clash of two principles at the lower bound on nominal interest rates?

The option of QE, for some observers, violates the rule on the prohibition of monetary financing. However, under current circumstances such sweeping assessment lacks appeal since the prohibition of monetary financing arguably serves the purpose to protect the central bank against bad fiscal policies that lead to inflation rates that are too high. Currently, broad-based purchases of sovereign paper are unmistakably motivated, however, by the intention to prevent the opposite scenario, namely the realisation of inflation rates that are too low for too long, possibly even negative on a sustained basis: preventing deflation requires actions that are fundamentally different from preventing excessive inflation. Nevertheless, it seems possible to address remaining skepticism if EA QE is designed such that, in particular, it will be phased out as soon as euro area inflation will have been lifted to inflations rates consistent with the ECB's definition of price stability.

This does not mean, however, that the design of EA QE can ignore free-riding incentives between governments which are at the heart of the no-bail-out clause. The medium term consequences of such ignorance may well be devastating. The logic of Chari and Kehoe (2008) is general. It does not stop at asymmetric policy options concerning the role of government debt purchases that may contribute to prevent very low inflation (or even deflation) as opposed to high inflation and that can be rationalized in a context of single monetary and fiscal policies.

In other words, the euro area cannot copy QE as conducted in single economies (i.e. nation states or strongly integrated monetary unions with elements of centralised budgetary decision-making at the union level). The euro area can at best introduce some notion of EA QE that takes the current incompleteness of the euro area architecture seriously.

To emphasise what is at stake, it helps to recall that the euro area has been organised around two major stylised principles:

i) The single monetary policy has been given a narrowly defined mandate, organised around the primary objective to maintain price stability for the euro area as a whole. There is some flexibility due to the medium term qualification, but a lasting failure to deliver inflation in line with this objective clashes with the ECB's mandate.

Moreover, the singleness of monetary policy has meant that standard monetary policy operations are typically conducted via full-risk sharing.[7] Arguably, this feature makes the euro area different from a currency board and its monetary policy more effective.

ii) The no-bail-out clause organises the relationship between euro area governments in the absence of a single fiscal policy. It respects that, for the time being, decisions which concern the budgets of euro area governments are firmly anchored at the national level. In substance it states that sovereign debt issued by a national government constitutes a liability to be backed by tax revenues collected in this country. It creates no obligation for other governments to back it through their own resources. Moreover, governments have so far ruled out to rely on joint issuances of mutualized government debt (i.e. they refuse to pool sovereign risks).[8]

EA QE, to the extent that it involves purchases of sovereign bonds, is a tool where both principles seem to clash, because it takes deliberately outright sovereign risks on the euro area balance sheet, unambiguously motivated, however, by the monetary policy intention of the ECB to fulfil its mandate.[9] It's hard to see how EA QE could satisfy both principles at the same time. It seems there is no simple way out.

The reminder of this sketch argues that an appealing solution can be found, once it is recognised that the design of EA QE involves a number of additional parameters (which do not matter for the design of standard QE in single economies). In particular, Eurosystem outright purchases of government bonds should be done with adequate risk-sharing, corresponding to the current allocation of fiscal responsibilities in the euro area. This solution will not reduce the effectiveness of government bond purchases from a monetary policy perspective. At the same time, it will respect the fiscal incentive structure, commensurate with the current degree of incompleteness of the euro area. For short, for marginal monetary policy operations specific to the lower-bound-environment the solution has the potential to provide stimulus (to the extent that QE can be effective) and, at the same time, to preserve incentive considerations embodied in the no-bail-out clause. Moreover, the solution will be naturally facilitated by the fact that the NCBs have typically remained well capitalized (and created buffers) after the adoption of the common currency.

II (In)effectiveness of QE at the ZLB: single economy

The EW-result is a general-equilibrium result that applies to a broad range of dynamic macro models. Its status is comparable to the Modigliani-Miller result on the irrelevance of the financing

[7] As concerns non-standard operations there are some exceptions, like the initial two packages of covered bond purchases.

[8] Mutualized government debt implies that at least in some states of the world losses will have to be shared ex post, implying a transfer of resources from solvent to defaulting member countries.

[9] This sketch takes for granted that any monetary policy action has fiscal implications, in line with Hellwig (2015) and Uhlig (2015). In most simple terms, such implications cannot be avoided since any change in the central bank's policy rate tends to affect the interest rate burden paid the government. Moreover, an independent central bank should not feel constrained by these implications. Having said this, outright purchases of government bonds in a monetary union are associated with risks and incentive effects that go beyond this channel.

structure of firms in finance.[10] In practice, the EW-result may be wrong, but it is a compelling starting point to see why it is such a formidable task to make monetary policy at the ZLB effective. The following *sketch* stresses, in particular, fiscal aspects, taking for granted, however, that for a description of a general-equilibrium result many alternative narratives can be used.

Consider a closed economy with a single central bank and a single government.[11] As a starting point, it is assumed that there exist one- period risk-free government bonds, which carry a nominal interest rate (labelled as i^B), assumed to be non-negative. Monetary policy is exclusively implemented via outright purchases or sales of government debt against money.[12] 'Money' refers to base money which is directly controlled by the central bank and which is assumed to carry a zero interest rate.[13]

Step 1: Effectiveness of QE at a positive interest rate ($i^B > 0$)

- Assume prices are flexible. Moreover, assume the central bank buys additional government debt from the private sector in a situation of a positive interest rate ($i^B > 0$). Such purchase is typically effective, in the sense that it affects the real economy. Why? The purchase replaces within the private sector an asset that commands a positive interest rate (i.e. the bond) against an alternative asset (i.e. money) that commands a non-pecuniary return.[14] These marginal purchases drive up the price of government debt and, correspondingly, lower the interest rate. Hence, the private sector, ceteris paribus, is willing to accept this exchange via a portfolio adjustment away from bonds towards increased holdings of money. Moreover, this exchange reduces the interest burden of the government. Why is this? The government now has an interest obligation to the central bank which can be returned, one-to-one, to the government via seigniorage. Hence, what used to be an interest rate burden of the government against the private sector is now netted out in the consolidated budget constraint of the public sector. Ceteris paribus, this frees up resources, making the exchange of assets effective. In particular, the effectiveness does not require a change in fiscal policies.[15]

[10] In line with this assessment, the EW-result is a manifestation of the general equilibrium reasoning summarised by Wallace (1981).

[11] Issues pertaining to open single economies are not addressed in this sketch. For a discussion of this case, involving exchange rate issues, see, for example, Svensson (2003) or Coenen and Wieland (2004).

[12] This assumption is in line with the taxonomy provided by Goodfriend (2011) in his generic discussion of traditional practices of US monetary policymaking.

[13] Section III extends this reasoning by allowing for the possibility of sovereign default, implying that government debt is not any longer risk-free. Section IV relaxes the assumption of a zero interest rate on money and considers negative yields.

[14] The non-pecuniary return of money (sometimes also called the convenience yield) typically reflects features pertaining to the superior ability of money to facilitate transactions. The special characteristics of money are backed by its role as a legal tender.

[15] This is most easily seen under the assumption of distortionary regular taxes. Under lump-sum taxes, the effects are limited to an adjustment towards optimal values of real balances. Note that the sketch so far is in line with proofs of the

- Assume nominal prices are rigid, adjusting to changes only with some delay. Then, the effectiveness of monetary policy implies that it has a stimulating effect, i.e. the reduced nominal interest rate translates into a reduced *real* interest rate which will act expansionary through positive demand effects.

Step 2: Ineffectiveness of QE at the ZLB ($i^B = 0$)

- Assume prices are flexible. Moreover, assume the just considered central bank purchases of government debt have driven the nominal interest rate to zero. This is the same as to assume that the expansion of the money stock has driven the non-pecuniary return attached to money to zero because of its sufficient abundance. Then, any further purchases of government debt will be ineffective, since money and government debt have become perfect substitutes.[16] Correspondingly, the interest rate burden of the government cannot be reduced any further, i.e. no additional resources could be freed up. Hence, effectiveness requires a change in fiscal policies, but not any further monetary action.[17]

- Assume nominal prices are rigid. Then the ineffectiveness of monetary policy implies that it cannot have any stimulating effect, i.e. the binding ZLB constraint prevents reductions in the real interest rate that would be required for monetary policy to be expansionary.

Step 3: Overcoming the ineffectiveness of QE at the ZLB

Is there nevertheless a way to restore effectiveness? A compelling way out is to borrow stimulus from the future (i.e. from a period when the ZLB constraint will no longer be binding) via intertemporal substitution, based on anticipation effects and the belief that the central bank is willing to commit to such future action. This is what forward guidance is about. It is difficult to implement because of the commitment aspect (which suffers from time inconsistency). Yet, in practice (which deviates in various ways from the assumptions underlying the EW world), there are some proxies for this: in particular, central bank purchases of long-term government debt may act as a certain substitute for forward guidance, because through such purchases the central bank deliberately exposes its own balance sheet to interest rate risk. In other words: future increases in the interest rate, via central bank sales of government debt, come together with accounting losses

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optimality of the Friedman rule under flexible prices (calling for $i^B = 0$), as given, for example by Chari, Christiano and Kehoe (1996).

[16] High-powered money is a non-redeemable liability. Because of this feature, the inter-temporal budget constraint of the government will be relaxed if the central bank says that it will hold the purchased debt forever. If such commitment is credible this will modify the sketched ineffectiveness result via anticipation effects, as stressed by Auerbach and Obstfeld (2003). Similarly, see Giavazzi and Tabellini (2015). From the fiscal perspective stressed in this note, this reasoning reflects that possible future roll-over problems, associated with the debt service of the government, will be avoided if the private sector believes that the additional money will permanently replace private holdings of government bonds.

[17] Changes to fiscal policies would have a particularly strong effect on prices if they generate a switch to active (or non-Ricardian policies), reflecting the logic of the fiscal theory of the price level. Under this logic appropriate changes in the price level re-establish the sustainability of fiscal policies via revaluations of outstanding nominal government debt in real terms. Recently on this in the euro area context, see Sims (2014).

on the remaining bonds held by the central bank. This may act as a signal that the central bank has no intention to prematurely increase the interest rate in the first place.

III (In)effectiveness of QE at the ZLB: monetary union

Consider a monetary union, with a single central bank and many governments in charge of national fiscal policies. There exist many one-period government bonds, carrying not necessarily identical nominal interest rates (labelled as i_k^B, denoting the interest rate on government debt in some representative country *k*). Monetary policy is exclusively implemented via outright purchases or sales of portfolios of these government bonds by the common central bank, with sub-ordinated national central banks acting as technical agents with expertise to buy government bonds.

III.1. EA QE without income sharing (abstracting from the possibility of sovereign default)

For simplicity, let us ignore initially the possibility of default. If all member countries were identical, nothing would change (in comparison with Section II). But assume countries are different, in the sense that country-specific risk-free interest rates of type i_k^B are different because, e.g., of different liquidity premia.

Assume central bank income (i.e. the interest income of the central bank on its portfolio of national government bonds) is not shared, but rather rebated according to its national source via the national central banks to the respective government. Such rule of no income-sharing essentially replicates the steps described in Section II – now, however, not for a single country, but for many countries in parallel. *What is important for the replicability of the result is that under no-income sharing the budget constraints that are relevant for national governments remain separated*.

Step 1: Effectiveness of QE at a positive interest rates ($i_k^B > 0$, everywhere)

- Assume prices are flexible. Moreover, assume the central bank buys a portfolio of additional national government bonds from private sector members in a situation of a positive interest rate everywhere ($i_k^B > 0$, everywhere). These marginal purchases drive up the price of government debt and, correspondingly, lower the interest rate everywhere. Hence, in all member countries the private sector, ceteris paribus, is willing to accept the additional injections of money via a portfolio adjustment away from bonds towards increased holdings of money. Moreover, this exchange reduces the interest burden of the government in every single country. The reason for this is that now each government has an interest obligation to the common central bank which it receives back, however, one-to-one via seigniorage through its NCB. Ceteris paribus, this frees up resources, making the exchange of assets effective. Extending the single economy reasoning summarised above, now resources will be freed up in every single country.[18] This takes place without any pooling of the budget

[18] Differently from the closed economy environment of Section II, now government debt may not only be held by private investors inside the country where it has been issued but also outside. However, this extension is innocuous, as long as

constraints that are relevant for national governments. Importantly, the release of resources can differ between countries, depending on the initial level of the interest rate and the volume of country-specific purchases that are undertaken. Moreover, the effectiveness of monetary policy does not require a change in fiscal policies anywhere.

- Assume nominal prices are rigid. Then, the effectiveness of monetary policy implies that it has a stimulating effect everywhere, i.e. the reduced *real* interest rate that is relevant in each country will act expansionary through positive demand effects.

Step 2: Ineffectiveness of QE at the ZLB ($i_k^B = 0$, everywhere)

- Assume prices are flexible. Moreover, assume the just considered central bank purchases of government debt have driven the nominal interest rates to zero everywhere. This is the same as to assume that the expansion of the money stock has driven the (possibly country-specific) non-pecuniary return attached to money to zero everywhere because of its sufficient abundance. However, the volumes of debt that have been purchased may differ between countries. Then, any further purchases of government debt will be ineffective, since money and government debt have become perfect substitutes everywhere. Correspondingly, the interest rate burden of no government could be reduced any further, i.e. no additional resources could be freed up. Hence, effectiveness requires a change in fiscal policy at least somewhere, but not any further monetary action.

- Assume rigid prices. Then the ineffectiveness of monetary policy implies that it cannot have any stimulating effect anywhere, i.e. the binding ZLB constraint prevents reductions in the real interest rate that would be required for monetary policy to be expansionary at least somewhere.

Step 3: Overcoming the ineffectiveness of QE at the ZLB

Is there nevertheless a way to restore effectiveness? Yes, this can be done via the same signalling channel that was sketched above – now, however, through possibly country-specific central bank purchases of longer term government debt as a substitute for forward guidance.

III.2 EA QE without risk sharing (allowing for the possibility of sovereign default)

The reasoning so far can be extended such that it covers the possibility of sovereign default. The just considered rule of no-income sharing then naturally generalises to a rule of no risk-sharing.

For simple illustration, assume the monetary union consists of two types of countries, called periphery and core. To simplify the exposition, the core never defaults, while the periphery faces an interest rate on government bonds that is higher than in the core ($i_P^B > i_C^B$), reflecting a probability p that government debt in the periphery will be served. With probability $1-p$ the periphery will default and impose a haircut of magnitude h_P on its outstanding debt, i.e. there exist two states in total. Let

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government debt of any type satisfies the law of one price across markets. Otherwise the effectiveness of marginal purchases will depend on the location of the seller of government debt.

us assume, for simplicity, that any differences in interest rates are entirely due to the default risk of the periphery. Moreover, bonds are priced at actuarily fair prices, demanded by risk-neutral investors, such that the following relationship holds:

$$p(1+i_P^B) + (1\text{-}p)(1-h_P) = 1+i_C^B$$

The key feature that will remain unchanged from Section III.1 is that the budget constraints that are relevant for national governments remain separated, in any state of the world. By construction, the core is not affected by events in the periphery. The periphery pays in the state of no-default a higher interest rate, but this does not lead to an outflow of resources to the core, since interest income is not shared. Conversely, in the state of default, there will be no transfer of resources from the core to the periphery, since there is no loss-sharing. *The separability of budget constraints holds true for any set of portfolio weights*, determining the composition of overall purchases in terms of national tranches of government debt.

What does the possibility of sovereign default imply for the effectiveness of monetary policy? For the core, because of the separation of budget constraints between countries, the reasoning of Section III.1 remains unchanged, in the sense that central bank purchases of core government debt become ineffective at i_C^B=0. The effects of central bank purchases of periphery government debt depend on how the default of the government takes place. In general, it is not trivial to conceptualise a situation in which the government defaults against its own (national) central bank.

Two pure forms can be distinguished in a stylised way.

- First, assume government and central bank activities are consolidated within a single public sector budget constraint. Then, central bank purchases of government debt from the private sector imply that this debt will be "retired", reducing the interest rate burden to be paid.[19] Moreover, since money is non-redeemable, there is no potential for a roll-over problem of outstanding debt. This consolidated perspective makes it difficult to think about the notion of an outright default, because there is a priori no limit to such purchases. At the same time, such perspective makes it difficult to conceptualize a constellation in which the central bank, responding to a change in macroeconomic circumstances, may at some point in the future have to defend its inflation objective under opposite (and normal) circumstances, namely via contractionary monetary policy to avoid excessive inflation. Contractionary policy implies in the model sketched so far that the central bank sells government debt, with the intention to increase nominal interest rates. The ability of the central bank to push through such intention requires that it controls independently its assets, here entirely in the form of government debt.

- This reasoning gives rise to a second perspective which is of relevance for the euro area and which stresses that the government and the central bank operate within separate budget constraints. In its purest version, this will eliminate the effectiveness of additional central bank purchases of periphery government debt in the first place, assuming that differences in

[19] This is the perspective that was implicitly taken in Section II describing the single economy scenario.

sovereign yields reflect, indeed, only default risks and that the core satisfies i_C^B=0. Essentially, any positive interest income of the NCB of the periphery in good states of the world will have to be kept as a buffer to be protected against a state in which the government defaults. Hence, no resources could be released, i.e. there is no reduced interest burden of the government.[20] This is the same as to say that a central bank which operates under a completely separate budget constraint behaves not differently from the private sector, as concerns its willingness to accept losses. In fact, additional central bank purchases of government debt may worsen the situation (i.e. create a burden) if the NCB of the periphery were to claim senior status vis-à-vis private sector claims. In general equilibrium such hierarchy of claims will be anticipated, making additional purchases of government debt ineffective at some positive level that will be higher than the above assumed value i_P^B.

The reality in the periphery may be approximately described by a combination of these two pure and extreme cases.[21] To put this differently: the lower bound on the interest rate in the periphery is likely to be given by a positive (i.e. risk-adjusted) value.[22] If this value is low, this signals that the NCB of the periphery is willing to accept losses, making room for a more generous treatment of private bond holders in the case of government default. A high value denotes the opposite scenario, implying that additional purchases of government debt become ineffective already at higher interest rates. A decision to make purchases under pari passu works in favour of a lower level.

To predict the outcome of this 'game' is not easy. Accounting losses are not a good guide to understand the potency of central banks. In principle, central banks can use future seigniorage revenues to replenish their capital. Moreover, central banks may well operate with negative capital, although the strategic implications of such (extreme) constellation are not trivial.[23] These features make it difficult to precisely predict how large the buffers of the NCBs need to be in order to avoid 'fiscal dominance'.[24] Such assessment, in any case, will depend on the degree of fiscal expansion chosen by national governments.

[20] With the same effect, the government can provide indemnification of the central banks purchases of government debt (i.e. the government commits to bear any losses and to claim any gains), as done, e.g., by the UK Treasury vis-à-vis the Bank of England's asset purchase facility.

[21] The first perspective is emphasised by de Grauwe and Yi (2015) and Sinn (2015), notwithstanding disagreement between the two studies concerning the desirability of EA QE. The second perspective is more strongly emphasised by Giavazzi and Tabellini (2015).

[22] For a discussion of the effectiveness of monetary policy at the ZLB via the compression of sovereign default risk (though in a closed economy context), see Smets and Trabandt (2012).

[23] For a detailed discussion, see del Negro and Sims (2014). Similarly, see Reis (2003). For an application in the euro area context, see Pâris and Wyplosz (2014) who argue that (future) seigniorage streams of NCBs can be mobilised in order to restructure excessive EA government debt without fiscal transfers between countries.

[24] For this concept, see Sargent and Wallace (1981).

In any case, given the fiscal dimension of the risks to be addressed, the feature of no risk-sharing naturally aligns the incentives of national governments with the intentions of the no-bail-out clause. This implies that, so to speak, the game will be concentrated in the periphery, separated from the core. The core may only be affected (typically at a later stage of crisis resolution, involving aspects beyond the narrowly defined motivation of EA QE), in case there exist systemic features of sovereign default, not yet covered and to be addressed in Section VI.

In sum, the stylised reasoning given so far supports the conclusion that EA QE without risk-sharing, when used for marginal operations in a ZLB environment, has the potential

- to facilitate country-specific monetary accommodation via purchases of abundant, liquid assets, compressing country-specific sovereign interest rates and, at the same time,

- to preserve the intention of the no-bail-out principle, in the sense that the Eurosystem balance sheet will not be a direct source of the pooling of sovereign risks.

III.3 EA QE with risk sharing (allowing for the possibility of sovereign default)

Let us consider the opposite approach, i.e. EA QE with risk sharing. Given the previous analysis it is easy to see that this establishes *a link between the budget constraints that are relevant for national governments*. It is natural to assume that in any state of the world incomes and losses will be shared according to capital key. The extent of the redistribution of resources between countries depends on the set of portfolio weights, determining the composition of overall purchases in terms of national tranches of government debt.

Given the simplifying assumptions made so far, it is worth emphasising that from an ex ante perspective there exists one particular portfolio composition where, in expected value, there is no redistribution of resources between countries. This will be the case if the composition of purchases is made according to capital key (see *Appendix I*). Under this assumption the core will receive from the periphery in the state of no-default via income sharing exactly those resources that it will have to return to the periphery in the state of default (via loss-sharing). In expected value, the flows that occur in the two states of the world will cancel out.

But the incentives are very different from the scenario described in Section III.2. In particular, ex post, in the state of default, there will be no natural basis for an agreement concerning the magnitude of the losses to be shared. Moreover, the assumption of an exogenous default probability (*1-p*) is no longer adequate, in view of moral hazard concerns.[25]

[25] On this, see Tirole (2015). In particular, in an asymmetric monetary union in which one group of countries has deep pockets, while the other group of countries is perceived to be risky, it is shown that it will not be optimal to extend contractual solidarity by entering ex-ante risk-sharing arrangements. Instead, the optimal contract is a simple debt contract and involves no risk sharing. Spontaneous solidarity can be shown ex-post via a bail-out, depending on the magnitude of adverse spill-overs to be contained or on the strength of altruistic motives.

IV Negative yields

The logic summarised so far can be generalised to an environment characterised by negative yields, thereby relaxing the *zero*-lower-bound assumption.

IV.1 Single economy

To generalise the reasoning described in Section II, let us now assume for simple illustration that the monetary base consists of two types of central bank liabilities which can be converted into each other one-to-one: on the one hand currency in circulation which pays no interest (i.e. $i^C=0$), and on the other hand reserves, to be held in accounts with the central bank, which are subject to a negative interest rate ($i^R<0$).[26] Currency is subject to storage costs, making it the preferred means of payment for small-scale purchases. By contrast, large-scale purchases are more easily facilitated through the electronic transfer of reserves. These features can ensure that currency and reserves will be voluntarily held, despite different returns.[27]

Consider marginal central bank purchases of government debt from the private sector, implemented via the creation of reserves. Moreover, assume that the interest rate on government bonds is initially positive ($i^B>0$). Such purchases, ceteris paribus, will be effective since they replace within the private sector an asset that commands a positive interest rate (i.e. the government bond) against an alternative asset (i.e. reserves) that not only commands a non-pecuniary return, but also leads to interest payments from the private sector to the central bank. From the consolidated perspective of the public sector, this exchange not only reduces the interest burden of the government. It rather creates net income to the government. Why is this? The government now has an interest obligation to the central bank which can be returned, one-to-one, to the government via seigniorage. Moreover, the central bank interest income on reserves held by the private sector can also be returned to the government via seigniorage. Since the exchange is voluntarily accepted by the private sector it frees up resources, making the exchange of assets effective. In particular, the effectiveness does not require a change in fiscal policies.

If the central bank continues to buy government bonds in this way, this will drive up the prices of government bonds – up to the point where their yield to maturity becomes sufficiently negative such that it coincides with the negative rate on reserves. At this point of satiation, the non-pecuniary return on reserves must be zero and reserves and government bonds become perfect substitutes. Moreover, additional central bank purchases of government debt will not free up any further resources, since the interest income of the central bank on its reserves will be identical to the losses of the central bank on its holdings of government bonds. In other words, QE becomes ineffective at the lower bound configuration characterised by $i^B = i^R<0$.

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[26] It would be straightforward to introduce a third type of central bank liabilities in order to distinguish between required reserves and excess reserves, where the former carry a different rate (identical to the rate charged in the main refinancing operations of the ECB).

[27] If modelled this way, the maximum difference between i^C and i^R that can be supported in equilibrium would be determined by the technology available to settle transactions. For the purpose of this sketch, the levels of the two rates are simply taken as given.

IV.2 Monetary union

The introduction of reserves which carry a negative interest rate leaves, ceteris paribus, the reasoning of Section III qualitatively unaffected, provided that the money in circulation and reserves are convertible one-to-one across the monetary union. Moreover, the available technology to settle transactions (via currency or reserves) is assumed to be identical across the monetary union. Then, country-specific differences will affect only the asset side of the central bank balance sheet, not its liability side.

If one maintains the above introduced simplifying assumption of a core country which never defaults and of a periphery country which defaults with some probability, monetary policy will now become ineffective at the critical yield configuration:

$$i_C^B = i^R < 0.$$

However, what remains unchanged is that under no risk-sharing the *budget constraints that are relevant for national governments remain separated, in any state of the world and for any set of portfolio weights* which determine the composition of national tranches of government debt. By contrast, risk sharing creates a *link between budget constraints*, leading to a redistribution of resources between countries in any of the two states of the world. Moreover, as a special case, it remains true that there exists from an ex ante perspective one particular portfolio composition where, in expected value, there is no redistribution of resources between countries. This will be the case if the composition of purchases of national government debt is made according to capital key (see *Appendix I*).

V Further remarks on EA QE without risk-sharing: modifications and extensions

V.1 Portfolio composition: capital key vs. flexible country-specific weights

As established above, without risk-sharing, portfolio weights according to capital key are no longer the obvious benchmark, since the budget constraints that are relevant for national governments will remain separated in any state of the world and for any set of portfolio weights which determine the composition of national tranches of government debt. In fact, the discussion in section III.2 suggested that a flexible scheme of country-specific weights, dictated by the idiosyncratic amount of accommodation needed in every single country, will be effective. But this conclusion is pre-mature, if one allows for relevant additional aspects. To illustrate them, let us consider pros and cons of two conceivable portfolios.

Option 1: EA QE w/o risk-sharing and flexible country-specific weights

- Pro: In a sense, such weighting structure may have *some* potential to mimic, for marginal operations in a lower bound environment, QE as done by, e.g., the Bank of England, in every single member country of the euro area. Euro area countries, while sharing a low inflation environment, arguably have different needs of (extra) monetary policy accommodation, reflecting various country-specific challenges related to differences in output gaps, structural

reform needs, and the available fiscal space. One may argue that it is first-best to offer accommodation directly where it is most strongly needed (in line with credit easing considerations, here applied to countries, not to market segments). QE with flexible country-specific weights has the potential to free up (marginal) support beyond what would be dictated by average area-wide concerns. If concentrated to those countries where the lower bound restriction is not yet binding (possibly because of country-specific differences in liquidity premia), it may ensure effectiveness with precisely targeted (possibly small) purchases.

- Contra: Such approach seriously challenges the singleness of the EA monetary policy. The ECB has a mandate to achieve price stability in the euro area as a whole. It should not embark on policies which ultimately may imply to actively steer 19 national inflation rates via country-specific QE. Since there are infinitely many combinations of national inflation rates that add up to an average rate of 'below, but close to 2%', the decision-making process may become dysfunctional.

  And the decision-making process would become even more politicised. While such approach has the potential to actively fine-tune stimulus to nominal demand at a country level, it will be controversial for the ECB to assess what it means for every single country to avoid "too low inflation for too long a time". In particular, the periphery needs below-average inflation (i.e. a real devaluation) to restore competitiveness and recreate growth. Otherwise, it seems difficult to imagine how in the periphery a lasting dependence on support from the core can be avoided. Yet, others may say that above-average inflation should be used as a tool to get a better control over debt-dynamics, thereby avoiding a restructuring of debt. Similarly, in the core the magnitude of the revaluation that may be acceptable will be very controversial. Such trade-offs, facing national policymakers, cannot be actively addressed, let alone the outcomes be actively coordinated, by the single monetary policy assigned to the ECB.

Option 2: EA QE w/o risk-sharing and weights according to capital key:

Pro: The capital key roughly captures differences of euro area countries in terms of GDP. Hence, if effective, EA QE would give symmetric stimulus to nominal demand across all countries. Without any active fine-tuning via the ECB, this deliberately fixed key has therefore the potential not only to lift average euro area inflation. It also has the potential to preserve inflation differentials, thereby respecting improved competitiveness dynamics. To the extent that inflation in the core will be temporarily lifted above the inflation objective of close to 2% this will soften the adjustment burden of the periphery. The tool is blunt, but it is in continuity with the idea that the single monetary policy should tacitly offer an implicit coordination device for all other policymakers, rather than to actively address country-specific concerns.[28]

[28] On this approach, see Issing (2005).

Contra: In the core yields stand at very low (and for a sizable maturity range already negative) levels that are historically without precedent. In case the core will behave in line with the predictions of the EW-irrelevance result, a large fraction of the purchases undertaken will be ineffective.[29] And the total amount of purchases may become relatively large.

Weighing the pros and cons of these two options, it seems save to conclude that the second option is the more robust one. In the worst case it may be relatively ineffective, but for reasons that can be linked to discussions that are known from the literature on the (in)effectiveness of QE in general. At the same time, the second option has the advantage that it draws a clear line between the area-wide dimension of EA QE and country-specific imbalances that need to addressed via a different set of tools. As to be discussed in Section VI, these two dimensions need to be kept apart in any comprehensive approach to escape from the current crisis.

V.2 Partly mutualized policies and EA QE with adequate risk-sharing

It is straightforward to extend the reasoning summarised so far to a decision under which i) the ECB buys a certain fraction of government debt (according to capital key) on its own account and ii) purchases fall to some extent on securities issued by supranational European institutions. Conceptually, this extension leads to the notion of EA QE with adequate risk-sharing. If these special purchases are done under full risk-sharing the resulting overall degree of limited risk-sharing will approximately correspond to the current allocation of fiscal responsibilities in the euro area.[30] This extension largely maintains the separation of the budget constraints that are relevant for national governments, *in any state of the world.* Upon such extension the degree of risk-sharing will be commensurate with the prevailing degree of fiscal incompleteness of the euro area.

But Europe is not static. In the context of the larger political debate in Europe, the ECB, as in the past, will continue to act as a catalyst for institutional reforms which will make the euro area more complete.[31] In support of such needed steps it will be easy to adjust the degree of risk-sharing, reserved for marginal purchases that involve outright sovereign risks.

VI EA QE vs. country-specific concerns: Eggertsson/Woodford meets Mundell

As stressed in Section I, the ECB can at best introduce some special notion of EA QE as long as it takes the current incompleteness of the euro area architecture seriously. Inevitably, this means that a clear line needs to be drawn between the area-wide motivation of EA QE (to be organised around the area-wide outlook for price stability) and country-specific concerns. EA QE with adequate risk-

[29] In this spirit, see the reference to the notion of a currently 'Super-Ricardian' core by Sims (2014).

[30] The correspondence would be exact if supranational European institutions were to issue joint-and-several liabilities.

[31] There are many blueprints out how this can be done. For a recent contribution, see, Farhi and Werning (2014).

sharing and with purchases according to capital key is a specification which meets this criterion. However, this implies that EA QE, if designed this way, will *not* be a tool to

i) fine-tune country-specific accommodation,

ii) safeguard the relative competitiveness of member states within the euro area,

iii) address issues related to sovereign defaults of member states.

These features make EA QE different from the standard version of QE as conducted in nation states or strongly integrated monetary unions. Under standard QE, by construction, there is no distinction between country-specific and area-wide concerns, implying that the mentioned features do not need special treatments via additional tools or policy options.

The euro area is different. For the euro area to recover from the crisis, EA QE can only be one tool to be complemented by many others which address country-specific concerns. Conceptually, a coherent discussion of such concerns requires to go back to the old insight of Mundell (1961) that the entry into a monetary union has not only benefits, but it also comes at the cost that any country loses (standard) instruments that could be used to address country-specific imbalances. Because of this insight sceptical observers see the euro as a mechanism which has reinstalled the hardship that prevailed under the gold standard.

How can such pessimism be countered? As long as the major elements of the current architecture remain unchanged, there will be no easy ways out.[32] A good number of additional tools that are feasible under current circumstances have already been created (like the ESM, the design of OMT and the creation of the Banking Union), ensuring that the euro area architecture these days is less incomplete than at the outset of the crisis. Other tools are still missing. To the extent that country-specific imbalances (most visibly in the case of sovereign default of a member state) have a systemic dimension, such tools are a matter of common concern. This makes it challenging to conceive a comprehensive package (consisting of a complete set of tools and policy options) which embraces all contingencies and covers all decision nodes.

To cover these issues in detail is beyond the scope of this sketch. Instead, it concludes with some remarks. These remarks try to identify tools and options which have the potential to address the three country-specific features identified above.[33] These tools and options are specific to the euro area, complementing EA QE (as defined above, i.e. as EA QE with adequate risk-sharing and with purchases according to capital key) and making the overall crisis management different from standard economies (with single monetary and fiscal policies).

[32] For a summary discussion on ways forward, i.e. 'Towards a Genuine Economic and Monetary Union', see the Report by the President of the European Council (2012).

[33] For a model-based analysis of selected country-specific options in the euro area in the aftermath of the recent crisis, see Martin and Philippon (2014).

i) Country-specific accommodation:

- Good macroeconomic crisis management typically relies on an effective combination of supply-side measures (often becoming effective with a certain lag) and demand-side policies (typically offering some short-term accommodation).

- For member countries in a monetary union, challenges of demand-side management arising from the lower bound constraint on nominal interest rates are reinforced to the extent that monetary accommodation is constrained by area-wide concerns. A lack of precise (i.e. country-specific) monetary accommodation, in principle, may at least partly be compensated for by country-specific fiscal support.[34] However, in those countries which suffer from high levels of (legacy) debt, this channel is curtailed by the lack of fiscal space.

- Hence, demand-side policies (i.e. both monetary and fiscal) lack effectiveness. This creates a premium for comprehensive supply-side adjustment and flexible structures.[35]

- At the same time, to regain flexibility in the fiscal domain, the assessment of excessive deficits under the SGP can be linked to a more broad-based evaluation of agreed economic policies and implemented reform measures.[36]

ii) Relative competitiveness of member states within the euro area:

- For any member country, the just mentioned reduced effectiveness of traditional domestic demand-side policies is reinforced by the lack of the nominal exchange rate, as a tool to affect the relative competitiveness vis-à-vis the rest of the euro area.

- Real devaluations, where needed, have to be achieved through price and wage restraint relative to the respective area-wide trends. This creates a premium for downward flexibility of nominal prices and wages.

[34] This is the main message of the analysis by Cooper and Kempf (2003).

[35] For a detailed analysis of the trade-offs specific to structural reforms of member countries in a monetary union, see Eggertsson, Ferrero and Raffo (2014). Essentially, for success, the strength of the reform package needs to mobilise a positive income effect which dominates a negative interest rate effect (specific to an environment where the lower bound constraint is binding).

[36] Yet, the binding criteria that may qualify for any such re-orientation of the assessment of the fiscal stance will be controversial. Alternatively, a more marked-based approach may tolerate exceptional fiscal deficits as long as sovereign spreads behave well. None of these modifications is without problems in view of past failures to track the determinants of government debt dynamics.

- So-called fiscal devaluations, operating through appropriate changes in national tax codes, may offer a certain alternative, but the design issues are complicated and implementation lags may be prohibitive.[37]

iii) Sovereign default:

- Governments of member states are without protection from their own central bank, i.e. they are without a lender of last resort. This feature makes them vulnerable to sovereign default. And it creates a premium for mechanisms that prevent speculative runs and facilitate, at the same time, a smooth restructuring of sovereign debt whenever fundamentally unavoidable.

- Since sovereign defaults have a systemic dimension such mechanisms are a matter of common concern. To prevent default dynamics driven by non-fundamental, speculative runs, insurance needs to be provided at the supranational level, ultimately involving the common central bank as a lender-of-last resort. Default dynamics resulting from fundamental imbalances should be addressed via a restructuring of government debt, allowing for a bail-in of private creditors.

- Yet, the distinction between speculative runs and fundamentally warranted sovereign defaults as well as their dependence on various types of policy interventions is non-trivial. [38]

- This problem has been recognised by the design of OMT where conditionality helps to alleviate the equilibrium selection problem. Further guidance towards equilibrium selection can be achieved via schemes that turn outstanding government debt below certain thresholds (like a GDP ratio of 60%) into safe assets, involving central bank support via collateral policies. Similarly, adjustments in bank regulations are needed to clarify which parts of euro area government debt will be treated as risk-free.[39]

- As concerns a more orderly approach towards the restructuring of sovereign debt, whenever fundamentally warranted, new initiatives should be welcome. They can be naturally linked to elements of the newly created crisis resolution framework of the Banking Union. To the extent that an excessive indebtedness of governments corresponds to an excessive exposure of banks, the agreed cascade of bail-in steps will help to minimise the ex-post exposure of the public sector (i.e. solvent governments and the ECB) vis-à-vis the defaulting government. Where appropriate, public funds should be used to directly

[37] For expositions of this concept, see Farhi et al (2014) and Lipinska and v. Thadden (2012).

[38] For details, see, among others, Camous and Cooper (2014), Dedola and Corsetti (2013), and Uhlig (2015).

[39] In this spirit, see, for example, Brunnermeier et al (2011).

stabilise systemically relevant parts of the financial system via recapitalization schemes. The intention of such approach is to facilitate risk sharing arrangements associated with sovereign default that actively involve the private sector.

- Such approach recognises that the key friction, which these days prevents a smooth resolution of the ongoing Greek debt crisis, is the large exposure of the public sector (i.e. solvent governments and the ECB) vis-à-vis the Greek government. This Greek constellation has created ex post a bargaining problem which has no smooth resolution in view of the no-bail-out provisions (which regulate the relationships between *public* players in the euro area).[40] Moreover, in view of this impasse, this constellation constantly triggers damaging exit speculations.[41] It seems that such speculations can be much better contained, if not entirely ruled out, under an approach which acknowledges that fundamentally warranted sovereign defaults, to be negotiated with private creditors, are well consistent with continued membership in the euro area.

[40] In line with the above summarised reasoning of Tirole (2015), spontaneous solidarity with Greece ex post via a bail-out from sovereign creditors may be rationalised via spill-overs that need to be contained or via altruistic motives. Yet, any such assessment is deeply controversial since even the sign of the spillovers is not clear. Phillipon (2015), e.g., argues that Greece is entitled to a 'fair debt relief', in the sense that Greece's debt should have been restructured much earlier and that this restructuring was prevented by legitimate fears of contagion, reflecting a general lack of preparedness among euro area policymakers. Others, like Feld et al (2015), argue that reckless behaviour of Greek authorities must not be rewarded ex post in order to deter other governments from adopting similar policies. In other words, a tough line is needed to limit damage in the euro area *outside* Greece. All this is overshadowed by the larger question of how to value politically the integrity of the euro area in its current composition.

[41] The (in-)ability to contain exit speculations is a relevant driver of macroeconomic outcomes, as shown in the analysis of Greek developments by Kriwoluzky et al (2014).

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Appendix I: EA QE with risk sharing and purchases according to capital key

The stylised central bank balance sheet underlying the discussion in the main text is given by

$$B^C + B^P = C + R$$

In terms of assets it consists of holdings of government bonds from the core (B^C) and the periphery (B^P), while liabilities consist of money in circulation (C) and reserves (R). As discussed in the text, let $i_P^B > i_C^B > -h_P$ and assume risk-neutral investors price bonds at fair prices, i.e.

$$p(1+i_P^B) + (1-p)(1-h_P) = 1+i_C^B$$

Let $i^C=0$, while i^R differs from zero, and assume that the share of reserves in total liabilities is given by $R/(C+R) = s_R$. The portfolio share of purchases falling on periphery debt is given by $B^P/(B^C + B^P) = s_P$, while the core has a share of $1-s_P$. Moreover, the periphery has a capital share of x_P in the central bank's capital, while the core has a share of $1- x_P$. As discussed in the text, central bank incomes and losses on its assets will be state-dependent, but not on its liabilities.

The results in Section III are special in the sense that central bank liabilities consist only of money in circulation (i.e. $s_R=0$), while Section IV assumes $s_R>0$.

Ex-post returns

State A: Periphery does not default

Risk-sharing:

Return to Periphery: $x_P[s_P(1+i_P^B) + (1-s_P)(1+i_C^B)] - x_P[s_R(1+i^R)]$

Return to Core: $(1-x_P)[s_P(1+i_P^B) + (1-s_P)(1+i_C^B)] - (1-x_P)[s_R(1+i^R)]$

No risk-sharing:

Return to Periphery: $s_P(1+i_P^B) - x_P[s_R(1+i^R)]$

Return to Core: $(1-s_P)(1+i_C^B) - (1-x_P)[s_R(1+i^R)]$

State B: Periphery does default

Risk-sharing:

Return to Periphery: $x_P[s_P(1-h_P) + (1-s_P)(1+i_C^B)] - x_P[s_R(1+i^R)]$

Return to Core: $(1-x_P)[s_P(1-h_P) + (1-s_P)(1+i_C^B)] - (1-x_P)[s_R(1+i^R)]$

No risk-sharing:

Return to Periphery: $s_P(1-h_P) - x_P[s_R(1+ i^R)]$

Return to Core: $(1-s_P)(1+ i_C^B) - (1- x_P)[s_R(1+ i^R)]$

Ex-ante returns

Risk-sharing:

Return to Periphery: $x_P(1+ i_C^B) - x_P[s_R(1+ i^R)]$

Return to Core: $(1-x_P)(1+ i_C^B) - (1- x_P)[s_R(1+ i^R)]$

No risk-sharing:

Return to Periphery: $s_P(1+ i_C^B) - x_P[s_R(1+ i^R)]$

Return to Core: $(1-s_P)(1+ i_C^B) - (1- x_P)[s_R(1+ i^R)]$

Comparing the expressions for the ex-ante returns it is easy to verify that they will be identical under risk-sharing and no risk-sharing if $s_P = x_P$, i.e. if the portfolio composition of purchases equals the capital key.

Appendix II: Summary of selected elements of the ECB's decision from 22 January 2015

The Governing Council of the ECB announced an expanded asset purchase programme (EAPP).[42] The programme adds the purchase of sovereign bonds to existing private sector asset purchase programmes launched already in late 2014, namely the asset-backed securities purchase programme (ABSPP) and the covered bond purchase programme (CBPP3). Combined monthly purchases will amount to €60 billion. They are intended to be carried out until at least September 2016 and in any case until the Governing Council sees a sustained adjustment in the path of inflation that is consistent with its aim of achieving inflation rates below, but close to, 2% over the medium term.

Universe of sovereign bonds to be purchased: The ECB will buy bonds issued by euro area central governments, agencies and European institutions in the secondary market against central bank

[42] For details, see documents listed at: http://www.ecb.europa.eu/home/html/faqassetpurchaseprogramme.en.html

money, which the institutions that sold the securities can use to buy other assets and extend credit to the real economy.

Coordination of purchases: As regards the additional asset purchases, the Governing Council retains control over all the design features of the programme and the ECB will coordinate the purchases, thereby safeguarding the singleness of the Eurosystem's monetary policy. The Eurosystem will make use of decentralised implementation to mobilise its resources.

Eligibility criteria: Securities to be purchased have to fulfil the collateral eligibility criteria for Eurosystem refinancing operations. In particular, if investment grade is not reached, securities will remain eligible, as long as the Eurosystem's minimum credit quality threshold is not applied for the purpose of their collateral eligibility. Moreover, during reviews in the context of financial assistance programmes for a euro area Member State, eligibility would be suspended and would resume only in the event of a positive outcome of the review.

Maturity: Securities purchased under the expanded asset purchase programme that are not covered by the ABSPP or CBPP3 must have a minimum remaining maturity of 2 years and a maximum remaining maturity of 30 years at the time of purchase.

Negative yields (lower floor): Securities trading at negative yields remain purchasable, as long as the yield to maturity exceeds the rate on the ECB's deposit facility (which currently stands at -20 basis points).

Secondary market functioning: Securities purchased under the expanded asset purchase programme that are not covered by the ABSPP or CBPP3 will be subject to a security-specific limit of 25% and an issuer-specific limit of 33% in terms of nominal value. The security-specific limit of 25% prevents the Eurosystem from forming a blocking minority in the event of a debt restructuring involving collective action clauses. Moreover, a blackout period around the issuance of new securities on the primary market will be applied.

Creditor treatment (pari passu): Regarding creditor treatment, the Eurosystem accepts the same (pari passu) treatment as private investors with respect to securities purchased by the Eurosystem, in accordance with the terms of such securities.

Portfolio composition (capital key): Purchases of securities under the expanded asset purchase programme that are not covered by the ABSPP or CBPP3 will be allocated across issuers from the various euro area countries on the basis of the ECB's capital key.

Treatment of hypothetical losses: With regard to the sharing of hypothetical losses, purchases of securities of European institutions (which will be 12% of the additional asset purchases, and which will be purchased by NCBs) will be subject to loss sharing. The rest of the NCBs' additional asset purchases will not be subject to loss sharing. The ECB will hold 8% of the additional asset purchases. This implies that 20% of the additional asset purchases will be subject to a regime of risk sharing.

Modalities of income sharing: *details still to be decided*.