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**Working Paper**

## The determinants of stagflation in a panel of countries

Wirtschaftswissenschaftliche Beiträge, No. 117 [rev.]

**Provided in Cooperation with:**

Chair of Economic Order and Social Policy, Julius Maximilian University of Würzburg

*Suggested Citation:* Berthold, Norbert; Gründler, Klaus (2013) : The determinants of stagflation in a panel of countries, Wirtschaftswissenschaftliche Beiträge, No. 117 [rev.], Bayerische Julius-Maximilians-Universität Würzburg, Lehrstuhl für Volkswirtschaftslehre, insbes. Wirtschaftsordnung und Sozialpolitik, Würzburg

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Bayerische Julius-Maximilians-Universität Würzburg

Wirtschaftswissenschaftliche Fakultät

**The Determinants of Stagflation in a  
Panel of Countries**

**Norbert Berthold**

**Klaus Gründler**

Wirtschaftswissenschaftliche Beiträge  
des Lehrstuhls für Volkswirtschaftslehre,  
insbes. Wirtschaftsordnung und Sozialpolitik  
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Nr. 117

2012

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# **The Determinants of Stagflation in a Panel of Countries**

First draft: April 2012

This draft: December 2013

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# The Determinants of Stagflation in a Panel of Countries

Norbert Berthold and Klaus Gründler

December 2013

## Abstract

This paper explores the determinants of stagflation. Three measures are proposed that gauge both the occurrence and the strength of stagflation. We investigate the empirical determinants of these measures, accounting for a range of theoretical hypotheses that have been discussed since the mid-1970s.

The results confirm the ambiguity in the influence of oil, although we find clear evidence that adverse supply-shocks enhance the probability and the magnitude of stagflation. However, while stagflation was oil-induced during the 1970s and 1980s, its occurrence in recent decades is strongly affected by monetary policy and labor productivity, indicating a paradigm shift in policy implications. The inevitable policy dilemma, suggested by the empirical persistence of stagflation, may thus be vincible. Yet, while stagflation was more severe during the 1970s and the 1980s, the likelihood of its recurrence turns out to be higher than often thought.

Keywords: Stagflation

JEL No.: E30, O40

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## 1 Introduction

When the members of the Organization of Arab Petroleum Exporting Countries (OAPEC) proclaimed the oil embargo in October 1973, the price of oil rose abruptly from 3.87 USD per barrel (1973) to 10.37 USD (1974).<sup>1</sup> This increase, accompanied by a reduction in supplies of food, simultaneously lowered the real income of non-farm workers and raised the rate of inflation in most developed economies. In the aftermath of the 1973 oil crisis, economists started to explore the origins of the stagflation process. Among the first was the study of GORDON (1975) who investigates the issue of commodity shortages that initiate inflation and a decline in output. The simulations suggest that surges in commodity prices are particularly severe in presence of wage rigidities. Similarly, the extensive work of BLINDER (1979) emphasizes the role of food and energy prices. MALINVAUD (1977) and SOLOW (1980) provide theoretical models that illustrate the effect of oil, wages and labor productivity, and also incorporate dynamics, substitutability in factor demands, and short-run nonmarket clearing. The role of wages and productivity was further discussed by a number of authors, for instance HICKS (1974), GRAY (1976), MODIGLIANI and PADOA-SCHIOPPA (1978), and GRUBB et al. (1982, 1983). The seminal book of BRUNO and SACHS (1985) extensively attends to the various causes of stagflation, emphasizing the influence of productivity, wages, commodity prices, and monetary policy.

More recent studies, e.g. BARSKY and KILIAN (2001), HAMILTON (2003), RÖGER (2005), HUNT (2005), and KILIAN (2008, 2009a) intensely discuss the effect of the oil price. As there is some proof that oil contributed its part to historical periods of stagflation, most of these papers suggest that oil is only part of the story. Likewise, JIMÉNEZ-RODRÍGUEZ and SÁNCHEZ (2010) find strong evidence that stagflation from the mid-1970s to the early 1980s, as well as - to a lesser extent - in the new millennium was oil-induced. The study also emphasizes that oil is still an important driver of stagflation, but its impact has declined during the last two decades. This point is discussed at length in KILIAN (2008). KILIAN (2009b) provides an explanation of the declining impact of oil. As he points out, it is essential to disentangle supply and demand shocks by virtue of the very different effects on the economy. For example, a rise in global aggregate demand directly stimulates the economy and simultaneously drives up the price of oil. If the rise in aggregate demand is driven by developing economies, the positive effect on exports in developed economies may overcompensate the negative effect caused by increasing commodity prices. Indeed, HAMILTON (2009) illustrates that the run-up of oil prices in 2007-2008 was caused by strong demand confronting stagnating world production. He examines the origins and consequences of oil price hikes in detail, showing that particularly the growing oil demand

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<sup>1</sup>Data source: FRED (2013).

in China has caused oil prices to rise. This prompts him to express that the consequences for the economy have been similar to those observed in earlier episodes, even if the causes of the price increases have been different. A conclusion that KILIAN (2009b) decidedly disagrees with.

In standard textbook macroeconomics, stagflation is induced by an adverse shift in aggregate supply. In such a framework, aggregate demand cannot result in anything but a move of prices and output in the same direction. In both popular press and academic literature, oil price shocks are considered one essential part in the explanation of stagflation. By contrast, BARSKY and KILIAN (2001) argue that oil is not nearly as important as often thought. This, however, rises the question which determinants actually *are* the driving forces behind stagflation. This is indeed a crucial question: if stagflation is due to exogenous shocks, then it presents an inevitable policy dilemma, because any attempt to lower the inflation rate would worsen the recession. BARSKY and KILIAN (2001), on the other side, are deeply convinced that stagflation is first and foremost a monetary phenomenon. If true, stagflation would be conquerable.

Most of the recent empirical studies often emphasize one specific factor to cause stagflation. To the best of our knowledge, little effort has been made to explore the origination of stagflation in a comprehensive model consisting of a range of possible impact factors. The fly in the ointment of bivariate models, however, is that the results are very likely to be inconsistent. The omitted variable problem often causes severe biases in empirical economic research.

To close the gap, this paper examines the roots of stagflation using the latest available data in multivariate empirical models. In section 2, we develop three measures to gauge stagflation. These measures capture both the appearance and the strength of stagflation in the world economy and, on the country-level, in a sample of developed economies. In section 3, we investigate the empirical determinants of these measures, accounting for a range of theoretical hypotheses that have been discussed since the mid-1970s. These factors contain interest rates, prices for commodities and oil, labor productivity, and wages. By reason of the nature of our measures, the empirical models include logit, count data, SVAR and panel estimations. The results confirm the ambiguity in the general influence of oil. However, the positive contribution of oil price *shocks* emerges as a clear empirical pattern. In line with HAMILTON (2009), we also find that the impact of oil has risen again in recent years and that oil has indeed contributed to the recession following the Financial Crisis. Another crucial determinant turns out to be the interest rate, providing evidence for the monetary explanation of stagflation. However, interest rates have been of minor importance during the 1970s and the 1980s, and did not become a main driver of stagflation until the early 1990s. The effect of interest rates in Europe,

on the other side, is conspicuously lower than in countries outside Europe. The influence of labor productivity, by contrast, is remarkably stable during the whole observation period and in each region. We also discover some interesting trends: while stagflation is less likely to occur today than in the past, a similar negative trend cannot be found concerning its magnitude. Quite the contrary, the strength of stagflation rose during the 1970 and the 1980s, only to remain on a more or less constant level in the post-1990 period. Furthermore, the persistence of stagflation is high. If a nation incurs stagflation in one year, it is very likely that this also applies for the upcoming period. We conclude in section 4.

## 2 Stagflation between 1970 and 2010

Stagflation emerges when prices rise and output declines or stagnates.<sup>2</sup> In some cases, a somewhat broader definition includes high or rising unemployment rates as a third element. This three-dimensional definition, however, increases complexity without generating noteworthy surplus insights, at least for the objectives of this paper. Our aim in this section is to identify periods of stagflation in a sample of 13 developed economies between 1970 and 2010. For this purpose we derive three concepts: the first concept is a binary variable that assumes 1 if stagflation occurred in the particular economy at  $t$ , and 0 otherwise. The second concept is a count data variable that gives the magnitude of stagflation in the world economy. The third measure gauges the extent of stagflation in each of the sample economies.

When measuring stagflation, the condition of a GDP decline in absolute values is fairly restrictive. It is much more appropriate to consider a decline in *growth* as the constitutive condition. By this means, consistency in the definition is granted, since inflation is defined as the growth of the price level exceeding a critical value rather than the mere increase of prices in absolute terms. As we want to allow for persistency of stagflation over a set of periods, we aim to find critical values  $\delta_k^*$  such that

$$\dot{k} = \frac{dk}{dt} < \delta_k^*, k \in (y, -p)$$

where  $y$  is GDP and  $p$  is the price level. What critical values would be reasonable to assume? One obvious choice of  $\delta_k^*$  is  $dk/d(t-1)$ , that would equal  $(d^2k/dt^2) < 0$ . Yet, such a measure under-predicts stagflation since it would require that the magnitude of

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<sup>2</sup>Our concept of stagflation is based on BAUMOL and BLINDER (2010) who define stagflation as a slowdown in growth combined with rising rates of inflation. This definition is conventional in recent research and has been applied in a number of papers, e.g. BARSKY and KILIAN (2001).

stagflation in the  $n$ th period must be higher than in the  $(n - 1)$ th period. On the other hand, using the sample mean  $T^{-1} \int_0^T \dot{k} dt$  would clearly over-predict stagflation. Instead, we rely on the derivation of critical values from economic theory.

The derivation of a critical value for *inflation* ( $\delta_p^*$ ) is straightforward. Most central banks in the world aim at a target inflation rate of about 2 percent. While this value is enshrined in the statutes of the European Central Bank (ECB), similar inflation targets can be estimated for other issuing banks. IRELAND (2007) shows that the current inflation target of the Federal Reserve Bank (FED) is about 2.5 percent, satisfying the average target between 1959 and today.<sup>3</sup> In addition, BERNANKE and MISHKIN (1997) point out that price stability in practice never means literally zero inflation, but usually something closer to a 2 percent annual rate. We therefore set the critical value of inflation equal to  $\dot{p} = .02$ .

For the derivation of the critical value for *economic growth* ( $\delta_y^*$ ) we use the evolution of factor productivity. When applying growth accounting in the standard growth model of SOLOW (1956), income increases can be decomposed into the contribution of labor, physical capital, and productivity ( $\psi$ ). The idea is that by using the mean value of factor productivity increases, the contributions of labor and capital on average are set to zero. So if  $\delta_y^* = T^{-1} \int_0^T \dot{\psi} dt$ , then in periods where economies fall below  $\delta_y^*$ , the average contribution of input factors is negative. We consider this case as a measure that gauges the general idea of the nature of stagflation quite well.

Figure 1 shows the kernel density of factor productivity increases in France, Germany, Italy, Ireland, Japan, the Netherlands, Spain, Sweden, the United Kingdom and the United States. The sample selection refers to the availability of data in the data base of GGDC (2005). The density function of  $\dot{\psi}$  is left-skewed (skewness:  $-.354$ ) with mean  $\bar{\dot{\psi}} \approx .012$ . The standard deviation is .0053, so the extent of variability in relation to the mean is moderate (43 percent). We use the mean of the density function as the critical value for  $\dot{y}$ , so  $\delta_y^* = \bar{\dot{\psi}}$ .

Putting together the assumptions on  $\delta_k^*$ , the first measure of stagflation will be the binary variable

$$\eta_{i,t} = \begin{cases} 1, & \text{for } \dot{p}_i > .02 \wedge \dot{y}_i < .012 \\ 0, & \text{else} \end{cases}.$$

Figure 2 illustrates the development of prices and real per capita GDP in the sample period 1970-2010 for the United States. Pictured is a scatter plot with lines connecting

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<sup>3</sup>However, IRELAND (2007) also noted that there have been some major fluctuations in the inflation target of the FED over time.



the dots in order to get an idea about the persistence of the movement. The critical values  $\delta_k^*$  are marked with solid lines so that a Cartesian coordinate system is created. Each observation in the second quadrant is stagflation according to our binary measure. Appendix A1 illustrates the same approach for 12 additional developed economies. As the graphs demonstrate, there are striking differences in the occurrence and persistence of stagflation. While some countries show a peculiar vulnerability to stagflation (e.g. United States, United Kingdom, Denmark, Spain and Australia), others have to struggle with stagflation to a much lesser extent (Japan, Finland and Canada). On the other hand, some countries show a trend towards less stagflation over the course of time (Ireland, Denmark and Sweden) whereas other nations have to sustain stagflation regularly (United States, France and United Kingdom). However, we can identify one pattern that is inherent to all economies: the *inflation* component of stagflation weakens over time, while the *GDP* component in general strengthens.

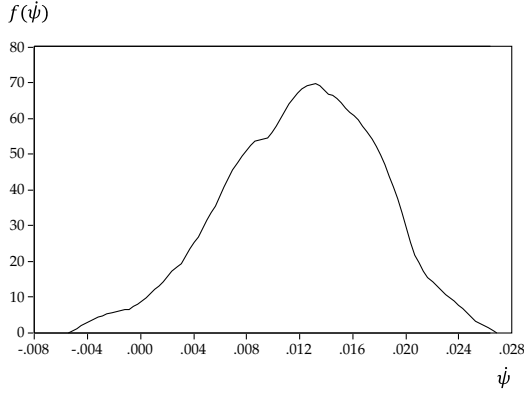
The binary variable shows whether stagflation was present in economy  $i$  at time  $t$ . So a simple measure to gauge the extent of stagflation in the world economy would be a count data variable that sums over all  $\eta_i$ . Our second measure is exactly defined this way, so

$$\tilde{\eta}_t = \sum_{i=1}^N \eta_{i,t}.$$

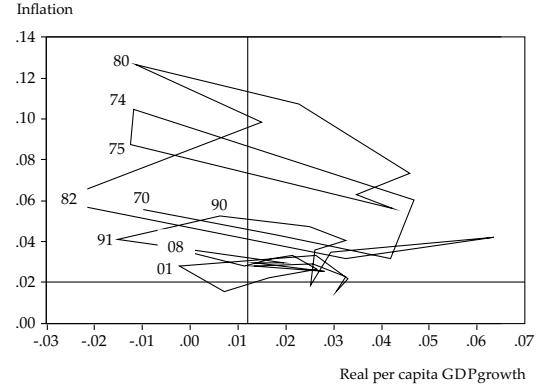
Figure 3 plots this measure over the sample period. We can identify three main stagflation periods: particularly in the middle of the 1970s, the beginning of the 1980s and the early 1990s, stagflationary tendencies were strong. Between 1974 and 1993, stagflation was an omnipresent threat, since this period afforded not a single year with zero stagflation. After 1993, the characteristic fluctuations took place on a much lower level. Figure 3 also indicates that stagflation has always been persistent within the three main stagflation periods. The current edge of the sample shows that stagflation in 2008 was as strong as ever. Nearly every country of the sample (11 of 13) has suffered from stagflation in this year. Apparently, the possibility of a recurrence of stagflation is quite rightly an important concern among policymakers. However, the historical picture of persistent stagflation cannot be detected in this case.

As  $\tilde{\eta}_t$  is defined as the sum of binary variables, it shows how often stagflation occurs in  $t$  but not how *strong* it was in the particular economy  $i$ . Our third measure  $\Lambda$  is concerned with this issue. The general idea is that the strength of stagflation equals the surface area  $A = |\dot{p} \times \dot{y}|$  in the second quadrant represented by the position vector  $\mathbf{k} = \dot{y}\mathbf{i} + \dot{p}\mathbf{j}$  where  $\mathbf{i}, \mathbf{j}$  are unit vectors. An alternative yet similar approach would be the length  $\|\mathbf{k}\|$  measured by euclidean norm. First, since each combination of inflation and

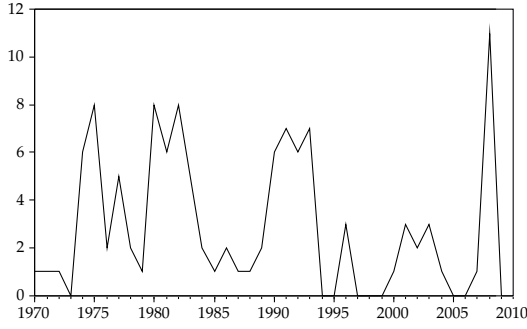
**Figure 1:**  
kernel density of factor productivity gains,  
developed economies, 1984-2004



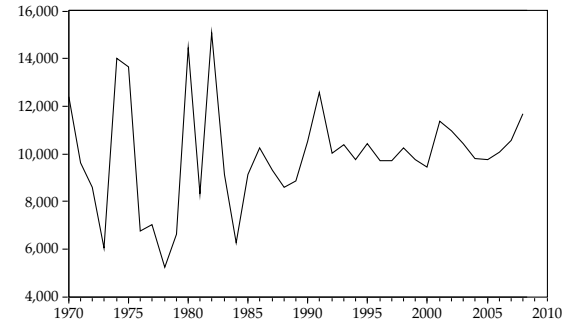
**Figure 2:**  
periods of stagflation in the United States  
( $\eta_{USA,t}$ ), 1970-2010



**Figure 3:**  
extent of stagflation in the world economy  
( $\tilde{\eta}_t$ ), count data, 1970-2010



**Figure 4:**  
extent of stagflation in the United  
States ( $\tilde{\Lambda}_{USA,t}$ ), 1970-2010



*Notes:* Figure 1 reports kernel density estimation of factor productivity changes in 10 developed economies: France, Germany, Italy, Ireland, Japan, Netherlands, Spain, Sweden, United Kingdom, United States. The time span is 1980-2004. Kernel is Epanechnikov,  $h = .005472$ . Data source is GGDC (2005). Figure 4 reports the magnitude of stagflation as described in the text using  $\gamma = 2$ . The data source is Heston et al. (2012).

GDP growth below  $\delta_k^*$  shall not be classified as stagflation, the data must be adjusted to  $\hat{k} \equiv \dot{k} - \delta_k^*$ . Second, we have to make sure that the observation  $\langle \hat{y}, \hat{p} \rangle$  lies in the second quadrant. This is the case for  $\hat{p} \geq 0$  and at the same time  $\hat{y} \leq 0$ . So in the third step, we want to disentangle the observations in the second quadrant from those lying in the other parts of the coordinate system. The basic idea is that only observations in the second quadrant are assigned with positive values. All other observations assume 'negative' areas. It simply does not matter whether an observation is in the first, the third or the fourth quadrant. They are all treated the same, and the interpretation of the surface area is always the extent of 'not-stagflation'. Neglecting subscripts for purposes of lucidity, this can easily be computed using

$$\Lambda_{i,t} = \begin{cases} -(\hat{p} \times \hat{y}) & \text{for } \hat{p}\hat{y} \leq 0 \wedge \hat{p} \geq 0 \\ -(\hat{p} \times \hat{y}) & \text{for } \hat{p}\hat{y} > 0 \wedge \hat{p} \geq 0 \\ -(\hat{p} \times \hat{y}) & \text{for } \hat{p}\hat{y} > 0 \wedge \hat{p} < 0 \\ (\hat{p} \times \hat{y}) & \text{else} \end{cases} \quad \forall i, t.$$

The variable  $\Lambda_{i,t}$  has a positive sign for  $\eta_{i,t} = 1$  and a negative sign for  $\eta_{i,t} = 0$ . However, we obtain  $\Lambda_{i,t} \in [-\infty, \infty]$ . This can cause serious problems regarding the interpretation of the coefficients when estimating  $\Lambda_{i,t}$ . We therefore generate  $\tilde{\Lambda}_{i,t} \equiv (\Lambda_{i,t} + \Lambda^0)^\gamma$  where  $\Lambda^0$  denotes the absolute value of the minimum of  $\Lambda$  in the sample. The adjusted variable  $\tilde{\Lambda}_{i,t}$  can only assume positive numbers and gives the strength of stagflation in the particular economy  $i$  at  $t$ . In order to award stronger stagflations a higher weight, we raise the term  $(\Lambda_{i,t} + \Lambda^0)$  to the power of  $\gamma$ . With increasing values of  $\gamma$ , the relative weight of strong stagflations rises.

Figure 4 illustrates this measure for the United States. The hikes caused by the first (1973) and second (1979) oil price crisis are clearly visible. At the same time, the figure shows that stagflation reached its historical maximum magnitude during the early 1980s. The extent of stagflation in the post-1980s period is notably lower than before. Yet, during the 1970s and the 1980s, there have always been periods where  $\tilde{\Lambda}_{USA,t}$  assumes very low values. Such episodes cannot be detected in later periods. The reason is that recessions and recoveries in the United States during the 1970s until the middle of the 1980s have been accompanied with high rates of inflation. From that time on, the FED committed itself more intensely to the target of price stability. As a consequence, the index is much more volatile in the early decades of the sample, because a recovery initiating high rates of inflation leads to a sharp increase in the extent of 'not-stagflation' and therefore a sudden decline in  $\tilde{\Lambda}_{USA,t}$ . Remarkably, whereas  $\tilde{\eta}_t$  assumes high values in the aftermath of the Financial Crisis, the increase in  $\tilde{\Lambda}_{i,t}$  in the United States is not that strong. This

is crucial, as it indicates that the individual extent has been lower than in the past, even though this period led to stagflation in a number of countries. Hence, both concepts complement each other, as each variable gauges a different version of what can be thought of as stagflation.

### 3 The empirical determinants of stagflation

The previous section provided three measures of stagflation. In this section, we investigate the empirical determination of these measures. The data sample contains a panel of 13 countries between 1970 and 2010 ( $T = 41$ ). The sample includes data for Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Spain, Sweden, the United Kingdom and the United States ( $N = 13$ ). The choice of the sample countries mainly refers to the availability of data. In addition, we aim to analyze the causes of stagflation within a heterogeneous group of developed economies. Otherwise we would have to include a range of covariates in order to consistently estimate the marginal effect of the variables of interest.

#### Variables and data sources

It is conventional to consider stagflation triggered by aggregate supply, as fluctuations of aggregate demand cannot lead to a combination of inflation and a decline in GDP *at the same time*, at least when consulting standard textbook macroeconomics. In such a context, any investigation of stagflation must mainly concentrate on aggregate supply. Indeed, most of the factors proclaimed to cause stagflation in previous studies are in fact supply-side determinants. We mentioned above the intense discussion among economists about the role of oil and monetary policy. In addition, most of the empirical work carried out in the 1970s and 1980s emphasizes the importance of wages and productivity. Summarizing earlier studies, our models include the following variables:

*Interest rates* (INT) - The role of central banks in the appearance of stagflation is a theme with long tradition, recently re-argued in BERNANKE et al. (1997), NELSON and NIKOLOV (2004), and KILIAN (2009a). LOYO (2000) and BARSKY and KILIAN (2001) even affirm that stagflation is first and foremost a monetary phenomenon. The basic idea underlying this approach is the theory of 'sluggish inflation' introduced by NELSON (1998). If a strong monetary expansion leads to a sustained increase in inflation over its steady state, stagflation can be demand-induced in dynamic models. In addition, higher

interest rates raise capital costs and lead to an increase in production costs and a decline in capital accumulation. This cost-push effect of interest rates has been modeled, for instance, by CAVALLO (1977) and FARMER (1988). The variable INT denotes the lending interest rate adjusted for inflation as measured by the GDP deflator. We lag this variable by one period for two reasons: first, investment decisions are mostly made in the intermediate or long-term. Second, the theory of sluggish inflation interpreted in the light of SARGENT (1998) suggests that agents learn only gradually about shifts in monetary policy. The data source of the lending interest rate is IMF (2013), the GDP deflator is from WORLD BANK (2013b).

*Unit labor costs (ULC)* - A number of studies in the aftermath of the 1973 and 1979 oil crises emphasize the role of wages in the stagflation process, e.g. MODIGLIANI and PADOA-SCHIOPPA (1978), BRANSON and ROTEMBERG (1980), GRUBB et al. (1982), and CUBITT (1997) to mention but a few. More recently, KILIAN (2009a) argues that real-wage rigidities can cause stagflation. Yet, wage gains are only hazardous if they exceed productivity improvements. The variable ULC captures this effect using unit labor costs from OECD (2013b).

*Productivity (PROD)* - Productivity gains strongly influence the development of aggregate supply. However, data on total factor productivity for the pre-1990 period is very sparse.<sup>4</sup> We instead use labor productivity growth PROD from OECD (2013c). As a matter of course, productivity and unit labor costs may be strongly correlated: the growth rate of unit labor costs is  $\Delta ULC = \Delta w - \Delta \psi_L$  with wage  $w$  and labor productivity  $\psi_L$ . Given that  $\Delta w = \Delta \psi_L$ , unit labor costs remain constant. If the influence of labor productivity on stagflation is negative, one can reasonably expect that wage increases in the past were smaller than productivity gains. We will take care of the probability of multi-collinearity between PROD and ULC later on.

*Commodity prices (RAW)* - GORDON (1975) and BLINDER (1979) show that rising costs for intermediates can lead to both inflation and a decline in output. Thus, we also study the development of the Commodity Price Index for raw materials of WORLD BANK (2013a), denoted with RAW. The index gives the development of a set of prices for raw materials on the world market. Again, it seems sensible to assume that these prices will primarily affect supply in the intermediate-term. Hence, we lag RAW by one period.

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<sup>4</sup>GGDC (2005) provides TFP data for a wide coverage of countries, but data for the majority of the sample countries only go back to 1980.

*Oil price (OIL)* - The contribution of the oil price has been subject to an intense and controversial debate among economists. The traditional view is that oil price shocks had negative effects on GDP and at the same time led to rising inflation rates during the 1970s and 1980s. This mindset is widespread in popular press and academic literature, declaring oil price shocks a substantial origin of stagflation. Using VAR models in a sample of five industrial economies, BURBRIDGE and HARRISON (1984) provide some early evidence for this perception. More recent studies of HAMILTON (2003, 2009) and JIMÉNEZ-RODRÍGUEZ and SÁNCHEZ (2010) confirm these findings, although the importance of oil seems to be declining. On the contrary, the work of BARSKY and KILIAN (2001) and KILIAN (2009a, 2009b) doubts this traditional view, countering that the influence of oil is not nearly as important as often thought. Further, KILIAN (2009b) illustrates that it is essential to disentangle the effect of oil supply and oil demand, since the consequences for the real economy differ in dependence on the market side causing the oil price to rise.

The price of oil traded on the world market influences the costs of production and transportation and affects consumption. A more thorough examination of national oil prices, however, uncovers a significant dispersion of oil importing costs. In other words, even if crude oil is traded on the world market, the costs of acquiring oil differ between the economies. The variable OIL accounts for this effect, using country-specific oil import prices from OECD (2013a). Similar to commodity prices, we assume that oil affects supply in the intermediate term. In addition, companies may keep parts of the required oil in stock. We thus lag OIL by one period.

*Time trend* - The measures of stagflation in section 2 show that stagflation on average was more severe during the 1970s and the 1980s than in later periods. By including the time trend  $\tau$ , we test the hypothesis that the probability of stagflation decreases over time.

*Lagged Stagflation* - The measures in section 2 also indicate that stagflation often is persistent over time. That means, if a nation incurs stagflation in  $t$ , it is likely that this also applies for the upcoming year. This persistency reflects the dilemma policy makers are faced with: reducing the inflation component by means of a restrictive monetary or fiscal policy worsens the recession. On the other hand, stimulating aggregate demand to enhance the short-run equilibrium of the economy would simultaneously lead to a further increase in the price level. One solution of this dilemma would be the expansion of the production potential. Yet, such policies have hardly any effects in the short-run. The consequence is persistency of stagflation over at least two periods. For this reason we include lagged endogenous variables in our model. The time lag is one year for each country, since the plots in section 2 show that in most cases stagflation is persistent for

**Table 1:** variables, data sources, and descriptive statistics of the regressors

variable	description	data source	mean	standard deviation
INT	lending interest rate adjusted for inflation as measured by the GDP deflator	lending rate: International Financial Statistics (IMF, 2013) GDP-deflator: World Development Indicators (World Bank, 2013b)	4.168	3.670
ULC	unit labor costs	Main Economic Indicators Database (OECD, 2013b)	9.230	3.990
PROD	labor productivity growth	Productivity Statistics (OECD, 2013c)	2.300	1.439
RAW	commodity price index for raw materials	Commodity Price Data (World Bank, 2013a)	103.642	35.290
OIL	country-specific import price for oil	IEA Energy Prices and Taxes Statistics (OECD, 2013a)	30.559	20.263

*Notes:* INT and PROD are reported in percentage values, ULC reports total unit labor costs of the economy and is in 100bn, RAW is in index points and OIL is in US dollars per barrel.

no more than two years.

Table 1 provides an overview of the variables, their means, standard deviations, and the referring data sources. We chose the data sources and the sample countries in order to maximize data availability. Even so, our panel is unbalanced as some data points are missing. The number of observations will be reported in each of the estimates. Both the Levin-Lin-Chu (LLC) test and the Im, Pesaran and Shin (IPS) test imply that the probability of the regressors to contain a unit root is very low and in most cases even close to zero.<sup>5</sup> However, there is one exception: the time series of oil import costs do not follow a stationary process. Hence, we use the first difference  $\Delta OIL$  instead of the absolute level. Another problem occurs with respect to the unit labor costs: as LLC

<sup>5</sup>See table A2 in the appendix for the probability of LLC and IPS. We have carried out both tests since LLC evaluates the existence of unit roots assuming that the coefficient of the lagged variables is homogeneous across all  $i$ , while IPS provides separate estimations for each  $i$  and thus allows for heterogeneity in the coefficient of the lagged regressors.

heavily rejects the existence of a unit root that is homogenous across all  $i$ , IPS discovers a unit root for at least one of the sample countries.<sup>6</sup>

### What determines the occurrence of stagflation?

The first empirical model is concerned with the binary variable  $\eta_{i,t}$  that assumes 1 if stagflation is present in  $t$ . Thus, we are interested in the question what variables determine the occurrence of stagflation in a particular country. We model the relationship between stagflation and the regressors using a fixed-effects logit specification of the form

$$P(\eta_{i,t} = 1 | \alpha_i, \beta) = \frac{\exp(\alpha_i + \mathbf{x}_{i,t}\beta)}{1 + \exp(\alpha_i + \mathbf{x}_{i,t}\beta)}.$$

The model makes three essential assumptions: first, conditional on the regressors  $\mathbf{x}_{i,t}$ ,  $\eta_{i,t}$  is an independent Bernoulli variable. Second, the probability of stagflation depends on  $\mathbf{x}_{i,t}$  through the logistic function and third, this probability is governed by the vector of structural parameters  $\beta$  and a country-specific parameter  $\alpha_i$ . Then the parameters can be estimated by first including dummy variables for the countries and then maximizing the unconditional maximum-likelihood function.

As our model only covers few variables that distinguish the countries, the inclusion of country-specific effects is requisite. Yet, as  $Cov(\mathbf{x}_{i,t}, \alpha_i) = 0$  is very unlikely, we cannot use a random effects model. Indeed, it is much more reasonable to assume that country-specific effects have their origin in institutions. These institutions, however, also determine  $\mathbf{x}_{i,t}$ , so the regressors and the unobserved effect must be assumed to be correlated. This argument is somewhat similar to BRUNO and SACHS (1985) who assume different labor market institutions to be responsible for different vulnerabilities to stagflation. ABREVAYA (1997) shows that the approximation of fixed effects with dummy variables using unconditional logit can lead to inconsistency in  $\beta$ . One alternative approach would be the estimator of CHAMBERLAIN (1980) that is consistent even in the presence of  $\alpha_i$ . The drawbacks of this method, however, are that it cannot produce estimates of the fixed effects and that unbalanced panels are especially problematic for the conditional estimator.

COUPÉ (2005) demonstrates that estimating unconditional-with-dummies regressions with  $T \geq 16$  only leads to a negligible amount of bias. Likewise, in a series of Monte Carlo experiments, KATZ (2001) suggests that researchers can safely apply both methods when

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<sup>6</sup>Note that the null and alternative hypotheses for IPS are formulated as  $H_0 : \theta_i = 0 \forall i$  vs.  $H_1 : \exists i \in N : \theta_i < 0$ . As the alternative hypothesis implies, the test already suggests non-stationarity if IPS discovers a unit root in *one*  $i \in N$ .



$T$  is larger than 16. With  $T = 41$ , our sample range significantly exceeds this critical value. Note that the cdf is necessarily logistic in our case, as  $\alpha_i$  cannot be eliminated in probit models.<sup>7</sup>

Table 2 shows the result of the estimation. Column (i) displays the outcome for the whole sample while columns (ii) and (iii) illustrate the results separately for European and non-European countries. For the sake of lucidity, dummy variables are excluded. We already mentioned that  $ULC$  exhibits non-stationarity. Furthermore, theory suggests multi-collinearity between  $PROD$  and  $ULC$ . Therefore, columns (i) – (iii) exclude  $ULC$ . The effect of unit labor costs is captured in column (iv).

Except for the Commodity Price Index, all the variables have the expected sign, they are significant in nearly each case and indicate a good fit to the data since the likelihood ratio assumes very low exceedance probabilities in all models. Column (i) covers the whole sample size of 13 nations between 1970 and 2010. The results show that both monetary policy and the oil price take a positive influence on stagflation. Thus, consulting this simple measure of stagflation, both paradigms seem to have a certain ability to explain the origins of stagflation. Beyond these factors, stagflation is less likely if labor productivity rises. Interestingly, the commodity price index does not mentionable contribute to the probability of stagflation at all.

One hypothesis that we drew based on the evolution of the binary measure in figure A1 is that stagflation was formerly more important than it is today. This seems indeed to be the case: the coefficient of  $\tau_{i,t}$  is highly significant and has a negative sign. Apparently, stagflation is a phenomenon that occurs much less frequently today than in past decades. Moreover, our guess that stagflation is persistent over two periods seems to hold regarding the coefficient of  $\eta_{i,t-1}$  that is significant and has a positive sign. If a nation suffers from stagflation in  $t$ , it is very likely that this will also be the case in the following year.

Estimating the model separately for European and non-European countries illuminates some interesting structural differences. Comparing (ii) and (iii), it becomes clear that interest rates influence aggregate supply in European countries to a much lesser extent than in countries outside Europe. Considering European nations only, the impact of interest rates is not significant at all. Likewise, the marginal effect of interest rates outside Europe is more than three times higher than in Europe. The same accounts for the vulnerability to oil price shocks: while the coefficient of  $\Delta OIL$  is positive and significant in both (ii) and (iii), the marginal impact of oil outside Europe is more than twice as high as in Europe. This discovery is in line with BURBRIDGE and HARRISON (1984) who find that the price of oil in general affects Canada, Japan and the United States more severely than European economies. Even more astonishingly, the negative

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<sup>7</sup>See BALTAGI (1995) and CAMERON and TRIVEDI (2005) for a more detailed discussion.

**Table 2:** logit regressions for stagflation, 13 developed economies, 1970-2010, dependent variable:  $\eta_{i,t}$ 

	(i) whole sample	(ii) Europe	(iii) Non-Europe	(iv) whole sample
$INT_{i,t-1}$	.099** [2.39]	.091 [1.37]	.304*** [3.07]	.008* [1.84]
$RAW_{t-1}$	-.005 [-.095]	.0004 [.04]	-.015* [-1.86]	-.008 [-1.34]
$\Delta OIL_{i,t-1}$	1.764*** [2.88]	1.319* [1.66]	3.533*** [3.09]	1.280** [2.21]
$PROD_{i,t}$	-.318*** [-5.55]	-.364* [-1.90]	-.478** [-2.38]	-.510*** [-3.95]
$ULC_{i,t}$				15.73** [2.51]
$\tau_{i,t}$	-.051*** [-2.65]	-.057** [-2.18]	-.032 [-.97]	-.039* [-1.74]
$\eta_{i,t-1}$	1.273*** [4.54]	1.451*** [4.12]	.347 [.62]	1.22*** [4.29]
$N$	387	251	136	387
McFadden $R^2$	.22	.17	.13	.22
Akaike	.95	1.03	.92	.96
$SEE$	.37	.39	.37	.38
$LR$ statistic	178.20***	46.08***	54.87***	175.41***
Iterations until convergence	5	5	5	5

*Notes:* Table reports unconditional-with-dummies logit regression, z-statistics shown in parentheses, SEE = standard error of regression, LR = Likelihood Ratio, Akaike reports  $\log(AIC)$ , optimization algorithm: Quadratic Hill-Climbing, \* $p < .10$ , \*\* $p < .05$ , \*\*\* $p < .01$ .

trend in the probability of stagflation over time cannot be detected in countries outside Europe. In this group of nations, stagflation is apparently just as relevant today as in the past.

The comparison of the fit of (i)-(iii) shows that the whole sample estimation works best considering McFadden R-squared, albeit the Akaike criterion indicates a better fit concerning the restricted sample of non-European countries. Nevertheless, the  $p$ -values of the likelihood ratio tests show that all three models describe the data quite well. Column (iv) illustrates that the fit cannot be improved by adding unit labor costs to the model. While McFadden remains unaltered, Akaike even exhibits a slight increase. We mentioned before that it is expedient to expect multi-collinearity between ULC and PROD. The variance inflation factor (VIF) of 34.12 confirms this assumption.<sup>8</sup> Mindful of the non-stationarity of ULC, the lack of increase in the model fit as well as the high VIF, we chose to exclude ULC in the following models. As we already mentioned before, the direction of the labor productivity coefficient can be assumed a proxy of ULC, so we do not fully neglect the effect emanating from unit labor costs. Note that similar to the results in table 2, the outputs of the upcoming estimations do not mentionable vary when in- or excluding unit labor costs.

One might object that the outcomes in table 2 are strongly influenced by the definition of the critical values that constitute  $\eta$ . Thus, we explore the effect of alterations in this definition. The first adjustment  $\eta(2)$  is more restrictive in terms of GDP growth, setting the critical values to  $\dot{p} = .02$  and  $\dot{y} = .005$ . The value of GDP growth in this measure equals the empirical standard deviation of  $\dot{y}$ . The second modification accounts for different preferences for price stability. Since some countries reveal notably higher inflation rates than  $\delta_p^*$  in the past, we use the sample median of  $\dot{p}$  for the adjustment of  $\eta(3)$ . Thus, critical values are  $\dot{p} = .039$  and  $\dot{y} = .012$ . The outcome of the logit estimations using  $\eta(2)$  and  $\eta(3)$  are shown in appendix A3. The results are very similar to those in table 2. Thus, we suggest that our findings are not essentially affected by the definition of  $\eta$ .

### What determines the strength of stagflation?

The preceding estimations show what determines the occurrence of stagflation. However, not all periods of stagflation are alike. In some cases, the economies are heavily affected, while in other cases, the consequences are manageable. For this reason, we subsequently

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<sup>8</sup>Based upon the coefficient of determination for  $X_j = \delta + \sum_{i \neq j}^N \alpha X_i + \epsilon$ , VIF calculates  $\frac{1}{1-R^2}$ . The higher VIF, the higher the probability of multi-collinearity. KUTNER et al. (2004) advocate for a critical threshold of VIF = 10 to qualify multi-collinearity.

aim to explain what influences the *strength* of stagflation. Thus, we will now focus on the two remaining measures of section 2. The first measure  $\tilde{\eta}_t$  is a count variable that sums up all binary variables that reflect stagflation in  $i$  at  $t$ , the second measure  $\tilde{\Lambda}_{i,t}$  is concerned with the strength of stagflation in each economy as described in section 3.

The count variable can be interpreted as the magnitude of stagflation in the world economy. Hence, the specification of  $\tilde{\eta}$  will be a simple time series model. As  $\tilde{\eta}_t$  is a discrete count variable with  $\tilde{\eta}_t \geq 0 \forall t$ , we use the Poisson and the Negative Binomial (NB) model to describe its behavior. The latter is necessary since overdispersion might be a problem owing to the sample variance of  $\tilde{\eta}$  (8.64) that significantly exceeds the mean (2.83). Comparing the results of Poisson and the Negative Binomial distribution is expedient by reason that NB allows the variance to be larger than the mean. WOOLDRIDGE (2010) and CAMERON and TRIVEDI (1986) explicitly favor the use of the Negative Binomial distribution if overdispersion occurs in Poisson models. Furthermore, DAVIDSON and MACKINNON (2004) allude that the Poisson model tends to underpredict the frequency of zeros in practical applications. Yet, figure 2 illustrates that a mentionable number of periods with zero stagflation are to be observed in the sample period. We calculate the coefficients  $\beta$  numerically using ML estimations with quadratic hill-climbing as optimization algorithm. As the utilization of  $\tilde{\eta}_{i,t}$  leads to a time series model, we use the cross-sectional mean of  $\mathbf{x}_{i,t}$  when required. We also think that the world price for oil is more reasonable than the application of the cross-sectional mean of oil-importing costs. The data source of the crude oil price is IMF (2013).

Since  $\tilde{\Lambda}_{i,t} \in \mathbb{R}^+$ , Poisson is not an option for the estimation of the strength of stagflation in a particular country. Instead, we apply a fixed effects panel regression (FE). As we mentioned before, individual effects of  $i$  are likely to emerge due to institutional differences rather than by random effects (RE), so we prefer FE over RE. The regressors of both estimations are equal to the regressors used in the logit model. Tables 3a and 3b illustrate the results of estimating  $\tilde{\eta}$  and  $\tilde{\Lambda}$ . The latter is shown for  $\gamma = 1$  and  $\gamma = 2$ .

The computation of R-squared for the Poisson and Negative Binomial model refers to CAMERON and WINDMEIJER (1996). In our case, this computation is of some advantage as it allows a more direct comparison between the Poisson, the Negative Binomial, and the FE models than consulting only the Akaike criterion. The results in table 3a show that both the count data and the FE models have a good fit to the data. Both the LR stat (in the Poisson and NB model) and R-squared (in the FE model) are strongly significant.<sup>9</sup> All variables have the expected sign, they are significant most of the time and are able to explain 40-50 percent of the variation in the strength of stagflation. However, the

<sup>9</sup>The significance of R-squared has been calculated using the Wald Test  $H_0 : \xi_j = 0 \forall j$  vs.  $H_1 : \exists j : j \neq 0$ . The Wald Test rejects  $H_0$  with  $p = .0000$  [Stat: 60.77].

**Table 3a:** regressions for the strength of stagflation, count data models, dependent variable  $\tilde{\eta}_t$ 

	Poisson			Negative Binomial		
	results	standardized	rank [dist. to 1]	results	standardized	rank [dist. to 1]
$C$	2.070* [1.84]			1.57 [1.17]		
$INT_{t-1}$	.069* [1.88]	.083*	3 [54]	.084* [1.93]	.101*	3 [38]
$RAW_{t-1}$	.002 [.29]	.024	6 [86]	.005 [.73]	.061	4 [63]
$\Delta OIL_{t-1}$	.337 [1.26]	.037	4 [79]	.424 [1.40]	.047	5 [71]
$PROD_t$	-.522*** [-2.82]	-.181***	1 [0]	-.469** [-2.12]	-.163**	1 [0]
$\tau_t$	-.036* [-1.81]	-.146*	2 [19]	-.035 [-1.30]	-.142	2 [13]
$\tilde{\eta}_{t-1}$	.034 [1.15]	.034	5 [81]	.005 [.15]	.005	6 [97]
$N$		39			39	
R-squared		.46			.49	
$LR$ statistic		46.48***			165.81***	
Akaike		4.57			6.63	
Pearson		2.31			.70	

*Notes:* Table reports Poisson and Negative Binomial regressions (ML/QML), z-Statistics shown in parentheses, LR = Likelihood Ratio, Akaike reports  $\log(AIC)$ ,  $*p < .10$ ,  $**p < .05$ ,  $***p < .01$ . The column 'standardized' gives standardized coefficients calculated using standardized independent variables with variance one. Marginal effects have been calculated similar to *Hilbe* (2011). The column 'dist. to 1' illustrates the percentage distance to the marginal impact of the most influential regressor.

**Table 3b:** regressions for the strength of stagflation, FE models, dependent variable  $\tilde{\Lambda}_{i,t}$ 

	$\gamma = 1$	standardized	rank [dist. to 1]	$\gamma = 2$	standardized	rank [dist. to 1]
$INT_{t-1}$	1.197*** [5.99]	.255***	2 [17]	231.25*** [6.17]	.295***	1 [00]
$RAW_{t-1}$	.004 [.17]	.090	6 [97]	2.41 [.50]	.030	6 [90]
$\Delta OIL_{t-1}$	7.330*** [3.26]	.107***	5 [63]	1485.61*** [3.52]	.130***	5 [56]
$PROD_t$	-2.342*** [-3.63]	-.196***	2 [17]	-491.41*** [-4.06]	-.246***	3 [17]
$\tau_t$	.248*** [3.13]	.171***	4 [40]	37.26** [2.53]	.153**	4 [48]
$\tilde{\Lambda}_{t-1}$	.286*** [6.24]	.286***	1 [00]	.252*** [5.35]	.252***	2 [15]
$N$		387			387	
R-squared		.38***			.34***	
Akaike		7.51			17.98	

*Notes:* Table reports fixed effects regression (FE), t-Statistics shown in parentheses, Akaike reports  $\log(AIC)$ , optimization algorithm is Quadratic Hill-Climbing,  $*p < .10$ ,  $**p < .05$ ,  $***p < .01$ . The column 'standardized' gives standardized coefficients calculated using standardized independent variables with variance one. The column 'dist. to 1' illustrates the percentage distance to the marginal impact of the most influential regressor.

$p$ -values show that the regressors are much more appropriate to model the strength in  $i$  rather than strength in the world economy. As expected, overdispersion is a problem in the Poisson model. The Pearson statistic is 2.31 and lies outside the acceptable range. Obviously, the default of the condition  $VAR(\tilde{\eta}|\bar{\mathbf{x}}_t) = E(\tilde{\eta}|\bar{\mathbf{x}}_t)$  leads to an underestimation of the variance. However, the comparison of the two count data models does not reveal significant structural differences. R-squared in both models assume similar values, the Akaike criterion is slightly lower in the Poisson model. The good fit of the count data models can yet not disguise the fact that most of the regressors are not significant. Our results indicate that the number of countries suffering stagflation depends mostly on the height of interest rates and labor productivity. Furthermore, we can observe a negative time trend with some significance, at least in the Poisson model. Astonishingly, both the price of oil and the price of commodities do *not* notably influence the number of nations possessing stagflation. The estimations of the count data models do not reproduce the strong influence of oil discovered in the logit models. We will explore this issue in detail later on.

Considering the magnitude of stagflation on the country level, table 3b illuminates that the most important drivers are interest rates, labor productivity, the degree of stagflation lagged by one year, and - with some reservations - oil import prices. These results in general favor the monetary explanation of stagflation. The outcome does not mentionable differ if we consider varying weight exponents  $\gamma$ . However, we do *not* find evidence that the extent of stagflation declines. Quite the contrary, we discover a positive time trend. This finding is crucial since it deviates from the results of the logit model. Apparently, there are huge differences in the *occurrence* and the *strength* of stagflation. According to the logit model in table 2, stagflation is less likely today than in the past. The count data models confirm this assumption since the coefficient of  $\tau$  has a negative sign and shows some significance. So in general, the *probability* of stagflation decreases. Though, if stagflation occurs, the *extent* seems to strengthen over time. Table 3b illustrates that the magnitude of stagflation is primarily driven by productivity declines, rising interest rates and the degree of stagflation in  $t - 1$ . Splitting the sample into European and non-European countries yields similar results with two exceptions that we could already find in the logit model: first, interest rates seem to be more important in non-European countries. Second, European nations are less vulnerable to oil price hikes.

### The influence of oil

While table 3a and 3b shed some light on the magnitude of stagflation, several of the results are odd. The most surprising outcome is certainly provided by the effect of the

oil price. According to the estimations of the count data models, the contribution of the oil price is both insignificant and inconsiderable in comparison with the other regressors. The FE models in table 3b lead to similar conclusions: while the oil price in these models exerts a significant impact, the marginal effect is considerably weaker than the effect of interest rates or labor productivity. The column 'standardized' gives the coefficient of the estimation where the independent variables have been standardized so that their variances are one. The advantage is that the marginal impacts of these coefficients can directly be compared. The column 'rank' assigns a rank to each regressor, depending on its relative empirical weight. In order to quantify the relative weight, we also depict the percentage distance to the strongest determinant in parentheses. In each of the estimations, the impact of oil is inconsiderable in relative terms. Monetary policy and the development of labor productivity seem to be of much greater importance. The distance to the independent variable with the largest weight is 70-80 percent (count data models) and 50-60 percent (panel estimations), respectively. Even in the FE model where oil price changes exert a significant influence, the additional contribution to stagflation is low.

One explanation of this peculiar result may be that oil price increases have to exceed a critical level in order to cause stagflation. In other words, one could suspect that only oil price *shocks* can trigger periods of stagflation. Another suggestion may be that a structural break in the data distorts the general effect. A further explanation refers to the findings of KILIAN (2009b). Kilian argues that it is essential to disentangle the roles of supply and demand when analyzing the effect of the oil price. The idea is that oil price hikes can have two origins: first, a decline in oil supply certainly leads to an increase in the crude oil price and may simultaneously rise prices and lower incomes. However, the oil price may also ascend due to an increase in worldwide demand. In this case, countries that have a current account surplus are faced with two opposing effects: on the one hand, consumption and investment decline due to the increase of the price level. On the other hand, exports rise as worldwide demand increases. Depending on the structure of the particular country, the second effect may overcompensate the first effect, leading to a temporarily increase in GDP, even if the oil price ascends. Kilian also argues that oil price hikes in the past are mostly triggered by a decline in oil supply, whereas in more recent years, demand is the decisive factor. This would explain why the impact of oil is ambiguous when estimating its effect over a long period without capturing in detail the causes of the oil price changes.

To implement the above suggestions in the empirical model, we apply the following adjustments of the estimations. First, we split the relevant time period into two sub-periods of equal length:  $q_1$  (1970-1990) and  $q_2$  (1991-2010). Second, we replace  $\Delta OIL$



with  $\varrho(\Delta OIL)$ . The dummy  $\varrho$  is 1 for  $\Delta OIL_{t-1} > .15$  and 0 otherwise. Therefore, we model the influence of oil price shocks, defined as annual growth rates higher than 15 percent. Table 4 shows the outcome of these adjustments and contrasts the results with the referring estimation over the whole sample period. As the limited degrees of freedom in the count data models do not allow to split the sample, table 4 reports Poisson estimates only for the whole sample period.

The effect of the different origins of oil price increases are captured in table 5. The identification of demand and supply shocks refers to KILIAN (2009b) who provides a detailed description of the underlying method. In contrast to alternative approaches of e.g. HAMILTON (2003), this method allows not only for isolating the supply shock, but also to quantify aggregate and oil-specific demand shocks. To briefly illustrate the general idea, consider a VAR model based on monthly data for  $\mathbf{z}_t$ , capturing the percentage change in crude oil production  $OPR$ , real economic activity  $REA$  and the real price of oil  $OIL$ . The data source of these variables is KILIAN (2009b). Using monthly data, the structural VAR model representation is

$$\mathbf{B}_0 \mathbf{z}_t = \alpha + \sum_{i=1}^{24} \mathbf{B}_i \mathbf{z}_i + \varepsilon_t$$

where  $\varepsilon_t$  is a vector of serially and mutually uncorrelated structural innovations. Given that  $\mathbf{B}_0^{-1}$  has a recursive structure such that  $\varepsilon_t$  can be decomposed into

$$\mathbf{e}_t \equiv \begin{pmatrix} e_t^{OPR} \\ e_t^{REA} \\ e_t^{OIL} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 \\ b_{21} & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{oilsup} \\ \varepsilon_t^{agdem} \\ \varepsilon_t^{oildem} \end{pmatrix},$$

$\varepsilon_t^{oilsup}$  gives the oil supply shock,  $\varepsilon_t^{agdem}$  denotes the aggregate demand shock and  $\varepsilon_t^{oildem}$  is the oil-specific demand shock. The latter can also be thought of as precautionary demand that arises from the uncertainty about shortfalls of expected supply. The calculation can only be carried out using monthly data, as the restrictions on  $\mathbf{B}_0^{-1}$  only hold in the very short-run. To incorporate these shocks into our model, we use yearly aggregates of the identified monthly shocks. Although this leads to a loss in information, it is still the only possibility to merge Kilian's shocks with our model, owing to the limited availability of the necessary data on a monthly base.

Table 4 provides some interesting insights on the origin of the oil price coefficient. First,  $\varrho_t(\Delta OIL_t)$  is strongly significant in every sub-sample and also in both whole sample estimations. Apparently, moderate increases in the oil price do not contribute to the emergence of stagflation. Quite the contrary, oil price *shocks* take a significant influence.

**Table 4:** adjusted regressions for the strength of stagflation, subsamples versus whole sample, dependent variable  $\tilde{\Lambda}_{i,t}$ 

	$q_1$ : 1970-1990		$q_2$ : 1991-2010		$\mathbb{P}(q_1 = q_2)$	whole sample (FE)		whole sample (Poisson)	
	(i)	(ii)	(i)	(ii)	each with (i)	(i)	(ii)	(i)	(ii)
$C$						2.070*		2.070*	1.72
						[1.84]		[1.84]	[1.52]
$INT_{i,t}$	.594	.671	.795***	.803***	.661	1.197***	1.152***	.069*	.072*
	[1.25]	[1.41]	[3.45]	[3.45]		[5.99]	[5.79]	[1.88]	[1.93]
$RAW_{i,t}$	-.098	-.203*	.006	.020	.264	.004	.018	.002	.002
	[-.93]	[-1.67]	[.40]	[1.15]		[.17]	[.70]	[.29]	[.36]
$\Delta OIL_{i,t-1}$	11.197**		5.16**		.174	7.330***		.337	
	[2.47]		[2.46]			[3.26]		[1.26]	
$\varrho_{i,t}(\Delta OIL_{i,t})$		22.210**		6.75*			9.61***		.611**
		[2.54]		[1.91]			[2.77]		[2.16]
$PROD_{i,t}$	-3.302**	-1.986	-2.70***	-2.778***	.653	-2.342***	-2.285***	-.522**	-.476***
	[-2.47]	[-1.37]	[-3.96]	[-3.58]		[-3.63]	[-3.54]	[-2.82]	[-2.59]
$\tau_{i,t}$	.812*	.577	-.23	-.236	.019	.248***	.236***	-.036*	-.028
	[1.84]	[1.36]	[-1.57]	[-1.45]		[3.13]	[2.93]	[-1.81]	[-1.38]
$\tilde{\Lambda}_{i,t-1}$	.213***	.207***	.251***	.236***	.749	0.286***	.283***		
	[2.94]	[2.87]	[4.26]	[4.04]		[6.24]	[6.15]		
$\tilde{\eta}_t$								.034	.038
								[1.15]	[1.26]
$N$	165	165	222	222		387	387	39	39
R-squared	.30***	.30***	.48***	.47***		.38***	.37***	.46***	.49***

Notes: t-statistics (FE) and z-statistics (Poisson) are shown in parentheses, optimization algorithm is Quadratic-Hill-Climbing,  $\mathbb{P}[\Xi(q_1) = \Xi(q_2)]$  has been calculated using the Wald test, \* $p < .10$ , \*\* $p < .05$ , \*\*\* $p < .01$ .

**Table 5:** adjusted regressions for the strength of stagflation, structural demand and supply shocks, dependent variable  $\tilde{\Lambda}_{i,t}$ 

	oil-specific shocks	all shocks
$INT_{i,t}$	1.051*** [5.29]	1.081*** [5.49]
$RAW_{i,t}$	.004 [.15]	-.005 [-.19]
$\varepsilon^{oilsup}$	5.518** [2.19]	6.01** [2.40]
$\varepsilon^{agdem}$		-8.316*** [-2.82]
$\varepsilon^{oildem}$	-.784 [-.34]	-1.947 [-.84]
$PROD_{i,t}$	-1.569** [-2.31]	-1.638** [-2.44]
$\tau_{i,t}$	.353*** [3.98]	.367*** [4.18]
$\tilde{\Lambda}_{i,t-1}$	.123*** [2.59]	.116** [2.46]
$N$	390	390
$R^2$	.34***	.35***

Notes: t-statistics are shown in parentheses, \* $p < .10$ , \*\* $p < .05$ , \*\*\* $p < .01$ .

In other words, not oil price growth in general but oil price growth that exceeds a critical level is an important driver of stagflation. In both sub-samples, the marginal impact of  $\varrho(\Delta OIL)$  is significantly positive and higher than the effect of  $\Delta OIL$ . In sub-sample  $q_1$ , the marginal effect approximately doubles. This documents that the more inchoate results in table 3b are misleading. Comparing both sub-samples, we can see a strong decline in the marginal effect of oil price shocks. In the period from 1970-1990, the impact of  $\varrho(\Delta OIL)$  is 22.21. However, in the post-1990 period, the effect nearly quarters to 6.75. The development of the coefficient indicates that oil price shocks have lost importance over the past two decades. These results are in line with the findings of JIMÉNEZ-RODRÍGUEZ and SÁNCHEZ (2010) who showed that the influence of oil has diminished since the early 2000s.

Aside from the notable change in the coefficient of oil price shocks, the model is quite robust when comparing both sub-samples. The Wald test yields high probabilities that the marginal impacts in  $q_1$  and  $q_2$  are identical. However, table 4 demonstrates that the influence of the interest rate has risen in more recent years. If true, the superiority of the monetary explanation holds no earlier than from the beginning of the 1990s. In contrast, the effect of labor productivity turns out to be very consistent. One further interesting result is provided by the trend component: while we find evidence that the strength of stagflation has risen between 1970 and 1990, it remains remarkably constant in the post-1990 period. In other words, the strong increase in the magnitude of stagflation that we found in table 3b is mainly triggered by developments that took place in the 1970s and 1980s. Ever since that time, the degree of stagflation remains on a more or less constant level.

Another crucial suggestion that we expressed above is that it is essential to disentangle the effects of demand and supply in the formation of the oil price. Table 5 shows the outcome of the FE estimation incorporating the structural shocks proposed by KILIAN (2009b). The results indicate that this distinction indeed matters. As suspected, oil price shocks positively affect the strength of stagflation. So a decline in oil production is likely to increase both the probability and the strength of stagflation. On the other hand, if the oil price hikes are due to an increase in demand, the strength of stagflation tends to weaken. Likewise, if worldwide aggregate demand increases, then stagflation will be less severe. These results are crucial, as they strongly pronounce that not all oil price hikes are alike. Whenever increases in the oil price are determined by aggregate demand, then the positive effect of exports can overcompensate the negative effect of rising production costs. In this case, an increase in the oil price does not lead to stagflation.

These results are more reliable than the utilization of the oil price or a naive oil shock for two reasons. First, table 5 demonstrates that the origin of the price increase

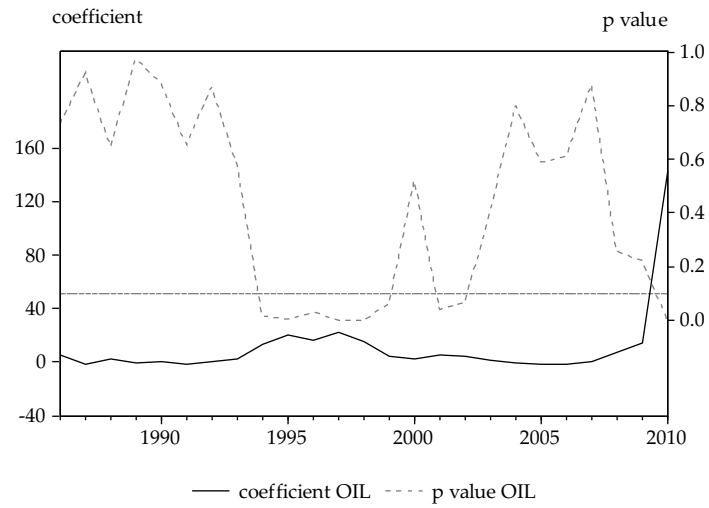
matters. Second, the measure of KILIAN (2009b) explicitly illustrates unexpected shocks. Estimations that only incorporate the evolution of the oil price do not capture the isolated effect of unexpected oil price increases and are likely to be biased. However, there is little hope of being able to estimate the link from expectations (or observables that drive expectations) to shifts in the uncertainty of future oil supply gaps. The huge advantage of the SVAR model is that it captures the desired effects without actually modeling expectations directly.

Whereas all previous results indicate that the importance of oil declined during the past decades, it is interesting to study whether this is a strictly monotonic development or if there are any mentionable fluctuations over time. To investigate how the oil price coefficient has evolved, we use rolling estimations of the FE model ( $\gamma = 1$ ) with window  $w = 6$ .

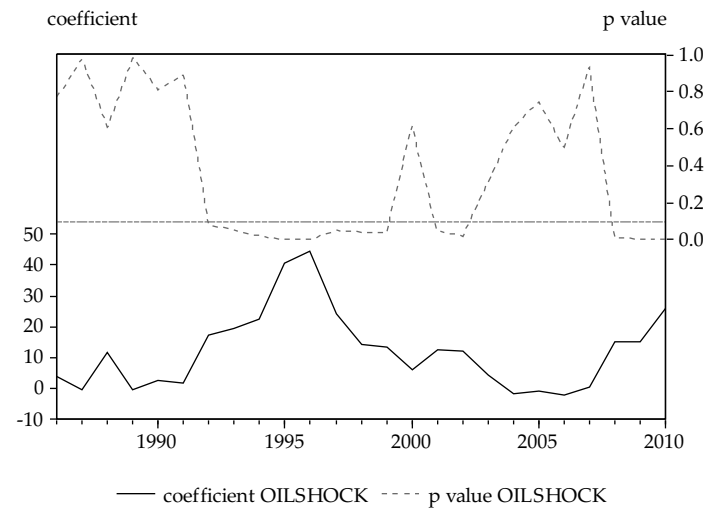
Figures 5 and 6 picture the end points of the particular window, i.e. 2010 shows the coefficient of the window 2004-2010. The first and obvious conclusion from the rolling estimate is that oil is only temporarily significant. Generally speaking, we can observe periods where oil makes a major contribution to the magnitude of stagflation and others in which oil is not important at all. The coefficient obviously has been close to zero and highly insignificant during the end of the 1980s and the early 1990s. During the 1990s, the impact of oil slightly rose again. Yet, since the early 2000s, oil became insignificant. Up to this point, our results are in line with the findings of JIMÉNEZ-RODRÍGUEZ and SÁNCHEZ (2010). Second, as figure 3 strikingly illustrates, the relevance of oil rose tremendously at the rear edge of the rolling estimation. At the same time, the  $p$ -value declined sharply and is even close to zero in the last sub-sample in period 2004 to 2010. Apparently, the vulnerability of the world economy to the oil price has risen again. Note, however, that the reduction of the sample sharply decreases the degrees of freedom and thus increases the probability of a bias in the estimation. For this reason, the results must be interpreted with caution.

KILIAN (2009a) states that the world economy has remained remarkably resilient to the sustained real oil price increases at the beginning of the 2000s, a suggestion unambiguously confirmed by our results. However, we also find some evidence for the argument in HAMILTON (2009) that oil price increases have contributed to the economic decline that followed the Financial Crisis. Even so, it is very reasonable to assume that the endogenous factors utilized in our models alone cannot explain the high magnitude of stagflation in 2008. In fact, the Great Recession rather has to be declared an outlier which has significantly been affected by the housing bubble and the breakdown of the financial markets. Oil, productivity and interest rates may have contributed their part, but this part is certainly secondary in comparison to exogenous determinants.

**Figure 5:** the development of the oil price coefficient ( $\Delta OIL$ ), rolling estimation of the FE Model,  $\gamma = 1$



**Figure 6:** the development of the oil price shock coefficient ( $\varrho \Delta OIL$ ), rolling estimation of the FE Model,  $\gamma = 1$



## 4 Conclusions

This paper has illustrated the determinants of stagflation, capturing its various facets in a number of empirical estimations. The results suggest that rising interest rates, declining labor productivity, and oil price hikes are major origins of stagflation. Yet, the impact of these factors exhibits non-linearities concerning its magnitude and its influence over time. One exception is labor productivity. The probability and the strength of stagflation significantly decline whenever improvements in productivity can be achieved. This effect is remarkably stable over time and can be found in European economies and in countries outside Europe in equal strength. Conversely, if labor productivity declines, the likelihood of stagflation rises.

The effect of the oil price is somewhat more ambiguous. The binary choice models indicate that the probability of stagflation rises if oil price increases took place in the previous year. By contrast, the general effect of oil is virtually negligible in both strength and significance when estimating the magnitude of stagflation. A more thorough examination brought to light that the response of economies to oil price changes depends on the extent of the price increase. A bulge in prices indeed turns out to be much more appropriate in explaining stagflation. Such a sudden and large increase can be thought of as a shock hitting the oil market. However, these shocks can occur due to both sides of the market. Our analyzes showed that it is in fact crucial to disentangle the effects of demand and supply in the occurrence of oil price shocks. While supply shocks significantly contribute to stagflation, the effect of a growing oil-specific and precautionary demand leads to the opposite effect. Apparently, the positive stimulation of the economy that is accompanied by the spurt of demand overcompensates the negative supply effect emanating from the rise in the oil price. Furthermore, the results suggest that the influence of oil was particularly stronger during the 1970s and the 1980s than today. This is in line with HAMILTON (2009) and KILIAN (2009b) who argue that oil price hikes in the 1970s were primarily driven by supply whereas the main force behind oil price increases during the 1990s and 2000s was ascending worldwide demand. If true, the effect of oil would have necessarily leveled off over time, as demand-induced oil price increases contribute little to periods of stagflation. The evolution of the oil price coefficient in our rolling estimation confirms the declining impact of oil. However, in the last sub-sample of 2005-2010, the influence of oil is both positive and highly significant. This result is astonishing in a way that it provides some evidence for HAMILTON (2009) who argues that oil contributed to the Great Recession following the Financial Crisis.

Interest rates turn out to be one of the most important drivers of stagflation in all of the estimates. However, the contribution is not significant before the post-1990 period. This

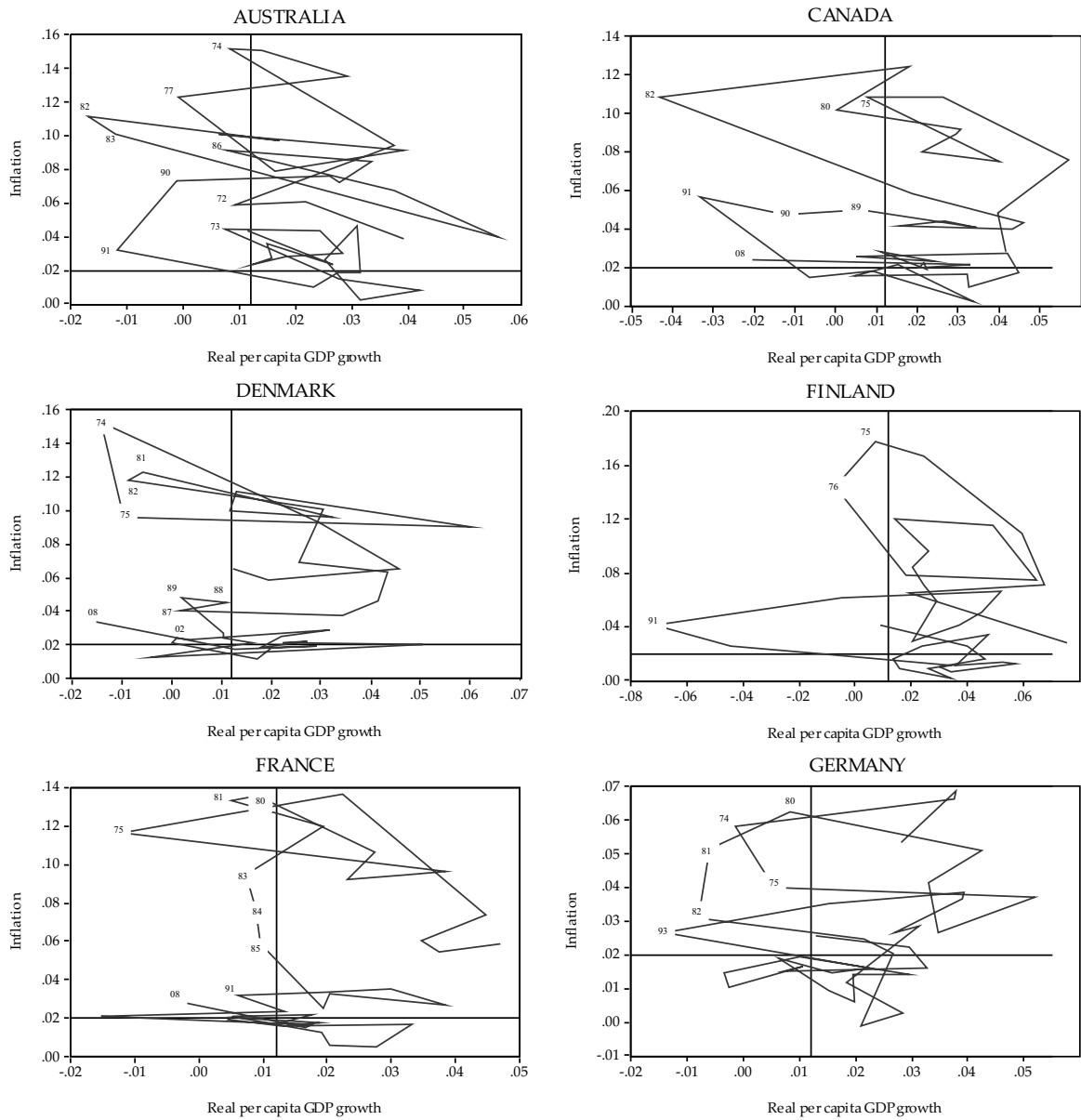
point is important, because it indicates that interest rates have replaced oil price shocks as the most compelling origin of stagflation from the early 1990s. This development leads to entirely new policy implications. Our results suggest that stagflation is often persistent over two periods, apparently presenting an inevitable policy dilemma. Indeed, if stagflation is caused by an exogenous supply shock, any attempt to lower inflation would make the recession more severe. In contrast, if stagflation is a monetary phenomenon, it may as well be conquerable. Our measures demonstrate quite clearly that the historical picture of persistent stagflation vanishes in the recent past.

The recurrence of stagflation has become an important concern among policymakers and economists in light of the downward trend in growth rates spreading in most developed economies, particularly in Europe. Our findings indicate that the probability of renewed periods of stagflation has declined since the 1970s, but even the 2000s spawned a number of stagflationary years. Even more gravely, the magnitude of stagflation does not possess a negative trend. A recurrence therefore would lead to economic consequences quite similar to those observed in previous decades. Generally, we found that stagflation today would have to be more easy to overcome than in the past, since the results suggest that the monetary view is gaining relevance. Moreover, opinions are voiced in recent economic discussions that the exogenous character of the oil price must be rethought. Rather, the work of KILIAN (2009b), ALQUIST et al. (2011), BODENSTEIN et al. (2011) and others suggest that models of endogenous oil prices should focus on the demand side of the oil market. It has recently been illustrated by KILIAN and HICKS (2013) that the oil price shock of 2003-2008 was driven by repeated positive shocks to the demand for all industrial commodities due to unexpectedly high growth rates in emerging Asia. This channel may become more and more important in the future in view of stagnating worldwide oil production and catching-up African and Asian economies. We could not find a significant impact of aggregate demand on stagflation in our estimates concerning the long time-span between 1970 and 2010. However, the positive influence of oil in the last sub-sample of the rolling estimation can be a hint that demand-induced stagflation in fact may become an important issue in the future.

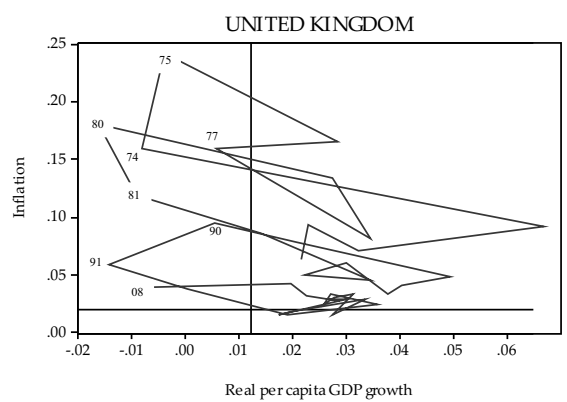
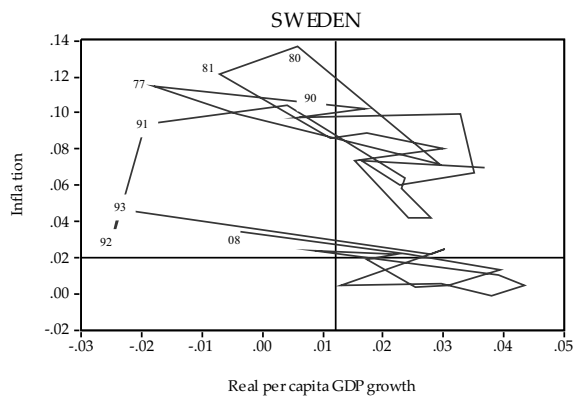
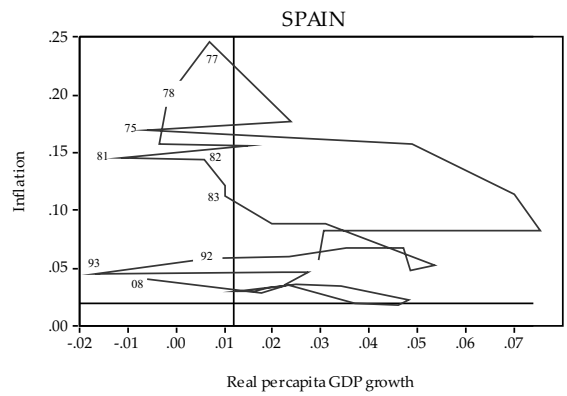
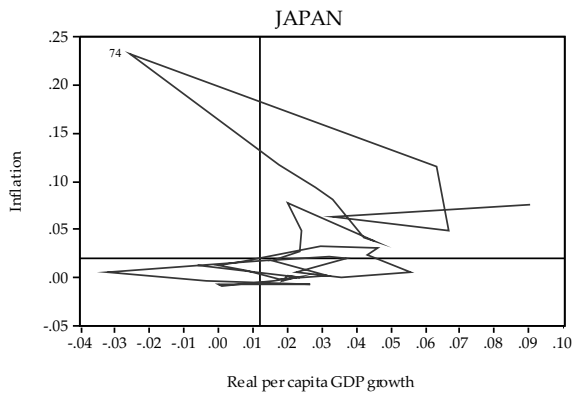
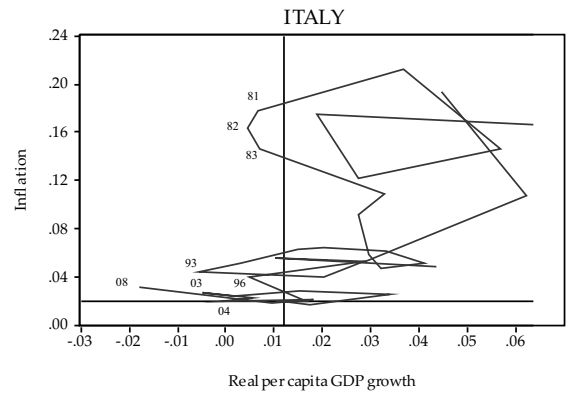
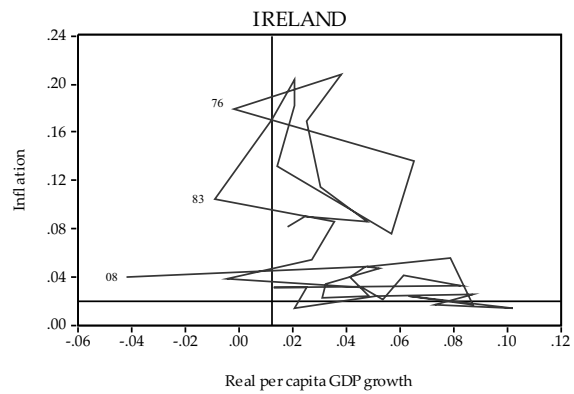


# Appendix

A1: stagflation in developed economies, 1970-2010 [1/2]



**A1:** stagflation in developed economies, 1970-2010 [2/2]



**A2:** panel unit root tests, exogenous variables

	Levin-Lin-Chu		Im, Pesaran and Shin	
	level	differences	level	differences
INT	.0010	.0000	.0001	.0000
ULC	.0000	.0000	.9121	.0000
PROD	.0000	.0000	.0000	.0000
RAW	.0758	.0000	.0078	.0000
OIL	.9997	.0000	.9999	.0000

*Notes:* Table reports the probability of a unit root, calculated by LLC/ IPS. The column 'differences' reports first differences.

**A3:** regressions for stagflation, alternative specifications of  $\eta$ 

	adjustment $\eta(2)$	adjustment $\eta(3)$
$INT_{i,t-1}$	.100*** [3.67]	.179*** [2.94]
$RAW_{t-1}$	-.005 [-.91]	.001 [-.17]
$\Delta OIL_{i,t}$	1.267* [1.80]	4.804*** [5.94]
$PROD_{i,t}$	-1.09*** [-6.84]	-1.73*** [-7.75]
$\tau_{i,t}$	-.002 [-.09]	-.024 [-1.17]
$\eta(q)_{i,t-1}$	1.64*** [4.68]	1.67*** [6.01]
$N$	387	387
McFadden $R^2$	.19	.34
Akaike	.74	.72
$SEE$	.33	.33
$LR$ statistic	135.38***	130.67***

*Notes:* z-Statistics shown in parentheses, SEE = standard error of regression, LR = Likelihood Ratio, Akaike reports  $\log(AIC)$ , \* $p < .10$ , \*\* $p < .05$ , \*\*\* $p < .01$ .

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