Unemployment and Inflation in Ireland: 1926 - 2012

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Abstract

Since the 1970s, the overarching view in the literature has been that a Phillips curve relationship did not exist in Ireland prior to the 1979 exchange rate break with Sterling. It was argued that, as a small open economy, prices were determined externally. To test this relationship, we study the determination of inflation between 1926 and 2012, a longer sample period than any previously used. We find that the difference between unemployment and the NAIRU is a significant determinant of inflation both in the full sample and in the subsamples spanning the periods before and after the Sterling parity link.

1. Introduction

This paper estimates a Phillips curve model for Irish consumer price inflation, using annual data for the period 1926 to 2012. This period includes the three monetary policy regimes that have been in force since the foundation of the state: the parity link with Sterling to 1979, the European Monetary System (EMS) from 1979 to 1998, when monetary policy effectively operated under an adjustable peg regime, and Economic and Monetary Union (EMU) from 1999 onwards. It also includes the transformation of the economy from one that was predominantly agricultural to one that is modern and highly advanced.

With few exceptions, a large literature on the Irish inflation process has failed to find a role for domestic demand.[1] Indeed, the notion of domestic demand playing a role seems to have been dismissed early on, and is not even tested in many papers. Instead, the literature views Ireland during the period of the link to Sterling as a small part of the UK economy and sees inflation pressures as largely determined with little or no role for excess demand in Ireland as captured by the unemployment rate or the output gap; see for example Flynn and Honohan (1986) and the summary in Kenny and McGettigan (1997). Bacon et al. (1982, p. 35) summarise the view of Irish inflation in this period:

…Up to 1979, the dominant influence on inflation was the relationship between Ireland and the UK. This arose given: (i) the maintenance of a fixed exchange rate with sterling; (ii) that the UK is the dominant trading partner; (iii) exports and imports constitute such a large proportion of activity in goods and services; and (iv) demand patterns for non-tradable goods and services tend to be somewhat similar for a variety of cultural and historical reasons.

To capture the state of the business cycles we rely in this paper on the difference between the rate of unemployment and the NAIRU, which we treat as an unobserved variable. Furthermore, we incorporate import prices in domestic

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[1] See for example, Geary and McCarthy (1976), Geary (1976), Flynn and Honohan (1986), Kenney and McGettigan (1997). An important exception is Bermingham et al. (2012), who control for international factors and use the short-run unemployment gap as a measure of slack in the domestic economy.

currency to control for external price developments. Our main finding is that both of these variables played important roles in accounting for movements in Irish inflation both during the period of fixed exchange rate against Sterling and afterwards. Thus, there is a well-defined Phillips curve in Ireland.

One reason why we find a role for domestic demand is our use of data for an extended sample period. Interestingly, prior to Phillips' paper, several other researchers, such as Tinbergen (1936 and 1951) and Klein and Goldberger (1955), studied the causality from unemployment (or some measure of demand slack) to (wage) inflation, with mixed results. However, as Humphrey (1985) notes, the major difference between these "early" estimates of the Phillips curve and Phillips' later work was the latter's implicit emphasis on a long time time-span of data for studying the relationships.[2] To our knowledge, no other authors have studied Irish inflation over such a long sample period.

The remainder of the paper is structured as follows. In Section 2 we briefly review the evolution of monetary arrangements, inflation and development of employment in Ireland since independence. Section 3 discusses the issue of the interaction of domestic demand and inflation in Ireland. Section 4 provides an overview of how the data are compiled and briefly reviews our final data series. In Section 5 we study the unit root properties of the data, discuss our benchmark specification and present estimates of the model. Section 6 concludes.

2. The Irish economy since independence

The sample period analysed in this paper includes a three monetary regimes, and a great deal of economic change. Here we discuss these developments in turn.

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[2] In more recent work, Haldane and Quah (1999) examine the evolution of the UK Phillips curve since the 1950s, paying particular attention to the role of policy-makers' beliefs. Gruen et al., (1999) conduct a similar exercise for Australia, paying particular attention to structural changes in the labour market and the role of import prices.

2.1 Monetary regimes and inflation

As noted above, monetary policy in Ireland has operated under several different regimes since the 1920s. Following independence in 1922, the monetary system was initially unchanged since the monetary arrangements appeared to function satisfactorily.[3] Nevertheless, the old arrangements were not deemed suitable for an independent country and in 1926 the Government established a Banking Commission to review the monetary and financial system and propose changes. The Commission advised that the State should establish its own currency at par with Sterling and that a new Currency Commission should assume responsibility for the issuance of bank notes. These recommendations were included in the Currency Act of 1927 that introduced the Saorstát pound, which was fully backed by Sterling assets and redeemable in Sterling in London.

While these arrangements fell short of those in economies with a central bank, the Irish financial system functioned well and was closely integrated with the London money market. With the new currency fully backed and the Currency Commission's objectives limited to ensuring convertibility against Sterling, the credibility of the exchange rate parity was not in question.

Further impetus towards the creation of a central bank came following the Commission of Inquiry into Banking, Currency and Credit which reported in 1938, and which led to the established of the Central Bank of Ireland (CBI) in March 1943. Kelly (2003) notes that the new central bank lacked some traditional banking functions, in particular the ability to restrict credit conditions, which implied that it was not in a position to set interest rates and to conduct an active monetary policy. Indeed, the functioning of the Currency Commission and the CBI, coupled with the fixed exchange rate against Sterling, implied that monetary arrangements in Ireland

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[3] This section draws on Brennan (1931), Moynihan (1975), Honohan (1995), Ó Gráda (1995), and Kelly (2003).

are best described as those of a currency board, at least until the early 1970s.[4] As a consequence, Irish inflation rates and interest rates followed closely those in Britain and were thus determined with little, if any, reference to domestic economic conditions although, of course, these were heavily influenced by those prevailing in the United Kingdom.

The close link to Sterling was broken in 1979 when Ireland joined the European Monetary System as a founding member. While monetary policy remained focussed on the requirement of exchange rate stability, the central rate of the Irish pound against the Deutsche Mark was realigned seven times by a total of 35.75% between September 1979 and January 1987.[5] The pound was devalued by a further 8% in January 1993, and the EMS bands were subsequently broadened to +/- 15% in the summer of 1993.

Finally, in January 1999 Ireland became a founding member of European Monetary Union. Irish interest rates and inflation rates were therefore again largely determined by developments outside of the domestic economy.

Thus, Ireland experienced three monetary regimes in the period that we study: the 1922-1978 Sterling period that involved a perfectly fixed exchange rate; the 1979-1998 EMS period that involved repeated devaluations against the German Mark; and the 1999-2012 EMU period that involved membership in a hard currency area with policy set with reference to economic conditions in the Euro area. Not surprisingly, these regimes are associated with quite different inflation behaviour. Table 1 shows that the annual inflation rate averaged between 4% and 6% in the two first periods, but less than 3% in EMU period.[6] Interestingly, while Irish inflation was almost equal to the rate of change of import prices in the Sterling period, it was higher than the rate of import price inflation in the EMS and EMU periods. One interpretation of

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[4] See Honohan (1995).

[5] See Artis and Taylor (1994, Table 1).

[6] Furthermore, the standard deviation of inflation was much lower after 1999 than before.

these findings is that while inflation was largely externally generated in the Sterling period, a large part of inflation was generated domestically from 1979 onward.

2.2 Economic developments

The period we study is characterized by significant structural change. Between 1841 and 1911, the share of employment in industry declined from 29% to 23% (O'Rourke (1995)), implying that Ireland was far from industrialized at the start of our sample period. Nevertheless, living standards increased markedly in the post-famine period, an apparent anomaly which is attributable to emigration. The flow of emigration continued through the first part of our sample period, however, the destinations for emigration abruptly narrowed following the 1929 Depression and the closing of the North American borders. This is emphasized by Neary and Ó Gráda (1991), who show that emigration to the US and Canada slowed from 18.8 per thousand of the population per annum in the period 1926-1931 to just 0.7 per thousand per annum over the period 1932-1939, with emigration to elsewhere not meeting the shortfall. The effect was a rise in the labour force, such that while the unemployment rate rose, so too did number employed. Policies undertaken by the Fianna Fail government which came to power in 1932 also acted to raise employment: a programme of house building created almost 20,000 construction jobs between 1932 and 1938.[7] In addition, the 'economic war' with Great Britain and the broader introduction of protectionist policies, had the effect of increasing domestic industry: while net agricultural output declined marginally during this period, industrial output increased some 46%. The employment effect in the agricultural sector was smaller however, since tariffs imposed on cattle exports by the UK as part of the economic war resulted in a shift in agricultural production away from land-intensive grazing towards labour-intensive tillage (Neary and Ó Gráda (1991)).

Lee (1989) notes that Ireland was 'unusually ill-equipped' for the economic impact of the Second World War. In particular, in contrast to other small, neutral, European

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[7] For a discussion of these measures see Lee (1989).

economies, Ireland had no industrial base: while Switzerland, for instance, saw unemployment fall from 13.2% in 1936 to 1.6% in 1945 as a result of an armament drive, Ireland had no similar reduction in unemployment, and no consequent shift towards industrial employment. On the other hand, the period also saw a resumption of emigration, albeit at relatively low levels and now predominantly male and to Britain, which relieved unemployment pressures.[8]

In the post-war period, industrial production grew more rapidly. From 1946 to 1952 jobs in industry increased by over 50,000, but even with this increase, the industrial workforce remained less than half the size of that in agriculture, and only 20% of the entire workforce (Lyons (1972)). Aside from this, the fear raised in 1942 by Sean Lemass that war-time emigrants might return to overburden the economy once hostilities ceased did not materialize, and with emigration continuing apace into the 1950s, the unemployment rate began to decline in the post-war period (Lee (1989)).

The introduction of Whitaker's program for Economic Development in 1958 had the reduction of unemployment as one of its main aims (Ó Gráda (1997)). While the opening of trade under the economic programs brought initial pain as redundancies increased, the size of the industrial workforce surpassed that in agriculture in the late 1960s. This was as much due to the decline in numbers working in the agricultural sector as it was the growth in the industrial sector: between 1961 and 1971, the agricultural workforce declined by 88,000, while the industrial workforce increased 61,000. Growth in the services sector ensured that overall employment rose over the period (Kennedy et al. (1988)).

Unemployment rose in the late 1960s and early 1970s, when the oil crisis sent it soaring. Nonetheless, throughout the 1970s, industrialization continued, and output increased by approximately 66%. A striking feature of this period is the dramatic increase in foreign direct investment (FDI). The abolition of the Manufacturers Act removed the prohibition on foreign ownership of industry and policies now actively

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[8] See the discussion in Ó Gráda (1997).

courted FDI: Barry (1999) reports that by 1983 Ireland attracted more than ten times more US FDI per manufacturing worker than the other EU countries combined. By 1995, foreign-owned manufacturing accounted for approximately 45 per cent of employment in manufacturing[9] This FDI focused increasingly on high-tech sectors such as chemicals and pharmaceuticals and IT, creating a high-skilled workforce which indigenous industry could not.

Nonetheless, through the 1980s, unemployment remained high as in other developed economies: multi-country studies, such as that by Bean et al. (1986) tried to explain the high unemployment in the 1980s. Walsh (1999) noted that emigration also continued apace in Ireland in the 1980s: of all males aged 15-19 in 1986, 20% had emigrated 5 years later. Indeed, in 1986, the same number of people was employed in Ireland as in 1926 (Kennedy et al. (1988)). It was not until the mid-1990s and the start of the Celtic Tiger that unemployment dropped precipitately. Social partnership resulted in wage restraint even as the economy began to pick up. Labor force participation rates increased also, particularly among females, and as economic expansion progressed, Ireland found itself experiencing net immigration. Indigenous industry, in decline for a number of decades, reversed the trend and began to expand.

The progression of the Celtic Tiger from a fundamentals-driven boom to a credit-fuelled property bubble saw the unemployment rate reach all-time lows. However, the bursting of the property bubble, and the concurrent global financial crisis, saw unemployment soar again jobs across the economy, in particular the construction, and net emigration returned.

While the unemployment rate provides information on the state of the economy at a point in time, in a Phillips curve setting it is important to compare the unemployment rate to the NAIRU, the rate of unemployment at which there is no upward or downward pressure on the inflation rate. The NAIRU is a time-varying

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[9] Barry et al (1999).

concept, and a number of factors affect it at each point in time. Emigration has often been referred to as the 'safety valve' which helped to keep unemployment lower than otherwise during much of the period (see, for instance, Walsh (1999)). In so doing, it is likely that emigration also affected the NAIRU, and therefore the level of inflation, given the unemployment rate.

A number of studies have argued that there is an equilibrium unemployment gap between Ireland and the UK, whereby, emigration from Ireland ensured that the Irish unemployment rate never rose too far above that in the UK.[10] Indeed, estimates have been made of the equilibrium level of the unemployment gap at which there would be no net flow of migrants.[11] Honohan (1992) shows that the Irish unemployment rate has tended to adjust in the medium term to movements in that in the UK. Meyler (1999) addresses the question of the impact of this gap on inflation more directly, by using it as the 'slack' measure when estimating a Phillips Curve relationship for Ireland. The intuition is that when the gap increases, emigration follows, reducing supply in the Irish labour market and increasing wage and price inflation. Nevertheless, Meyler (1999) finds that, over the period 1979-1999, the gap is not a significant determinant of Irish inflation.

However, Meyler's (1999) study does not seek to directly estimate the impact of emigration on the Phillips Curve. While we are not aware of estimates of the effect of emigration on the NAIRU for Ireland, an interesting study for Spain suggests that a decline of almost 15 percentage points in the unemployment rate over the period 1995-2006, would have resulted in an annual increase in inflation of 2.5 percentage points, were it not for a high level of immigration: the proportion of foreign workers in the Spanish labour force increased from 1% in 1995 to 14% in 2006 (Bentolila et al. (2007)). Since the inflation rate was stable or declining through this period in Spain, this study gives an indication of the effect of immigration on the NAIRU. It seems

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[10] For a discussion, see Fitzgerald (1999).
[11] For example, see Honohan (1984).

reasonable to infer that emigration might have a symmetric but opposite effect.

3. Literature review: domestic demand and inflation in Ireland

Surprisingly few papers have sought to estimate a Phillips Curve for Ireland, arguably because of a long-held belief that domestic demand had no role to play in the Irish inflation process. This view was apparently formed following a series of papers by P.T. Geary and co-authors in the 1970s (Geary (1976), Geary and Jones (1975), Geary and McCarthy (1976)). These studies, which found no statistically significant role for domestic demand as measured by a number of specifications of unemployment, were based on samples of annual data over periods of approximately 20 years. The finding was put down to the small, open nature of the Irish economy, despite the fact that non-traded goods constitute a large part of the CPI basket. This sentiment, repeated throughout these papers, was summarized by Geary and Jones (1975, p. 63):

"In the context of a small open economy, of course, this outcome is hardly surprising. If such an economy is a price taker in trade, domestic excess demand will largely be met at existing prices by imports while domestic excess supply will be absorbed by exports."

Even prior to these statistical findings however, the view that domestic demand was not a relevant factor was evident in Geary et al. (1970). This paper notes that in the post-war period to 1966, the trends in consumer prices in Ireland and the UK were similar because money incomes exceeded productivity to the same degree in both economies. The paper notes, with some alarm, the divergence in inflation rates thereafter, and argues that this is the result of wages in Ireland outstripping those in the UK (Geary et al. (1970), p. 347):

"Wage push inflation is seen to be the major cause of inflation since 1966."

Nelson (2008), quoting Central Bank and government texts from the time, argues that the sense that domestic inflation drivers were entirely cost push persisted through

much of the 1970s. He argues that policymakers believed that inflation could be controlled by nonmonetary instruments (such as wage control), rather than maintaining monetary and fiscal policy consistent with an output gap of zero, with the result that low inflation was not restored until the mid-1980s. While Nelson's review has been criticised (see Honohan and Murphy (2010)), during the late 1970s and into the 1980s, the literature continued to focus on factors other than domestic demand as drivers of inflation. The role of exchange rates, and tests for the presence of purchasing power of parity through cointegrating relationships with foreign price levels became a particular focus, as the public discussion moved towards the issue of EMS membership and a break in the Sterling parity link.[12] Even studies from this period which examined the role of domestic drivers of inflation, for instance Hackett and Honohan (1981), focused on cost developments, leaving demand factors "*for further work*".[13] Indeed, in that year, Honohan (1981), discussing the issue of whether Ireland is a Small Open economy, solely pointed to the unpublished master's thesis of O'Casaide (1977) as a study which found a link between consumer prices of non-traded goods and a measure of domestic excess demand. Only in 1989, did O'Connell and Frain provide evidence of a role for domestic demand: over the period 1977Q1 to 1985Q4, they found that foreign inflation explained 52% of domestic inflation, and excess domestic demand explained 26%. However, the authors capture domestic demand by the difference between the growth rate of the money supply and the realized growth in output, and attach little weight to this finding.

Some more recent studies have studied the role of excess domestic demand, with varied success. Kenny and McGettigan (1996) estimated both traded and non-traded inflation over the period 1979 to 1995. While a role for domestic demand in traded prices may be more difficult to detect, they report that even for non-traded prices,

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[12] See, for example, Browne (1984), Callan and Fitzgerald (1989), Honohan and Flynn (1986) and O'Connell and Frain (1989).

[13] Of course, it is possible that demand factors impact on production costs, for instance if wage rates depend on business conditions.

they found no impact of domestic demand (p. 83):

"The supplementary aggregate demand type effects, somewhat surprisingly, do not indicate a significant short-run role for either the change in the unemployment rate or the stance of fiscal policy."

In contrast, Leddin (2010) finds a role for unemployment in a New Keynesian framework while Bermingham et al. (2012) and Meyler (1999) find a significant role for unemployment gaps. However, the sample periods in these later studies differ from those examined by Geary and others, suggesting that there may have been a change in the structure of the economy, perhaps post-EMS. This is an issue we will examine in more detail in Section 5.

Nonetheless, the dominant idea from that earlier time period, summarized by Bacon et al. (1995, p. 35), that

"up to 1979, the dominant influence on inflation was the relationship between Ireland and the UK"

seems difficult to justify when looking at long-run data from that time. In the first instance, although the correlation between annual inflation in the UK and Ireland is 0.92 over the period 1923 to 1979, this says little about the transmission mechanism at work. A naive and obviously too simplistic view is that all components of the CPI were tradable with prices set in British markets. A more developed hypothesis is that non-traded goods prices were determined by production costs that were very similar to those on British economy because of the close integration of the two economies, similar demand conditions and the fixed exchange rate. Under the latter view, the non-traded component of inflation and therefore overall inflation was determined by Irish factors, but these were in turn so strongly influenced by developments in the British economy that it was difficult to detect their role, given the small samples typically studied.

Furthermore, while the median difference between CPI inflation in Ireland is the UK

between 1923 and 1979 is very small at 0.05 percentage points, the standard deviation is in excess of 2.5 percentage points, implying that a 95% confidence band for the difference in inflation is 10 percentage points wide. Even omitting the Second World War period (and thus excluding an 8 percentage point deviation in 1943), the median difference in the rates is approximately 0.01 percentage points but the standard deviation is in excess of 1.8 percentage points (Figure 1), implying a 95% confidence band in excess of 7 percentage points. Such large deviations point to the possibility of a role for domestic demand in determining inflation in Ireland.

4. Data description

4.1 The data

In this section we review the data used in our econometric analysis. We use data on unemployment, inflation and import prices over a period of 80 years. Such long time series are not readily available from a single source; the data used here are compiled from a number of secondary sources.

We draw on Gerlach and Stuart (2014) who discuss in detail the compilation of long time series from a number of sources. Briefly, the current vintage of data is used as far back as possible since it is assumed that it is subject to smaller measurement errors than older vintages. Older time series are then spliced together using growth rates in order to construct a single time series. When more than one series was available, the decision of what series to use was based on a comparison of growth rates over overlapping periods.

Unemployment rate figures from 1923 to 1938 are taken from the ILO's International Labour Review. For the period 1939 to 1982, data are from Mitchell (2007). Finally, for the most recent period, 1983 to 2012, data are available from the Central Statistics Office (CSO). While the unemployment data at the very start of our sample may contain measurement errors (for instance, due to changes in social welfare eligibility

criteria), any such errors would bias the estimated parameter on employment towards zero and reduce its statistical significance. However, and as we show below, unemployment is significant in our estimates.

The Consumer Price Index (CPI) is available from the CSO for the full period from 1923 to 2012. An import price index is available from the CSO beginning in 1930. Prior to this, the import price is proxied using UK wholesale prices taken from Mitchell (2007).

4.2 Review of individual time series

In this section we review the final data series used. We begin by plotting Irish CPI inflation and the unemployment rate in Figure 2. As noted in Section 2, unemployment rose when the North American borders closed in the wake of the 1929 Depression and it remained high through the Second World War, before generally declining in the post-War period up to the late-1960s. Inflation also increased both during the Second World War as shortages pushed prices up, and in its immediate aftermath as the population tired of austerity and sought pay increases. The oil shocks in the 1970s, and a succession of pay increases as unions tried to maintain real wages in the face of rising inflation, saw both inflation and unemployment rise sharply. The declining levels of both variables thereafter are evident as the Celtic Tiger took hold, before the financial crisis raised unemployment and decreased inflation in the years up to 2010.

The correlation of unemployment and inflation depends on the nature of the shocks that hit the economy. Thus, shifts in aggregate demand will tend to raise inflation and lower unemployment relative to trend, generating a negative correlation between inflation and the unemployment rate. By contrast, contractionary supply shocks raise unemployment relative to trend and raise inflation, and thus generate a positive correlation. The correlation between inflation and the output gap does indeed seem to vary over time (Figure 2). Thus, during the period of the Second World War, both the inflation rate and the unemployment rate rose, suggesting that

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a contractionary supply shock had occurred. Following the establishment of EMU and during the recent financial crisis, however, the correlation turned negative.

Figure 3 plots the annual change in the import price series and Irish CPI. Unsurprisingly, import prices are more volatile than CPI. While this is particularly the case during the Second World War and the first oil crisis in the middle of the 1970s, changes in import prices are also much larger than changes in the CPI through the late-1940s/early-1950s and the late 1980's/early-1990's.

5. Econometric estimates

5.1 Unit root tests

Before estimating the econometric models, we first test whether the rates of change of consumer and import prices and the unemployment rate have unit roots. We perform Augmented Dickey-Fuller (ADF) and Elliott-Rothenberg-Stock (ERS) unit root tests on the annual changes of consumer and import prices and the unemployment rate (Table 2).

The Augmented Dickey-Fuller tests indicate that when the lag length is selected using the Schwarz Information Criterion (SIC) we can reject the hypothesis of a unit root at the 1 per cent confidence level in all cases, except for inflation for which we can reject it at the 5 per cent level. When the Akaike Information Criterion (AIC) is used we fail to reject the null for the inflation rate. However, this may be because of a lack of power. Using the Elliott-Rothenberg–Stock (ERS) test, which has greater power, we reject the null at the 5 per cent level for inflation, and at the 1 per cent level for the unemployment rate and import price inflation. We therefore treat all variables as stationary.

5.2 Benchmark Specification

We use a standard Phillips curve model to explain Irish inflation. Whilst there has been much theoretical and empirical debate over the specification of the Phillips

curve relationship since the 1960s, it remains a central part of the toolkit of many policy makers and central bankers.[14]

The model holds that inflation, π_t, depends on its lagged value, proxying inflation expectations; the difference between unemployment, u_t, and the NAIRU, u_u^*; and the rate of change of import prices (measured in local currency), ω_t. Phillips curve models are best interpreted as a reduced form for inflation in which both demand factors, as captured by the wedge between the unemployment rate and the NAIRU, and supply factors/cost-push shocks, as captured by import prices.

Since the lag structure is not known a priori, we allow for two lags of past inflation, the current and two lagged values of the output gap and the rate of change of import prices to enter. The model can be written:

(1) $\quad \pi_t = \alpha_{0,t} + \alpha_1 \pi_{t-1} + \alpha_2 \pi_{t-2} + \beta_0 \tilde{u}_t + \beta_1 \tilde{u}_{t-1} + \beta_2 \tilde{u}_{t-2} + \gamma_0 \omega_t + \gamma_1 \omega_{t-1} +$
$\quad\quad\quad \delta_2 \omega_{t-2} + \mu D_t + v_t$

where, for reasons that are made clear below, D_t denotes a dummy variable. In the interest of brevity, we refer to $\tilde{u}_t \equiv u_t - u_t^*$ as unemployment below.

We have added a time subscript to the constant to allow for the possibility that it may change over time. Such changes are empirically very important and capture changes in steady-state inflation rate over time.[15] While we will generally assume that $\Delta \alpha_{0,t} = 0$, we will also consider the case in which the intercept follows a random walk with drift: $\Delta \alpha_{0,t} = \delta + \phi_t$.

This model is deliberately overparametrised and we do not expect all lags to be needed. However, since we have no priors about the lag patters, it is desirable to start from a loose specification and let the data speak.

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[14] For instance, a Phillips curve relationship has been used to explain why core inflation failed to decline and why unemployment rose so dramatically in the aftermath of the "Great Recession". Montoya and Döhring (2011) summarise the recent evidence.

[15] For an excellent review of the literature on changes in the inflation process over time and some empirical evidence for the US, see Cecchetti et al. (2007).

In order to estimate this model, we need to make some assumptions about the NAIRU. Two possibilities are obvious. We could assume that it is constant, in which case it is subsumed in the intercept that we will include when estimating equation (1). Of course, it seems highly implausible that the NAIRU has been constant in the 80-year period that we consider. We therefore go on to estimate the unemployment-inflation relationship under the assumption that the unobserved NAIRU has followed a random walk, that is, $u_t^* = u_{t-1}^* + \varepsilon_t$.

To see how this can be done, for ease of exposition consider a simplified version of equation (1):

(2) $\pi_t = \alpha_{0,t} + \alpha_1 \pi_{t-1} + \beta_0 (u_t - u_t^*) + v_t$

Differencing the equation and noting that $\Delta u_t^* = \varepsilon_t$, we have that:

(2') $\Delta \pi_t = \delta + \alpha_1 \Delta \pi_{t-1} + \beta_0 \Delta u_t + (\Delta v_t + \Delta \phi_t v_{t-1} - \beta_0 \varepsilon_t)$.

Equation (2') implies that, under the assumption that the NAIRU or the intercept follow random walks, estimates of the impact of unemployment on inflation parameters can be obtain by regressing the Phillips curve model in equation (1) in first difference form, provided that the errors are allowed to follow a first-order moving average structure.

It is easy to see that, given β_0, the relative importance of the v_t, ϕ_t and ε_t shocks, as captured by the ratio of their variances, will determine the size of the MA coefficient. Thus, if the v_t or ϕ_t shocks are dominant, the MA parameter will be close to -1 hereas if the ε_t shocks are dominant the MA parameter will be close to 0. Since it seems likely that shocks to inflation are much larger than innovations to the NAIRU, we expect a moving average coefficient "close to" -1. If the intercept follows a deterministic time trend or a random walk with drift, δ will be non-zero and the model for the change in inflation must be estimated with a constant. Since the inflation rate is stationary in the full sample, α_0 is constant so that $\Delta \alpha_0 = 0$. Equation (2') does therefore not include an intercept even if equation (2) does.

However, it is of interest to estimate the model for both the period and before and after the abandonment of the peg to Sterling in 1979. Since inflation in Ireland fell after 1980, one would expect that, adding time subscripts, $\alpha_{0,t}$ declined in that period. To allow for this possibility, in what follows, we assume that it follows a random walk with drift. It is therefore of interest to estimate the model for the 1980 to 2012 period with a constant.

To keep the notation simply, the above analysis considered the simplified Phillips curve in equation (2). Redoing the same analysis using the more general Phillips curve in equation (1) we obtain:[16]

(2") $\quad \Delta\pi_t = \delta + \alpha_1\Delta\pi_{t-1} + \alpha_2\Delta\pi_{t-1} + \beta_0\Delta u_t + \beta_1\Delta u_{t-1} + \beta_2\Delta u_{t-2} + \gamma_0\omega_t$

$$+ \gamma_1\omega_{t-1} + \gamma_2\omega_{t-2} + \mu\Delta D_t + (\Delta v_t - \beta_0\varepsilon_t - \beta_1\varepsilon_{t-1} - \beta_2\varepsilon_{t-2} + \Delta\phi_t).$$

5.3 Estimates

Next we turn to the econometric work. Since preliminary regressions indicated that δ, α_2, β_0, β_1 and γ_2 were insignificant in the full sample, we dropped these parameters. Following the suggestion in Stock and Watson (2011), we report ordinary and White standard errors in Table 3. Given that the price level data starts in 1924 and we have one lagged inflation rate, we use the sample period 1926-2012.

Since preliminary estimate of equation (1) in level form indicated that dummies for 1941, 1943 and 2009 were highly significant, we included these too. The dummies are intended to capture movements in inflation that are unrelated to the unemployment rate. As noted in Section 4, inflation and unemployment were both high during World War 2, suggesting the occurrence of a contractionary supply shock. In particular, once the 'phony war' ended, wartime conditions began in earnest in 1941. Real GDP shrank in the order of 1.7% that year, and consumption declined in real terms by almost 7.5 per cent, while the decline in investment appears to have been

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[16] If the constant in the equation was fixed, Kalman filtering could be used to obtain direct estimates of the NAIRU. In this model in which the constant may change, we can't distinguish between changes in the intercept and in the NAIRU.

even larger.[17] Ó Gráda (1997) reports that the number of new private cars registered dropped from 7,480 in 1939 to just 240 in 1941. The government introduced a 'standstill' on wages in May 1941, such that the share of wages in net manufacturing output declined from an average of 48.9% in 1936-40 to 46.0% in 1941-43. In 1943 war time shortages began to take hold strongly. Lyons (1972) notes that in 1943 private motoring virtually ceased, long distance travel became increasingly difficult even using public transport, gas and electricity usage were cut, coal became almost unobtainable at times, and rationing began of bread, tea, butter, sugar and clothes. At the same time prices were rising in excess of 10% in 1941 and 12% in 1943. This evidence points to two large supply shocks in 1941 and 1943. Since the Phillips curve model emphasises the role of aggregate demand for inflation (high demand/low unemployment is associated with high inflation), it will have difficulties fitting the data in a period when supply shocks are important. The dummies for 1941 and 1943 are therefore included.

The third dummy is for 2009 when the start of the financial crisis and the onset of a severe recession led to an immediate collapse of inflation. In this instance, both output and prices fell together. It seems plausible that the realisation that the downturn was severe and would last for an extended period reduced expectations of future inflation, which are not captured by a backward-looking Phillips curve model which therefore underestimates the decline in inflation. This is evident from the downward revision to inflation forecasts. For instance, by late-2009 the IMF was forecasting that inflation in Ireland would be -0.3% in 2010, a downward revision of over 2 percentage points compared to the forecast for 2010 made in late-2008. Between 2008 and 2009 the IMF also revised down its forecast for inflation in 2011 by

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[17] Consumption and investment data for the 1938-1944 period are available from a White Paper on National Income and Expenditure presented to the Oireachtas in March 1946; real GDP data are taken from Gerlach and Stuart (2014).

approximately 1.5 percentage points, and for both 2012 and 2013 by almost 0.9 percentage points.[18] A dummy is therefore needed to capture this effect.

The results in the first column of Table 3 show that lagged inflation and the current and lagged rate of change of import prices are highly significant. The long-run pass-through of import prices is estimated to be $\frac{\gamma_0 + \gamma_1}{1 - \alpha_1} = \frac{0.39}{0.56}$ and thus somewhat below unity. The twice lagged unemployment rate is also highly significant, suggesting a slow passthrough from the cyclical state of the economy to inflation.[19] These findings are not sensitive to whether standard or heteroscedasticity robust standard errors of the White type are used.

A Q-test of the hypothesis that the residuals do not display second-order serial correlation does not reject (p = 30.9%) and a Jarque-Bera test of the hypothesis of normality also does not reject the null (p = 32.1%). However, a Chow test for a break in 1979-80, when the fixed exchange rate to Sterling was abandoned, rejects the hypothesis of parameter stability (p = 1.9%).[20] Of course, the change from a managed to float to membership in EMU in 1999 could also have led to a changed in the inflation process. While there are only 14 data points in the EMU period, we interacted each of the regressors with a dummy taking the value of unity from 1999 onward and reestimated the model. While the dummy variables were all insignificant individually and jointly (p = 36.5%), the limited number of observation after 1980 suggests that these results should be interpreted with caution.

5.4 Subsample estimates

Given that Ireland transitioned from a fixed exchange rate to a managed float in 1979, it seems possible that the inflation process, and therefore the Phillips curve, changed. Next we therefore re-estimate the equation for the subsample 1926-1979

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[18] See the online databases for the IMF's World Economic Outlook in October 2008 compared to the database for October 2009.

[19] A two-year lag from unemployment to inflation might seem long. However, one would normally expect about a 4 quarter lag from the output gap to inflation. Since unemployment is a lagging variable in the business cycle, a longer lag from unemployment to inflation seems plausible.

[20] The test is conditional on the estimated values for the parameters on the dummy variables.

when the Irish pound was linked to Sterling. As before, we first explored whether a constant was significant if included but found that it was not (p = 6.1%). The results in column 2 of Table 3 show that the parameter estimates for this sub-period are very similar to those for the full period. In particular, twice-lagged unemployment is highly significant. The hypothesis that the residuals do not display serial correlation of the second order cannot be rejected (p = 32.8%) and the hypothesis of non-normality of the residuals also does not reject (p = 95.9%).

Column 3 of the same table presents the results for the 1980-2012 period. With inflation falling from almost 19% in 1981 to less than 2% in 2012, there is a strong declining trend in this subsample. The fit of the equation, as captured by the Adjusted R-squared, is not as good as before and, crucially, the twice-lagged unemployment rate is now insignificant. These results suggest that the Phillips curve evaporated after the peg to Sterling was abandoned.

However, and for the reasons discussed above, with inflation declining gradually in this sample it seems appropriate to introduce a constant in the regression. The results, in column 4, show that it is highly significant. Interestingly, so is the twice-lagged unemployment rate.[21] The estimated parameter is also much larger in absolute value than in the full sample and the estimated parameter on import prices is much smaller. This latter finding is compatible with the idea that because the exchange rate was flexible in the post-1979 period, import prices were more volatile and swings in them were less persistent than previously, leading firms to adjust prices less to import price changes. Tests for serial correlation and non-normality of the residuals again do not reject (p = 15.1% and p = 86.8%, respectively).

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[21] The referee has suggested that the impact on unemployment on inflation has become more rapid in the latter part of the sample. This conjecture is in fact quite correct: in the second sample the results are broadly similar if the once- or twice-lagged unemployment rate is used; this is not the case in the first sample.

6. Conclusions

Early, influential research indicated that there was no Phillips Curve relationship in Ireland in the period towards the end of the Sterling exchange rate link. This was attributed to the small open nature of the Irish economy, and its particularly close links with the UK, which was taken to suggest that there was no role for domestic factors in price determination. This view has long been held in the literature, where little further attempt has been made to estimate this relationship, and the only studies that find a role for domestic factors in the determination of prices focus on the post-EMS period.

However, these early studies covered relatively short sample periods. In this paper we study the determination of consumer price inflation in Ireland in the period 1926-2012, a longer sample period than any other previously used to test the relationship. We estimate a backward-looking Phillips Curve incorporating unemployment relative to the NAIRU, to capture the state of the business cycle and import prices to capture external price developments. We model the NAIRU as a random walk and let steady-state inflation follow a random walk with drift in the 1980 to 2012 period. We find a statistically significant effect of unemployment on inflation. While the exact estimate varies over time, the effect is present in both the 1926-1979 period, when the Irish pound was pegged to Sterling, and the 1980-2012 period when the Irish pound first participated in the ERM and then was subsumed in the euro area.

As a result, we conclude that the findings in early studies that no Phillips curve relationship existed simply reflected a particular, relatively short sample period. The impact those findings had on policy was surely important, and our results surely give weight to Nelson's (2008) argument that Irish policymakers should have focussed more on maintaining monetary and fiscal policy consistent with an output gap of zero, rather than non-monetary instruments to control inflation. The implications could be far-reaching if, as Nelson argues, this misperception was one of the main reasons for the failure to restore low inflation until the mid-1980s.

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		Table 1	
	Mean and standard deviation of inflation, import prices and unemployment in each monetary regime		
Variable	Monetary regime	Mean	Standard deviation
Inflation	1923-1978	4.22	5.41
	1979-1998	6.10	5.57
	1999-2012	2.55	2.65
Import price inflation	1923-1978	3.96	10.19
	1979-1998	3.94	6.85
	1999-2012	1.10	4.70
Unemployment rate	1923-1978	8.75	3.50
	1979-1998	13.22	2.96
	1999-2012	7.32	4.35

	Table 2		
	Tests for unit roots, 1923-2012		
Variable	Augmented Dickey-Fuller tests		Elliott-Rothenberg-Stock test
Choice of lag length	SIC	AIC	
Inflation	-3.22**	-2.35	3.08**
Unemployment rate	-2.67*	-2.89*	2.81**
Import price inflation	-6.04***	-6.04***	0.80**

Notes: */**/*** denotes significance at the 10%/5%/1% level. The exact sample period depends on the number of lags used. SIC and AIC denote the Schartz and Akaike information criteria.

Regression	1	2	3	4
Sample period	1926-2012	1926-1979	1980-2012	1980-2012
Constant				-0.13 (0.05)*** [0.06]**
Lagged inflation	0.44 (0.07)*** [0.06]***	0.32 (0.10)*** [0.10]***	0.36 (0.15)** [0.19]	0.41 (0.09)*** [0.10]***
Import price inflation	0.29 (0.03)*** [0.03]***	0.32 (0.03)*** (0.93)***	0.14 (0.05)** [0.06]**	0.20 (0.05)*** [0.06]***
Lagged import price inflation	0.10 (0.04)** [0.04]***	0.13 (0.05)*** [0.04]***	0.12 (0.05)** [0.07]	0.14 (0.06)** [0.07]**
Twice lagged unemployment	-0.17 (0.07)** [0.07]**	-0.19 (0.09)** [0.09]**	-0.23 (0.14) [0.15]	-0.27 (0.05)*** [0.06]***
MA(1)	-0.90 (0.07)*** [0.07]***	-0.92 (0.08)*** [0.07]***	-0.39 (0.25) [0.35]	-1.00 (0.15)*** (0.18)***
Adj. R-squared	0.70	0.75	0.65	0.72
Q-test for 2nd order errors, p-value	0.31	0.33	0.54	0.15
Jarque-Bera test for normality, p-value	0.32	0.96	0.61	0.87
Breusch-Pagan-Godfrey test for heteroscedasticity	0.68	0.36	0.74	0.41

Table 3: Estimates of the Phillips curve for Ireland

Notes: Standard errors are reported in parenthesis, White standard errors are reported in brackets.
*/**/*** denotes significance at the 5%, 2.5% and 1% levels, respectively.

Figure 1: Histogram of differences between Irish and UK inflation rates, 1923-1979
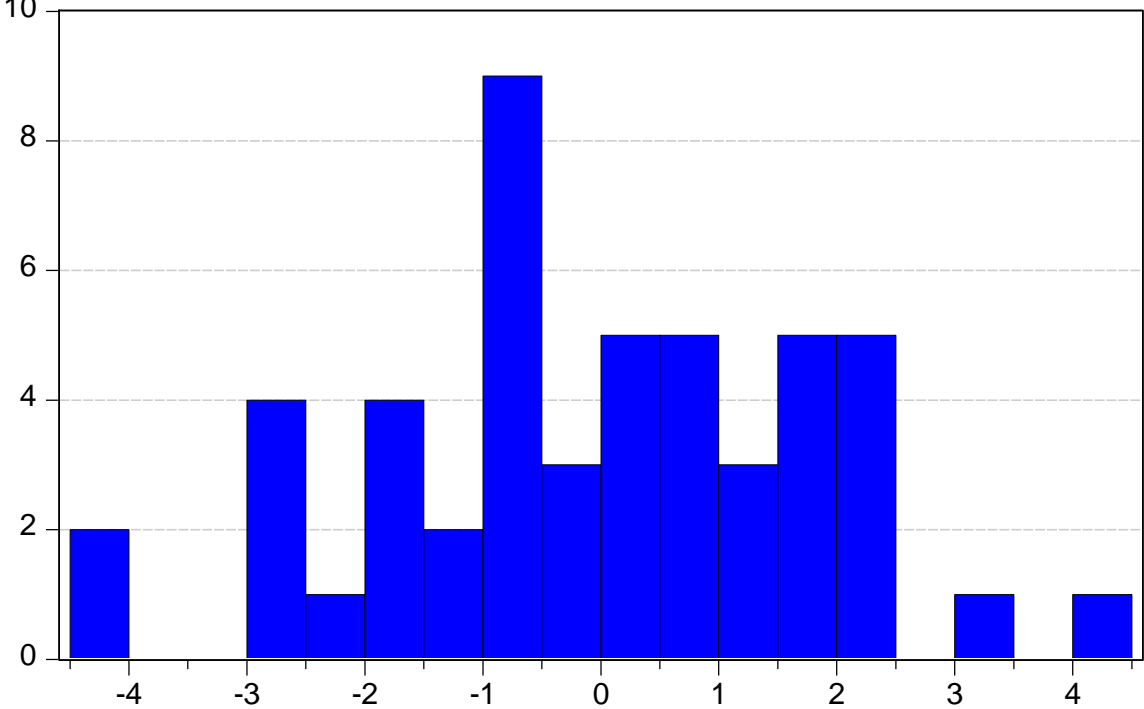
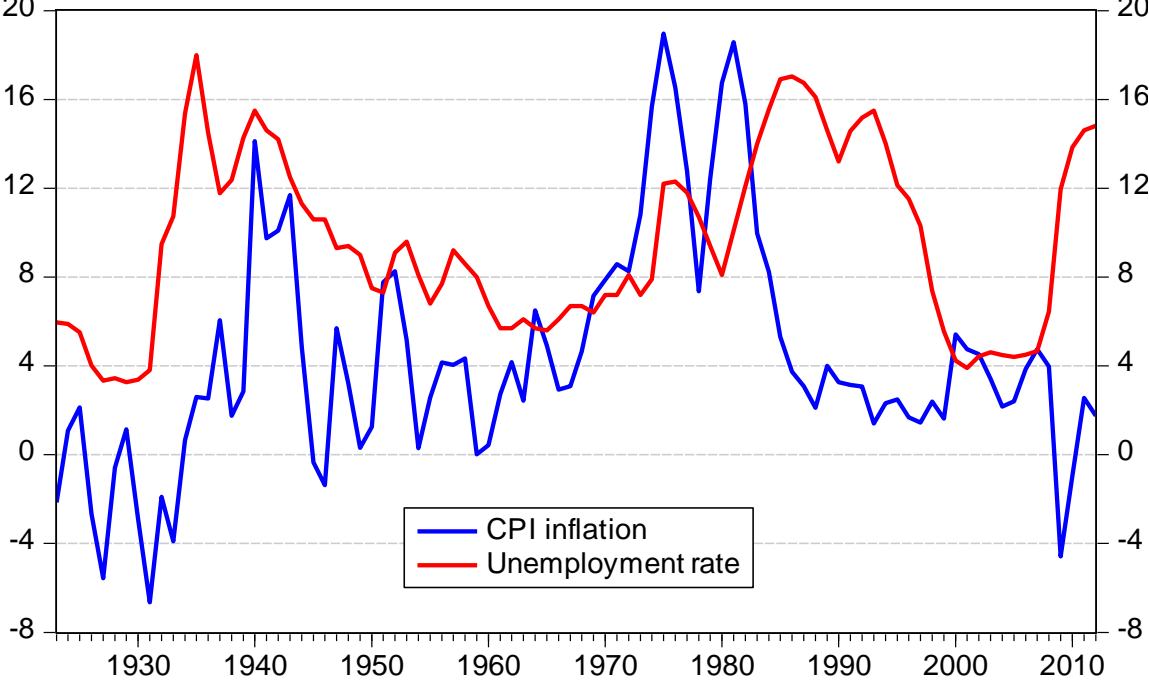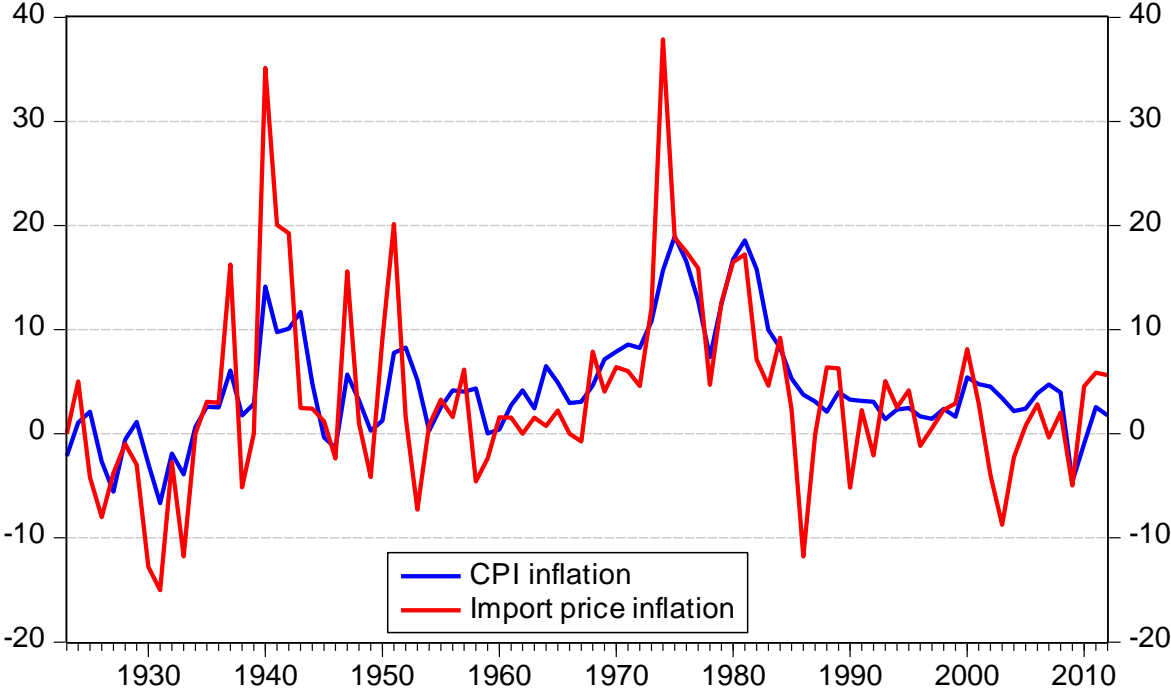**Figure 2: CPI inflation and unemployment**

Figure 3: CPI and import price inflation

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