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Financial Integration and the Construction of Historical Financial Data for the Euro Area*

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Abstract

Time series analysis for the Euro Area requires the availability of sufficiently long historical data series, but the appropriate construction methodology has received little attention. The benchmark dataset, developed by the European Central Bank for use in its Area Wide Model (AWM), is based on fixed-weight aggregation across countries with historically distinct monetary policies and financial markets of varying international importance. This paper proposes a new methodology for producing back-dated financial series for the Euro Area, that is based on the time-varying distance of periphery countries from core countries with respect to monetary integration. Historical decompositions of the residuals of vector autoregressive models of the Euro Area economy are then used to explore and compare the monetary policy implications of using the new methodology versus the use of AWM fixed weight series.

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1 Introduction

Analysis of the macroeconomic behaviour of the Euro Area is a key topic of interest not only for economists in Europe, but also for the global economy. No monetary union of this magnitude has previously occurred in the modern world, and the formation of the Euro Area raises many issues that need to be confronted in attempting to understand the economic characteristics of this coalition.

One key issue is historical analysis, which involves constructing appropriate data. The common euro currency has existed only since 1999 (with euro notes and coins becoming available in 2002), and the period since then does not provide sufficient observations to enable detailed empirical macroeconomic analyses to be undertaken. Nevertheless, historical data is crucial for the contemporary development of economic policy, so that its construction is important for future economic progress; see, for example, the discussion of data formation in (European Central Bank, 2001, p.35). There is also a broader need for historical Euro Area data as researchers attempt to analyse the impact of this monetary union on both Europe and the global economy, see for example Rudebusch and Svensson (2002) and Dees et al. (2007).

The issue of constructing appropriate historical Euro Area data is a deep one, involving the history of European monetary integration. Although there is no clear date that unambiguously marks the beginning of this integration, important milestones include the beginning of operation of the European Monetary System (EMS) in March 1979, the beginning of stage one of the European Monetary Union in 1990, the signing of the Treaty on European Union (the "Maastricht Treaty") in 1992 and the 1998 events of eleven countries[1] meeting the conditions for admission to the Euro Area and the establishment of the ECB (Scheller, 2004). This route has not always been smooth. For example, the EMS crises of 1992 and 1993 marked a period of considerable uncertainty about the prospects for continued movement towards monetary integration (Ungerer, 1997, pp. 260-271). Further, the countries participating in the European Exchange Rate Mechanism(ERM), which preceded the euro, changed over time and not always in the direction of continued integration[2]

[1]This excludes Greece, which became the twelth member of the Euro Area in 2001.

[2]For example, Spain joined the ERM in 1989, while Austria did not become a member until 1995 despite the fact that it had pegged its currency to the Deutschmark from the 1970s. Further, the UK (a Euro Area non-member) joined the ERM in 1990 but withdrew during the September 1992

Indeed, the Euro Area is not fixed, with expansions of the European Union being reflected in additional Euro Area members as and when these countries meet the convergence requirements[3]. The question of how to construct data appropriate for modelling the expanded Euro Area is an important topical problem, as this on-going process involves new member countries which typically have very different historical macroeconomic policies and characteristics from the original members. Further, at least hypothetically, there is also the possibility of countries leaving the monetary union at some future date. Therefore, the membership is dynamic. However, the recent literature that addresses historical aggregate Euro Area economic behaviour typically constructs data prior to 2001 based on the twelve Euro Area members as at that date, with a variety of techniques used to construct cross-country aggregates for these earlier periods. The most common approach is to employ a constant pre-specified set of weights, manifested for example in an aggregate interest rate series constructed using constant (GDP) weights in the widely-used quarterly AWM database, for which the sample period starts in 1970. A prevalent alternative is to use German data pre-1999, and a Euro Area aggregate subsequently. The former assumes an economic and financial homogeneity across countries that did not exist over most of this historical period, and thus fails to reflect the ERM crises and the changing monetary policies of countries that are now members of the Euro Area. On the other hand, the latter assumes that Germany is representative of the Euro Area as a whole. Neither appears entirely appropriate to deal with the changing membership of the Euro Area.

This paper proposes an alternative data historical aggregation method which we believe to be particularly appropriate for capturing the changing extent of monetary integration. In section 2 we discuss the current methods of construction for historical Euro Area aggregates and outline their uses to date. Then, Section 3 sets out our alternative approach, based on the idea of quantifying convergence of periphery countries towards a set of core countries, such that the former have increasing weights as integration progresses. Section 3.3 implements this methodology using exchange rates, with interest rates and inflation being discussed in an associated appendix. We then explore the effects of using our constructed financial variables for studying the Euro Area in Section 4, using historical decompositions of the residuals of vec-

EMS crisis, while Italy also withdrew from the ERM during this crisis and rejoined only in 1996 (Ungerer, 1997, pp.301-306). More recently, problems in Greece (and, to a lesser extent, elsewhere) have raised concerns about the future direction and form that monetary integration in Europe might take.

[3]Recently, Slovenia (2007), Cyprus and Malta (2008), and Slovakia (2009) have joined the Euro Area .

tor autoregressive models to assess how innovations in interest rates have influenced prices and output over the period of monetary integration. Section 5 concludes.

2 Methods for Constructing Euro Area Data

As just noted, there are essentially two approaches used to construct historical data to represent the Euro Area. This section discusses these in more detail, together with extant comparisons of the impact of different choices on empirical results. The main features of the databases providing Euro Area aggregates are summarized in Table 1, which provides a brief description of the weighting methods used in aggregating real, price and interest rate data, as well as the sampling frequencies and sample starting points and a pointer to the relevant source website, where available.[4]

2.1 Current methodologies

2.1.1 Cross-country aggregation

AWM database

The most prominent example of historical Euro Area data obtained from cross-country aggregation is the Area Wide Model (AWM) database, which provides quarterly measures of many economic and some financial variables, backdated to 1970. Constructed by the European Central Bank (ECB) in the process of building a model for the Euro Area (see Fagan et al., 2001, 2005), this database is now "standard" when undertaking academic and central bank based research on the Euro Area (see Dieppe, 2005). It is updated approximately annually, and is available to researchers from the Euro Area Business Cycle Network website.[5]

Apart from serving its original purpose, AWM data has now been used in the study of New Keynesian models of the Euro Area (see, eg, Gali et al., 2001), and in recent Dynamic Stochastic General Equilibrium (DSGE) models of Europe (see, eg, Smets and Wouters, 2003). It has played a role in the development of coincident and leading indicators for Europe (see, eg, Giannone and Reichlin, 2004; Banerjee et al., 2005), been used in studies of money demand and inflation (see, eg, Gerlach and Svensson, 2003), and in estimating monetary policy reaction functions (Gali et al., 2001). Details regarding the construction of AWM data are provided in Fagan et al. (2001), with aggregation being over the twelve Euro Area countries that defined the

[4]Golinelli and Pastorello (2002) provide a useful review of aggregation methods used in different papers investigating money demand in Europe.

[5]See http://www.eabcn.org/area-wide-model

area from 2001 to the end of 2006[6]. For most series, aggregation is performed on log levels, using weights based on real GDP in 1995, adjusted for purchasing power parity (PPP). This involves an implicit (and unrealistic) assumption of constant real exchange rates, but the aggregation of log levels using constant weights preserves the growth rates of aggregate variables. The AWM weights for the "euro 12" are given in Table 2.

Interest rates are aggregated in levels (rather than log levels), and although the AWM weights of Table 2 are used when individual country data is available for the entire historical period, substantial portions of the relevant raw interest rate data are unavailable. When data are missing, the weights on the available series are rescaled so that they sum to unity. One consequence of this rescaling is that the resulting aggregate series reflect time varying "composition effects", as well as simple time variation in the interest rates themselves.

The consumer price series in the AWM database is a quarterly average of the monthly Harmonised Index of Consumer Index (HICP) provided by Eurostat from 1990 onwards. The HICP uses its own set of weights, and the AWM historical values for the 1970s and 1980s are calculated by applying the 1995 HICP weights to growth rates in prices, and then using this series to construct a price index.[7]

Other approaches

Eurostat compiles many Euro Area aggregates, by transforming the national series into the euro currency and then aggregating (ECU currency is used prior to the euro). In contrast to the AWM data, the Eurostat approach maintains the consistency of the national accounts, but time variation reflects variation in exchange rates as well as variation in the underlying series. A different methodology is used for HICP, which (from 1995) has its own set of annual time-varying weights drawn from "household final monetary consumption expenditure" in each country (Eurostat, 2004). However, Eurostat series are available only from the 1990s onwards, so they are not widely used for academic research purposes.

A feature of the Eurostat database is that several Euro Area aggregates are available, reflecting the differing membership of the area. Thus, in 2007, data series for a specific macroeconomic aggregate (such as GDP) are published for the twelve Euro Area members of 2001-2006 or for the 15 members as of 2007, with a third series using a time-varying membership reflecting actual membership at the specific date. The same starting date (generally 1995) applies in all cases, so that they differ

[6]The original AWM database, outlined in Fagan et al. (2001), aggregated the eleven original Euro Area members as of 1999. However, subsequent versions of the database include Greece, while the latest version (dated September 2009) covers 16 member countries.

[7]Personal communication with Jose Emilio Gumiel from the ECB.

only in the countries being aggregated, hence leaving the researcher to select which is the most appropriate for a particular purpose.

OECD data for the Euro Area was previously compiled using fixed GDP weights adjusted for PPP, but the weights were based on 1990, and therefore differ from those used in the AWM database. These data are available from 1970, but have not received extensive use in the literature, probably because the methodology is similar to that of the AWM but its coverage is less extensive. For an example of its use, see Gerlach and Schnabel (2000). More recently, much of the OECD data for the Euro Area is sourced from Eurostat; see the OECD statistical databases at http://stats.oecd.org.

In order to avoid the perverse feature that a common currency aggregate of levels can fall even when all countries experience growth, Beyer et al. (2001) aggregate variables using growth rates. Additionally they propose a time varying weight methodology, which ensures consistency between movements in the components of the area wide aggregate and the behaviour of the aggregate, so that "the aggregate of the deflators corresponds to the deflator of the aggregates" to paraphrase Beyer et al. (2001, p.F103). The time varying weights in their construction of GDP are given by the share of GDP in the previous period valued in current ECU, and with constant exchange rates, this aggregation would be analogous to the aggregation of log levels in the AWM data base. Marcellino et al. (2003) also use aggregation in growth rates in their study of the Euro Area.

2.1.2 Representative country

Some researchers (see, for example, Brüggemann and Lütkepohl, 2006; Brüggemann et al., 2008; Corsetti and Pesenti, 1999) argue that the use of synthetic Euro Area data prior to the common currency is inappropriate because such data does not represent the outcome of a meaningful economic process. Typically, these researchers suggest the use of German data prior to the euro, since Germany is widely regarded as the leading continental European economy during the period, and early ECB monetary policy was largely designed to follow the successful example of the German Bundesbank. Additionally, Germany had the least adjustment to the convergence criteria of the Maastricht Treaty so that its data process is less distorted by policies designed to meet those criteria.

The use of German data as "representative" effectively places a weight of one on Germany prior to 1999 and then assigns weights across all twelve (or more) euro countries for subsequent data. Where required, such as for real output or monetary aggregates, some method of accounting for German reunification is adopted. Brüggemann and Lütkepohl (2006) find little evidence of instability in a VAR model for M3, GDP and the long term interest rate when using this approach. Some authors use German interest rates in models alongside Euro Area aggregates of other variables (such as inflation and or output). This practice is not common, but it can be justified by the view that German interest rates represent the European policy stance (Gerlach and Smets, 1999), or that they "offer the maximum safe return adjusted for risk" (Artis and Beyer, 2004).

On the other hand, the evidence provided by Ehrmann and Fratzcher (2005) that the relationship between European and US financial markets changed with the advent of the euro is doubtful, since the break they observe is synchronous with a change in the nature of their data, namely from German to weighted Euro Area series. Indeed, the existence of this break may be indicative that Germany pre-1999 is not fully representative of the later Euro Area.

2.2 Dataset comparisons and choice of data

Differences between the various available aggregates for the same underlying variable may be slight, or have little consequence for the analysis at hand; see, for instance, the European business cycle dating exercise undertaken by (Artis et al., 2004) or Moneta (2005) study of the leading indicator properties of European interest rates spreads. Conversely, the graphical comparison undertaken by Beyer et al. (2001) suggests there can be potentially important differences between aggregates, while the cointegration study of money demand undertaken by Bosker (2006) shows that the results can be sensitive to the particular data set used. Hong and Beilby-Orrin (1999) provide a general illustration of how different weighting assumptions can lead to different relationships between variables. Considering four potential methods of aggregating Euro Area data, they demonstrate that it is possible for different weighting structures to induce a positive move in one aggregated total and a negative move in another, even though both are based on the same underlying national data.

The fact that the aggregation method can influence an analysis implies that researchers working on the Euro Area economy need to consider what methodology suits their purpose, because no single data set is likely to satisfy all research needs. Policy analysis is especially tricky, because the nature of policy making in Europe has changed over the last thirty years. During the 1970s and 1980s policies were set by national governments, so that Euro Area aggregates for this period are irrelevant from a policy-making perspective simply because there was no area wide policy. Aggregates for this era can therefore, at best, reflect policy and its effects in a subset of countries that are deemed to be "representative" for the purposes of analysis. As discussed above, a number of authors have argued that German monetary policy during this period is representative of the subsequent Euro Area. Against this, however, Nautz and Offermanns (2006) find that modelling the pre-euro period using synthetic Euro Area aggregates (constructed using the Beyer et al. (2001) methodology) out-performs German data in an empirical exchange rate model used to forecast post-euro exchange rate behaviour against the US. On the other hand, Brüggemann et al. (2008) examine whether the use of German or aggregated national data pre-euro provides better forecasts of Euro Area data, with results dependent on the variable in question.

Particularly in the 1990s, the various national monetary policies evolved into arrangements designed to meet the agreed criteria for Euro Area membership, and international aggregates (based on a growing number of countries) become increasingly relevant for the analysis of policy, at least for those countries that were progressing towards Euro Area membership. As already noted, this issue is a current one, since the progression of the new member countries of the European Union towards Euro Area membership raises the issue of how their data should be incorporated into Euro Area aggregates.

Overall, it seems that aggregation based on a constant weighting scheme (such as the AWM benchmark) is unlikely to be appropriate for studying policy over the entire postwar period, as is the use of an abrupt structural break in weights (as in Brüggemann and Lütkepohl, 2005, 2006). Our analysis in Section 3 illustrates that a simple fixed weight aggregation over the euro twelve is distortionary for the analysis of exchange rates, and it is reasonable to anticipate that similar issues will arise in relation to the contemporary question of measuring other monetary and financial characteristics of the expanding Euro Area.

3 Proposed Data Construction Methodology

This section deals with our proposed methodology for constructing historical data for the Euro Area and applies it to construct a bilateral exchange rate series against the US dollar. This methodology is based on the idea of measuring the distance from monetary/financial integration between a set of core countries and ones that can (at least initially) be described as the periphery. The core may be considered leading European countries with respect to their financial markets and monetary policy over the entire period, whereas this does not apply for the periphery countries. While financial markets in the latter may be described as underdeveloped in the 1970s, the process of monetary integration in Europe has been associated with greater integration across financial markets; see Cappiello et al. (2006).

This core/periphery country distinction suggests that the use of constant weights for financial and monetary aggregates will tend to overweight the importance of the countries that were relatively unimportant in international financial terms in the early parts of the sample, and thereby underrepresent the role of the leading European markets. This point is illustrated very clearly by considering the AWM weights in Table 2. Spain, Italy, Portugal and Greece account for 36% of the AWM Euro Area weights. Comparing monthly (inverse) bilateral exchange rates for the German mark and French franc against the US dollar in Figure 1(a) with a corresponding AWM-weighted aggregate of the twelve Euro Area countries[8], the figure emphasises the role of periphery countries in financial aggregates computed using AWM weights during the 1970s and early 1980s.

3.1 Sliding weights

Rather than employing constant weights, our method tapers (up) weights for the periphery countries so that they achieve their full weight only with full monetary integration, represented by the establishment of the Euro Area in January 1999. For the pre-euro period, this methodology depends on measuring the time-varying distance (in terms of monetary integration) of the periphery countries from those in the core, with the latter countries assumed to be integrated throughout. Although the discussion below is in terms of the pre-euro period, it can easily encompass the situation of new member countries joining the Euro Area, as discussed further in Section 3.4 below. The pre-2007 euro twelve would constitute the core, and new member countries the periphery, which are assumed to reach full integration on joining the area.

Our method is based on the existence of a variable x such that $x_{j,t}$ is the value at time t (prior to January 1999) for periphery country j, and $x_{core,t}$ is the corresponding value at t for the core countries, while $|x_{j,t} - x_{core,t}|$ measures the distance that country j is (at t) from monetary integration with the core. Since the periphery and core are in a monetary union from the establishment of the Euro Area, $x_{j,t} \equiv x_{core,t}$ for $t \geq$ January 1999. In order to render it measure-free, this distance at time t is scaled by the distance of j from the core at a base date selected to represent the commencement of the process of integration. We work with monthly data and select March 1979 for this purpose, due to its importance in the history of European monetary integration, as the date at which the European Monetary System began

[8]All individual country exchange rates were first converted to euro rates using the irrevocable exchange rates of 31 December 1998. To construct AWM equivalent series, the AWM weights are then applied.

and the ECU was created[9]. Previous literature on European integration often selects this date as a watershed, as in Artis and Zhang (1999). Therefore, our measure of the relative distance that country j is from integration with the core at time t is given by

$$d_{j,t} = \min \left\{ \frac{|x_{j,t} - x_{core,t}|}{|x_{j,base} - x_{core,base}|}, 1 \right\} \tag{1}$$

where $0 \leq d_{j,t} \leq 1$, with 0 representing full integration and 1 representing no integration at t. This measure is relative to the distance at $t = base$, namely at March 1979. Where the distance exceeds the base date value, namely $|x_{j,t} - x_{core,t}| > |x_{j,base} - x_{core,base}|$, then $d_{j,t}$ is assigned the value 1. By construction, if the selected base date falls within the sample period, and the latter includes the post-1999 period of full integration, both extreme "regimes" will be present in the sample.

We also assume that we have available a weight $w_{j,F}$ that represents the importance of country j once integration has been achieved. In practice, for this purpose, we adopt the AWM weights of Table 2. Then, based on $w_{j,F}$ and the distance (1), the sliding weight $sw_{j,t}$ for country j at time t in constructing the historical Euro Area aggregate is computed as:

$$sw_{j,t} = w_{j,F} \times (1 - d_{jt}) \,. \tag{2}$$

That is, the sliding weight $sw_{j,t}$ represents a changing fraction of the final weight for country j, where that fraction is inversely related to the relative distance from the core in relation to distance at our base date of March 1979.

3.2 Implementation issues

Implementation of the methodology of subsection 3.1 requires selection of the variable x measuring monetary integration and the classification of countries into core and periphery categories. For these purposes, we focus on the exchange rate, because one essential feature of the Euro Area is that it is a *currency union*, which leads us to define a periphery country's convergence to the Euro Area in terms of it approaching its irrevocable exchange rate of 31 December 1998. To be more specific, we use the (inverse) bilateral exchange rate with the US dollar as x, with full integration represented by the \$/euro rate of January 1999 onwards. Focussing on bilateral rates with the US is relevant, since it is the dominant world currency. Values of

[9] The ECU weights were considered as alternative weights, but some ECU countries (UK and Denmark) are not currently part of the Eurozone. Additionally backdata is not available on this basis and would hence also need to be constructed.

$x_{j,t}$ for the earlier period are obtained as the periphery country's (inverse) bilateral rate with the US at t[10], expressed in the common euro currency using its irrevocable euro conversion rate. Through PPP and UIP arguments, the exchange rate also encompasses monetary integration measures based on inflation and interest rates.

As the focus in our application is on appropriate sliding weights for constructing Euro exchange rate back data, we define the Euro Area core as consisting of the two dominant currency markets during that period; Germany and France. We do this, because only the German Deutschemark and French franc had sufficient volume to merit separate inclusion in the BIS Triennial surveys prior to the introduction of the Euro. However, as Austria pegged its currency to the Deutschemark, which the Dutch guilder also followed closely, we also include these two countries in the core. Also, since the core represents the group of countries which are not far from the dominant European exchange rates of the Deutschemark and French franc, we include the Benelux countries which traditionally followed the dominant rates, and the Irish punt which followed the French franc closely from 1976 onwards. Our selection of the core is based on the observed behaviour of the candidate exchange rates. However, Artis and Zhang (2001) select the same grouping when they chose those which satisfied the theoretical criteria for an optimal currency area using a range of macroeconomic data.[11] Others, such as Camacho et al. (2006), examine business cycle synchronicity across this set of countries using variables such as trade links and industrial production to extract commonalities. The resulting cores differ slightly. However, given our methodology, if a small weighted currency (such as the Irish punt), which is closely correlated with the core is instead placed in the periphery, the effects on the resulting weights are negligible. All studies agree on the core position of France and Germany.

Our core countries are listed on the left hand side of Table 2. Other definitions of core and distance from core might be considered, with a leading contender being based on the so-called German leadership hypothesis for interest rates in Europe, which would place Germany alone in the core and define distance from the core in terms of short-term interest rates, eg see Karfakis and Moschos (1990). However, the validity of the German leadership hypothesis remains an open issue; see, for example, Hassapis et al. (1999) or the results for forecasting short-term interest rates in Brüggemann et al. (2008). On the other hand, our inclusion of other countries in the core is compatible with Dunne et al. (2007), who find interest rate leadership to be contested between France and Germany at the introduction of the euro, and with

[10] These were all obtained from the OECD.

[11] In fact, Artis and Zhang (2001) do not include Luxembourg in their analysis, presumably due to data limitations. Otherwise their core is identical to ours.

the conclusion of Nautz and Offermanns (2006) that the behaviour of the German mark alone does not forecast that of the euro.

The core countries account for a total of 62.8% of the total aggregation weight, with Germany and France contributing 28.3% and 20.1% respectively. The series $x_{core,t}$ is computed for the pre-euro period by aggregating the individual core country exchange rates (expressed in euros), using the AWM weights for these countries scaled up to total unity. Since only the euro currency exists from January 1999 onwards, $x_{core,t} = x_{j,t}$ for $t \geq$ January 1999. The resulting series is shown in Figure 1(b).

The periphery countries then consist of those on the right hand side of Table 2 consisting of Italy, Spain, Greece, Portugal and Finland. During the 1970s and 1980s the financial markets in these countries were not well-developed internationally integrated markets, and all of them appear as having high measures of 'original sin' in the Eichengreen et al. (2005) measures even for as late as 1993-1998. Additionally they all experienced multiple banking and/or currency crises during those two decades, see Eichengreen and Bordo (2002) and in the case of Finland for example, suffered a serious structural shock associated with changing trade dependence with the former USSR.

In order to construct our synthetic Euro Area series, the sliding weights of (2) for the periphery are employed alongside the fixed weight of 0.628 for the core. This implies that the weights pre-1999 may sum to less than 1, in which case all weights are redistributed to ensure a sum of unity. By construction, through (2), no weight is allocated to the periphery, and hence all weight is allocated to the core, at the base date of March 1979.

The next subsection applies this methodology to construct a historical (inverse) bilateral exchange rate series for the euro with the US dollar, with interest rates and consumer prices discussed in an appendix. It is worth noting that the weights obtained from (2) are readily applicable to other Euro Area financial aggregates, such as equity returns. While they could also be used for real measures (such as real GDP), the impact will be much less marked than for financial series.

3.3 Euro Area exchange rates

The AWM data base includes several trade weighted indicators of historical exchange rates[12], but it does not include any bilateral series. We constructed the AWM-

[12]This includes the ECB's Effective Exchange Rate (EER) which is based on trade with 12 countries (Australia, Canada, Denmark, Hong Kong, Japan, Norway, Singapore, South Korea, Sweden, Switzerland, United Kingdom and United States), as well as others based on groups of up to 42 countries.

weighted bilateral monthly exchange rate series shown in Figure 1(a), and discussed above, as a synthetic series for euros to US dollars using the (fixed) AWM weights for the pre-1999 period. Euro Area exchange rate series with other (non-euro) countries can, of course, be constructed from this US/euro exchange rate series using the no-arbitrage condition.

Figure 1(b) shows the Italian, Spanish, Greek, Portugese and Finnish exchange rate series $x_{j,t}$, alongside the historical exchange rate series we construct for the core countries against the US, $x_{core.t}$. A cursory glance at this figure explains the influence of the periphery countries on the AWM aggregate in Figure 1(a). In particular, although the exchange rates of Italy and Spain were not of international significance in the 1970s, their combined weight of over 30% has a large influence on this aggregate. Further, although Portugal and Greece have very low weights, the fact that their currencies were far from their final euro exchange rate values early in the sample period implies that they also have a non-trivial influence on early values of the AWM aggregate. Indeed, Figure 1(b) shows that Greece and Portugal made substantial progress towards their eventual euro exchange rates during the first half of the 1980s, and this progress is reflected in our sliding weights.

Figure 2 provides a selection of our sliding weights, with $base$ = March 1979, to show how our scheme accounts for the increasing influence of the periphery countries as their currencies approached the irrevocable exchange rates. Noteworthy features of these weights are the strong increases in the influence of the Italian and Spanish contributions over the period from 1979 to 1992 (accompanied by corresponding decreases in the German and French contributions), that were hastened by the EMS crisis in 1992. The Greek and Portuguese contributions began at around 1980, but remain low because of the relatively small sizes of these two economies.

Figure 1(c) contrasts the series computed using (constant) AWM weights and our sliding weight methodology, where the large divergence in the 1970s is apparent. Our constructed "historical" series has reduced the exchange rate in the early 1970s relative to a method based on the AWM weights, downweighting the extreme values of the peripheral countries' exchange rates depicted in Figure 1(b) and moving closer to the exchange rates in the core countries. We believe that this new euro exchange rate with the US dollar provides a useful measure of a European exchange rate that was important for financial markets during the 1970s and 1980s. Finally, Figure 1(d) illustrates the (inverse) Deutschmark and French franc bilateral rates to the US dollar together with our constructed series.

3.4 Robustness Analysis

Our calculated sliding weight exchange rate series depends on our choice of March 1979 as the base date from which integration is assumed to begin, our classification of countries into core and peripherery, and our use of the $US/Euro exchange rate as our indicator of monetary integration, and it is useful to assess the impact of each of these choices. It is also useful to outline how our back-dating scheme can account for the entry of new countries into the monetary union.

Two reasonable alternative base dates for our sliding weights are January 1970 (the first observation in our data set) and February 1992, which was when the Maastricht Treaty was signed. The consequences of using these alternative dates are illustrated in Figure 3(a), where hist70 and hist92 indicate sliding weight exchange rate series that have been calculated using exactly the same procedures as our historical series in Section 3.2, but using January 1970 and February 1992 (respectively) as the base date. Figure 3(a) shows that use of the earlier base date leads to a higher valuation of European currency over 1975 to 1999, with differences being particularly apparent in the decade from 1975 to 1985. On the other hand, use of the later date leads to a slightly lower valuation of European currency, especially from about 1980 until 1995. Neither of these differences is large, relative to the difference between our 1979 based series and one that uses constant AWM weights.

We examine the effects of our classification of core countries by considering four alternative classifications; one in which Germany is the sole member of the core, one that includes just Germany and France in the core, and two others that successively add Italy and Spain into the core. We use March 1979 as the base date in all cases. The first classification leads to a different measure than one that uses the German Mark as a representative European currency, but the resulting measure (labeled histg in Figure 3(b)) is nevertheless highly dependent on the US/DM exchange rate. This series shows that the use of just Germany in the core leads to a lower valuation of the European currency relative to our preferred sliding weight measure (hist79), especially during the early parts of the sample. However, once we add France to Germany to form the core, the resulting sliding weight exchange rate series (histgf) closely resembles that implied by our chosen core. An expansion of the core to include Italy, and then further to include Spain, leads to sliding weight exchange rate series (histgfi and histgfis) that now resemble the constant weight AWM series more closely than our chosen series. These latter changes are dramatic, showing that the differences between our sliding weight exchange rate series and the constant weighted AWM series are largely driven by the values of Italian and Spanish currencies over the period from 1970 to 1985.

We conduct another exercise that considers a change in the way we measure country j's preparation with respect to joining a currency union. In our earlier implementation of equations (1) and (2) we obtained x_{jt} by converting each country's exchange rate with the US Dollar into a $US/euro exchange, but now we consider x_{jt} measured as euro/$US. With all measurements and calculations done in terms of euro/$US, the final series (histr) is converted to $US/euro only for presentation purposes in Figure 3(c). Also for comparison, we weight each individual country's euro/$US exchange using the AWM weights to obtain a series called AWMR, which is then converted back to $US/euro for presentation. The resulting (new) sliding weight series values the euro slightly lower than the previous series until the late nineteen eighties, while the new constant weight AWMR series is substantially lower than its AWM counterpart over the same period. The exercise shows that the sliding weight aggregated series is relatively robust to the choice of the variable x_{jt} that is used to form our weights.

The set of countries in the Euro area has changed since the introduction of Euro, and although the new countries are relatively small and affect aggregated series very little, it is useful to discuss how our backdating schemes would account for this. Slovenia was the first accession country to attain full membership, entering in January 2007 after satisfying the Copenhagen criteria that were determined in June 1993. A revision that incorporates this information would use June 1993 as the base and treat the Euro12 countries as the core, using our sliding weight exchange rate series (hist79) as $x_{core,t}$ in (1) for June 1993 $\leqslant t \leqslant$ December 2006. Since the PPP adjusted GDP contribution of Slovenia to the Euro area in 2007 was approximately 0.38%, the revision would set the final weight $w_{Slovenia,F} = 0.0038$ in (2) and hence obtain the Slovenian sliding weight series $sw_{Slovenia,t}$. The revised aggregated exchange rate series would then combine the Slovenian and hist79 exchange rate series in the ratio $sw_{Slovenia,t} : (1 - sw_{Slovenia,t})$.[13] Neither the revised series, nor a further series which accounts for the entry of Cyprus and Malta into the monetary union in January 2008 are visibly distinguishable from our hist79 series,[14], but we could expect notable differences once Poland or Hungary joined, or if the UK were to join. We illustrate the effect of changing the set of countries in the Euro area by comparing sliding exchange rate series based on the Euro11 (i.e. the Euro12 countries excluding Greece) and our series (which is based on the Euro12 countries) in Figure 3(d). The series based on

[13] The Slovenian/USD exchange rate is first converted to USD/Euro using the irrevocable exchange rate of 239.64T/Euro. The estimated final weight for Slovenia is derived from the 2009 CIA fact book.

[14] The incorporation of Cyprus and Malta into the monetary union, involves the calculation of sliding weights for June 1993$\leq t \leq$ December 2007, using the Euro13 countries as the core, $w_{Cyprus,F} = 0.00158$ and $w_{Cyprus,F} = 0.00068$.

the Euro11 is labeled hist11. Although Greece has a final weight of only 0.025, we can see that it has a small but noticeable effect on the aggregated sliding weight series from about 1980 until about 1992.

4 Monetary Policy Implications

It is interesting, and potentially important, to track how the use of different aggregation methods might influence our understanding of how monetary policy variables (typically interest rates) affect policy target variables (such as prices and output), and we use the technique of historical decomposition to undertake such an analysis.

4.1 Historical distribution using a VAR

Historical decomposition is based on innovation-accounting techniques in the context of vector autoregressive (VAR) models, but instead of decomposing the forecast variance of a series into components due to various structural innovations, it decomposes forecast change in that series beyond a fixed (in-sample) point in time into components due to structural innovations. Such decompositions are particularly useful in the context of this paper, because they enable in-sample study of the joint evolution of policy and target variables over particular episodes of time.

Working with a moving average representation of an N-variable VAR model for y_t, with raw and structural innovations denoted by u_t and $P^{-1}u_t$, the decomposition is based on

$$\begin{aligned} y_{t+j} &= c + \sum_{s=j}^{\infty} \phi_s u_{t+j-s} + \sum_{s=0}^{j-1} \phi_s u_{t+j-s} \qquad (3) \\ &= c + \sum_{s=j}^{\infty} \phi_s u_{t+j-s} + \sum_{i=1}^{N} \sum_{s=0}^{j-1} (\phi_s P e(i)).(e(i)' P^{-1} u_{t+j-s}), \end{aligned}$$

where $e(i)$ is a vector that has a 1 in the ith position (and zeros elsewhere). The first term provides a baseline that summarises initial conditions at time t, and our focus is on the last term, which decomposes forecast errors u_{t+j} made from time t onwards into components attributable to each of the N structural innovations in $P^{-1}u_{t+j-s}$ that occur subsequent to t. Unlike variance decomposition, historical decomposition can involve negative contributions and, for a specific period, a single contribution can be bigger than the sum of all contributions. The decomposition allows one to show how a single set of structural shocks (in our case interest rate shocks) influence the evolution of one (or more) of the variables included in the VAR. In our case, the matrix P used to identify the structural shocks is an orthogonalising matrix based on the Choleski decomposition, although other transformation matrices could have been used.

Our decompositions are based on a slightly modified version of the Sims (1992) model[15]. More explicitly, we include the short-run interest rate (r), the log exchange rate for the US dollar vs euro (e), log commodity price index (cp), log consumer prices (p) and log GDP (y). As in Sims (1992), identification of structural shocks is achieved by orthogonalising the contemporary effects based on this variable ordering, so that (structural) interest rate innovations affect all other variables in the current period, and (structural) innovations in log output have no immediate effect on the other variables. This ordering accentuates the effects that structural shocks associated with interest rates have on the target variables of prices and output. The commodity price index is an international variable, while all other variables relate to the Euro Area.

Following Sims (1992), we work with an unrestricted VAR (hence cointegration is not imposed), so that all variables are in levels. Our data is measured at a quarterly frequency with monthly data converted to this frequency by averaging, and the effective estimation sample includes observations that run from the first quarter of 1971 to the last quarter of 2007. The VAR employs 4 lags, consistent with Sims' 14 lags in monthly data. Two datasets are used in estimation, with the key difference between them being that one data set employs Euro area interest rates, exchange rates and prices that have been constructed using the sliding weights discussed in Section 3.3, while the other employs Euro area interest rates, exchange rates and prices that have been constructed using AWM weights. Details relating to the construction of the sliding weight exchange rate series have been discussed in Section 3.3, while interest rates and consumer prices are discussed in the Appendix. The commodity price and output data are common to both data sets, and these variables are drawn from the AWM database.

4.2 Aggregation effects

Parameter estimates from both sets of data are very similar and imply well behaved models (in that eigenvalues fall within the unit circle and impulse response seems to settle). Residual based tests find no evidence of serial correlation, which indicate

[15] Our model does not employ money supply, as this series for the Euro Area is not available from the AWM database. The change from the Sims (1992) specification in omitting money supply reflects subsequent developments in monetary policy and changed views of the inflation process.

that the chosen lag length (of 4) is sufficient in each case. Nevertheless, the historical decompositions implied by the two VARs suggest some difference in the analysis of the effects of the policy shocks on the target variables. A selection of historical decompositions that use the first quarter of 1971 as the reference date are provided in Figures 4 and 5.

Figures 4a) and b) give the cumulated impacts of interest rates shocks on prices (and hence inflation) in the AWM and the sliding weight data respectively. In each panel the solid line represents the (cumulated) effect of interest rate shocks on prices estimated by the VAR system, and the short dashed lines present 95% confidence bands around the historical decomposition. The long dashed line represents the total movement in prices measured using each model. The point estimates of the decompositions are measured imprecisely, in common with most applications, but we follow standard practice and focus on the economic history suggested by these estimates. To aid interpretation, consider where prices would have been in 2007 in the absence of any interest rate innovation, given the AWM data (illustrated in Figure 4a). Here, we see that without the negative contributions of interest rates, prices would have been higher (closer to the zero line). In inflation targeting regimes we anticipate that interest rate innovations - which broadly represent monetary policy shocks - should run countercyclical to prices; that is when prices are rising (i.e. total price residuals are above the zero line), interest rate innovations should be acting to bring them down, and hence show as contributing negatively to an estimated price outcome.

In this light Figure 4a), using the AWM dataset, shows that the contributions of interest rate innovations to price outcomes are always positive from the third quarter of 1981 until the third quarter of 1996, during a period when inflationary pressures are also positive. Hence it appears that monetary policy settings were too easy. From the last quarter of 1997 to the end of the sample period inflationary pressures were low, and interest rate innovations were contributing to this lower inflation. Only in the short intervening period from 1996Q4 to 1997Q3 were interest rate innovations contributing to offset higher prices. Although the sliding weights dataset confirms the direction of most of these findings, the countercyclical episode of interest rate innovations to inflation just mentioned lasts longer in this case (namely, to the end of 1997). Further, in the early part of the sample (1971 to 1974) there is also evidence of countercyclical monetary policy shocks with the sliding weight data, with policy acting to keep prices stable in this case. It may also be noted that the differences between the contribution of interest rate innovations to prices and those of the other variables (that is, the differences between the solid and dashed lines) is more marked around the end of the 1970s for the sliding weights data than in the AWM case.

Although fighting inflationary pressures is the primary aim of monetary policy, the impact of monetary policy on output is also taken into consideration by most pragmatic policy makers. Figure 5 gives the estimated impacts of interest rate innovations on output for the VAR models as the solid line, with 95% error bands shown by the short dashed lines, and the total output series as the long dashed line. Output outcomes are again expected to show evidence of countercyclicality with respect to interest rate innovations, although perhaps with a slight lag, as inflationary pressures build up with excess demand and drop with excess supply. Countercyclical effects are evident in both datasets, although we see one more instance in the sliding weight data than in the AWM data. Around 1976 there are differences in the timing and lengths of countercylical effects according to the two datasets, with the sliding weights data implying that monetary policy plays an important role in the recovery from the early 1970s recession.

It is a common result that interest rate innovations contribute to negative output results from late 1982 until mid 1985, but the effect is longer by a full year when using the AWM data. A notable difference between the datasets occurs in the mid 1980s when in the sliding weights database, interest rate innovations almost zero two years from 1985Q3, while the AWM database results indicate countercyclical monetary policy did not begin until the end of 1986, but was more ponounced. Further, in 1997Q4 (in the aftermath of the East Asian crisis), interest rate innovations begin to stimulate the economy in the sliding weights dataset, but this does not occur until two quarters later according to the AWM dataset. Also, for the period from 2004Q2 to 2005Q3, the sliding weights interest rate innovations act to offset growth in the economy, which is not the case for the AWM estimates. Thus, the sliding weights dataset provides more evidence of active monetary policy acting to offset cyclicality in growth than does the AWM data.

Our purpose here has been to point out that the choice of methodology for creating a Euro Area wide data is not without consequence, and data needs to be fit for purpose. In particular, while it may be sensible to aggregate real economic variables on the basis of GDP weights as in the AWM database, we believe this is not the case for monetary or financial variables. The consequences of these changes may lead to differences in policy evaluations, as witnessed in the above historical decompositions.

5 Conclusions

In an introductory discussion of monetary policy in the Euro Area, the European Central Bank (2001, p52) refers to the importance of "long runs of *backdata*" to underpin econometric analysis essential to understand the operation of the economy in which monetary policy operates. The Area Wide Model project detailed in Fagan et al. (2005) provides such series, and this has become the benchmark for historical analyses of the Euro Area. However, this database is not suitable for all purposes. It does not cover all series that a researcher may wish to include, nor is its method of aggregation using fixed weights appropriate in all circumstances.

This paper has focussed on the issue of constructing backdata for monetary and financial variables, first showing the rather dramatic changes in the levels of the historical euro exchange rate implied by using alternative weighting mechanisms. We propose a sliding weight methodology that incorporates the convergence of exchange rates in periphery countries to their irrevocable exchange rates during the development of the current Euro Area. Our methodology addresses the Rudebusch and Svensson (2002) suggestions for ensuring that synthetic backdata are appropriate. We construct historical Euro Area series for short and long interest rates, and consumer price inflation, in addition to exchange rates. The methodology could, of course, be applied to further series, including stock market prices. Although we recognise that other methods might have more desirable properties in alternative applications, we believe that our approach gives a more realistic view of the historical evolution of monetary and financial variables associated with the Euro Area than a fixed weight aggregation. Further, our sliding weight methodology recognises that, while some countries (such as Germany) may have had a dominant role in the development of Euro Area monetary policy, the use of German data alone pre-1999 may not be an adequate proxy for the later Euro Area (Nautz and Offermanns, 2006, see also).

Our application to a simple VAR model of the Euro Area demonstrates that different implications for the role of policy can be obtained when an historical analysis is undertaken using our data rather than the benchmark AWM dataset for the Euro Area. In particular, the historical decompositions point to a more active role for interest rates in countering cyclical movements in growth. Whether this reflects the true workings of monetary policy over the period is an open question, but it does accord with the reputation of the Germany monetary policy in the pre-euro period. Further investigation of this issue is beyond the scope of the present paper, but our work indicates the need to carefully consider the appropriateness of different methods of historical aggregation in the context of increasing monetary integration.

Constructing historical data for the Euro Area is an important practical issue, which is also a contemporary one as new member countries join the area. Our sliding weight methodology can handle this situation of time-varying membership, without distorting analysis of policy in the Euro Area between 1999 and 2007 by the unrealistic assumption that the new members participated from the initial adoption of the euro currency. The alternative assumption of a structural break as each new member joins is unattractive, not only due to the number of such breaks that may apply, but it also because it fails to recognise the increasing role of such countries in Euro Area policy-making as they prepare to join the area.

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Appendix: Other Euro Area Aggregates

Here we briefly discuss the impact of the use of sliding weights on interest rate and consumer price aggregates, compared with series constructed from AWM weights. The series discussed here, like the bilateral exchange rates, are monthly.

Interest rates:

Considerations relating to the aggregation of interest rates are that the short term interest rate in the Euro Area is set by the ECB and is common to all member countries, whereas the long term interest rate is market determined and can differ between countries. Cross country variations in the latter reflect the degree of commitment that market participants believe that countries might have with respect to meeting the Euro Area targets for fiscal and monetary probity, different institutional structures, different country and sovereign risk factors, and different inflationary outlooks brought about by supply side and other factors.

Our raw interest rate series relate to three month and ten year maturities, and most are from the OECD, or from datastream or International Financial Statistics of the IMF when OECD data was not available. Details are available from the authors upon request. We construct interest rate series for short and long term bonds for the period from January 1970 until December 1993, and then use interest rates for the Euroibor and the ECB's 10 year bond thereafter. The latter series are available from the ECB from 1994 onwards, and since these series are already in common use and they smoothly splice onto our sliding weight series at that point, we stop our own weighting there, rather than when the euro was introduced in 1999. In constructing our historical rates for 1970 to 1993, we use the same set of sliding weights as those used for the exchange rates in section 3, and when country specific observations on interest rates are not available for a given month, we redistribute these weights across the available interest rates in proportion.

Figures 6(a) and 6(b) show our constructed short and long term interest rates, together with the German short and long term interest rates, and corresponding rates that have been constructed using the AWM weights. We treat the AWM weight series in the same way as our historical weighed series in that we stop using the AWM weights after 1993, and use the ECB data on the Euroibor and 10 year bond thereafter. The divergence between our sliding weight interest rate series and those based on AWM weights is most pronounced in the period between 1976 and 1980. During this period, our series shows a much greater decline in interest rates (corresponding to the fall in German rates) than the AWM series. Subsequent to this date our interest rate series have similar patterns to the corresponding AWM aggregates, and they become very similar in the early 1990s. The series are also close at the beginning of the 1970s, but this proximity is partly a consequence of data availability, since Italian and Spanish short rates are unavailable for this period, as are long rates for Spain. Note that this unavailability has less influence on our aggregate than on the AWM series, because the exchange rate series were further from the core at that time and hence these periphery countries had little weight in our aggregation (see Figure 1(b)). As might be expected, both weighted series for short and long rates are higher than their German counterparts, suggesting that the monetary policy indicator for Germany over 1970 to 2009 was not representative of Europe as a whole.

Consumer Prices and Inflation:

The ECB uses the harmonised index of consumer prices (HICP, constructed by Eurostat) as the basis of monetary policy decisions, and as observed in Hill (2004), the aggregation involved to produce this series is temporally consistent, but not spatially consistent. The HICP inflation series starts from 1991, but cross-country aggregation for dates prior to 1990 needs to address a series of problems, because different countries constructed their price indices differently, and some, but not all countries have produced seasonally adjusted indices. The HICP price series starts from 1996, several years later than the inflation series. Diewert (2002) provides a comprehensive critique of the construction of the HICP, which he describes as neither consumer nor producer theory based, but an amalgamation of the two. A further concern, but a side-issue in our context, is an apparent strengthening in seasonality from 1999 onwards, which possibly pertains to treatment of sales data in the construction of the underlying indices.

Given that price and inflation levels are often important in the construction of real interest rates, real returns and purchasing power parity tests, and that relevant back data for aggregate data is limited, we construct inflation and price series that are consistent with the financial data. More specifically, we aggregate the individual country CPI (all items) series by aggregating the monthly growth rates using the sliding weights obtained from Section 3 and then converting the growth rates to a price index, setting January 1970 as 100. We then splice our resulting price series into the available HICP series (which starts in 1996), rebasing the former so that the HICP price series is extended into the past.

For inflation, we backdate the available HICP inflation series (that starts in 1991) by converting our constructed price index into a monthly series that measures annual growth in prices. Figure 7(a) shows the Euro Area annual inflation rate (observed on a monthly basis) that results from these calculations, along with corresponding German[16] and French inflation rates. To show the differences implied by our approach, Figure 7(b) compares our calculated Euro Area annual inflation rate against a series that aggregates monthly growth rates of prices using the AWM weights. The inflation rate via the sliding weights method is somewhat lower in the 1970s, and because its weight on Germany in the late 1980s is lower, it reflects a higher European aggregate at this time than the AWM weighted inflation rate.The sharp drop in 1988 that is evident in the AWM graph is due to probable data recording errors in the original price data for the Netherlands.

Finally, a quarterly seasonally adjusted HICP series is available from 1992 onwards. For the quarterly sliding weight prices series used in the analysis of Section

[16] German inflation in Figure 7(a) shows an artificial decline in 1991, which is due to the inclusion of (lower) prices from the former East Germany in an index previously based on prices from West Germany. This effect has been removed from the aggregate series.

4, we use the quarterly averages of the annual inflation series constructed using the monthly sliding weights, to back-cast the seasonally adjusted HICP series. The resulting series then adjusts for the apparent seasonal patterns noted above.

Figure 1: Exchange Rates

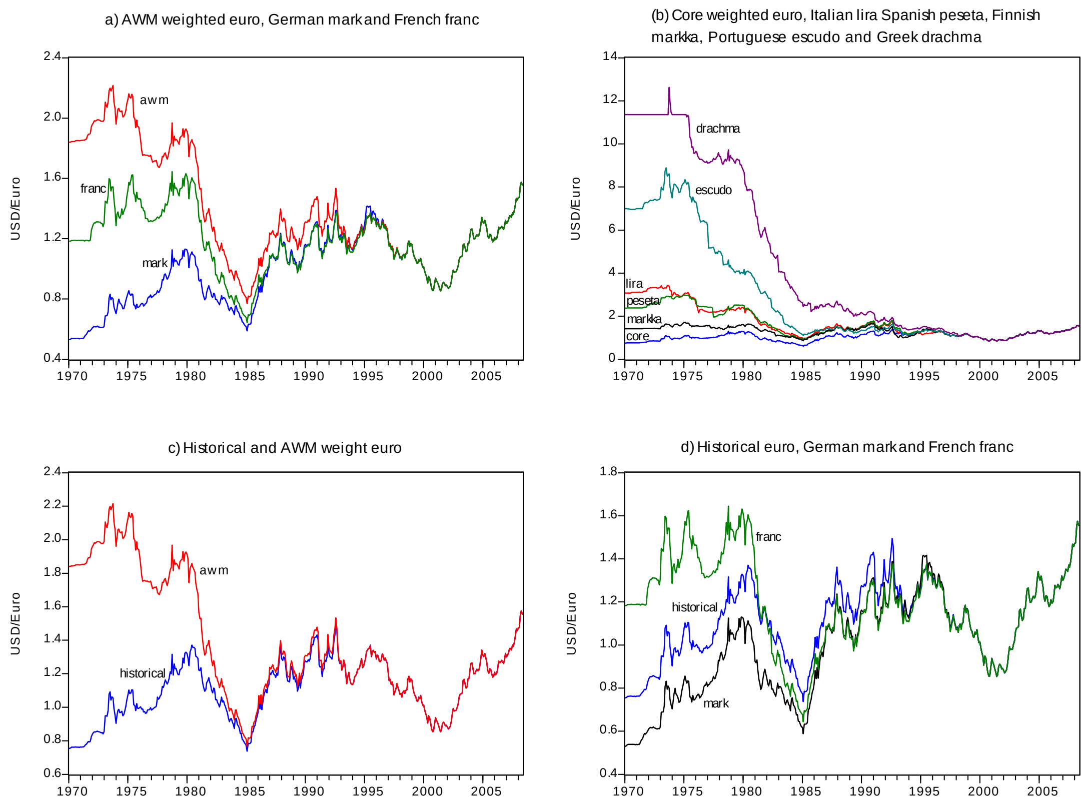


Figure 2: Sliding weights for selected countries

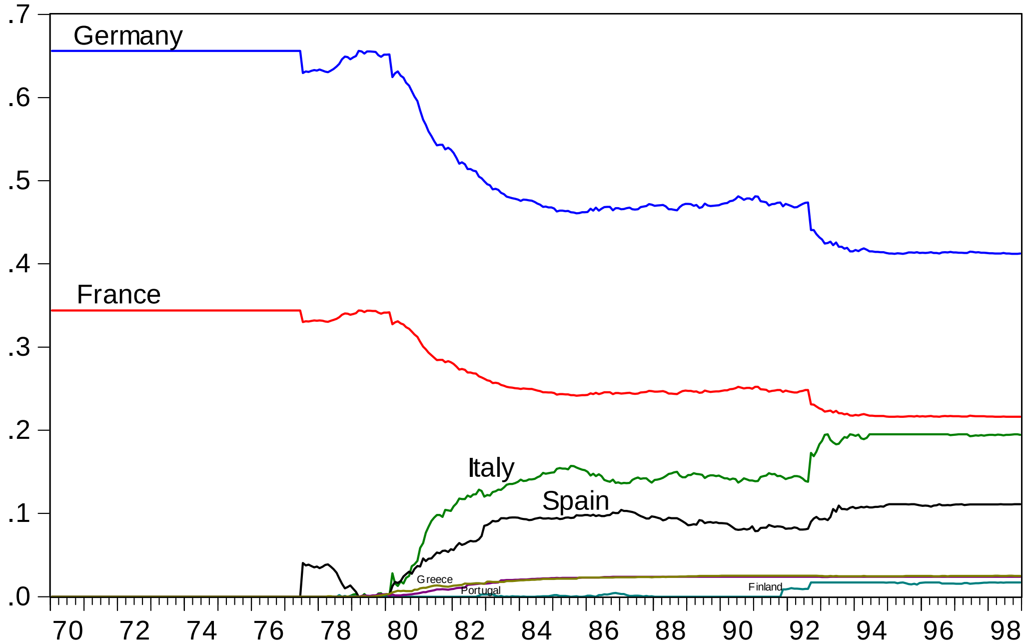


Figure 3: Variations in Aggregation Methodology

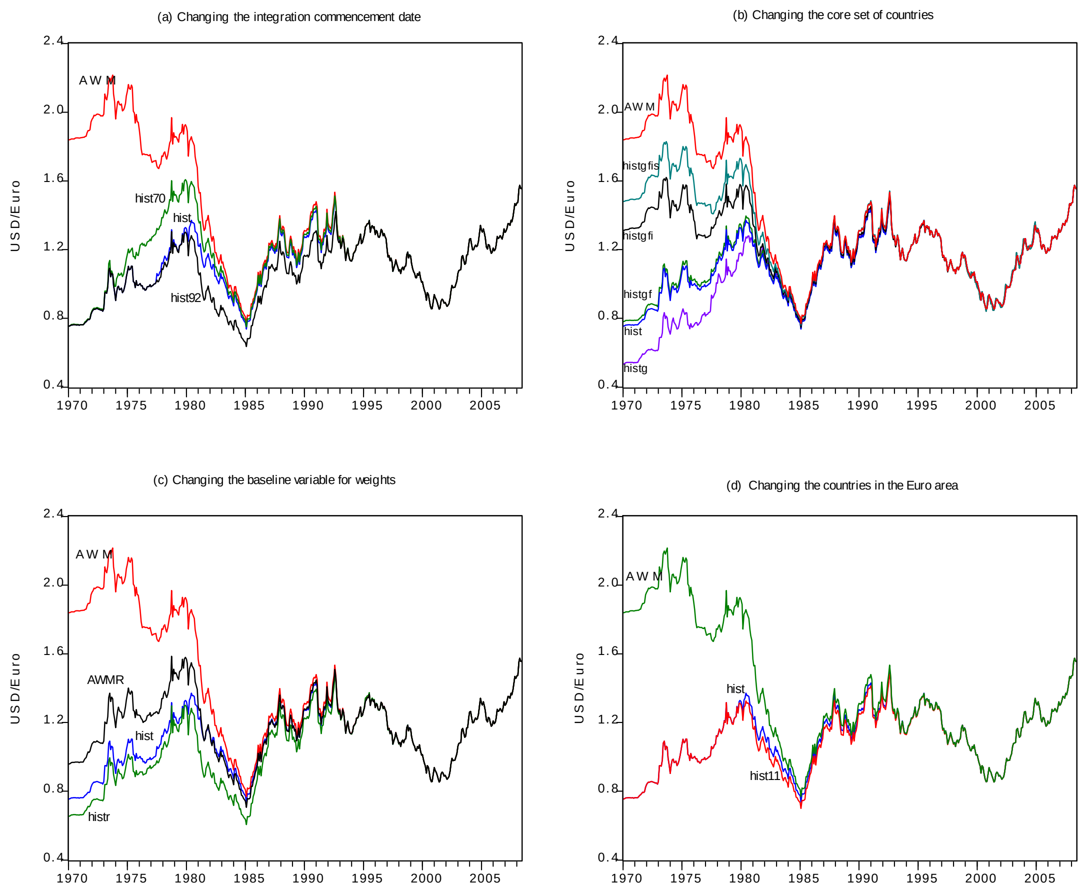
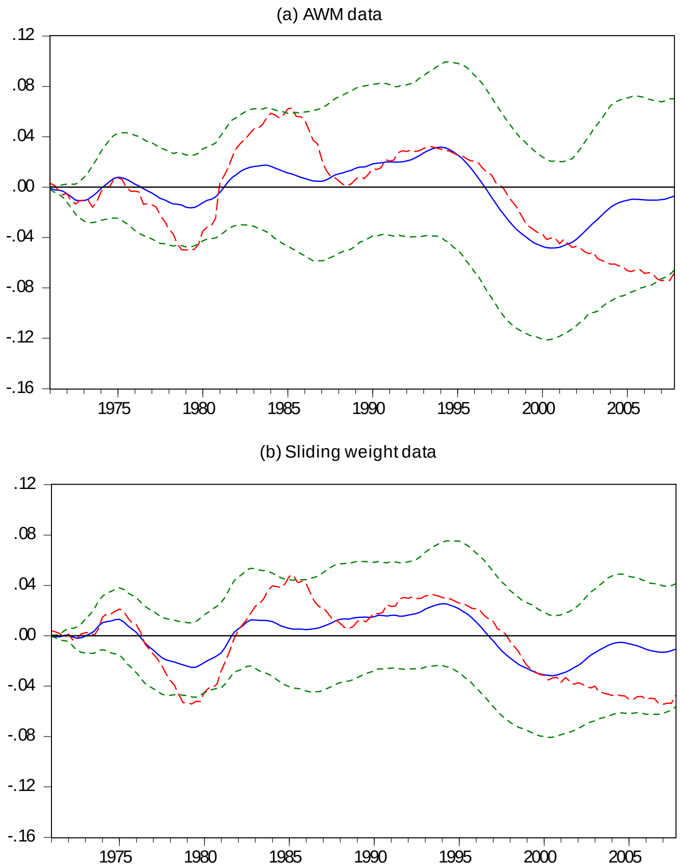
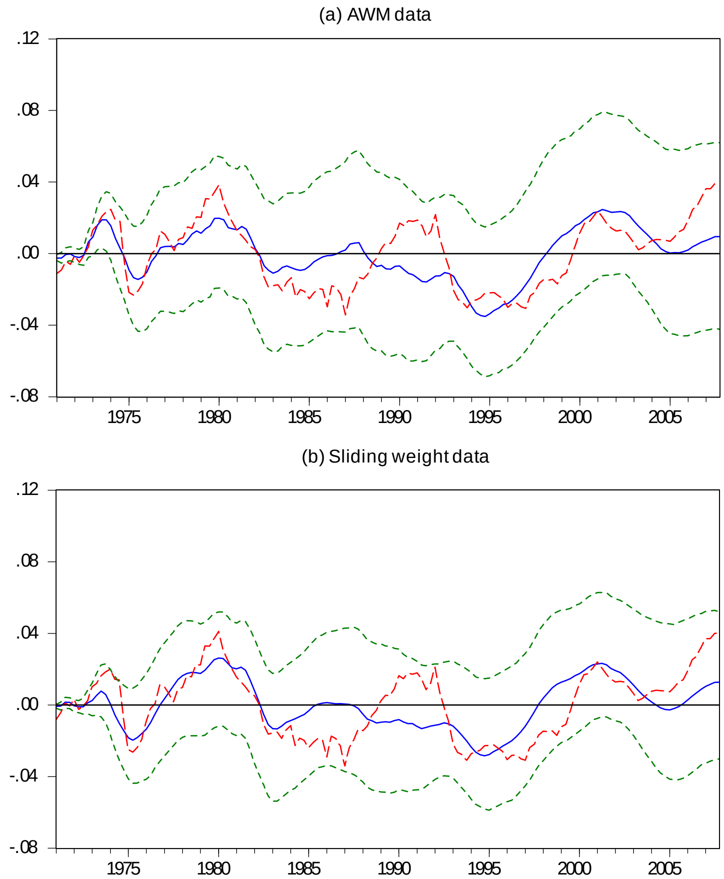


Figure 4: The contributions of interest rate innovations to prices



Note: The bold (blue) and dashed (red) lines respectively indicate the interest rate contributions and total prices. The green dotted lines provide 95% confidence bands for the interest rate contributions.

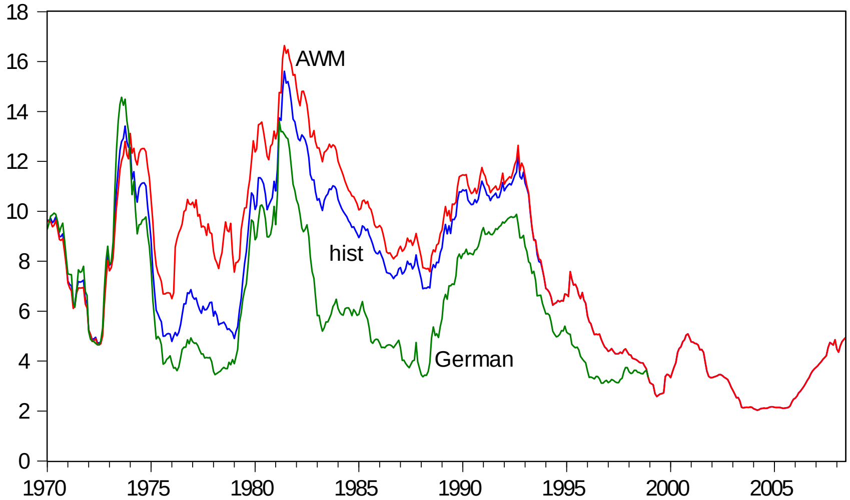
Figure 5: The contributions of interest rate innovations to output



Note: The bold (blue) and dashed (red) lines respectively indicate the interest rate contributions and total output. The green dotted lines provide 95% confidence bands for the interest rate contribution

Figure 6: Interest Rates

a) short rates: AWM, German and Historical



b) long rates: AWM, German and Historical

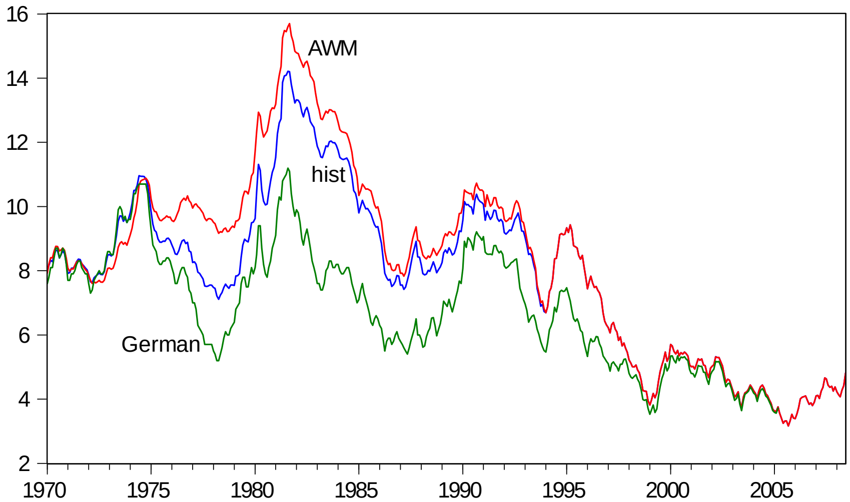
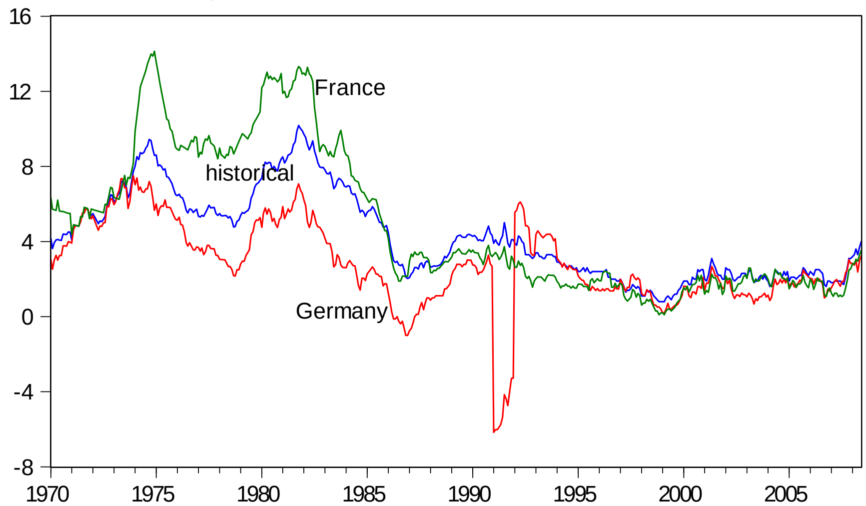


Figure 7: Inflation

a) Inflation: German, French and historical



b) Inflation: AWM and historical

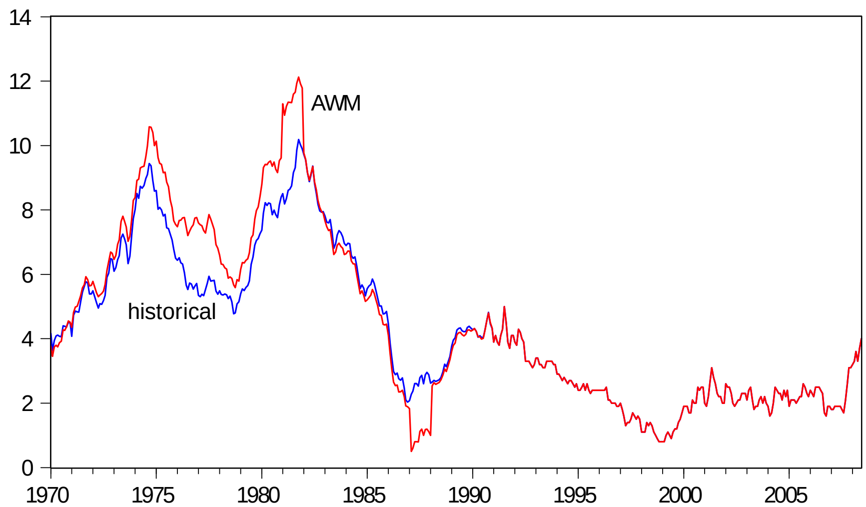


Table 1: Summary of alternative data sources

	weighting methods			sample	
	real variables	prices/inflation	interest rates	frequency	period
AWM	fixed weights PPP adjusted 1995 GDP	post-1990: quarterly average of HICP historical values: growth rates applied with 1995 HCIP weights to obtain price series	as for real variables	Q	1970 -
Eurostat	transform national data to Euros then aggregate	HICP: own set of aggregation weights	uses Euro yield curve (from 2004)	varying M,Q,A	varying many from 1995
OECD	now uses primarily Eurostat data, previously fixed weights	1. Chain linked index based on private final consumption expenditure survey with PPP weights from 1993 National Accounts. For 23 European countries. 2. Eurostat HICP data	not provided	Q,A	varying
Beyer et al (2001)	time varying weights based on share of GDP in prior period	implicit price deflator as for real variables	not provided	M,Q	1980-2001

* Relevant websites: AWM: http://www.eabcn.org/area-wide-modelw. Eurostat: http://epp.eurostat.ec.europa.eu. OECD: http://stats/oecd/org

Table 2: Aggregation weights for Euro Area countries

country	AWM weight	country	AWM weight
Core		Periphery	
Germany	0.283	Italy	0.195
France	0.201	Spain	0.111
Netherlands	0.060	Greece	0.025
Belgium	0.036	Portugal	0.024
Austria	0.030	Finland	0.017
Luxembourg	0.003		
Ireland	0.015		

Notes: Our classification places countries on the left hand side of the table in our "core", and those on the right as "periphery". The weights are taken from the explanatory notes accompanying the August 2004 update of the AWM database.