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Stagflation in the World Economy: A Revival?

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Abstract

Stagflation has decayed the world economy during the 1970s and the early 1980s. Recent empirical studies suggest that particularly the oil crises of 1973 and 1979 led to these high stagflationary periods. However, there are still some questions unanswered: is stagflation still a problem in the world economy? What factors other than the oil price cause stagflation? What affects the extent of stagflation? Did the determinants of stagflation change over time? Are there differences between the economies?

We aim to answer these questions applying logit, count data and fixed effects PLS estimations using panel data of 13 countries between 1970 and 2010. First, we provide measures to specify the appearance as well as the magnitude of stagflation. Using these measures, we find that the economies show different vulnerabilities to stagflation. Moreover, the quantity of stagflation in the world economy appears to vary over time, although stagflationary periods occur regularly between 1970 and 2010. As we will show, stagflation is still a threat in present, albeit the probability of its occurence decreases over time. Contrariwise, the magnitude ascends, if stagflation emerges. Our findings indicate that stagflation is caused by the interplay of varoius factors and that the historically significant influence of oil price hikes has become virtually irrelevant during the 2000s. Interestingly, we found evidence that this impact has risen again at the rear edge of the sample. Nonetheless, stagflation nowadays is mainly triggered by growing interest rates and declining labor productivities.

Keywords: Stagflation
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1 Introduction

The phenomenon of stagflation has been discussed intensely during the high stagflationary periods in the 1970s and the 1980s. A large variety of studies, e.g. *Bruno* and *Sachs* (1985), *Kilian* (2009a) and *Röger* (2005), showed that the oil price can be considered as one major cause of stagflation in the past. However, as *Barsky* and *Kilian* (2001) as well as *Hunt* (2005) point out, there is some empirical evidence that stagflation cannot solely be explained by oil price hikes. In fact, this perception is not particularly new: *Gordon* (1975) illustrated that the role of raw material prices is crucial for the emergence of stagflation, whilst a large variety of authors, such as *Branson* and *Rotemberg* (1980), *Modigliani* and *Padoa-Schioppa* (1978), *Grubb* et al. (1982) and *Cubitt* (1997), added valuable theoretical and empirical insights considering the link between stagflation and wage setting. Stagflation is apparently determined by a variety of different factors whose identification is indispensable in order to model the occurence of stagflation as accurately as possible. The aim of this paper is to explore these factors in detail and to deduce some general statements on the origin of stagflation. For this purpose, we investigate the determination of both the *probability* and the *magnitude* of stagflation using miscellaneous theoretical determinants as proposed by the economic literature.

Our analysis is structured as follows: chapter 2 demonstrates under what conditions stagflation can arise within an ordinary AS/AD model. As we will show, stagflation is always a pure supply-side problem. Next, we develop a simple binary measurement to identify stagflationary periods. According to our measure, stagflation is a phenomen that occurs regularly in the course of time, albeit a decreasing trend in its appearance can be observed. Stagflation in general seems to be less likely today than in the past. However, unlike *Kilian* (2009a) stated, stagflation did not only occur during the 1970s. Strong stagflationary tendencies can be observed regularly during the past decades, particularly in subsequence to the Financial Crisis. Yet, as *Hamilton* (2009) shows, these developments are mainly triggered by demand-induced stagnation of global production rather than by physical disruptions of supply. Anyhow, as he concludes, this fact cannot obscure that there have been strong similarities to the historical incidents of the 1970s.

In chapter 3, we compile an econometric model estimating the *probability* of stagflation at a given point in time using unconditional-with-dummies logit regressions within a panel sample containing 13 countries between 1970 and 2010. We deviate from previous approaches employed by *Bruno* and *Sachs* (1985), *Kilian* (2009a) as well as *Jiménez-Rodriguéz* and *Sánchez* (2010) and others by estimating multivariate logit models using several factors that determine our binary stagflation measure. By this means, we aim to estimate stagflation *directly*, whilst recent studies largely measure the influence on inflation and growth separately.

Subsequently, we derive two measures to display the *strengh*t of stagflation. While the first characteristic identifies the number of countries suffering stagflation at a given point in time, the second will be engaged in disclosing the extent of stagflation within each country of our sample. Next, we evaluate the determination of these measures using Poisson, Negative Binomial (measure one) as well as fixed effects PLS (measure two) models. Our results indicate that the *probability* of stagflation declines over time. Contrariwise, as our fixed effects model shows, the *strenght* of stagflation increases. We also found evidence that the impact of interest rates and labor productivity is comparatively stable, whilst the historically tremendous influence of oil price hikes has become virtually irrelevant during the 1990s and 2000s. Yet, there is some evidence that the importance of oil has risen again at the rear edge of the sample. We will also show that stagflation is always a persistent problem, i.e. the probability of stagflation in $t+1$ is comparatively high if countries revealed stagflationary tendencies in t.

2 Measuring Stagflation between 1970 and 2010

In this chapter, we identify stagflationary periods between 1970 and 2010 within our sample of 13 economies. As *Baumol* and *Blinder* (2010) point out, stagflation can be defined as a slowdown of growth combined with rising rates of inflation.[1] First of all, we wish to answer the question under what conditions stagflation arises and whether we can identify one aggregate market side that dominates its emergence. This derivation is indeed fairly straightforward and the solution is obvious. Nevertheless, it provides an important implication for the upcoming investigations.

Given elasticities $|\varepsilon| \in]0,1[$, the price functions of supply (AS) and demand (AD) in dependence of GDP (Y) can simply be denoted geometrically as $p = c + dY$ (AS) and $p = a - bY$ (AD). We assume rational individuals, so $a, b, c, d \in \mathbb{R}^+ \setminus \{0\}$, where $\frac{\partial p}{\partial Y}\big|_t = \varpi \forall t$. AS and AD constitute the equilibrium of the economy $(p|Y)$ in period $t = 0$ where the existence of multiple equilibria as proposed by inter alia *Sonnenschein* (1973) is negated.[2] To model a shift of the particular curve, we add constants ϕ and θ and achieve the new functions $p' = c + dY' + \phi$ and $p' = a - bY' + \theta$, which mark the economic equilibrium $(p'|Y')$ in $t = 1$. Since AS and AD can shift in both directions, we model $\phi, \theta \in \mathbb{R}$. The equilibrium in $t = 0$ is established at $AS = AD$, that is

$$c + dY = a - bY \Leftrightarrow Y = \frac{a-c}{d+b} \tag{1}$$

and

$$p = c + dY = c + d\left[\frac{a-c}{d+b}\right] \tag{2}$$

To derive the conditions under which stagflation arises, we have to investigate for which event the constraints $p' > p$ as well as $Y' < Y$ are true.

The equilibrium GDP level in $t = 1$ is

[1]Some authors, however, argue for a high or rising unemployment rate as a third constitutive element of stagflation.
[2]We already assumed this point implicitly with $\frac{\partial p}{\partial Y}\big|_t = \varpi \forall t$.

$$AS' = AD' \Leftrightarrow c + dY' + \phi = a - bY' + \theta \Leftrightarrow Y' = \frac{a - c - \phi + \theta}{d + b} \tag{3}$$

Comparing (1) and (3), $Y' < Y$ is true for $\theta < 0, |\theta| > |\phi|$ as well as for $\phi > 0, |\theta| < |\phi|$. On the other hand, the equilibrium inflation level p' in $t = 1$ is

$$p' = c + d \left[\frac{a - c - \phi + \theta}{d + b} \right] + \phi \tag{4}$$

In order to derive unambiguous conditions on the appearance of $p' > p$, we rearrange (4) as follows:

$$p' = c + d\left[\cdot\right] - \frac{d\phi}{d + b} + \phi + \frac{d\theta}{d + b} = c + d\left[\cdot\right] + \phi(1 - \frac{d}{d + b}) + \theta(\frac{d}{d + b}) \tag{5}$$

We substitute $\frac{d}{d+b}$ with Ψ which denotes the ratio of $\frac{\partial AS}{\partial Y}$ in comparison to the combined gradients $\nabla AS + \nabla AD$. It can as well be interpreted as the ratio of elasticity of supply in comparison to the combined elasticity, $\varepsilon_{AS}/(\varepsilon_{AS} + \varepsilon_{AD})$. The domain is $\Psi \in]0, 1[$, since $b, d \in \mathbb{R}^+ \setminus \{0\}$. Using Ψ in (5) gives

$$p' = c + d\left[\cdot\right] + \phi(1 - \Psi) + \theta\Psi \tag{6}$$

We can now interpret the interplay between ϕ and θ regarding p'. Leaving all factors except ϕ and θ constant, a positive change in p can only occur if one of the two rearmost terms $\Omega := \phi(1 - \Psi) + \theta\Psi$ in the formula above exceeds the other. Ω equals zero for $\phi = -\frac{\theta\Psi}{1-\Psi}$ respectively $\theta = \frac{\phi(1-\Psi)}{\Psi}$. That means, the condition $p' > p$ is true for either

$$\phi > 0, |\phi| > \left| -\tfrac{\theta\Psi}{1-\Psi} \right|$$

or

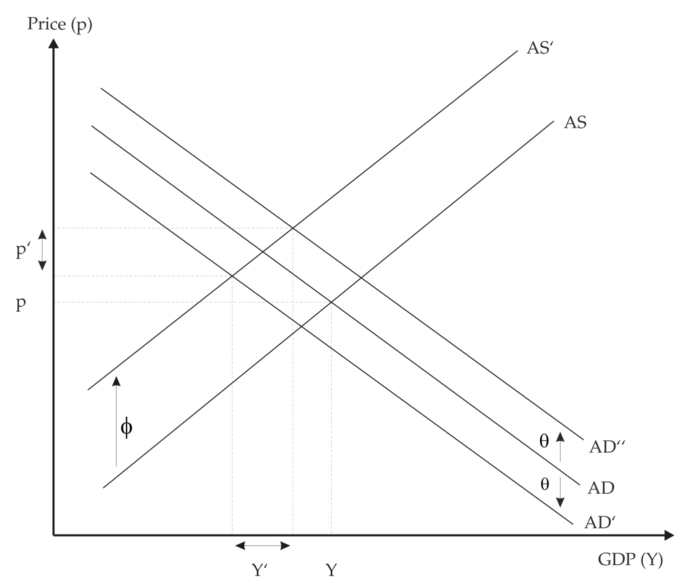
$$\theta > 0, |\theta| > \left| \tfrac{\phi(1-\Psi)}{\Psi} \right|$$

As we have now derived conditions for $Y > Y'$ respectively $p < p'$, it is apparent that these constraints are not compatible concerning θ. That means, a shift of demand cannot lead to higher prices and a cutback of GDP *at the same time*. On the other hand, stagflation can be explained using solely the supply-side, since the derived conditions allow a unification with respect to ϕ. According to the equations above, stagflation emerges if the following three conditions are fulfilled:

$$\begin{array}{ll} (i) & \phi > 0 \\ (ii) & \phi > |\theta| \\ (iii) & \phi > \left| -\frac{\theta\Psi}{1-\Psi} \right| \end{array}$$

Note that condition (i) is already implicitly covered by conditions (ii) and (iii) and is only listed to emphasize out the importance of $\phi \in \mathbb{R}^+ \setminus \{0\}$. Condition (iii) shows that the elasticities of supply and demand also contribute an important role in the formation of stagflation. Regarding our results, stagflation is always a mere supply-side problem. To provide a more intuitive interpretation of the conditions above, figures 1 and 2 picture the emergence of stagflation using the three derived conditions.

Figure 1: Origination of Stagflation



The figure shows that a reduction of aggregate supply can explain a decline in GDP and rising inflation at the same time. However, this combination can only occur if ϕ is positive and if the cutback in AS is higher than the positive or negative growth rate of AD.

It is immediately apparent that stagflation is always triggered by aggregate supply. However, the necessity of a GDP decline in *absolut* values is fairly restrictive and therefore not reasonable. To reproduce stagflation, it is much more useful to appoint a decline in *growth* as a constitutive feature. Following this definition, stagflation occurs if GDP growth falls below a critical value δ such that $\frac{\mathrm{d}Y}{\mathrm{d}t} < \delta$. Though, we have to specify this quantity more in detail in order to declare a given combination of inflation and slowdown of economic growth as a stagflationary situation. We therefore have to deduct critical values for p and Y. If the variables exceed (Δp) respectively deceed (ΔY) their critical values, the economy will be classified as stagflationary.

In recent studies, stagflation is often measured using the conditional covariance approach as proposed by *Den Haan* and *Sumner* (2004). The general idea is to test the null hypothesis $H_0 : Cov(\Delta p_h, \Delta Y_h) = 0, h = \{t, ..., t+k\}$ for the particular economy i, where t denotes years, quarters or months and refers to exogenous shocks. If H_0 is rejected and $Cov(\Delta p_h, \Delta Y_h) < 0$, then h will be classified as stagflation.[3] While this measure is favorable for a wide range of issues, it causes three problems considering our analysis: first, the covariance only accounts for linear relationships. As *Fischer* (1993) shows, this condition is not fulfilled in the majority of cases regarding Δp and ΔY. Second, the covariance crucially depends on the choice of the time horizon h. The results therefore can be heavily distorted, choosing the 'wrong' h.[4] It is also questionable whether the assumption $h_i = h \forall i$ is reasonable since this condition implies synchronous shocks and business cycles within our sample countries. Third, the negative covariance can be significant, even if the expression of one or both variables does not exceed a critical value. E.g., the measure can classify a period as stagflation, even if price increases are moderate. However, we would consider such a situation as a recession rather than stagflation. In order to circumvent these problems, our measure will rely on critical values for Δp and ΔY.

The derivation of a critical value for *inflation* (Δp^{cr}) is fairly straightforward. Most central banks in the world are aiming 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) showed that the current inflation target of the Federal Reserve Bank (FED) is about 2.5 percent, satisfying the average target between 1959 and today.[5] In addition, *Bernanke* and *Mishkin* (1997) showed 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 Δp at +.02.

For the derivation of the critical value for *economic growth* (ΔY^{cr}) we follow the Solow Residual as proposed by *Solow* (1957). The idea is that, according to the neoclassical theory, economic growth can be decomposed into the growth contribution of capital (K) and labor (L) as well as an increase of factor productivity (ψ). The growth rate $\Delta(\psi)$ therefore measures the share of ΔY that cannot be explained by

[3] The measure is in fact more complex but the general idea remains the same. Our objections considering the application of this measure within our analysis remain unaffected by this simplification. In addition, *Jiménez-Rodríguez* and *Sánchez* (2010) followed the above described approach where the respective variable Δz_h denotes z's response to oil price shocks. It must be noted, however, that *Den Haan* and *Sumner* (2004) originally did not propose this measure as a mean to identify stagflation. Moreover, the authors provide a wide range of valuable indicators to measure the co-movement between real activity and prices such as the correlation coefficient of VAR forecasting errors.

[4] In our case, we also made an implicit assumption on h setting the horizon to one year. However, we do not refer to shocks as a constitutive attribute of h, so the probability of a bias is significantly lower.

[5] However, *Ireland* (2007) revealed that there have been some major fluctuations in the inflation target of the FED over time.

factor accumulation. See Appendix A1 for the mathematical derivation of $\Delta(\psi)$.

To estimate the Solow Residual, we use data of the Total Economy Growth Accounting Database of the Groningen Growth and Development Centre [see *GGDC* (2005)]. Table A2 in the appendix shows the values of $\Delta(\psi)$ for 10 industrialized countries between 1980 and 2004. The sample period refers to the available data of *GGDC* (2005). The mean of $\Delta(\psi)$ in A2 is .012. The standard deviation between the average rates of the countries observed is .007. Apparently, the fluctuations around the average rate of factor productivity are not notably strong. We also see that the rate of technical progress is positive most of the time, since 80 percent of the observations in table A2 have positive numbers. If technical progress is (almost) always positive and furthermore comparatively constant over time, economies can only be considered as stagflationary if the growth rate of GDP falls below the average value of $\Delta\psi$. We therefore set the critical value for *economic growth* at .012.

We have now derived the critical values Δp^{cr} and ΔY^{cr} that constitute stagflation. Due to our assumptions, stagflation occurs if GDP growth rate falls below .012 and if inflation exceeds .02. Our measure therefore will be a binary variable that is defined as follows:

$$\eta_{i,t} = \begin{cases} 1, & \text{for } \Delta p_{i,t} > .02 \wedge \Delta Y_{i,t} < .012 \\ 0, & \text{else} \end{cases} \quad \forall i,t,\ \eta \in \mathbb{F}_2$$

Based on this definition, we measure stagflation within our sample. Note that this sample exceeds the number of countries shown in table A1, since the database of *GGDC* (2005) does not include values for the 3 additional nations (Australia, Denmark and Portugal). To achieve a larger sample for the following econometrical estimations, we assume that the average of $\Delta(\psi)$ approximately holds for the additional countries as well. Since we only add developed countries, this assumption does not seem to be too improbable.

Figure 2 shows at which points in time stagflation occurs in the economies observed. To get an idea of the persistence of stagflation, we use xy line plots. The secants to the abscissa and the ordinate charted in the figures mark the critical values of GDP growth and inflation. Whenever there is an observation in the upper left quadrant, there is stagflation. By dint of these graphics, we can ascertain some major deviations in the occurrence of stagflation between the particular economies: 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 latter finding is crucial, since it emphasizes our assumption regarding the measure of stagflation:

Figure 2: Stagflation in Several Developed Economies, 1970-2010 (1/2)

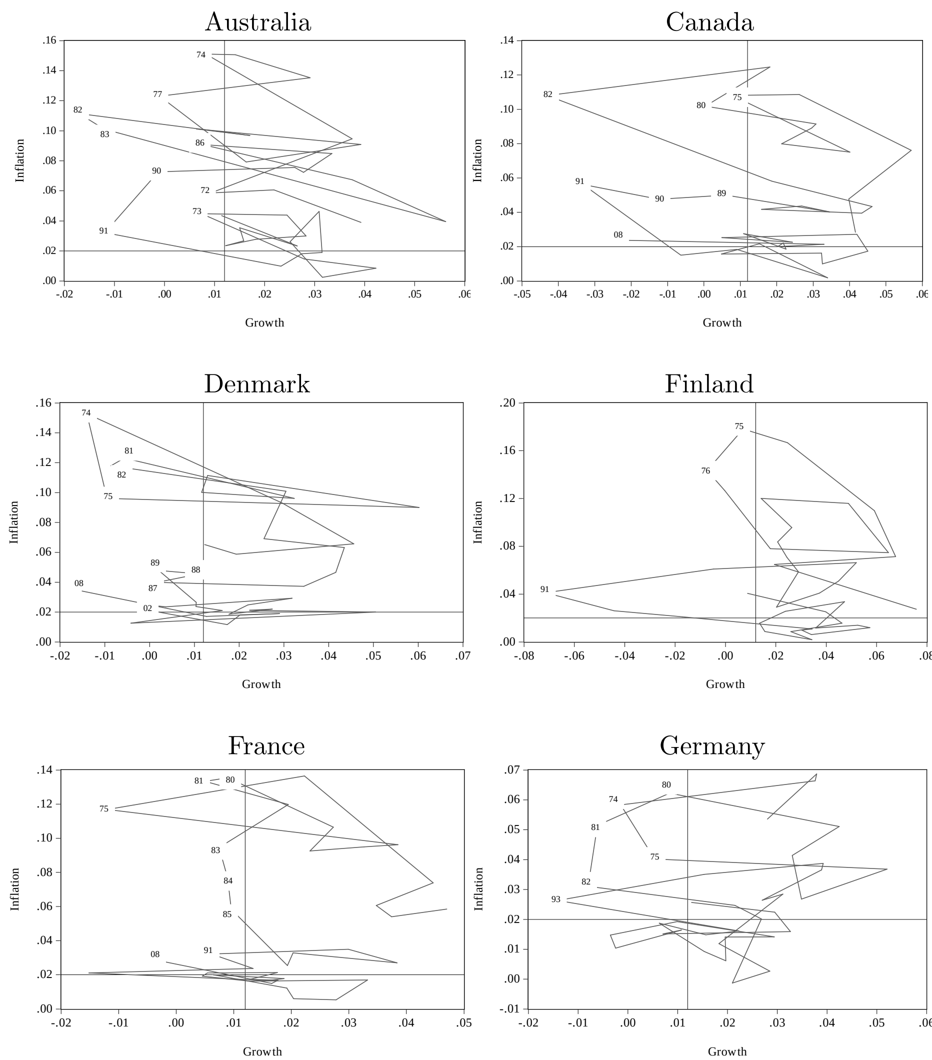
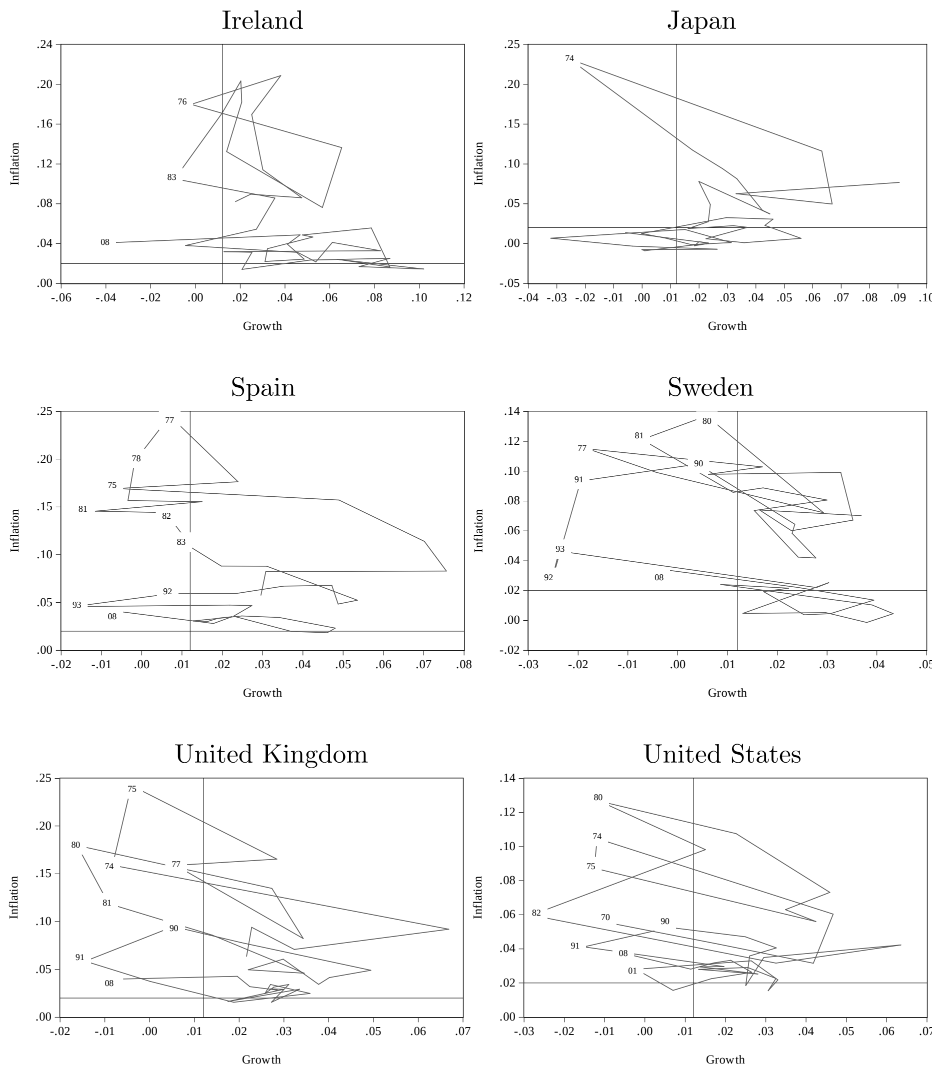


Figure 2: Stagflation in Several Developed Economies, 1970-2010 (2/2)



issuing banks nowadays commit themselves to the target of price stability to a higher extent than during the 1970s or 1980s. The decrease of the inflation component can also lead to a decline of the covariance $Cov(\Delta p_h, \Delta Y_h)$. Yet, just because the inflation component is weaker does not mean that there is no stagflation or that stagflation is less severe. In fact, the strength of stagflation tends to increase with regard to the slowdown of GDP growth: while output growth on average was still positive during the first high stagflationary period in our sample (1974: +1.3%), it significantly decreases from one high stagflation epoch to another (1982: +.4%, 1991: -.4%, 2008: -.8%).

Figure 3: Number of Stagflationary Countries, 1970-2010

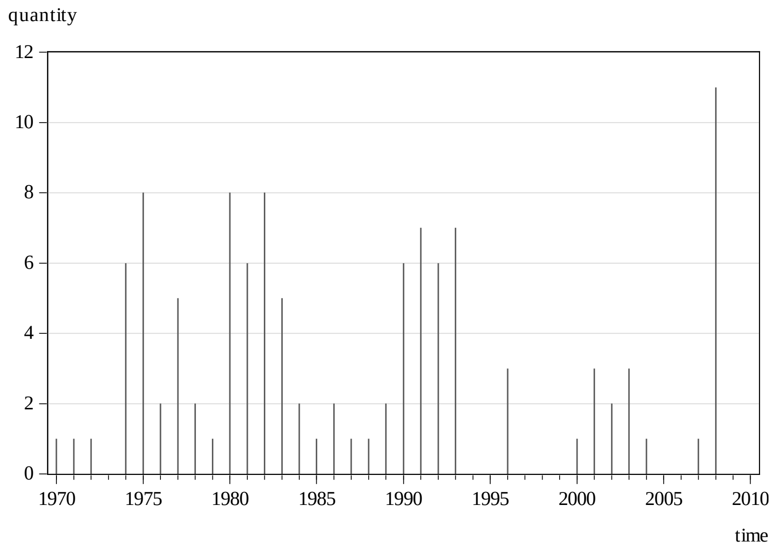


Figure 3 shows how often stagflation occurs in the sample during the observed time period. This contemplation equals $\tilde{\eta}_t = \sum_{i=1}^{N} \eta_{i,t}$. We can identify three main stagflation periods: particularly in the middle of the 1970s, the begining of the 1980s and the early 1990s, stagflationary tendencies were strong. Between 1974 and 1993, however, stagflation was an omnipresent threat, since this period afforted not a single year with zero stagflation. After 1993, the characteristical fluctuations took place on a much lower level. Figure 2 also indicates that stagflation has always been persistent within the three main stagflation periods. Looking at the current edge of our sample, we see that stagflation in 2008 was as strong as ever. Nearly every country of the sample (11 of 13) has suffered stagflation in this year. However, the historical picture of persistent stagflation cannot be detected. Apparently, the Financial Crises distorted the essentially negative trend.

3 A Model to explain Stagflation

In this section, we compile a model that is able to explain the stagflation measured in the previous chapter. 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 ($N = 13$).[6] At first, we estimate a logit model in order to identify the determinants that influence the probability of stagflation. Our dependent variable is the binary variable $\eta_{i,t}$ which we derived in the previous section. Again, $\eta_{i,t}$ assumes a value of 1 if the particular country i suffers stagflation in t and 0 otherwise.

As we mentioned before, stagflation always is a supply-side problem. It occurs if aggregate supply (growth) significantly declines and if this cutback is stronger than the positive or negative growth rate of demand. Furthermore, the elasticity of supply must not be significantly smaller than the elasticity of demand, since ϕ has to exceed $\left|-\frac{\theta\Psi}{1-\Psi}\right|$. Mindful of the conditions derived in chapter 2, we specify our model using variables that primarily explain a decline in growth of aggregate supply. Such a cutback mainly occurs if the costs of the input factors rise or productivity decreases. We do not account for external effects such as war or natural disaster since none of these events took place within the sample during the period under review. Hence, the exogenous variables are defined as follows:

Interest rates - Higher interest rates directly lead to higher capital costs and a decline in capital accumulation. Thus, it is a reasonable assumption that interest rates do have a significant impact on stagflation. The role of central banks in the formation of stagflation has been stressed by a variety of authors, such as *Nelson* and *Nikolov* (2004), *Kilian* (2009a) as well as *Bernanke* et al. (1997). We will therefore control for the contribution of monetary policy including the interest rate level of the sample countries. The variable shall be denoted with $INT_{i,t-1}$. Since investment decisions are mostly taken in the intermediate or long-term, we lag $INT_{i,t}$ with one year.

Unit Labor Costs - As *Kilian* (2009a) portends, real-wage rigidities may be an important determinant of stagflation. Similar proposals has been made by *Branson* and *Rotemberg* (1980), *Modigliani* and *Padoa-Schioppa* (1978), *Grubb* et al. (1982) and *Cubitt* (1997). Moreover, increasing wages leading to rising manufactoring costs may cause a decline in aggregate supply. Yet, wage gains are only hazardous for aggregate supply if they exceed the productivity improvements. Thus, unit labor costs can be considered an appropriate measure for the influence of wage on stagflation. The variable $ULC_{i,t}$ accounts for unit labor costs in our model.

Productivity - As we already mentioned in the previous chapter, productivity $PROD_i$ strongly influences the growth of aggregate supply. In contrast, decreasing productivities directly lead to a decline of AS. How-

[6] The countries are selected according to the availability of data. In addition, we aimed to consider developed countries only.

ever, the data on factor productivity from *GGDC* (2005) as used in chapter 2 does not cover the whole sample period and countries. We therefore proxy this measure using labor productivity growth data from the OECD (2011c). As a matter of course, productivity and unit labor costs may be strongly correlated: the growth rate of unit labor costs is given by $\Delta ULC = \Delta w - \Delta\psi_L$ where w denots wage and ψ_L names labor productivity. For $\Delta\psi_L = \Delta w$ unit labor costs remain constant. If the influence of labor productivity on stagflation is negative, wage increases must be smaller than productivity gains. In other words, unit labor costs decrease. The fulfillment of the condition $\Delta\psi_L > \Delta w$ which equals $\frac{\partial\eta}{\partial\psi_L} < 0$ is also an indicator for weak or dragging-behind labor unions. We will take care of the probability of multicollinearity betwen $PROD_i$ and ULC_i later on.

Commodity prices - *Gordon* (1975) showed that rising costs for intermediates lead to both inflation and a decline in output. Thus, we include the development of the Commodity Price Index for raw materials of the World Bank (2011a), denoted with RAW. Since the refering index is calculated measuring the development of raw materials on the world market, the values are identical for every nation in our sample. Again, it seems sensible to assume that increasing prices will primarly affect supply in the intermediate-term. Hence, we lag the index value by one period.

Oil price - Using vector autoregressions within a sample of five industrialized countries, *Burbridge* and *Harrison* (1984) showed that oil price shocks had negative effects on GDP and at the same time led to rising inflation rates during 1961-1982. Recent studies such as *Kilian* (2009a, 2009b) confirm these findings, although the importance of oil seems to be declining. *Jiménez-Rodríguez* and *Sánchez* (2010) came to a similar conclusion. Nevertheless, it is uncontroversal that oil can be identified as one major driving force of stagflation. At least for the 1970s, this assumption is undoubted in economic literature. A more thorough examination of national oil prices, however, reveals significant dispersions of oil importing costs. In other words, even if crude oil is traded on the world market, the costs of acquiring oil differs between the economies. We account for the effect of oil using crude oil import costs in US dollars per barrel, denoted with OIL_i. Similar to commoditiy prices, it is reasonable to assume that rising oil import costs affect the supply side in the intermediate term. On the one hand, companies may keep parts of the required oil in stock. On the other hand, oil import costs do not rise suddenly but develop over time. We therefore lag OIL_i by one period.

Time trend - We learned from chapter 2 that - although some stagflationary tendencies can be stated in the 1990s and the 2000s - stagflation mainly took place in the 1970s and the 1980s. By including the time trend τ, we test the hypothesis that the probability of stagflation decreases over time.

Lagged Stagflation - Figure 2 in chapter 2 indicates that stagflation often is persistent. That means, if a nation incurs stagflation in t, it is likely that this also applies for the upcoming year. For this reason, we include an AR(1)-process in our model. The time lag is one year for each country, since the stagflation plots

Table 1: Variables, Data Sources and Descriptive Statistics used within the Stagflation Models

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, 2011) GDP-deflator: World Development Indicators (World Bank, 2011b)	4.168	3.670
ULC	unit labor costs	Main Economic Indicators Database (OECD, 2001b)	9.230	3.990
PROD	labor productivity growth	Productivity Statistics (OECD, 2011c)	2.300	1.439
RAW	commodity price index for raw materials	Commodity Price Data (World Bank, 2011a)	103.642	35.290
OIL	country-specific import price for oil	IEA Energy Prices and Taxes Statistics (OECD, 2011a)	30.559	20.263

Notes: INT and PROD are reported in percentage values, ULC is in 100bn, RAW is in index points and OIL is in US dollars per barrel.

in figure 2 show that in most cases the duration of stagflation is about two years.

Table 1 provides an overview of the variables, their means and standard deviations and the refering data sources. Both the Levin-Lin-Chu (LLC) test as well as the Im, Peseran and Shin (IPS) test for stationarity in panel data imply that the probability of the existence of a unit root within most explanatory variables is very low and in most cases even close to zero.[7] Though, both tests indicate that the development of the oil import costs OIL_i does not follow a stationary process. We therefore account for the oil price considering the first difference ΔOIL_i instead of the level OIL_i. Another problem occurs with respect to the unit labor costs (ULC): as LLC heavily rejects the existence of a unit root that is homogenous across all i, IPS discovers unit roots for at least one of the sample countries.[8]

[7]See table A3 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 homogenous across all i, whilst IPS provides separate estimations for each i and thus allows for heterogeneity of the coefficient of the lagged regressors.

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

Unambiguously, we have to give consideration to the unobserved effect a_i, owing to the heterogeneity of the sample countries. In our case, first differences or random effect models (RE) do not seem to be operational. Particulary the restrictive constraint of $Cov(x_{i,t}, a_i) = 0$ for all explanatory variables x that is necessary for the RE model is almost certainly not satisfied since it is much more reasonable to assume that country-specific effects are rather triggered by institutions than by random effects. We therefore apply the unconditional-with-dummies logit method by adding a dummy variable c_i for each country $i = 1, ..., N$. There has been an intense discussion in the econometric literature whether or not this approach is reasonable, since studies of *Abrevaya* (1997) and others indicate that approximating fixed effects with dummy variables using unconditional logit can lead to inconsistency in β. However, while conditional maximum likelihood as proposed by *Chamberlain* (1980) leads to consistent estimates of β, it does not provide estimates of the fixed effects a_i. In our example, including fixed effects is inevitable considering the large heterogeneity of nations in the sample. As figure 2 demonstrates, some nations strongly tend to be stagflationary whilst others show a very low susceptibility to stagflation. A similar proposal was expressed by *Bruno* and *Sachs* (1985) who hold different labor market institutions responsible for different vulnerabilities to stagflation. Obviously, there are some significant country-specific fixed effects in the sample. *Coupé* (2005) demonstrated that estimating unconditional-with-dummies regressions does not lead to a significant bias in β if the panel set has a relatively large number of time periods. He bases his conclusion on a panel sample with $T = 16$. With $T = 41$, our sample range significantly exceeds the sample size of *Coupé*. Therefore, our sample can be considered as large enough to cope with the inconsistency problem. In addition, we use logit instead of probit or other binary choice models since *Baltagi* (1995) demonstrated that the probit model is not suitable for the specification of fixed effects in cases like ours.

Table 2 depicts the outcome of the estimation. Column (i) displays the results of applying the model on the whole sample whilst columns (ii) and (iii) illustrate the results separately for European and non-European countries. Dummy variables are excluded from table 2 in order to preserve clarity. We already mentioned that ULC exhibits non-stationarity. Furthermore, there are some theoretical hints that multicollinearity between $PROD$ and ULC might be significant. Columns $(i) - (iii)$ therefore exclude ULC, whilst column (iv) presents the estimating results affiliating unit labor costs as well.

The results of the regression are surprisingly good, given the heterogeneity of nations in the sample and the long time-period. Except the Commodity Price Index, all the variables have the expected sign, they are significant in nearly each case and also indicate a good fit to the data since the likelihood ratio assumes very low exceedance probabilities for all models.

Column (i) covers the whole sample size of 13 nations between 1970 and 2010. As expected theoretically, interest rates and ascending prices for oil increase the probability of stagflation. On the other hand, stagflation is less likely if labor productivity rises. The negative influence of $PROD$ on the probability of stagflation indicates that wage demands on average have been smaller than productivity gains between 1970 and 2010. This may be a hint that labor unions either have weak bargaining power or can not anticipate productivity growth accurately.

Table 2: Logit Regressions for Stagflation, 13 Nations, 1970-2010
[dependent variable: $\eta_{i,t}$]

	Model 1			Model 2
	(*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	520	360	160	386
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 parantheses, SEE = standard error of regression, LR = Likelihood Ratio, Akaike reports log(AIC), optimization algorithm: Quadratic Hill-Climbing, $*p < .10, **p < .05, ***p < .01$. Due to lagged variables, N is 520 instead of 533 (sample size).

In addition, we anticipated that the relevance of stagflation decreases over the course of time. 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. That means, if a nation shows stagflationary tendencies in t, it is very likely that the economy will also sustain stagflation in the upcoming period.

Estimating the model seperately 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. In addition, the marginal effect of interest rates outside Europe is more than three times higher as in Europe. The same accounts for the vulnerability to oil price shocks: whilst the coefficient of ΔOIL is positive and significant in both (*ii*) and (*iii*), the marginal impact of oil price hikes outside Europe is more than twice as high as in Europe. Our results confirm the findings of *Burbridge* and *Harrison* (1984) who detected that the price of oil in general affects Canada, Japan and the United States unambiguously stronger than European economies. As the results of table 2 indicate, this assumption still holds. In contrast, commodity prices do not reveal any significant influence at all.

While stagflation becomes more and more unlikely in European nations, this finding can not be confirmed for countries outside Europe. Since the coefficient of $\tau_{i,t}$ is insignificant in column (*iii*), we can *not* find a statistical trend regarding non-European countries.[9] Stagflation is apparently just as relevant today as in the past.

The comparison of the fit of (*i*)-(*iii*) illustrates that the whole sample estimation works best considering McFadden-R^2, albeit the Akaike criterion indicates a better fit concerning the restricted sample of non-European countries. Nevertheless, the p-values of the likelihood ratio test show that all three models describe the data fairly well. As column (*iv*) illustrates, the explanatory power cannot be improved by adding unit labor costs to the model. Whilst McFadden remains unaltered, Akaike even exhibits a slight decline. We mentioned before that it is expedient to expect multicollinearity with respect to ULC. The variance inflation factor (VIF) of 34.12 confirms this assumption.[10] Mindful of the non-stationarity of ULC, the lack of increase in explanatory power as well as the high VIF-factor, we chose to exclude unit labor costs within 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 η. Thus, we control for two other definitions of η. The fist adjustment $\eta(2)$ is more

[9] The probability that stagflationary periods occur less often in the course of time equals merely about 40 percent.

[10] 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 multicollinearity. *Kutner* et al. (2004) advocate for a critical threshold of VIF = 10 to qualify multicollinearity.

restrictive in terms of GDP growth. Critical values of $\eta(2)$ are $(.02|.005)$, where $\Delta Y^{cr}(2) = .005$ reflects the deviance of ΔY^{cr} by one standard deviation. The second modification accounts for different preferences for price stability. Since some countries reveal notably higher inflation rates than p^{cr} in the past, we use the sample median of p for the adjustment of $\eta(3)$. Critical values are therefore set to $(.039|.012)$. The outcome of estimating the logit model using $\eta(2)$ and $\eta(3)$ are shown in appendix A4. The referring estimations generate results highly comparable to those in table 2. As a consequence, our findings are not essentially affected by the definition of η.

So far, we have not been able to evaluate the *strenght* of stagflation. For this reason, we hereinafter develop two measures that reflect the *extent* of the respective stagflation in t. *Measure one* is a counter variable that simply sums up all $\eta_{i,t}$ in t, that is $\tilde{\eta}_t = \sum_{i=1}^{N} \eta_{i,t}$. Note that this variable is equal to the quantity of stagflation pictured in figure 3 of the previous chapter. This variable can be interpreted as the strenght of stagflation in the world economy. Thus, our specification of $\tilde{\eta}$ will be a simple time series model. As $\tilde{\eta}_t$ is a discrete counter variable with $\tilde{\eta}_t > 0 \forall t$, we use the Poisson as well as the Negative Binomial (NB) regression model. The latter is necessary since overdispersion might be a problem as the sample variance of $\tilde{\eta}$ (8.64) exceeds the mean (2.83). Controlling the Poisson results using the Negative Binomial distribution seems to be expedient by reason that NB allows the variance to be larger than the mean.[11] 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 took place within the sample period. As before, we calculate the coefficients β numerically using ML estimations with quadratic hill-climbing as optimization algorithm. Again, the design matrix $(\bar{X})$ contains all exogenous variables as described in table 1. Though, since we specify a time series model, $\bar{X}$ embodies the cross-sectional mean $\bar{X} = N^{-1} \sum_{i=1}^{N} X$ of all regressors.[12]

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 nation i. Our *second measure* Λ is concerned with precisely this problem. The general idea is that the strenght of stagflation increases with the size of the area $|\Delta p \Delta Y|$ that spans over the given combination of $\Delta p_{i,t}$,$\Delta Y_{i,t}$ and the origin. First, we have to adjust the growth rates of p and Y for the sake of redifining the origin as $(\Delta p^{cr}|\Delta Y^{cr}) = (.02|.012)$ by calculating $\hat{p}_{i,t} = \Delta p_{i,t} - \Delta p^{cr}$ and $\hat{Y}_{i,t} = \Delta Y_{i,t} - \Delta Y^{cr}$. In order to seperate stagflationary periods from prosperous, recessive or deflationary epochs, we define $\Lambda_{i,t}$ as follows:[13]

[11] See *Gschlößl* and *Czado* (2006) for a detailed discussion about the use of distributions to model count data with overdispersion and spatial effects. *Wooldridge* (2010) as well as *Cameron* and *Trivedi* (1986) explicitly favour the use of the Negative Binomial distribution if overdispersion occurs in Poisson models.

[12] As a matter of course, X equals $\bar{X}$ with respect to the Commodity Price Index (RAW).

[13] We ignore subscripts in the formula in order to preserve clarity.

$$\Lambda_{i,t} = \begin{cases} -\hat{p}\hat{Y}, & \hat{p}\hat{Y} \leq 0 \land \hat{p} \geq 0 \\ -\hat{p}\hat{Y}, & \hat{p}\hat{Y} > 0 \land \hat{p} \geq 0 \\ -\hat{p}\hat{Y}, & \hat{p}\hat{Y} > 0 \land \hat{p} < 0 \\ \hat{p}\hat{Y}, & \hat{p}\hat{Y} \leq 0 \land \hat{p} < 0 \end{cases} \forall i, t.$$

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 $\breve{\Lambda}_{i,t} := \left(\Lambda_{i,t} + \Lambda^0\right)^\gamma$ where Λ^0 denotes the absolute value of the minimum of Λ in the sample. The adjusted variable $\breve{\Lambda}_{i,t}$ can only assume positive numbers and can be interpreted as the strenght of stagflation in the particular economy i at t. In order to award more heavily stagflations a higher weight, we raise the term $\left(\Lambda_{i,t} + \Lambda^0\right)$ to the power of γ. With increasing values of γ, the weight of strong stagflations rises. In contradistinction to η, the measure $\breve{\Lambda}$ does not own static constitutive limits.

Since $\breve{\Lambda}_{i,t} \in \mathbb{R}^+$, our Poisson model obviously cannot be applied for estimating $\breve{\Lambda}_{i,t}$. We therefore model the strenght of stagflation in i using PLS estimations. As we mentioned before, individual effects of i are likely to emerge due to institutional differences rather than by random effects. We thence choose a fixed effects model (FE) to investigate the determinants of the extent of stagflation. Let $\bar{x}_i = T^{-1}\sum_{t=1}^{T} x_{i,t}$ be the time mean of the particulary explanatory variable x. We cut out the unobserved effect a_i using the time-demeaning transformation $\ddot{x}_{i,t} := x_{i,t} - \bar{x}_i$. Accordingly, the FE model will be specified as

$$\breve{\Lambda}_{i,t} - T^{-1}\sum_{t=1}^{T} \breve{\Lambda}_t = \Xi^T \ddot{X}_{red} + \ddot{\epsilon}_{i,t} \tag{7}$$

where $\Xi = (1, ..., 7)$ contains the coefficients of the FE estimation. Since we estimate a FE transformed model, $\ddot{X}_{red}$ equals X except for the first element. Tables 3a and 3b depict the results of estimating $\tilde{\eta}$ and (7). The latter is shown for $\gamma = 1$ and $\gamma = 2$. As a matter of course, INT_{t-1} and $PROD_t$ in table 3a denote average values of the sample countries. In addition, we use the crude oil price of the world market rather than oil importing costs for the estimation of the count data models.[14]

The computation of R^2 for the Poisson and Negative Binomial model may not be so familiar since the coefficient of determination is rarely reported in empirical studies concerning count data. Though, ever since *Cameron* and *Windmeijer* (1996) proposed a R^2-measure based upon the deviance residual, the coefficient of

[14] Data source: International Financial Statistics of the IMF.

Table 3a: Regressions for the Strenght of Stagflation, Count Data Models
[dependent variable $\tilde{\eta}_t$]

	Poisson			Negative Binomial		
	results	marginal impact	rank [distance to 1]	results	marginal impact	rank [distance to 1]
C	2.070* [1.84]			1.57 [1.17]		
INT_{t-1}	.069* [1.88]	.66	3 [74]	.084* [1.93]	.81	3 [65]
RAW_{t-1}	.002 [.29]	.23	4 [91]	.005 [.73]	.58	4 [75]
ΔOIL_{t-1}	.337 [1.26]	.06	5 [97]	.424 [1.40]	.08	5 [97]
$PROD_t$	-.522** [-2.82]	-2.60	1 [0]	-.469** [-2.12]	-2.33	1 [0]
τ_t	-.036* [-1.81]	-1.20	2 [54]	-.035 [-1.30]	-1.17	2 [50]
$\tilde{\eta}_{t-1}$	.034 [1.15]	.04	6 [98]	.005 [.15]	.01	6 [99]
R^2		.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 parantheses, LR = Likelihood Ratio, Akaike reports $\log(AIC)$, $*p < .10, **p < .05, ***p < .01$. Marginal impact shows the change in $\tilde{\eta}$ if the exogenous variable changes by one standard deviation. Marginal effects have been calculated similar to *Hilbe* (2011). Distance to 1 illustrates the percentage distance to the marginal impact of the most influential regressor.

Table 3b: Regressions for the Strenght of Stagflation, PLS (FE)
[dependent variable $\breve{\Lambda}_{i,t}$]

	$\gamma = 1$	marginal impact	rank [distance to 1]	$\gamma = 2$	marginal impact	rank [distance to 1]
INT_{t-1}	1.197***	4.07	2	231.25***	786	2
	[5.99]		[17]	[6.17]		[09]
RAW_{t-1}	.004	.16	6	2.41	99	6
	[.17]		[97]	[.50]		[89]
ΔOIL_{t-1}	7.330***	1.83	5	1485.61***	371	5
	[3.26]		[63]	[3.52]		[57]
$PROD_t$	-2.342***	-4.07	2	-491.41***	865	1
	[-3.63]		[17]	[-4.06]		[0]
τ_t	.248***	2.93	4	37.26**	441	4
	[3.13]		[40]	[2.53]		[49]
$\tilde{\eta}_{t-1}$	0.286***	4.92	1	.252***	725	3
	[6.24]		[0]	[5.35]		[16]
N		520			520	
Akaike		7.51			17.98	
R^2		.38***			.34***	

Notes: Table reports fixed effects regression (PLS), t-Statistics shown in parantheses, Akaike reports log(AIC), optimization algorithm: Quadratic Hill-Climbing, $*p < .10, **p < .05, ***p < .01$. Marginal impact shows the change in $\breve{\Lambda}$ if the exogenous variable changes by one standard deviation. Distance to 1 illustrates the percentage distance to the marginal impact of the most influential regressor. Due to lagged variables, N is 520 instead of 533 (sample size).

determination has increasingly found its way into empirical research employing count data. In our case, this computation is of some advantage as it allows a more direct comparison between the Poisson or the Negative Binomial model and the PLS (FE) models than consulting solely the Akaike criterion.

The results in table 3a illustrate that both the count data and the FE models seem to have a certain explanatory power since both the LR stat (Poisson and NB) and R^2 (FE) are highly significant.[15] All variables have the expected sign, they are significant most of the time and are able to explain 40-50 percent of the variance of the strenght of stagflation. However, as the p-values indicate, the regressors are much more appropriate to model the strenght in i rather than the number of stagflationary countries. As expected, overdispersion seems to be a problem in the Poisson model as the Pearson satisitic (2.31) lies outside the acceptable range. Obviously, the default of the condition $VAR(\tilde{\eta}|\bar{X}) = E(\tilde{\eta}|\bar{X})$ leads to an underestimation of the variance. The comparison of the two count data models does not reveal significant structural differences so the deductions regarding the significance and relative strenght of the particular regressors do not differ mentionably between the models. However, whilst R^2 is highly comparable, the AIC is rather an argument for the Poisson model. The relative high explanatory power of the count data models can yet not disguise the fact that most of the regressors do not show significance. Our results indicate that the amount of stagflationary countries depends mostly on the height of interest rates and labor productivity. Furthermore, we can observe a negative time trend that is slightly significant, at least within the Poisson model. However, both the oil price and the price for commodities do *not* notably influence the number of stagflationary nations. One explanation of the insignificance might be the small sample size ($T = 41$) of the count data models. Nonetheless, the strong influence of oil that we have observed within the logit estimation cannot be confirmed.

On the other hand, the PLS estimation provided by table 3b illuminates that the strenght of stagflation in i is heavily triggered by oil import prices, interest rates, labor productivity and the AR(1) process. These results do not mentionably differ if we consider varying weight exponents γ. However, we do *not* find evidence that the extent of stagflation declines. Quite the contrary, we discovered a significantly positive influence of the 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 *strenght* 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 τ has a negative sign and furthermore reveals some significance. Our assumption about the emergence of stagflation can thus be expanded as follows: in general, the *probability* of stagflation decreases. Though, if it comes to stagflation, the *extent* seems to significantly strengthen over time, i.e. the area spanned over $\hat{p}\hat{Y}$ and the origin increases.

The most surprising result, however, is provided by the coefficient of the oil price. Oil price hikes obviously do not provide any significant influence on the strenght of stagflation in the world economy, that is the number of countries that suffer stagflation in t. For both the Poisson and the Negative Binomial model, the p-value exceeds the threshold of 20%. Furthermore, the marginal effect of the variable, defined as the expected change

[15] The significance of R^2 has been calculated using the Wald Test $H_0 : \xi_j = 0 \forall j$ vs. $H_1 : \exists j \in \Xi : j \neq 0$. Since the FE regression does not include an intercept, we cannot use the probability of the F-statistic. The Wald Test rejects H_0 with $p = .0000$ [Stat: 60.77].

in $\tilde{\eta}$ if the regressor changes by one standard deviation, is negligible in comparison to the other exogenous variables. Similar conclusions can be drawn with respect to the PLS estimations in table 3b: while the oil price contributes a significant impact of the value of $\breve{\Lambda}_i$, the marginal effect is considerably weaker than the influence of the other variables. The column named 'rank' displays the rank in marginal impact of the referring regressor. In addition, we have depicted the percentage distance to the strongest determinant in parantheses. It is immediately apparent that oil importing costs do only possess a minor importance: $\Delta OIL_{i,t-1}$ ranks at the 5th position and is hence the least important of all regressors that can be considered significant. Moreover, the relative distance to the most powerful determinant is more than 60 percent. We can thus state that - similarly to the count data estimations - oil importing costs do not provide a major effect on the dimension of stagflation. In contrast, table 3b illustrates that the magnitude of stagflation is primarily driven by productivity declines, rising interest rates and the degree of stagflation in $t-1$. This indicates that wage increases lower than marginal productivity compensation can diminish the amount of stagflation. Splitting the sample into European and non-European countries reveals highly comparable marginal impacts with two exceptions: first, interest rates seem to be more important in non-European countries than in Europe. The coefficients of the two subgroups deviate by 53 percent. Second, European nations are less vulnerable to oil price hikes (marginal impact non-Europe vs. Europe: +12 percent).

While we are now able to understand large parts of the emergence of stagflation, the peculiar results with respect to the oil price coefficient remain unsatisfactory. One assumption might be that the weight of the oil price fluctuates over time and that the calculation of PLS distorts this gentle wave motion due to the averaging of the method. Another suggestion might be that oil price increases have to exceed a critical level in order to cause stagflation. In other words, one could suspect that exclusively oil price *shocks* can trigger stagflationary periods. At last, a structural break might be conjectured. To investigate whether or not these assumptions are reasonable, we adjust model (7) and implement our suggestions as follows:

$$\breve{\Lambda}(q)_{i,t} - q^{-1} \sum_{t(q)=1}^{q} \breve{\Lambda}(q)_{i,t} = \Xi(q)^T \ddot{X}(q)_{red} + \ddot{\epsilon}(q)_{i,t} \tag{8}$$

where q refers to the subsample $q < T$. The design matrix $\ddot{X}(q)_{red}$ contains the regressors analog to $\ddot{X}_{red}$ for $\gamma = 1$ as used in (7) with two adjustments: first, the AR(1) process is modeled using $\breve{\Lambda}(q)_{i,t-1}$ instead of $\breve{\Lambda}_{i,t-1}$. Due to the time-demeaning transformation, the probability of $\breve{\Lambda}_{i,t-1} = \breve{\Lambda}(q)_{i,t-1}$ is negligible. Second, we use $\varrho(\Delta OIL_{t-1})$ instead of ΔOIL_{t-1}. The dummy ϱ equals 1 for $\Delta OIL_{t-1} > .15$ and zero otherwise. Therefore, (8) models the influence of oil price shocks, defined as annual growth rates higher than 15 percent. The graphs of $\breve{\Lambda}$ and ΔOIL indicate that a structural break may have occured in 1990. Hence, table 4 shows the estimation of (8) for two subsamples: q_1 runs from 1970 to 1990, whilst q_2 covers the period from 1990 to 2010. We contrast the results to the congruent estimation over the whole sample. As the degrees of freedom would not be sufficiently large enough to compute a consistent estimation of the count data models splitting the period under consideration in subsamples, table 4 does not report Poisson estimations for q_1 and q_2.

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 subsample and also within both whole sample estimations. Whilst moderate oil price increases have not influenced the number of stagflationary nations to a mentionable amount, oil price *shocks* obviously do affect $\tilde{\eta}_t$. That means, not oil price growth *itself* but oil price growth that *exceeds a critical level* - in our case 15 percent - can cause stagflation. The latter also explains the odd result of the low marginal effect of rising oil importing costs within the PLS models. Consulting both subsamples, the marginal impact of oil strongly increases using $\varrho(\Delta OIL)$ rather than OIL. In subsample q_1, the marginal effect even approximately doubles. As a result, oil must be conceded a much higher priority as implicated by table 3b. Still, it is essential to note that the marginal effect indeed rises but anyhow lags behind the most influential variables. Moreover, confirming recent studies of inter alia *Jíménez-Rodríguez* and *Sánchez* (2010) who found that the influence of oil has diminished since the early 2000s, the coefficient of $\varrho(\Delta OIL)$ in q_2 amounts barely one third of the coefficient in q_1. In general, we can summarize that oil price shocks contribute large parts to the strenght of stagflation. Yet, this influence abates. Apparently, the historical importance of the oil price has fallen.

Another guess that we expressed before was that the model befalls a structural break. Table 4 indeed confirms this assumption: R-squared differs significantly concerning the whole model estimation and the subsample q_2. Anyhow, the Wald-statistic assumes quite high probabilites for the test of identical coefficients in q_1 in q_2. Nonetheless, table 4 can be apprehended that a variety of (smaller) structural changes took place during the sample period. This fact becomes particularly clear when looking at the major causes of stagflation within the two subsamples. Whereas oil and - with some restrictions - labor productivity can be considered most important for stagflationary periods between 1970 and 1990, it have been the *interest rates* that mainly triggered stagflation in the 1990s and the 2000s. However, interest rates have not contributed significant parts to the stagflationary epochs observed in the 1970s and 1980s. At the same time, the impact of oil importing costs has diminished. Labor productivity, though, appears to be one important factor that influences the extent of stagflation regularly. The weight of this influence seems to be peculiarly constant, since the coefficient does not mentionably differ between the two subsample models and the whole sample model depicted in table 4.

One further interesting point concerns the trend component: while we find evidence that the extent of stagflation has risen between 1970 and 1990, there are some hints that $\breve{\Lambda}$ remains comparably constant in the 1990s and the 2000s. That means, the strong increase of the magnitude of stagflation that we illuminated in table 3b apperas to be mainly triggered by developments that took place in the 1970s and 1980s. Ever since that time, the degree of stagflation ranges on a relatively constant level. However, as matter of course, splitting the whole sample into subsamples veils the general trend effect in such a way that the subsample time trend may not be overinterpreted.

We saw that the influence of oil price hikes, although beeing conductive to large parts of the degree of

Table 4: Adjusted Regressions for the Strenght of Stagflation, Subsamples versus Whole Sample

	q_1: 1970-1990		q_2: 1991-2010		$\mathbb{P}(q_1 = q_2)$	whole sample (PLS)		whole sample (Poisson)	
	(i)	(ii)	(i)	(ii)	each with (i)	(i)	(ii)	(i)	(ii)
C								2.070*	1.72
								[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]	
$\varrho_{i,t}(OIL_{i,t})$		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]
$\breve{\Lambda}_{i,t-1}$	.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	260	260	260	260		520	520	41	41
R^2	.30***	.30***	.48***	.47***		.38***	.37***	.46***	.49***

Notes: Table reports fixed effects regression (PLS), t-Statistics (FE) shown in parantheses, optimization algorithm: Quadratic-Hill-Climbing, $\mathbb{P}[\Xi(q_1) = \Xi(q_2)]$ has been compiled by the Wald test, $*p < .10, **p < .05, ***p < .01$. Due to lagged variables, N is 520 instead of 533 (sample size).

former stagflations, notably decreases over time. In other words, increasing oil prices in the 2000s endangered the economies to a much lesser extent in terms of stagflation than in the past. A similar proposal has been expressed by *Jíménez-Rodríguez* and *Sánchez* (2010) who found a strong link between stagflation and oil price shocks in G7 economies during the 1970s and the 1980s. However, the authors state that this connection has diminished since the early 2000s. Regarding our results, this conclusion seems to be right. But the look at the rear edge of the sample reveals another perspective. To investigate how the oil price coefficient develops over time, we use rolling estimations of the FE model ($\gamma = 1$) with window $w = 6$.[16]

Figures 4 and 5 depict the end points of the particular window, i.e. 2010 pictures the coefficient of the window 2004-2010. The results of the rolling estimations are highly enlightening since they allow us to derive two general statements about the evolution of the oil coefficient: first, oil importing costs are only temporarily significant.[17] Generally speaking, we can observe periods where oil contributes largely 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. Subsequently, the impact of oil rose again. Yet, since the early 2000s, oil has become insignificant. As we mentioned before, this is in accordance to the findings of *Jíménez-Rodríguez* and *Sánchez* (2010). Second, as figure 3 strikingly proofs, the relevance of oil rose tremendously at the rear edge of the rolling estimation. At the same time, the p-value declined sharply and can be considered equal to zero within the last subsample 2004 to 2010.[18] Apparently, the vulnerability of the world economy to the oil price has risen again.

Jíménez-Rodríguez and *Sánchez* (2010) do not cover the recent increase of the impact of oil at the end of the 2000s since their sample only includes data until 2007. Furthermore, we deviate from their approach as we directly estimate stagflation using a wide range of exogenous factors that influence stagflation. *Kilian* (2009a) stated that the world economy has remained remarkably resilient to the sustained real oil price increases at the beginning of the 2000s. Our estimations confirm this conclusion. However, as *Hamilton* (2009) documented, oil price increases have contributed to the economic decline that followed the Financial Crisis. As the rolling estimation of the PLS model indicates, this respsonse has been significant. However, one has to bear in mind that it is very reasonable to assume that endogenous factors alone cannot explain the high values of both $\tilde{\eta}$ and $\breve{\Lambda}$ in 2008. Thus, the Great Recession rather has to be declared as an outlier which has significantly been affected by exogenous shocks, preeminently the bursting of the housing bubble and the breakdown of the financial markets. Oil might have contributed its part to the Great Recession but this part is certainly secondary in comparison to other determinants.

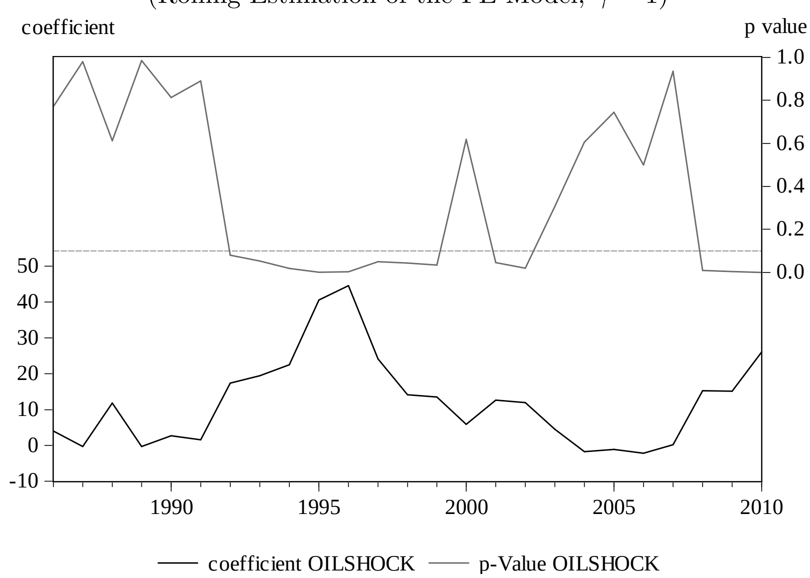
[16] The general idea of a rolling regression is to define a window w that scrolls through the subsample. Each data point represents the estimation of $\breve{\Lambda}_{i,t} - T^{-1}\sum_{t=1}^{T}\breve{\Lambda}_t(w) = \Xi^T(w)\ddot{X}_{red}(w) + \ddot{\epsilon}_{i,t}(w)$ that refers to the sample from t to $t+w$. The zth iteration will accordingly allude to the subsample $t+z$ to $t+z+w$.

[17] As an interesting side note, it can be stated that the correlation between the strenght of the impact of oil and the development of the oil price itself is moderately strong ($COR = .34$). That means, if the oil price increases, the impact of oil will generally also tend to increase, but as the correlation is mediocre, this does not necessarily have to be the case.

[18] Self-evidently, reducing the sample leads to lower degrees of freedom and therefore increases the probability of a bias in the estimation. For this reason, the results must be handled very cautiously.

Figure 4: The Development of the Oil Price Coefficient (ΔOIL)
(Rolling Estimation of the FE Model, $\gamma = 1$)

Figure 5: The Development of the Oil Price Shock Coefficient ($\varrho\Delta$OIL)
(Rolling Estimation of the FE Model, $\gamma = 1$)



4 Conclusions

The present paper has evaluated the causes of stagflation using a variety of different estimations. As we demonstrated, the differentation between the *likelihood* that stagflation occurs and the *strenght* of stagflation is crucial. To distinguish between these two dimensions, we provided three measures that gauge both the probability and the magnitude of stagflation. Applying this measures, we demonstrated that stagflation occured regularly within the past decades, albeit a decreasing trend in its emergence can be observed. As we illustrated using with-dummy-logit regressions, this occurrence is mainly triggered by interest rates, productivity losses and oil price hikes. Moreover, stagflation in general seems to erupt much less frequently today than during past decades and is heavily swayed by the occurrence of stagflation in the previous year. Whilst this persistence is exceptionally distinctive within European countries, non-European countries are much more vulnerable to an increase of the oil price or the interest rates. In addition, the negative trend that can be observed concerning the whole sample cannot be found within the restricted analysis of non-European nations.

Afterwards, we estimated the determination of the magnitude of stagflation. Evaluating both the number of stagflationary countries as well as the strenght of stagflation in i, we found some interesting deviations from the logit results. Apparently, the number of nations incuring stagflation at a given point in time is essentially influenced by interest rates and productivity losses. Oil price hikes do not contribute to this measure at all. Likewise, the outcome of the time trend is ambiguously. While the Poisson regression reveals some significance, the Negative Binomial model does not cover a decline in the number of stgaflationary countries. Analyzing the strenght of stagflation *within* the particular nations, we can confirm the assumption of negligible relevances considering oil import costs. The most interesting point within this estimation, however, may be found in the strongly significant positive time trend. Based upon these findings, we drew the following interim conclusion: the probability of stagflation in general declines over the course of time. Yet, if it comes to stagflation, the magnitude today is significantly stronger than within past decades.

Subsequently, we aimed to investigate this point more in detail splitting the sample in two equal subsamples and accounting for the effect of oil price shocks rather than for regular (and often mediocre) rises in oil importing costs. This analysis shed light on two remaining nebulosities of the previous outcomes: first, the increase of the magnitude of stagflation mainly took place between 1970 and 1990. Since then, the extent of stagflation more or less remained unaltered. Second, oil price shocks indeed influence stagflation to a much higher extent than regular oil price increases. Such shocks even reveal significance within the count data models and furthermore double the marginal impact of oil within the PLS estimation. To analyse the impact of oil more in detail, we turned our view to the evolution of the oil price coefficient using rolling regressions. These estimations disclosed that the importance of oil is very unstable and strongly fluctuates over time. Periods with tremendous influence of oil are regularly replaced by periods where oil is circumstantial. In addition, we spotted that the importance of oil has risen again in subsequence of the Financial Crisis.

The persistence of stagflation implies that economic policy must intervene in order to shorten the duration if it comes to stagflation. However, as *Bernanke* et al. (1997) showed, even if stagflation in the 1970 arose exogenously with respect to global macroeconomic conditions, it has been propagated by the reaction of monetary policy makers: high inflation rates prompted the central banks to raise interest rates. As a result, the global economy sunk into a deep recession. Our results confirm this assumption since the coefficient of the interest rate is strongly significant in virtually each of our estimations. On the other hand, as *Kilian* (2009b) stated, not all stagflationary periods are alike. Particularly the causes of oil price shocks have to be disentangled concerning demand and supply shocks in the crude oil market. As we illustrated in the second chapter, stagflation is always a pure supply-side problem triggered by a variety of factors. If aggregate supply remains unaltered, then stagflation can not arise in any event. However, if it comes to stagflation, figuring out which market side influences the stagflation-inducing factors is crucial, since the implications for economic policy differ strongly considering demand or supply.

As our findings prove, stagflation is much more unlikely today than in the past. The threat emerging from potentially anew stagflations might therefore not be considered particularly severe. Anyhow, we demonstrated that in subsequence to the Financial Crisis, the world economy has suffered stagflation to an extent that strongly superpasses every previous magnitude. In addition, we illustrated that the degree of stagflation tends to strenghten over time. Mindful of these findings, it still seems to be wise to keep an eye on the major determinants that we were able to derive in order to prevent future stagflationary periods.

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Appendix

A1: Derivation of the Solow Residual

Using the Cobb-Douglas production function

$$Y = \psi K^{\alpha} L^{1-\alpha} \tag{9}$$

where α denotes the production elasticity that is similar to the capital income share, the Solow Residual can be derived as follows: First, we have to take the logs of (9)

$$\log(Y) = \log\psi + \alpha\log(K) + (1-\alpha)\log(L) \tag{10}$$

Second, we have to differentiate (10) with respect to time

$$\Delta\log(Y) = \Delta\log\psi + \alpha\Delta\log(K) + (1-\alpha)\Delta\log(L)$$

Rearranging gives the growth rate of factor productivity that is called the Solow Residual or the rate of technical progress:

$$\Delta\log\psi = \Delta\log(Y) - \alpha\Delta\log(K) - (1-\alpha)\Delta\log(L) \tag{11}$$

Note that $\Delta\log(Y) \approx \frac{(Y_t - Y_{t-1})}{(Y_{t-1})}$ equals the growth rate of Y. Since the growth rates of GDP, capital and labor as well as the capital income share can be observed empirically, we can calculate $\Delta\psi$. To include the cyclical component into our calculation, we have to consider the degree of utilization of the production factors. We therefore multiply K with the degree of utilization $\zeta := \frac{Y}{Y^p}$ where Y^p denotes the production potential. In addition, we substitute L with the product of workers employed N and the hours worked per employee κ. The rate of technical progress therefore can be estimated using the following equation:

$$\Delta\log\psi = \Delta\log(Y) - \alpha\Delta\log(K\zeta) - (1-\alpha)\Delta\log(N\kappa)$$

A2: Factor Productivity Growth ($\Delta\psi$), 10 Industrial Nations (1980 - 2004)

Year	ESP	FRA	GER	IRE	ITA	JAP	NED	SWE	UK	USA	Average
1980	.044	.000	.011	.017	-.002	n.A.	-.017	.010	-.019	-.022	.002
1981	.028	.009	-.006	.029	-.003	n.A.	-.012	-.009	.007	.008	.006
1982	.022	.044	-.011	.011	-.003	n.A.	-.010	-.001	.024	-.025	.006
1983	.027	.005	.011	-.019	.006	n.A.	.035	.006	.028	.022	.014
1984	.052	.007	.028	.046	.038	n.A.	.024	.029	.001	.010	.027
1985	.028	.012	.016	.027	.006	.053	.003	-.001	.013	.005	.016.
1986	.010	.010	.007	-.002	.009	.012	.015	.011	.030	.010	.009
1987	.011	.007	.005	.048	.018	.027	.000	.016	.025	.002	.016
1988	.020	.022	.025	.053	.012	.049	.020	-.006	.009	.010	.020
1989	.008	.017	.031	.049	.010	.035	.028	.003	-.012	.005	.018
1990	.000	.003	.048	.046	-.008	.041	.002	-.008	-.008	.004	.012
1991	-.001	-.010	.047	.018	-.011	.016	.006	-.007	-.006	-.005	.005
1992	.012	.005	.003	.037	.013	-.010	-.011	.002	.023	.025	.010
1993	.015	-.006	-.004	.013	-.002	.009	-.002	.005	.029	.002	.006
1994	.019	.011	.025	.028	.027	.000	.020	.030	.027	.009	.020
1995	.002	.001	.021	.053	.023	.011	.019	.018	.007	-.004	.015
1996	-.003	-.004	.010	.040	-.005	.011	.005	.003	.013	.015	.009
1997	.004	.006	.012	.072	.006	.011	.002	.020	.008	.010	.015
1998	-.006	.013	.004	.035	.000	-.012	.026	.013	.004	.009	.009
1999	-.004	.030	.015	.045	.004	.012	.019	.011	.003	.012	.015
2000	-.008	.027	.023	.031	.006	.019	-.021	.020	.024	.011	.013
2001	-.013	.006	.003	.013	-.005	.005	-.013	-.002	.007	.000	.000
2002	-.004	.003	.004	.028	-.021	.012	.021	.024	.014	.018	.010
2003	-.001	-.004	.004	.022	-.013	.012	-.016	.021	.019	.027	.007
2004	-.002	.013	.013	.017	-.008	.026	.015	.034	.020	.024	.015
Average	.010	.009	.014	.030	.004	.017	.006	.010	.012	.008	.012

Data source: *GGDC* (2005) and own calculations. The sample of the estimations exceeds the countries depicted in A2 due to limited amount of data in *GGDC* (2005).

A3: Panel Unit Root Tests for the Exogenous Variables

	Levin-Lin-Chu		Im, Pesaran and Shin	
	level	first differences	level	first 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.

A4: Regressions for Stagflation, Alternative Specifications of η

	adjustment $\eta(2)$	adjustment $\eta(3)$
$INT_{i,t-1}$	.100*	.179***
	[3.67]	[2.94]
RAW_{t-1}	-.005	.001
	[-.91]	[-.17]
$\Delta OIL_{i,t}$	1.267*	4.804***
	[1.80]	[5.94]
$PROD_{i,t}$	-1.09***	-1.73***
	[-6.84]	[-7.75]
$\tau_{i,t}$	-.002	-.024
	[-.09]	[-1.17]
$\eta(q)_{i,t-1}$	1.64***	1.67***
	[4.68]	[6.01]
N	520	520
McFadden R^2	.19	.34
Akaike	.74	.72
SEE	.33	.33
LR statistic	135.38***	130.67***

Notes: Table reports unconditional-with-dummies logit regression, z-Statistics shown in parantheses, SEE = standard error of regression, LR = Likelihood Ratio, Akaike reports $\log(AIC)$, $*p < .10, **p < .05, ***p < .01$. Due to lagged variables, N is 520 instead of 533 (sample size).