Welfare costs of inflation in the euro area

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Abstract

We estimate the welfare costs of inflation in the euro area taking into account that part of the euro banknotes are held abroad. Indeed, for economies for which the foreign demand of the domestic currency is non-negligible, failure to control for currency held abroad may lead to overestimating the domestic welfare costs, since the inflation tax is partly borne by foreign residents. We find that welfare costs are zero at the 2% level of the nominal interest rate and are minimized at 1%. This in turn implies a deviation from Friedman rule of zero nominal interest rate and the optimal targeting of a positive but moderate value of the inflation rate also from the point of view of the minimization of the welfare costs of inflation.

JEL classification: E41, C22.
Keywords: money demand, welfare cost of inflation, currency abroad

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1 Introduction

The statement that inflation is costly can hardly be questioned. The features of the costs of inflation have been systematically investigated by the literature and found to be of both economic and social nature. In particular, welfare costs linked to high and volatile inflation include high risk premia, the distorsive interaction between inflation and the tax code, the inefficient distraction of resources from production of goods to financial activities, lower capital accumulation and the arbitrary redistribution of wealth (see for instance Friedman 1969, Driffill et al. 1990 and Fischer 1995). However, few reasons have been put forward in favour of maintaining a positive inflation rate. Nowadays, central banks of major advanced economies are pursuing an objective of price stability implying a low but still positive inflation rate over the reference horizon.[1]

A common way to measure the welfare cost of inflation is the approach proposed by Bailey (1956): the area under the (inverse) money demand function. This measure estimates the costs arising from a specific source of inflation-related costs (the so called "shoe-leather costs") which are associated to the inefficient management of agents' monetary holdings due to high inflation. Given that higher nominal interest rates increase the opportunity cost of holding money and assuming that monetary balances yield direct utility via liquidity services, the rationale underlying the shoe-leather costs is that higher expected inflation – via its impact on nominal interest rates – will lead agents to inefficiently economizing on their monetary balances.

The monetary aggregate most used in literature to compute the shoe-leather costs is M1 (the sum of currency in circulation and overnight deposits), which indeed represents a close empirical counterpart of the notional monetary balances featuring in the theoretical models of the demand for transaction balances. However, official M1 series provided by central banks are affected by measurement errors that are relevant for the computation of welfare costs. In fact, M1 series include all currency circulating outside banks regardless of the country of residence of the holder, thus mixing domestic and foreign holdings (see Prescott, 1996). Large currency holdings abroad may potentially lead to mis-specification of the money demand equation used for the computation of social welfare. In addition, not controlling for the foreign circulation of domestic currency may lead to overestimating the welfare

[1] For a general survey about pros and cons of inflation see Issing et al. (2001).

costs accruing to domestic agents as a result of domestic inflation. When a substantial part of the domestic currency is held abroad the desirability of implementing the Friedman rule of zero inflation (or zero nominal rate) should be questioned (Schmitt-Grohé and Uribe, 2009).

The distortions implied by not disentangling domestic and foreign monetary holdings have started to be increasingly relevant in several countries. For instance, the FED's official estimates published in the Flow-of-funds accounts show that foreign hoardings of US dollar currently account for around 40% of total currency in circulation; Leung et al (2010) estimates that between 50% and 70% of the Hong Kong dollar in circulation in 2009 was held abroad; Bartzsch et al (2011) hint that in 2009 German euro banknotes outside the country (euro area) account for around 63% (46%) of all currency issued by the Deutsche Bundesbank.

The aim of this paper is twofold. First, we propose an estimate of the euro area money demand which is adjusted by currency held abroad. In particular, we use data after the introduction of the euro banknotes at the monthly frequency. Secondly, we compute the welfare costs of inflation by taking into account both domestic and foreign seigniorage.

2 Currency abroad and welfare

Our empirical exercise is based on estimates of the demand for the narrow monetary aggregate M1 adjusted for the circulation of the euro currency abroad over the 9 years from 2002 to 2010.

Official data of the notional stock of M1 are available at the monthly frequency and on a seasonally adjusted basis from the Statistical Data Warehouse of the ECB. However, as already mentioned, official data include all currency circulating outside MFIs, regardless of the country of residence of the holder. Therefore, they usually provide an upward-biased measure of the holdings of currency by domestic agents. In order to correct the data for this measurement error, we need an equally long time series of the estimated value of the euro currency circulating abroad.

A study by Porter and Judson (1996) reviews a number of methods that can be used to estimate the amount of currency circulating abroad. Most of these methods, unfortunately, are based on the seasonal technique and can be used to generate reliable estimates only at the annual frequency; others, instead, provide estimates at irregular points in time (e.g., the monetary de-

mographic model). One exception is the shipments-proxy method proposed by Feige (1994, 1997), which has been implemented also by the ECB to generate monthly estimates of the amount of the euro currency held by non-euro area residents.[2]

The shipments-proxy method focuses on the net shipments abroad of domestic currency banknotes. For the euro area is the sum of individual country statistics with respect to non-euro area countries. In particular, considering only the net-exporter countries, the leader is Germany with a share of total net export of 76%, followed by France with 13.5% and Italy with 6.4%. The strongest net importer is Austria, with a negative share of around 30%. The ECB itself however warns that the use of euro banknotes outside the euro area cannot be estimated precisely. The estimate of the amount of euro banknotes circulating abroad that is published regularly on *"The international role of the euro"* is most likely downward biased. Indeed, the published data is considered to be a lower bound, given that the banking channel is only one of a number of channels for euro banknotes shipped outside the euro area: anecdotal evidence suggests that the outflows of euro banknotes via non-MFI channels as tourism or workers' remittances are often greater than the backflow via non-bank channels.

As Figure 1 shows, according to the shipments-proxy approach, the share of the euro currency circulating abroad has tended to rise over the past few years. In particular, it increased gradually after the cash change-over in 2002 and then stabilized over the period 2005-2006. After the collapse of Lehman Brothers it increased steeply to stabilized again at just below 110 billion when the financial crisis hit the sovereign bond market of some euro area countries. At the end of 2010 euro banknotes estimated to be in circulation outside the euro area amounted to 13% of the total euro area currency in circulation. However, taking into account ECB suggestions the share could actually be as high as 25%. As a comparison, in the US official estimates (based on the shipments proxy approach) suggest that dollars circulating abroad amount to around 40% of total circulation, but at the same time the FED warns that it might be as high as 60%.

[2] The Federal Reserve Board in its Flow of Funds Accounts provides estimates of US dollar circulating abroad since 1996 using the same method.

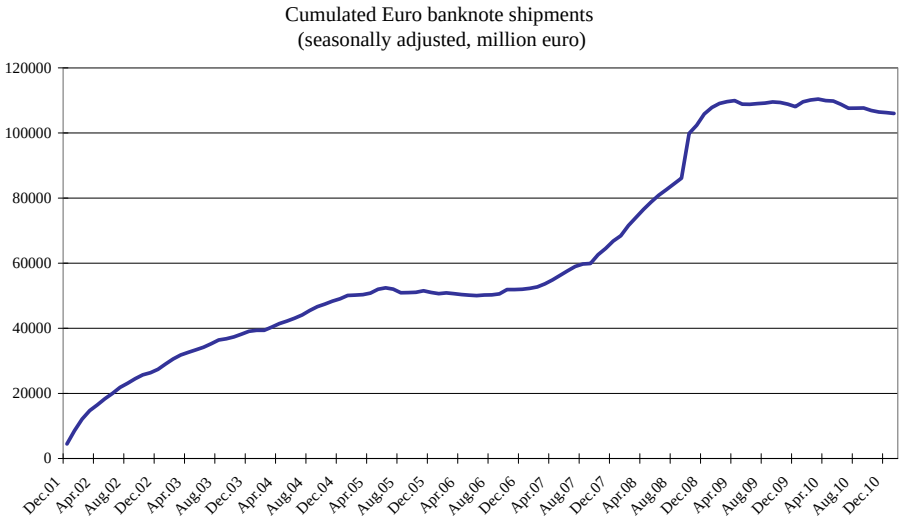

Figure 1 ECB estimates of the euro currency held abroad

Regardless of whether including or excluding currency held abroad from the monetary aggregate, empirical works usually assume that the domestic demand for real balances is a function of a reference interest rate (r) and a measure of the volume of transactions (y): $M_t/P_t = L(r_t, y_t) = m(r)\, y$. However, not considering money abroad may lead to inaccurate estimates of the money demand and, most likely, to upward biased estimates of the domestic welfare cost of inflation. This because Bailey's measure of shoe-leather costs assumes that money is held entirely by residents. In particular, the Bailey's "welfare triangles" obtained as integrals of the inverse money demand function on the interval $[m(r), m(0)]$, are corrected for the revenue accruing from seigniorage:

$$w(r) = \int_0^r m(x)dx - rm(r) \tag{1}$$

where $m(x)$ denotes the money demand function. However, as noted by Calza and Zaghini (2011), in the presence of foreign holdings of the domestic currency, the correct specification of the welfare costs becomes:

$$w(r) = \int_0^r m^h(x)dx - rm(r) \tag{2}$$

where m^h is the demand function for domestic monetary holdings, while m refers to the total amount of money issued (i.e. also including currency holdings abroad). Indeed, while domestic residents only incur utility losses to the extent that their own demand for monetary services is distorted by inflation, the government obtains seigniorage revenues from the entire amount of money that is issued, regardless of the country of residence of its holders.

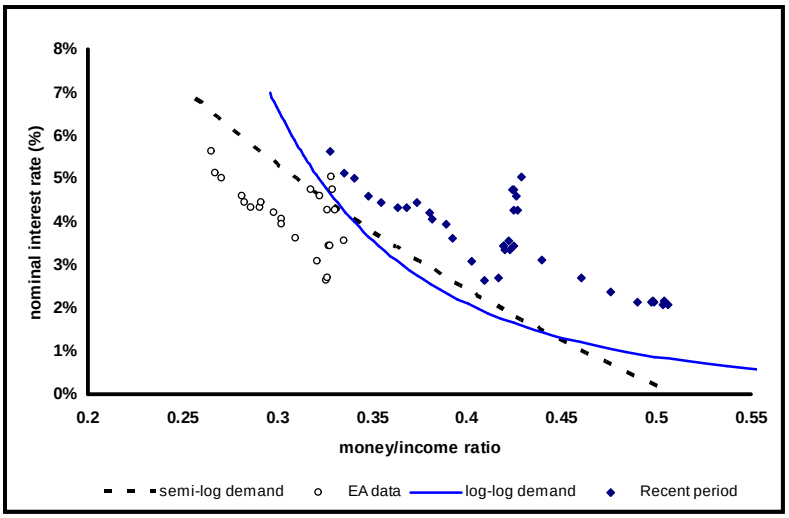

Figure 2. Euro area money demand (1996-2010)

Figure 2 depicts the scatter plot of quarterly Euro area money-income ratio with respect to interest rate from 1996 to 2010 and two estimated money demand functions. In particular, data from the decade 2001-2010 are depicted in bold. While it is difficult to say anything about the elasticity of the money demand with respect to the nominal interest rate (the steepness of the curves), it is clear that data concerning the most recent period lay further away on the right hand side with respect to earlier quarters. Thus, even without any consideration of the currency held abroad, it seems it is worth investigating the most recent period: as suggested by the scatter plot, money demand might have well adjusted to the new economic framework of euro banknotes. In addition, the crisis years are clearly visible in Figure

2, since the increase in the short-run nominal interest rate (both EONIA and Euribor) happened in a context of relatively stable money/income ratio determining a sort of vertical clustering of data. In the rest of the paper we first propose an estimate of the money demand of euro area residents over the past decade which does not include currency abroad, and then we compute the welfare cost of inflation reflecting both domestic demand and foreign seigniorage.

3 Empirical estimates

3.1 Adjusted money demand

Equilibrium money demand relationships are conventionally estimated in a cointegration analysis framework (see Sriram, 2001; Coenen and Vega 2001, Duca and van Hoose, 2004). As a preliminary step, the statistical properties of the variables (both in level and in log format) are examined using standard unit root tests (augmented Dickey-Fuller and Phillips-Perron) as well as the KPSS stationarity test. The results - not reported for the sake of brevity - suggest that over the sample period from January 2002 to December 2010 all the variables can be modelled as I(1) in levels.

Focusing on a semi-logarithmic specification of the money demand we run several cointegration tests, obtaining mixed evidence supporting the possibility of a long-run relationship between the money ratio and the nominal interest rate. Two tests are supportive of cointegration (Zivot and Johansen) at the conventional statistical levels, while the Philips-Ouliaris test does not rejects the null of no-cointegration.

Bearing in mind the possibly weak long-run statistical properties of the aggregate money demand, in Table 1 we report the estimated equilibrium relationship between the ratio of money to GDP (adjusted for currency abroad) and the nominal interest rate (3-month Euribor) using three alternative single-equation estimators: (1) standard OLS; (2) the Engle and Yoo's (1991) "three-step" approach to the Engle-Granger estimator; and (3) the dynamic OLS method by Saikkonen (1991).[3]

[3]The lags and leads of the estimates are selected using the Schwartz Information Criterion.

Table 1. Estimated long-run interest rate coefficients

	$\ln(M/Y) = B - \xi r$	
	B	ξ
OLS	0.4457	3.9507^{***} (0.785)
EY(1)	0.4460	4.128^{**} (1.860)
DOLS(1,1)	0.4473	4.078^{**} (1.748)

Note: Standard errors in parentheses. *, **, *** denote statistical significance at the 10%, 5% and 1% critical levels, respectively. Number of lags (and leads for DOLS) in levels are reported next to the estimator. Newey and West robust standard errors.

Regardless of the estimation procedure employed, the estimated long-run interest rate semi-elasticity is statistically significant at the conventional levels. In addition, both sign and magnitude of the coefficients are consistent with the interpretation of the cointegrating vectors as equilibrium money demand relationships.[4]

3.2 Domestic welfare costs of inflation

The coefficients in Table 1 define the horizontal position and curvature of the money demand function adjusted for currency abroad $m^h(r)$ and must be substituted in (2) to estimate the consumer surplus lost by euro area agents because of a positive nominal interest rate.[5] Figure 3 shows the shoe-leather costs net of total seigniorage revenues for different levels of the nominal interest rate obtained via the various estimates of $m^h(r)$ reported in Table 1.

As usual, the shoe-leather costs are convex in the nominal interest rate but, interestingly, for values below $r = 2\%$ the function lies below the X-axis. Thus, our estimates suggest that the welfare costs associated with very low nominal interest rates are not only small, but actually slightly negative. In particular, welfare costs are minimized at a value of the nominal interest rate around 1 per cent.

[4] The values for the intercept are calibrated as in Lucas (2000) so that they equal the average value over the sample of $me^{-\xi r}$.

[5] Note that in order to compute the seigniorage revenues, we also need to substitute in (2) the parameters of $m(r)$, the money demand estimated over the same time period for the whole M1 (i.e. including currency abroad).

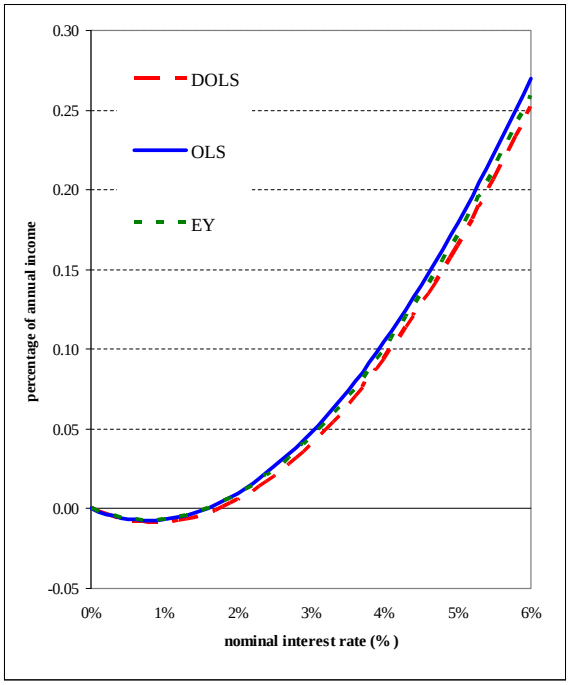

Figure 3.Welfare costs for different estimates of m^h

Negative values of the shoe-leather costs are not intuitive, but can be explained by the existence of foreign demand for euro currency. In fact, in a closed economy, and assuming that money provides utility-enhancing liquidity services, the shoe-leather costs are non-negative and increase with the steady-state inflation rate. However, in the presence of substantial foreign demand for domestic currency, the welfare costs can become negative if, for some levels of inflation, the disutility to domestic agents stemming from positive inflation is more than offset by the associated transfer of resources from abroad. In other words, the loss to domestic agents because of the money demand distortions is more than compensated by the seigniorage revenues from foreign holders of domestic currency.

This result is consistent with the model proposed by Schmitt-Grohé and Uribe's (2009) which suggests that, when the share of the domestic currency circulating abroad is very large, optimal policy may involve deviations from

the Friedman rule. The targeting of positive inflation rates would be the choice of the domestically benevolent government which finds it optimal to impose an inflation tax as a way to extract resources from the rest of the world in the form of seigniorage revenue.

At the empirical level, a similar but stronger results is obtained for the US by Calza and Zaghini (2011). They find a broader range for the nominal interest rate for which the transfer from abroad allows negative shoe-leather costs. In particular, welfare cost of inflation are minimized at the 5% level of the nominal interest rate.

In order to illustrate more in details the effect of the inflation tax on foreign holders of euro currency, Figure 4 reproduces the baseline shoe-leather cost function based on the OLS estimates together with a function obtained under the counterfactual of no foreign demand for the euro currency. In practice, we estimate this shoe-leather cost function by substituting $m^h(r)$ for $m(r)$ in the second term of the formula of the welfare triangle (2) . This is equivalent to treating the euro area as a closed economy and using the seigniorage revenues that the government extracts at home only (instead of total seigniorage revenues) to compute the welfare costs of inflation. For comparison purposes, we also include a shoe-leather costs function based on monetary data unadjusted for foreign holdings.

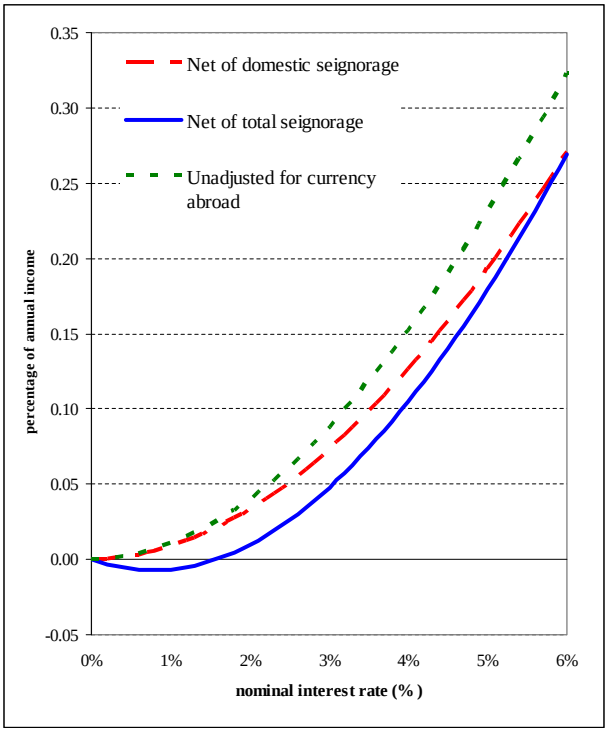

Figure 4. Welfare costs and seigniorage revenues

The difference between our baseline shoe-leather cost function (blue, solid) and that obtained under the counterfactual of zero foreign demand for the euro currency (red, dashed) provides information on the magnitude of the inflation tax on foreign residents. As expected, under the counterfactual scenario, the shoe-leather costs are non-negative and, consistent with the Friedman rule, are minimized for $r = 0$. However, for relative high levels of the nominal interest rate, the functions under the baseline and counterfactual scenarios converge as the utility losses to domestic agents from rising inflation increasingly offset the transfer of real resources from abroad. The shoe-leather cost based on unadjusted data (green, dotted) are higher, suggesting that the failure to account for the circulation of euro banknotes abroad leads to a non-negligible overestimation of the welfare costs of inflation arising from money demand inaccurate estimation.

3.3 Robustness analysis

We run several robustness checks but results were not significantly affected. First we use the EONIA rate instead of the 3-month Euribor, maintaining the same semi-log specification. We then tried an unconstrained version of the money demand function of the type:

$$\log(m) = \log(B) + \beta \log(y) - \xi r \tag{3}$$

The estimated values of the interest rate semi-elasticity are in line with those reported in Table 1 and consistent with a long-run money demand function. In addition, negative values of the shoe-leather costs appear again at low levels of the nominal interest rate.

4 Concluding remarks

Overall, our results suggest that the fact that a non-negligible share of the euro currency is held abroad has important implications for the computation of the welfare costs of inflation for domestic agents. After adjusting official M1 data for the estimated holdings of currency abroad, we obtain an estimate of the domestic shoe-leather costs which is significantly lower than when considering the whole M1 aggregate. In addition, it is likely that our calculations might err on the high side because of two factors: (1) we use estimates of the foreign hoardings of euro banknotes that are believed to underestimate the true amount of currency abroad, and (2) we assume that the deposits included in M1 are entirely not remunerated, which may lead to overestimating the distortions to money demand caused by inflation (Cysne and Turchick, 2010).

The fact that welfare costs may become negative implies a deviation from the Friedman rule of zero interest rate. Indeed, as noted by Schmitt-Grohé and Uribe (2009), in an economy with a significant share of its domestic currency circulating abroad, the inflation tax is to a large extent borne by foreign residents, which implies a transfer of real resources from the rest of the world to the currency-issuing economy. Thus, when setting the optimal monetary policy, the government of the issuing country would need to carefully weight the welfare gains in terms of reduced opportunity costs for domestic agents against the losses stemming from reduced seigniorage revenues associated with the holdings of currency abroad.

Our estimates show that in the euro area welfare costs are equal to zero at the 2% level of the nominal interest rate and are minimized at a level of around 1%. This in turn implies that, given the possibly low level of the euro area natural interest rate (Mesonniere and Renne; 2007) and the fact that our estimates are most likely upward biased, the targeting of a small but positive inflation rate might be optimal even from the point of view of the minimization of the welfare costs of inflation.

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