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ABSTRACT

Inflation is a persistent economic variable, which means that future values of inflation are partly determined by its past realizations. Inflation persistence varies in its magnitude among OECD countries and explaining this phenomenon remains a challenge.

Literature suggests that inefficiencies in domestic labor markets may explain differences in the responsiveness of inflation to a shock; but in times of increasing flexibility in labor markets, higher competitiveness and better-anchored inflation expectations, are these relationships still valid?

In order to investigate the role of labor market institutions on inflation persistence in most recent times, a dynamic model for inflation with country fixed effects and time dummies is estimated on a sample of 20 OECD countries over the period 1980-2012.

The findings suggest that the effect of labor market institutions is not anymore of the same magnitude, but still labor market inefficiencies can hamper the absorption of a shock by slowing down the prices adjustment process.

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1. INTRODUCTION

Nowadays, the concept of inflation sounds familiar to us in its broad definition of the rate at which the level of prices of goods and services rises over a certain period. As soon as we move away from this broad perspective in order to understand inflation dynamics, the only sure thing is that inflation is the protagonist of a huge debate in which, often, no one seems to be right.

At the beginning of the 20th century, related literature was very fragmented and based only on “*discontinuous and qualitative*”¹ evidence. Academic environment would have to wait up until 1958 to find agreement on observed inflation trends, when it embraced the revolutionary contribution of Phillips (1958). Phillips advanced a negative inflation-unemployment relation that is nowadays better known as the Phillips Curve, which convinced policy-makers that there was an optimal rate of unemployment that would have ensured prices stability. This overwhelming consensus, however, clashed with the reality and economists struggled to motivate differences in the UK and USA data or the unexpected upward shift of the relationship experienced in the 1950s.

Ten years later, Friedman (1968) argued that in the long-run the curve was “nonsense” because rational-agents care only about real wages, which in turns they would adjust to make the supply of labor equal to the demand; indeed, in Friedman’s words:

*“Inflation is always and everywhere a monetary phenomenon [...]”*²

However, the very break in the history of inflation models is in 1975, the year in which, according to Gordon (2011), a well-marked “*bifurcation*” occurs.

The contribution that most triggered the break in the literature is well-known “Lucas critique” by Lucas (1976) who criticizes the use of econometric policy evaluation on past data to forecast the effect of a new policy by arguing that economic agents adjust consequently to a new policy according to their expectations on policy makers’ actions. This implies that regression coefficients of an econometric model are not time-invariant because they move along agents’ behavior; this invariant nature makes policy forecasting unreliable if done on past data. In Lucas’ words, his thoughts are summarized as:

“Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows

¹ Gordon (2011).

² Friedman and Schwartz (1963).

that any change in policy will systematically alter the structure of econometric models.”

The Lucas critique had serious implications on the conception of the Phillips Curve, because if agents will adjust to a new policy, policy makers cannot exploit a long-run tradeoff between unemployment and inflation.

The introduction of rational expectations in macroeconomics by Lucas marks the history of the Phillips Curve by creating a clear bifurcation.

Aside from all the peculiarities between and within the two forks, the main discordant element is the role of past inflation in determining future rates. The traditional side in the literature conceives inflation dynamics as partially determined by a pure, persistent component, expressed as lagged inflation, which, not only reflect expectations but also several price-setting frictions.

Following this approach, inflation is a persistent process that deviates from its inertial past values after a demand or supply shocks and then, once the shock is occurred, it less or more slowly re-adjusts to its long-run level. Thus, in this design, inflation persistence can be defined as “*speed with which inflation converges to equilibrium after a shock*”³ and what determined the magnitude of this speed, remain a challenge.

The opposite school of thoughts instead refuses the inertial nature of inflation to consider this variable as a purely forward-looking process, detached by any explicit supply shock and driven by expectations, which make inflation able to “jump” when new relevant information is acquired by agents.

Determine who is right and who is wrong remains a great challenge for empirical literature. However, this work embraces the mainstream view of a backward-looking inflation process, motivating this specification by the fact that economic agents rely on past inflation as a proxy for the expectations used in price setting.

Among the backward-looking side of the literature, one of the issue that most remains challenging is to understand the nature of inflation persistence. In Fuhrer (2009) terms, the issue is to understand if inflation “*inherits*” its feature from supply shocks’ persistence or it exhibits its own “*intrinsic*” persistence; in case of intrinsic persistence, it is important to understand its sources.

A large part of the related literature points out that inflation persistence is exhibiting a declining path, started roughly around the early 1990s⁴. One of the major justifications suggested for this

³ See *e.g.* Andrews and Chen (1994), Pivetta and Reis (2007) and Marques (2004).

⁴ See *e.g.* Levin and Piger (2003), Cogley and Sargent (2005) and Stock and Watson (2007).

decline is that central banks are now more effective in dealing with monetary policy and that better-anchored expectations around a clearly communicated target reduce the uncertainty on eventual highly persistent inflation rates. Alternatively, or complementary, this decline in inflation persistence may be due to structural changes in the labor market; the widespread shift toward a higher flexibility in the labor market may have reduce the timing of adjustment of inflation (*i.e.* less persistence).

Since the dawn of the Phillips curve debate, economists have struggled to explain cross-country differences in empirical Phillips Curve's realizations, for which the sources had often been sought in the characteristics that differentiate domestic labor markets. Indeed, as Gordon (2011) reports, economists tried to explain the differences between UK and USA invoking the less responsibility of American trade unions or the greater flexibility of UK labor markets, given their more compact size.

The labor market structures and its institutions have extensively summoned as a determinant for inflation.

Back in the 1960s, Hines (1964) provides evidence of a relationship that prepares the ground for an extensive literature's effort; the impact of trade unions on rate of change of wages. Hines (1964) is not the first to suggest that unions affect the rate of change of wages and in turn inflation, but he is the first who justifies this relationship regardless of the demand of labor. Moreover, he is the first who suggests to proxy the degree of militancy with the rate of membership, still nowadays the most used measure of unions' power.

Self-interested unions and other labor market institutions can be a source of rigidity in nominal wages which not only can affect inflation itself, but it can also contribute to slow down inflation adjustment processes.

There is an extensive literature on the relationship between labor market institutions and inflation rates and a wide interest in explaining persistence in the context of Dynamic Stochastic General Equilibrium models (DSGE)⁵, but little has been done in providing empirical evidence of a relationship between labor market institutions and inflation persistence. Moreover, within this little related literature, results are mixed.

In fact, one can argue that, in comparing Europe and United States, the relatively higher European inflation persistence reflects a less flexible labor market; persistent differentials within the very Union also may be explained by the different speed of adjustment of inflation, which may differ for the different labor market structures of these countries.

⁵ See *e.g.* Coudert (2015) and Campolmi and Faia (2004).

Bowdler and Nunziata (2007) examine how labor market coordination and union density impact inflation adjustments. In their exercise, the authors do not focus explicitly on inflation persistence, but they provide evidence of a positive and significant interaction between union density and lagged inflation and that persistence is a decreasing function of labor market coordination in wage bargaining. The authors justify this finding embracing the hypothesis provided by Driscoll and Holden (2003a), who argue that inflation persistence may be the results of a coordination failure in the labor market and that more coordinated unions are better candidate to internalize the macroeconomic consequences of their decisions. Besides this justification, Bowdler and Nunziata (2007) suggest that labor market institutions may affect inflation not only in the single period, but they may take effect through time by making inflation less responsive.

The finding in Bowdler and Nunziata (2007) is then confirmed by Correa-López *et al.* (2010) who extend the model to account for the effect of product market competition; aside from confirming the evidence provided in Bowdler and Nunziata (2007), they also find out that the lower the product market regulation, the less persistent is inflation.

Notwithstanding, both Bowdler and Nunziata (2007) and Correa-López *et al.* (2010) investigate these relationships on a sample covering 20 OECD countries from the 1960s to the 1990s, a time span characterized by both high inflation and strong and active unions. If inflation expectations are really better-anchored today and if the central banks are more effective in achieving price stability, the relationship between unions and inflation may be weakened nowadays. If one accounts also for the evident and widespread drop in union membership, which, following Hines (1964), should indicate a decrease in unions' "*pushfulness*", this relationship may not be valid anymore.

Indeed, Correa-López *et al.* (2010) perform a set of dynamic simulation of their preferred specification, in order to understand the role of these institutions on the evolution of the OECD countries' economic performances. The dynamic simulation for the period 1990-2006 reveals that neither the degree of coordination nor union density had a large effect on inflation performance.

Biroli *et al.* (2010) undertake a similar exercise for the period 1970-2006, finding evidences on a reducing impact on the responsiveness of inflation of minimum wage, union density and strict employment protection. Again, the relevance of this finding may be questionable in more recent times; they also estimate the model over a sample covering the period 1999-2006, but given the limited time span, it may not be the case to draw important conclusions.

Jaumotte and Morsy (2012) try to assess whether product and labor market inefficiencies are accountable for the persistent inflation differentials in the Euro Area, by focusing both on inflation and on its lagged term. Contrarily to Correa-López *et al.* (2010), their finding on product market regulation is mixed, while they find a significant effect of employment protection legislation, union density and intermediate coordination in the wage-bargaining structure in making inflation more persistent. However, they rely on the Arellano-Bond estimator which is not very suitable for “small N – large T” panel; as a robustness check they also test their hypothesis with the OLS estimator, but their sample covers 24 years, a too short time span for a consistent OLS estimation of a dynamic model.

Another attempt to explain European inflation differentials is by Moretti (2014), who investigates the effect of product and labor market regulation on inflation persistence for a panel of 12 countries on different samples, all in the range 1990-2007. The author focuses only on employment protection legislation and on the indicator of Regulation in Energy, Transport and Communication (ETCR), an aggregate indicator of the degree of product market regulation; while the author find that strict employment protection legislation slightly decrease the responsiveness of inflation, she rejects an effect of ETCR on inflation persistence. The author also attempts to substitute employment protection legislation with union density as a robustness check, but she finds out that an increase in unionization decreases the persistence of inflation, but it increases the responsiveness of inflation to the output gap. However, the author estimates the model *via* FGLS estimator to deal with heteroscedasticity on a time horizon of roughly 10 years. Despite FGLS performs better than OLS in case of heteroscedasticity, it is not suitable for small samples, a case in which OLS is preferable⁶.

On a similar track, D'Adamo and Rovelli (2013) investigate the topic, by separately observing inflation in the traded and non-traded goods and services, on a sample of 27 European countries. Consistently with the hypothesis of a decreased unions' influence, he does not find an impact of union density of inflation persistence, but confirm the mitigating effect on persistence of higher degree of coordination in wage-bargaining and also find out that higher public spending on active labor market policies makes inflation less persistent. However, given the unavailability of price series for traded and non-traded goods, their analysis is carried out on a sample of 16 years, a time span that seriously undermines the consistency of the OLS estimator; moreover, main effects of the labor market institutions do not enter in the model and this fact can alter the values of the interaction coefficients.

⁶ See *e.g.* Greene (2003).

Following the above-mentioned literature and acknowledging its limitations, this work is aimed at investigating in deep whether a wide set of labor market features can affect the persistence of inflation, explaining cross-country differences in inflation responsiveness. This exercise is carried out by estimating *via* OLS a backward-looking Phillips Curve augmented with several labor market indicators over a panel of 20 OECD countries⁷ covering the period 1980-2012. This work contributes to the existing literature in the following ways.

The first contribution concerns the treatment of wage bargaining. Here, it is well accounted the difference between centralization and coordination, while the existing literature focuses only on the latter variable, without exploring the possibility on a different impact of centralized wage bargaining. Moreover, in the proposed model, a three-way interaction among union density, coordination/centralization and lagged inflation is tested, in order to see if there is a combined effect on inflation persistence. Indeed, the existing literature has interacted only one variable at a time, without considering the possibility that unions may affect inflation persistence differently, depending on the wage bargaining structure.

In addition, the coordination variable used here differs from the usual indicator used in the previous literature; the indicator, provided by Visser (2015), lies in a wider range, enhancing many more facets of wage bargaining. The centralization variable, taken as well from Visser's database, has been introduced recently and never used for similar purposes.

Secondly, the sample does not focus only on European countries, but include for instance United States and Canada, countries characterized by a more flexible labor market, in order to widen the sample.

Most importantly, the analysis is carried out from 1980 to 2012, a period characterized by low and stable inflation, increasing flexibility and competitiveness in the labor market, decentralization in wage bargaining and declining union density. The question that this work seeks to answer is whether, in an era of well-anchored inflation expectations and effective monetary policy, the magnitude of the relationship between labor market structure and inflation dynamics can be considered still valid or not.

According to the literature, one may argue that, given the evidence provided on labor market institutions, the decline in inflation rate and its documented reduced persistence may be explained precisely by the enhanced flexibility in the market. On the other hand, in time of monetary union, targeted inflation objectives and where economic agents are well away from the nightmare of high and persistent inflation of the 1970s, labor market institutions may have

⁷ The countries in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

lost their significance in explaining inflation rates and prices' responsiveness, so that the reasons behind cross-country differences need to be found somewhere else nowadays.

Existing literature provides little evidence on most recent times, since all the exercise are carried out on European countries and covering a too short time horizon to draw significant conclusions.

This work provides evidence on the relationship between inflation, its dynamics and labor market institutions, finding that, in a world of well-anchored inflation expectations, labor market institutions are not significant and direct drivers of inflation anymore. On the other hand, ignoring labor market features would be a mistake because the results suggests that inefficient institutions contribute to make inflation more persistent.

The rest of the work is organized as follows. Chapter 2 reviews the concept of inflation persistence by discussing its theoretical justifications and measurements employed by the related literature; following the theoretical discussion, a descriptive evidence of the decline of the persistence parameter among OECD countries is provided and possible sources of inflation persistence are discussed.

Chapter 3 compares labor market institutions and their evolution through time in OECD countries; for each institution is then provided a theoretical justification of how the variable may affect the persistence of inflation.

The suggested relationships are then empirically tested following the methodology described in Chapter 4. The results are then presented and discussed in Chapter 5, in which the stability of the results is assessed too, through several robustness checks. Chapter 6 concludes.

2. INFLATION PERSISTENCE

In his thorough review on inflation persistence, Fuhrer (2009) provides a very intuitive definition on what persistence means. He defines persistence as the economic equivalent of the concept of “*inertia*” in physics:

*“Unless acted upon by a net unbalanced force, an object will maintain a constant velocity”*⁸.

The analogy works very well at an intuitive level, since an economic variable is said to be persistent if it shows the tendency to remain close to its most recent level, unless some other economic force deviates it elsewhere.

To give a more technical definition, persistence refers to how long inflation remains close to its most recent level, representing indeed the duration of a shock hitting inflation. A common and more technical definition given by the literature identifies persistence as the “*speed with which inflation converges to equilibrium after a shock*”⁹; if this speed is low, inflation is said to be highly persistence and *vice versa*.

Following Fuhrer (2009), inflation persistence is a twofold concept that can be studied under two different approaches, defined by Marques (2004) as univariate and multivariate. Indeed, the taxonomy of inflation persistence requires distinguishing between reduced-form and structural persistence. Following the univariate approach, the focus is on the reduced-form of inflation persistence, which identifies with this concept, an empirical property of inflation that has no economic interpretation.

On the contrary, the multivariate approach investigates structural persistence that refers to the persistence motivated by economic factors.

Even if it may appear just an academically instrumental division, the link between the two types of persistence remains a challenge.

⁸ Isaac Newton’s law of motion first published in its “*Philosophiae Naturalis Principia Mathematica*” in 1687.

⁹ See *e.g.* Andrews and Chen (1994), Pivetta and Reis (2007) and Marques (2004).

2.1 REDUCED-FORM OF PERSISTENCE

2.1.1 Measuring Reduced-Form of Persistence

As reduced-form of persistence is defined as an empirically detected property, the related literature of the univariate approach has put a lot of effort in attempting to measure this property. However, there is no general agreement regarding the best measure of persistence.

Most of the approaches refer to the autocorrelation function, as the correlation of the variable X_t with its own k^{th} lags, defined as:

$$\rho_k = \frac{\text{cov}(X_t, X_{t-k})}{\sqrt{\text{var}(X_t)}\sqrt{\text{var}(X_{t-k})}} = [1; -1] \quad (2.1)$$

Therefore, the variable's autocorrelation function is:

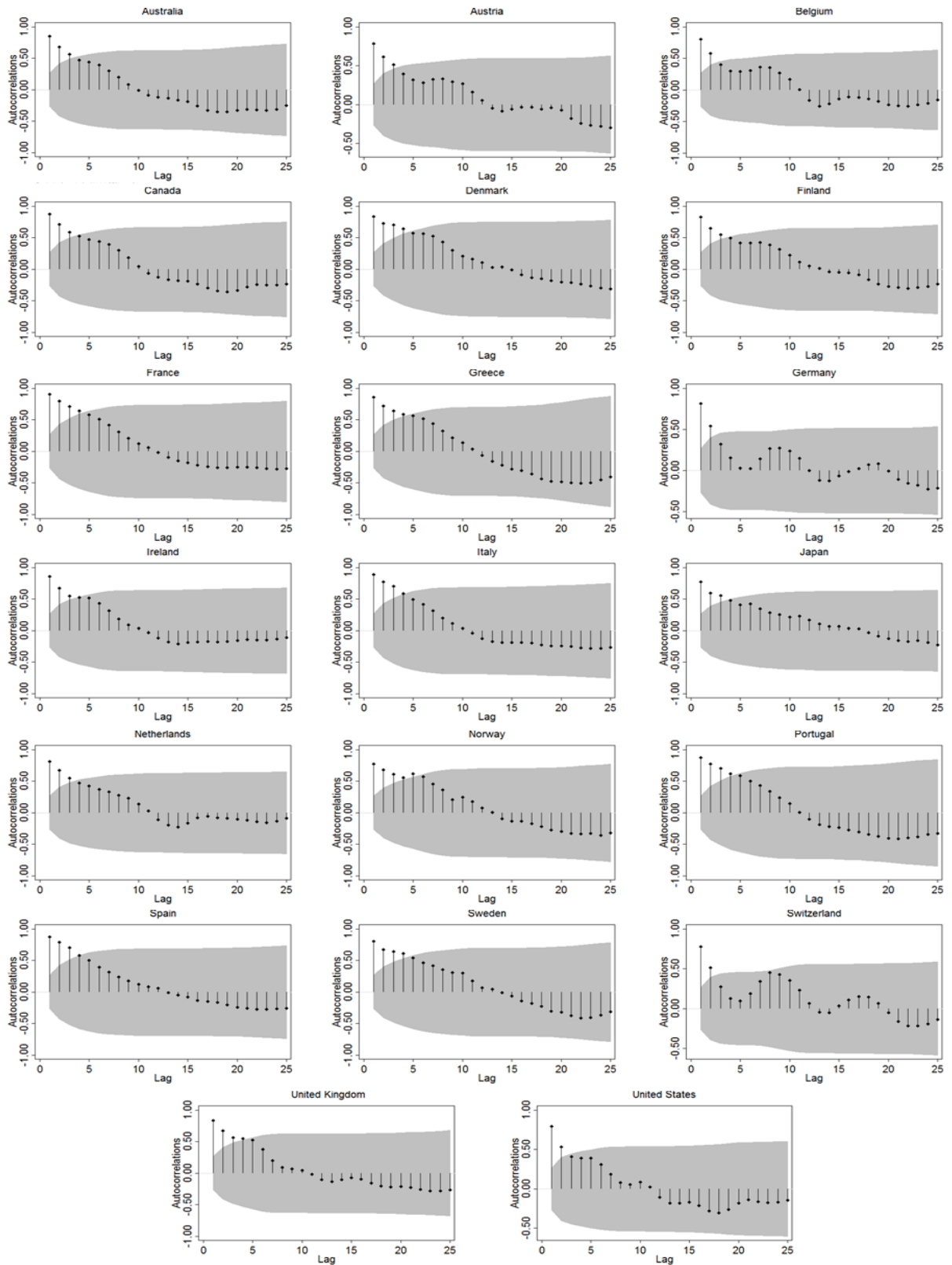
$$A = (\rho_1, \dots, \rho_k) \quad (2.2)$$

Indeed, a first naive approach to determine whether a time series exhibits persistence is to look at which speed the function A decays. A time series showing an autocorrelation function dying out slowly on its lags is defined a persistent time series, and *vice versa*.

Figure 1 shows the plots of the autocorrelation functions for OECD countries' inflation series in the sample. All the series exhibit a slow tendency to decay except for Greece and Switzerland. The different path in the autocorrelation functions of these two countries may be the outcome of strict disinflationary policies put in practice by central banks.

As Fuhrer (2009) points out, autocorrelation functions may be the best way of depicting overall inflation persistence since they summarize much of the information in a time series. Nonetheless, autocorrelation functions do not provide a scalar measure that can be analyzed through time neither a single number.

Figure 1 - Autocorrelation Functions of Inflation Time Series in OECD Countries - 1980-2012



Under the univariate approach, persistence is handled by looking at the time series representation of inflation, which, following much of the related literature such as Pivetta and Reis (2007) and Levin and Piger (2003), can be designed as a univariate autoregressive model of order k :

$$\pi_t = \mu + \sum_{j=1}^k \alpha_j \Delta \pi_{t-j} + \varepsilon_t \quad (2.3)$$

To investigate persistence in a time series, the Dickey-Fuller decomposition comes in handy; indeed, a time series can be rewritten as follow:

$$\pi_t = \mu + \rho \pi_{t-1} + \sum_{j=1}^{k-1} \varphi_j \Delta \pi_{t-j} + \varepsilon_t \quad (2.4)$$

Where $\rho = \sum \alpha_j$ is the sum of the autoregressive coefficients and $\varphi_{k-1} = -\alpha_k$.

As we define persistence as the speed with which inflation converges to equilibrium after a shock, it is straightforward to point out how persistence is closely related to the impulse-response function (IRF) of a time series. The cumulative impulse-response function (CIRF) of a time series is given by $\frac{1}{1-\rho}$ where ρ is the parameter defined in equation (2.4). However, the latter is an infinite-length vector not suitable for qualifying as a useful measure of persistence. Andrews and Chen (1994) provide a comprehensive discussion on three of the most accredited measures in the literature, namely the “sum of the autoregressive coefficients”, the “spectrum at zero frequency” and the “largest autoregressive root”.

The sum of the autoregressive coefficients is the most straightforward option, given the close and monotonic relationship linking the CIRF and ρ , thus one can fairly rely on ρ to have an estimate of the persistence of a time series.

A second measure of persistence is the spectrum at zero frequency which measures the low frequency covariance of a time series which, from (2.3) and (2.4), is defined as:

$$h(0) = \frac{\sigma_\varepsilon^2}{(1-\rho)^2} \quad (2.5)$$

where σ_ε^2 is the variance of ε . As for the sum of the autoregressive coefficients, also this measure of persistence is directly dependent on the magnitude of ρ .

Another proposed measure is the largest autoregressive root of an AR model. However, this measure is widely criticized since it summarizes very poorly the IRF; the shape of the IRF depends too heavily on the other roots, thus this approach cannot be reliable.

Of the three listed measure, the sum of the autoregressive coefficients and the spectrum at zero frequency can be seen as reliable substitute; however, they may not deliver the same results. Indeed, the drawback of the spectrum at zero frequency is that changes in persistence may be caused not only by ρ but also by changes in σ_ε^2 .

To complete the review on measures of persistence, another common one is the “half-life” which is defined as the number of periods for which the effect of a unit shock to inflation remains above 0.5, as defined by Marques (2004). This measure is very useful for descriptive purposes since it is measured as a unit of time, but it has been widely criticized because it can severely understate the magnitude of the persistence process.

To sum up, given the straightforward monotonic relationship between the cumulative impulse-response function and ρ makes Andrews and Chen (1994) advocating ρ as the simplest but best scalar measure of persistence for a time series.

2.1.2 *The Median Unbiased Estimator*

As it is known, when the lagged dependent variable is included in a regression model as an independent variable, the ordinary least squares (OLS) estimates result downward bias in small samples. Moreover, standard estimators are downward biased, especially when the autoregressive parameter approaches the unity. As it follows, estimating ρ from (2.4) *via* OLS is not free from finite sample biases. For example, Andrews (1993) shows that for values of ρ equals to 0.3, 0.7, 0.85, and 1.0, the probability the standard estimator is downward biased are 0.66, 0.78, 0.87, and 0.995 respectively.

For this reason, there is the need of obtaining a more robust estimator in dealing with persistent time series; a widespread solution for empirical application in the literature is the median unbiased estimator derived in Andrews (1993) for a basic AR(1), then extended to model of higher order by Andrews and Chen (1994).

Consider the following AR (1) process:

$$Y_t = \mu + \rho Y_{t-1} + \varepsilon \quad (2.6)$$

for $t = 0, \dots, T$, for some $\mu \in \mathbb{R}$, and $\rho \in (-1, 1]$.

The model can be rewritten equivalently as:

$$Y_t = \tilde{\mu} + \rho Y_{t-1} + \varepsilon \quad (2.7)$$

where $\tilde{\mu} = \mu(1 - \rho)$ and $\rho \in (-1, 1]$.

Let $\widehat{\rho}_{LS}$ be the least squares estimator of ρ from regressing Y_t on its lag; the main property exploited by Andrews and Chen (1994) for obtaining the estimator states that, if the model is correct, the distribution of $\widehat{\rho}_{LS}$ depends only on ρ .

The median unbiased estimator is such defined because the probability of overestimating and underestimating ρ is the same. In particular, the median unbiasedness holds if and only if the distance between the estimator and the true parameter is, on average, less than or equal to the distance between the estimator and any other value the parameter can assume in the parameter space.

Finally, consider the estimator $\widehat{\rho}$, which has a uniquely defined and strictly increasing median function $m(\rho)$; then $\widehat{\rho}_U$ is the median unbiased estimator of ρ where:

$$\rho_U = \begin{cases} 1 & \text{if } \widehat{\rho} > m(1), \\ m^{-1}(\widehat{\rho}) & \text{if } m(-1) < \widehat{\rho} \leq m(1), \\ -1 & \text{if } \widehat{\rho} \leq m(-1) \end{cases} \quad (2.8)$$

This bias-correction method allows us to overcome the limits of the normal linear regression; the only problem with this estimator, is that it cannot assume values greater than 1, but since inflation time series are, at least in theory, safely stationary, this should not constitute a problem.

2.1.3 Inflation Persistence in OECD Countries

So far, we discuss on how to obtain the median unbiased estimator by Andrews and Chen (1994); in this section, the procedure is applied in order to estimate how our persistence parameter has evolved so far in OECD countries.

Here, a path of values of persistence through the years is obtained by rolling the procedure discussed in the previous paragraph on a sample of 20 OECD countries¹⁰ on yearly data from 1961 to 2014 with a moving window of 14 years, in line with Fuhrer (2009) and Pivetta and Reis (2007), although they focus on quarterly data.

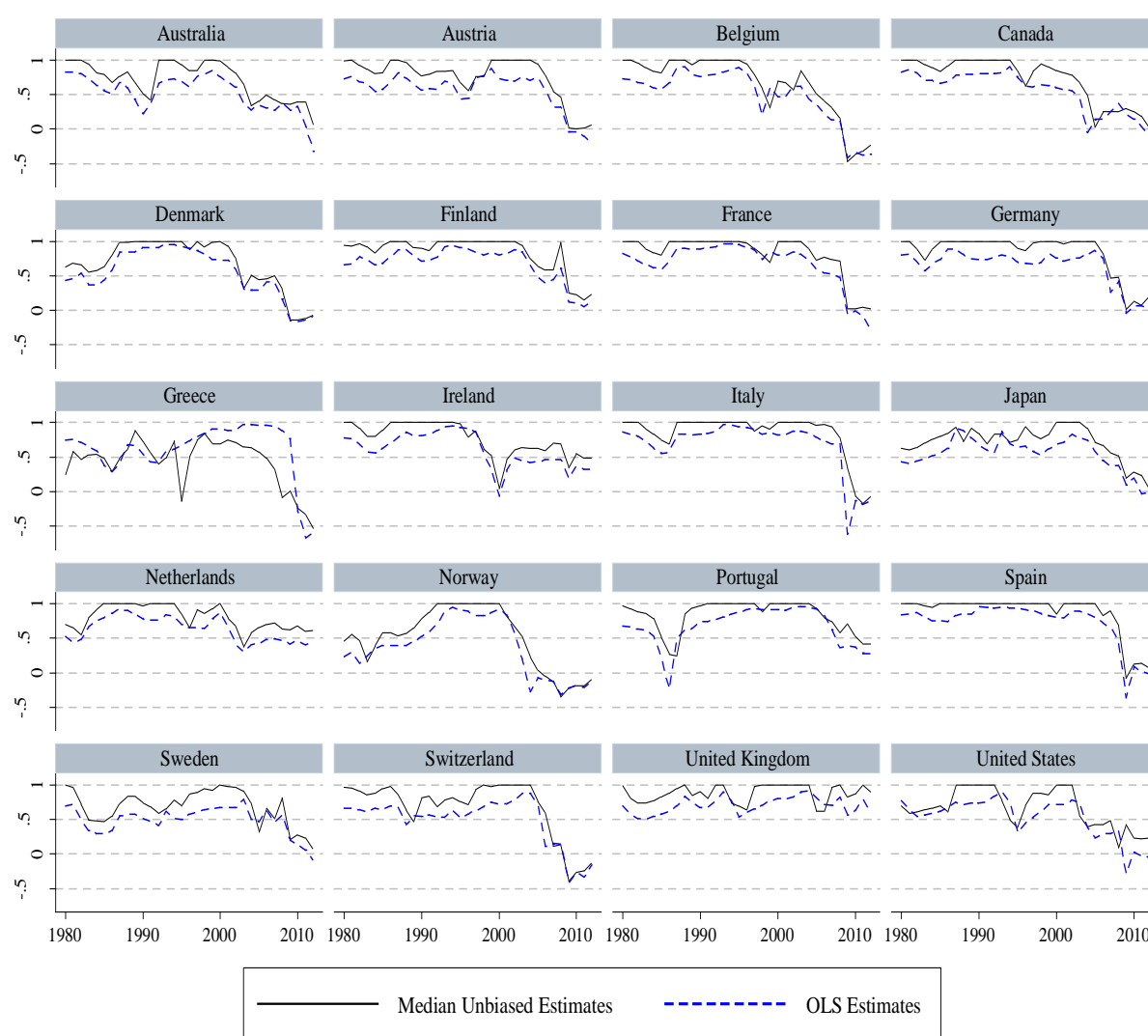
The inflation time series have been modelled as an AR (1) process according to the AIC and BIC criteria, assuming the series are stationary.

Figure 2 shows the OLS estimates and the median unbiased estimates for the persistence parameter for OECD countries from 1980 to 2012.

¹⁰ The countries in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Although this is a naive way of estimating inflation persistence, results show that inflation persistence among the countries in the sample exhibits a general declining path occurring mostly between the 1990s and the 2000s, as pointed out in much of the related literature. Indeed, Levin and Piger (2003) find that inflation has tended to return to its average value since the 1980s, a result that holds even after correcting for a downward shift in the average inflation rate. On the same line, Cogley and Sargent (2005) through a model in which the inflation process is allowed to change over time, find evidence of a decline occurring in the 1980s and 1990s, as Stock and Watson (2007) too.

Figure 2 - Rolling Estimates of Inflation Persistence in OECD Countries - 1980-2012



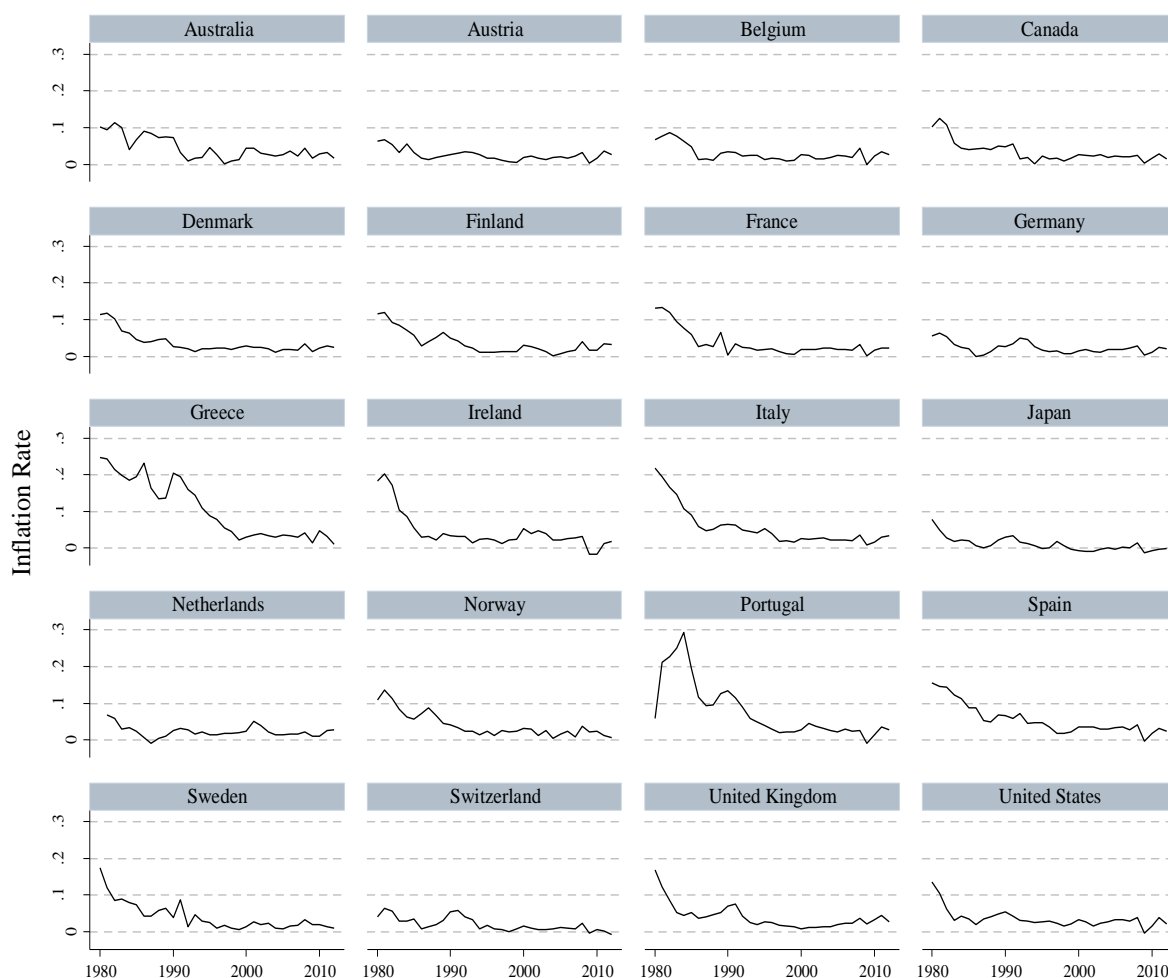
One may argue that this decline may be explained for the Eurozone by the institution of the European Monetary Union, following which, much effort has been put into keeping inflation around the 2% target, but it appears not to be the end of the story. As we can see from our rough evidence, the fact that some countries in the sample share a common monetary policy justifies

less than one could expect. The timing with which persistence starts to decline and the range in which it lies in the 2000s varies within the euro-area subsample and the decline is common for countries not in the euro-area too. This fact may indicate that cross country differences may be explained by national peculiarities other than monetary policy, although the main differences arise between the euro-area countries and those with sovereign independence.

Indeed, inflation persistence may, for example, explain inflation differentials among the euro-area; by looking at Figure 3, one can see that, after the institution of the European Monetary Union, differences in the inflation rates still persist among euro-area countries.

The common path is stable and low inflation that, however, reflect more a global trend rather than a common feature of the euro-zone. The decline in inflation persistence may be a consequence of the general low level of inflation rates.

Figure 3 - Inflation Rate in OECD Countries - 1980-2012



Indeed, Taylor (2000) finds out that inflation is positively correlated with persistence of inflation, suggesting that the low inflation of the last decades may be one of the sources of the decline of inflation persistence. However, discussing the reasons why persistence is so low

nowadays refers to the area of the multivariate approach, which is the very focus on this work; a comprehensive discussion on economic sources of persistence is thus discussed in the next section.

2.2 STRUCTURAL PERSISTENCE

So far, we discuss about the reduced-form of persistence, which is considered by the literature as an empirical feature of inflation without an economic interpretation. Structural persistence instead refers to the persistence that originates from economic sources, a well investigated issue by the literature and still challenging. As shown in the previous section, inflation persistence appears to be declining in the last decades, a fact that raises the question if persistence is merely an intrinsic feature of inflation or there is something else behind.

Understanding the reasons and sources of persistence is important in a number of ways, monetary policy decisions in the first place. To understand the magnitude of this topic, one can for example, think to the persistent inflation differentials across the European Union after years of a common monetary policy. These differentials may be the reflection of cross-country differences of inflation persistence, driven by different national economic features.

As there is no general agreement, neither on whether the behavior of inflation has to be explained by a forward or backward-looking component, different interpretations of cross-country differences in inflation patterns have been advanced so far.

One part of the literature research differentials and sources strictly in monetary policy and central bank's decision; Erceg and Levin (2003) focus on the fact that inflation persistence may not be an inherent characteristic of the economy, but they study the possibility that it varies with the stability and transparency of the monetary policy regime. Similarly, Orphanides and Williams (2005) underline the importance for a central bank to communicate clearly its objectives and targets. "*Imperfect knowledge*" of the public raises the persistence of inflation, making a monetary policy less efficient than it would be in a rational expectations environment, as well as in Benati (2008), who suggests that when central banks are more explicit in communicating their inflation goal and they act consequently and coherently, domestic inflation may enjoy less persistence. Davig and Doh (2014) observe how a shift to an aggressive monetary regime or a low-volatility regime result in a decline in inflation persistence. In the previous section, we mentioned that Taylor (2000) provides evidence of a positive correlation between inflation and persistence, showing that in the United States, persistence has been lower when the inflation rate has been lower. On a similar trail of stability and transparency, the author suggests that in time of low inflation regimes, there is a lower "*pass-through*" of the costs'

changes in prices by firms. Firms associate low inflation with less persistent changes and the extent to which they match cost increases and prices decreases.

Sticking to the monetary sphere, several authors suggest a relationship between inflation *inertia* and shifts in the exchange rate regime, arguing in particular that inflation appears to adjust more slowly under a floating regime by reasonably assuming a higher inflation volatility, as for instance in Alogoskoufis and Smith (1991).

However, literature is divided on this interpretation. Burdekin and Siklos (1999) cast considerable doubts on the effects of a regime shift, finding no evidence supporting the hypothesis. Interestingly, the authors provide evidence for an upward effect of wars on persistence, but most of all, the effects of the two oil price hikes in the 1970s - 1980s.

So far, we have discussed about inflation persistence as an exclusively monetary phenomenon, but this may not be the end of the story. A number of different factors drives inflation rates and one can reasonably assume that persistence may be driven by not only the credibility and the stability on the monetary policy but also by what impact inflation *per se*.

Indeed, Angeloni *et al.* (2006), considering a hybrid New Keynesian Phillips Curve, distinguish four sources of persistence, embedded in the right-hand-side of the following equation.

$$\pi_t = \rho_t \pi_{t-1} + \rho_f E(\pi_{t+1}) - \lambda \hat{\mu}_t + \xi_t \quad (2.9)$$

where π_t denotes inflation, expressed in terms of its own lag and $E(\pi_{t+1})$ the conditional expectation of information of inflation at time $t+1$, $\hat{\mu}_t$ is the deviation of desired mark-up from the actual one and ξ_t an exogenous mark-up shock.

As follow (2.9), the authors identify four sources of persistence:

- i. Persistence in the mark-up gap
- ii. Dependence on past inflation due to the price-setting mechanism
- iii. Persistence due to the formation of inflation expectations
- iv. Persistence in the stochastic error term

Persistence in the mark-up gap is also referred as “extrinsic” persistence. In presence of nominal rigidities in price setting, a determinant of inflation that affect also its adjustment process is how the actual mark-up deviates from the desired level. The larger is the mark-up gap and the more firms adjust prices, the larger will be the change in aggregates prices; if there is persistence of a large mark-up gap, inflation in turns is more persistent.

The second source is the so-called “intrinsic” persistence, which the authors relate to price-setting mechanisms as well as related literature, generally agreeing an increase in price-stickiness increases also the degree of inflation persistence.

The expectation-based persistence is instead what explained also in Erceg and Levin (2003) and Orphanides and Williams (2005) above-mentioned.

Thus, inflation persistence is not considered only as monetary phenomenon, but it is something that can be explained by looking at the behavior of firms in setting prices and at the determinants of their markup. For instance, the Eurosystem Inflation Persistence Network enhanced the importance of rigidities in price-setting behavior of firms in explaining how long it takes for prices to adjust. Within this network, Dhyne *et al.* (2005) show that, based on micro data on consumer prices, the average consumer price duration in the euro area lies in a range of four-five quarters, compared with the United States, for which the estimated duration is around two quarters.

As discussed in the introductory section, a part of the literature (even though not a large one) attempts to assess if not only inflation but also its speed of adjustment may be affected by domestic labor market institutions, a hypothesis discussed both theoretically and empirically in the following sections.

3. INFLATION PERSISTENCE AND LABOR MARKET INSTITUTIONS

So far, the focus was mostly on the univariate approach and on the monetary interpretation of the inertial inflation phenomenon but the main purpose of this work is to attempt to explain this phenomenon in terms of labor market institutions.

This section tackles the issue, from a theoretical perspective, of understanding whether country specific patterns of inflation persistence can be explained by differences in domestic labor market structures, together with taking a closer look to how labor market institutions have evolved in the last decades among OECD countries.

The starting point for the underlying assumption on which the rest of this work is based is the effects that labor market institutions have on inflation. It is generally agreed that rigidities and inefficiencies in the domestic labor market can affect inflation dynamics in several ways, through wages and the marginal product of labor, for instance. Labor market features such as unions, minimum wage norms or government efforts in public spending on the labor market act through the wage channel by affecting firms' marginal costs and in turn pricing decisions. On the other hand, rigidities driven by strict employment protection legislation or also unions' activities and request, may affect feature like working hours, which translates into a change in productivity.

Given these relationships between inflation and labor market institutions, a higher degree of labor market rigidity may be the source of higher persistence in inflation too. Since inflation persistence is also defined as the “*speed with which inflation returns to baseline after a shock*”¹¹, one can reasonably expect that, all else being equal, a more flexible and competitive market is a feature that certainly helps to dampen the effects of a macroeconomic shock. For instance, in an already highly inflationary environment, powerful unions may be reluctant to wage cuts or staff reduction leading to a situation of wage inflexibility, which leaves firms no option, but to raise prices, going to slow further the return of prices to a sustainable level (*i.e.* more persistent inflation)

¹¹ See Willis (2003).

In line with these assumptions is the European Central Bank, the latter requiring to its members to implement structural reforms to achieve more labor market flexibility since its establishment. As ECB (2008) points out:

“Economic reforms in the goods, capital and labor markets, as well as the completion of the Single Market, aim to remove barriers to competition, increase market flexibility and allow more intense national and cross border competition. In general, such structural reforms are very relevant to monetary policy, as they are important for mitigating inflationary pressures and inflation persistence in response to adverse shocks. More specifically, rigidities in the wage and price-setting mechanisms or ongoing excessive wage developments may delay the necessary adjustments of relative prices to economic shocks and thereby give rise to inflation persistence.”

Indeed, features like rigidities in wage and price-setting mechanism, inefficient wage-setting policies, the loss of competitiveness due to high unit labor cost can be interpreted as a sort of “barrier”; even if their direct impact on inflation is mixed¹², these barriers may affect inflation dynamics by delaying its recover from shocks and thus contributing to highly persistent inflationary scenarios.

In line with the last statement also Bowdler and Nunziata (2007) who point out that the effects of labor market features may not be instantaneously effective on inflation, but they may take effect through time, hampering the adjustment process rather than increasing directly inflation.

Notwithstanding the negative effects on economic performances, institutions such as unions may instead be beneficial in securing price stability when they act in defense of workers without being foolish. Following Driscoll and Holden (2003a) for instance, inflation persistence may be the consequence of coordination failures in the labor markets. Nevertheless, if the wage bargaining is done by coordinated unions, it is more likely that each union is aware of the macroeconomic implications of its decision, being averse to the inflationary consequences of a higher wage *premium*.

However, so far we discussed about scenarios of strong unions, inflexible labor markets and high inflation. The last decades have experienced both stable and low inflation rates in OECD countries, together with a general effort of these countries toward the achievement of more flexible domestic labor market in order to face and survive the increase in competition due to the several structural changes in the economy. Besides, since the early 1980s, union

¹² See A. Brauer (1997).

membership experiences a huge and widespread decline, even in the Scandinavian countries, historically the most unionized among OECDs.

These trends raise the question of whether the basis for the assumptions discussed so far are still solid. Indeed, the combined consequences of the decrease in union density and the increase in flexibility in the labor markets may be precisely one of the determinant for the achieved more stable and less persistent inflation. On the other hand, the achievement of low inflation and subsequent maintenance of low rates may be the results of better actions of central banks and better anchored inflation expectations. In such environment, the labor market structure may not be so influential after all and, given the weakening of their positions, unions may not be able anymore to affect economic performance as they did in the last decades.

3.1 LABOR MARKET INSTITUTIONS IN OECD COUNTRIES

In order to investigate more deeply the relationship between inflation persistence and labor market institutions, this section takes a closer look to that latter, by showing cross-country differences in the variables of interest of this work and by providing a theoretical justification for the assumption made so far.

Today, labor markets receive much more attention by policy makers and economists than in the early decades; indeed, since the 1990s, the focus was mostly on macroeconomic issues and solution. As Freeman (2008) points out, by the end of the century, better economic performances of the United States, despite very similar macroeconomic policies with respect to European major economies, raise the question about labor market institutions being an important explanatory feature of cross-country differences in economic performance. Historically the North American market is more flexible than the European market, which although exhibits huge differences within. Indeed, as discussed in paragraph 2.2, prices in Europe adjust slower than they do in the United States, a fact that may reflect the greater flexibility that characterizes American markets.

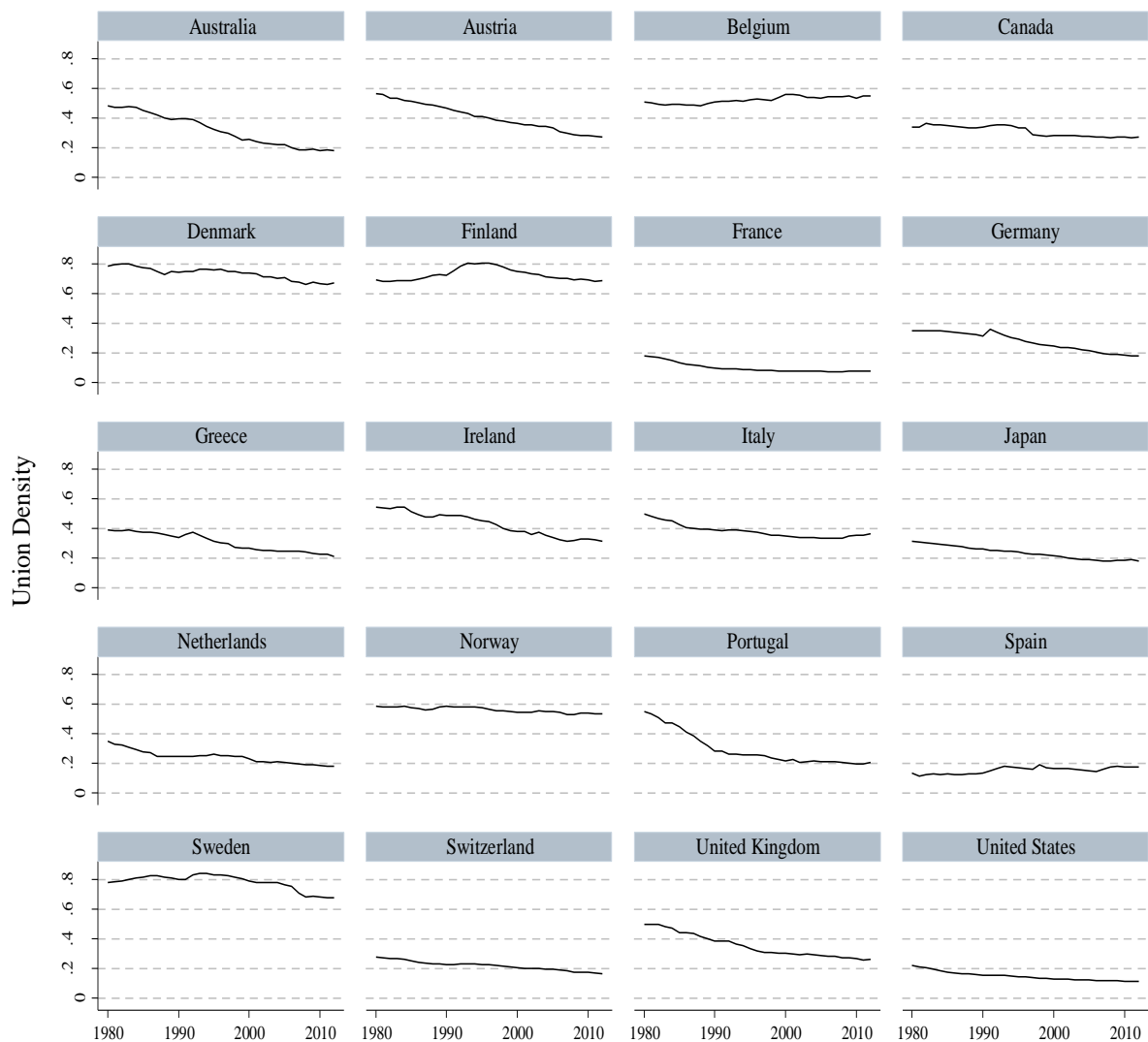
On the other hand, much of the related literature that has attempted to deepen these relationships, focuses on samples including the 1970s decade in which both inflation and union membership hiked and the economic system looked much more different than nowadays.

As mentioned before, a comprehensive discussion on how the labor market structure has evolved since the 1980s is provided, in order to better understand OECD dynamics and trends.

3.1.1 Union Density

One of the labor market feature that has received much attention by the literature, in particular in analyzing unemployment and inflation dynamics, is the role of the unions and their role in wage setting. Union density is defined as the proportion of paid workers who are union members and it is often used as a proxy for how powerful unions are in a given country; as one can see in Figure 4, each country in the sample has its own very peculiar rate of unionized workers.

Figure 4 - Union Density in OECD Countries - 1980-2012



Not surprisingly, the least unionized countries are the United States (with only 12% of workers being union member in the last decade), consistent with their liberal economic model characterized by greater private sector freedom, low levels of regulation and government involvement. The only country with a lower level of unionization is France, which trend, however does not really indicate a “union aversion” but rather it is the reflection of their labor

law system. Under the “*délégués du personnel*” system, French workers have the right to vote and be represented by shop stewards whether or not they are members of a union and thus, they can support a confederation even without joining it.

On the other hand, the most unionized countries are the Scandinavian that as a long tradition in extensive welfare systems, in which unions play a prominent role. In countries such as Denmark, Finland and Sweden, labor unions are responsible for distributing unemployment insurance rather than a state agency and in most cases, receiving benefits is conditional to belonging to a union, a system usually referred as Ghent System; indeed, Western (1995) finds out that the presence of a Ghent System is associated with higher union density.

Although the large differences among OECD countries, most of the union trends share a declining path. In recent years, literature has extensively tried to explain which drivers brought to such a drop in union membership by associating the drops mostly to structural changes in advanced economies. Western (1995) relates the decline to the growing economic openness, unemployment, the electoral failure of social democratic parties and the decentralization of collective bargaining. In line with Western (1995), Visser (2006), basing on an extensive analysis of union membership in 24 countries, identifies higher and longer term unemployment rates, increased competition and the increased use of flexible employment contracts as key drivers for the decline of union density.

Recalling Figure 3, that shows the evolution of inflation rates in OECD since 1980, it is straightforward to notice that inflation as well is showing a declining behavior, occurred around early 1990s. This general decline is mostly attributable to the success of central banks in moderating prices and the introduction of inflation targeting policies, but according to empirical literature, there may something else.

Indeed, literature has extensively looked for a relationship between inflation dynamics and unions, usually finding that the presence of strong unions tends to be explanatory for higher inflation. The underlying assumption is that strong unions tend to cause wage increases or be reluctant to wage cuts or staff dismissal, all factors that make business costliest and thus leading to price increases. If the pin of the bargaining power is favorable for the labor supply, the more disposable weapons, such as strikes, unions have, the more likely firms are going to weaken their willingness to resist union demands.

The wage-setting process may take time, though; in an environment of prolonged bargaining, this stalemate impedes firms to adjust prices, and to this extent, unions may contribute to slow the price adjustment process.

Although the above-mentioned assumptions, the recent decline in union membership may cast some doubts on the degree of influence unions may have nowadays. In times of widely persistent unemployment and increase competition, firms may have gained the upper hand in the bargaining process; moreover, it seems unions are failing to adapt to the changing economic environment of the new millennium, unfitting for a more open, competitive and private-oriented system. All factors together, it is reasonable to assume a weakening of the influence unions had on inflation in the past decades.

3.1.2 Coordination and Centralization of Wage Bargaining

So far, we discussed about unions by taking for granted their behavior, assuming all countries share the same bargaining structure in which unions care only and exclusively to workers' rights and wages, without taking the external environment in consideration; this simplified point of view may be very misleading. In fact, unions among OECD countries are different and they vary mostly in term of how well the wage bargaining process is coordinated and how strongly it is centralized.

In the previous paragraph, we discuss about the fact that the wage-setting process may take time. When there are several unions in action, achieving an agreement amongst them may be difficult; the more uncoordinated these unions are, the farther the moment for firms to consequently adjust prices. Thus, in studying inflation persistence is important to take into consideration not only union density, but also how the bargaining process is carried out.

To understand why coordination is so important, the problem can be seen as a real realization of the famous prisoner's dilemma. In this game, the police catch two prisoners, but they do not know exactly who committed the crime and which person just helped. The two prisoners are questioned separately; if they both stay silent, their punishment is 6 months in prison. If one confesses and the other remains silent, the latter goes to jail for 10 years and the first does not go to jail. If they both confess, they go to jail for 2 years. Even though the two would be better off if they both stayed silent, the dominant strategy is always to confess because it is the only way one can avoid 10 years of prison.

Just like the prisoners, if there are many unions in the system, each union's individual self-interest is to negotiate wages that exceed the one that would secure a stable inflation rate. Nevertheless, unions are tempted to break the wage accord (defect) to secure higher wages whilst the others stick to it. This coordination failure leaves the parties worse off because if all

unions negotiate only to benefit their interests, prices inevitably go up and high inflation is bad for both firms and workers.

Centralization in wage bargaining is thus important because the more centralized the wage setting is (*i.e.* low number of unions), the easier is the communication and the higher are the chances that wage negotiations are carried out in a more synchronized way. Communication shifts the balance of the game by giving the parties the possibility of understand which is the best deal for both of them. As the prisoners would have confessed if they could deal with each other, so it is more likely that unions internalize the macroeconomic consequences of their bargaining posture and stick to the agreement, when communication is easier to give the low number of unions.

This solution of the bargaining game holds if a high degree of centralization corresponds to an equally high degree of coordination. These concepts are closely related but distinct; centralization identifies the most dominant level at which wages are negotiated.

Highly centralized negotiations are usually coordinated, but there can be a highly centralized system with low cooperation or on the other hand, a high number of different unions, cooperating amongst them, as for example in Japan.

Figure 5 shows the average degree of centralization while Figure 6 the average degree of coordination, both for 20 OECD countries for the last three decades.

At first glance, on one can see that the highest degree of centralization occurs in Belgium, Finland and Greece¹³, while on the other hand, the most highly decentralized countries are Canada, United States and Japan, in which negotiations take place mostly at the local level.

We can see more straightforwardly how distinct are the features of centralization and coordination in deepening wage-bargaining structures; while Canada and United States are characterized by low coordination, Japan appears to have a remarkably coordinated bargaining structure, despite the low centralization level.

This may reflect the fact that, although negotiations are carried out at local level, there are three influent unions to which each local unit responds; thus, even if local units carry out their negotiations by their selves, the presence of strong and influential unions may favor a more coordinated environment.

¹³ Up until the 1990, bargaining at company level was illegal in Greece.

Figure 5 - Average Degree of Centralization of Wage Bargaining in OECD Countries – 1980-2012

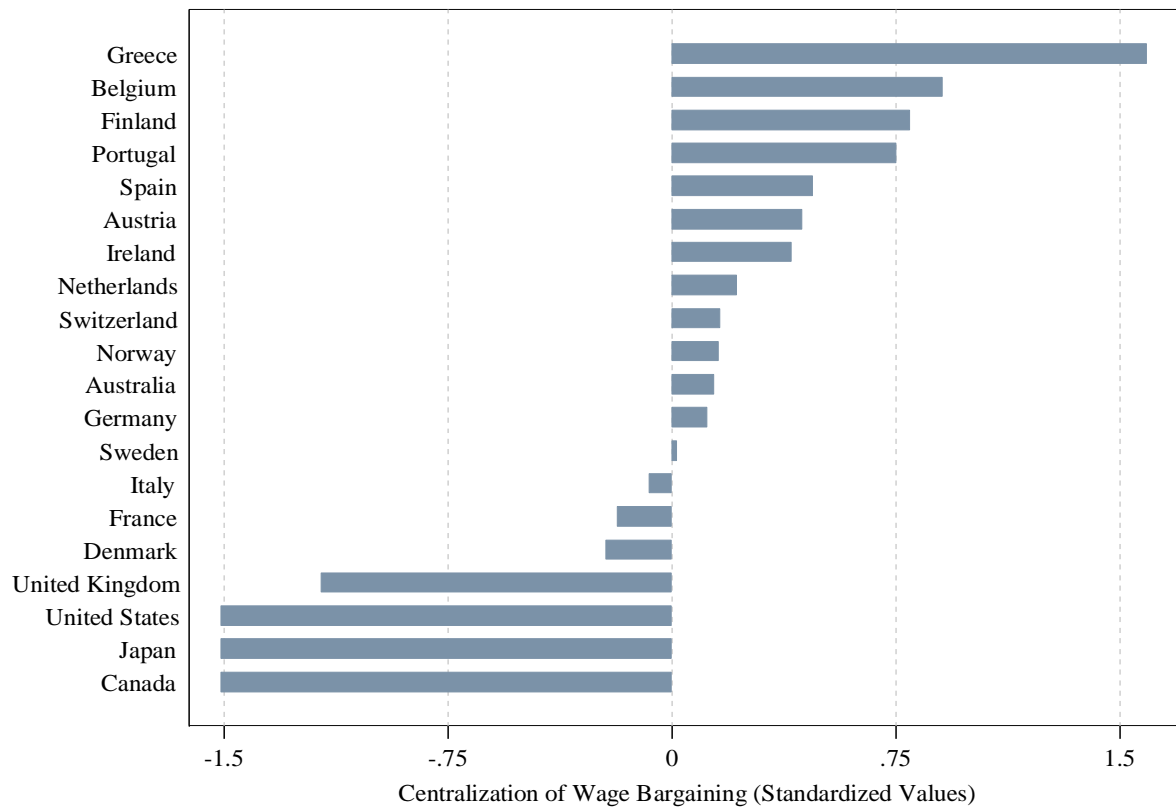
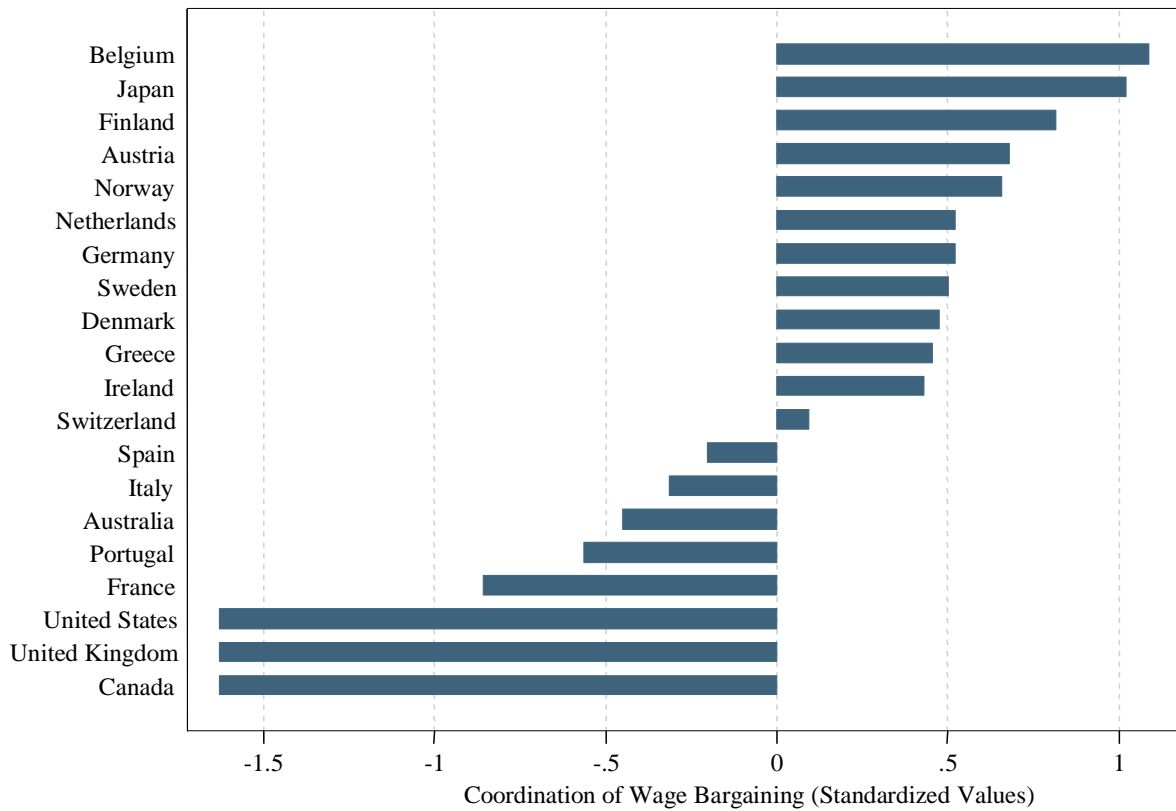


Figure 6 - Average Degree of Coordination of Wage Bargaining in OECD Countries – 1980-2012



Even though there is no consensus about it, wage bargaining in OECD countries is experiencing a general trend toward decentralization since the 1980s, despite the differences characterizing the bargaining structures among them. According to Karlson and Lindberg (2011), the most marked shift appears to happen for Sweden, Denmark, UK and the Netherlands, countries with very different models. Decentralized bargaining in UK possibly reflects their historically voluntarist approach in which the state refrains to intervene in industrial relations. On the other hand, this shift in wage bargaining is surprising for Denmark and Sweden; these two countries belong to the Nordic model in which there is a great unions' involvement and usually the collective bargaining takes place at national level. The authors also underline the remarkable shift occurring in the Netherlands, in which, historically, the state is particularly involved in the wage setting process.

So far, we discussed about how beneficial a centralized bargaining system can be and about the recent shift toward decentralization that OECD countries are experiencing. This raises the question of whether this trend may translate in a harmful outcome for the economy.

In an important contribution by Calmfors and Driffil (1988), the authors point out that the effect of centralization can be twofold, not just a monotonic negative relationship. If high centralization favors cooperation which in turns bring to the achievement of less self-interest unions, on the other decentralized systems may be good too. Indeed, the authors advance the hypothesis of a hump-shaped relationship between centralization and inflation, identifying only an intermediate level as potentially harmful for the economy. Decentralized system may enhance competition among labor supplier, with a consequent wage restraining effect. The relationship between centralization and inflation may be hump-shaped because if wages are raised uniformly, no relative price can change. This uniform raise can be achieved in case of complete centralization as in case of complete decentralization.

In case of intermediate degree of centralization, if this is associated with a low level of coordination, neither the competition-effect nor the internalizing macroeconomic consequences prevail. This environment may end up in slowing negotiations in which both labor demanders and suppliers advance only self-interested claims; when adjustments are necessary in the economy and inflation is high or unstable, such labor market characterization may be anything but beneficial, contributing to make inflation more persistent.

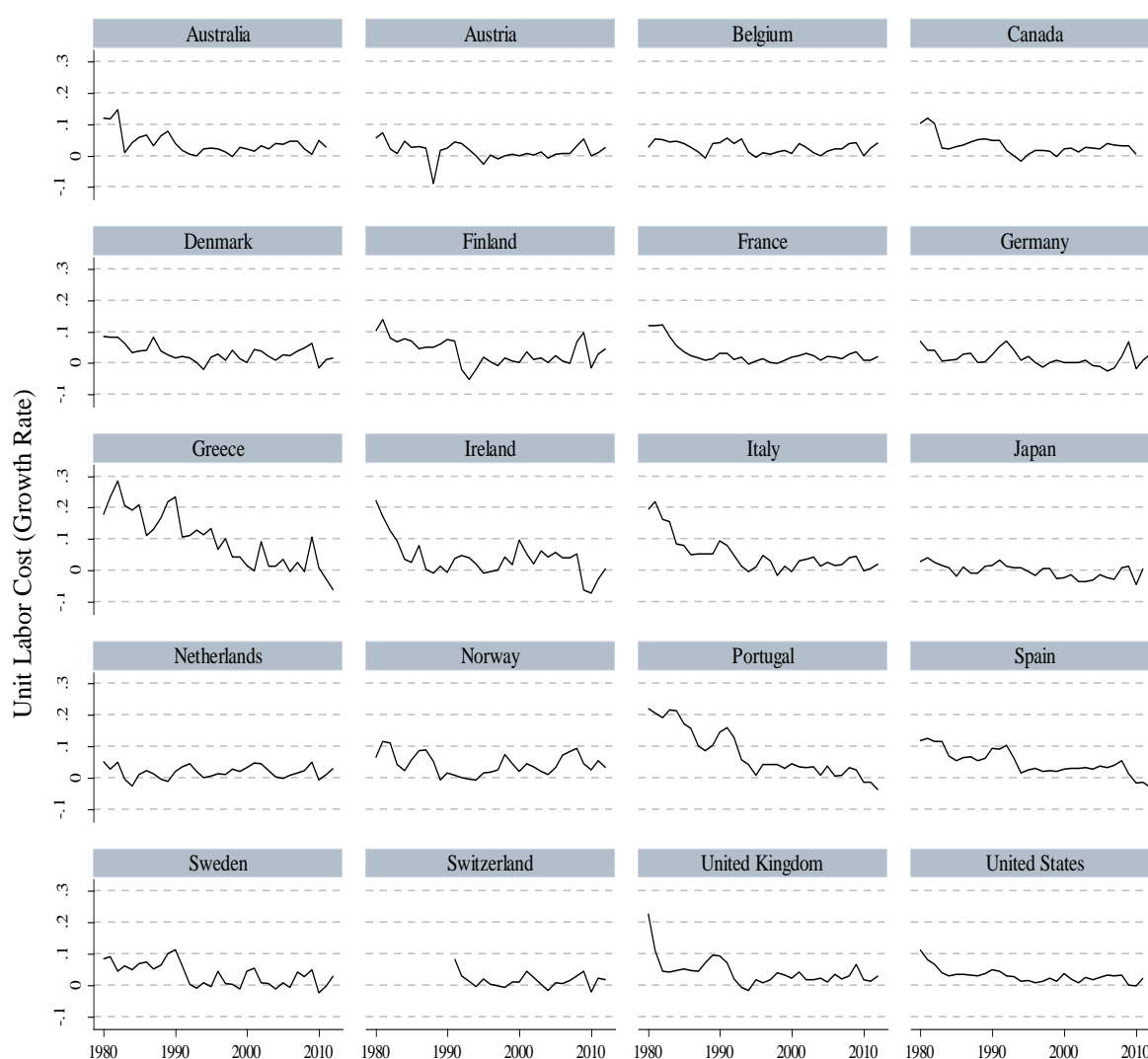
However, there is no real general consensus on the influence the bargaining structure has on inflation, but, keeping in mind Calmfors and Driffil (1988) allows us to better understand the possible channel through which unions can influence macroeconomic performance, an influence that can be beneficial or harmful depending on a given structure of wage-setting.

3.1.3 Unit Labor Cost

Unit labor cost measures the average cost of labor per unit of output and it can be seen in a broader perspective as the “price of labor”. For this reason, it is the most widely used proxy for competitiveness and, since it is considered a good predictor of inflation, it is often employed in empirical investigation using a New Keynesian formulation of the Phillips Curve or mark-up models, for instance.

Indeed, if we look at Figure 7, it is impressive how the unit labor cost growth follows for OECD countries follow a path that is very close to the inflation rate one (Figure 3). The graphs reveal a general decreasing trend for this index, which reflect the efforts of OECD countries to enhance labor market flexibility and to regain the competitiveness necessary to face the rise of emerging markets.

Figure 7 - Unit Labor Cost (Growth Rate) in OECD Countries - 1980-2012



In fact, unit labor cost is one of the major concerns in the Euro Area and it is usually advocated as the main cause of inflation differentials among the monetary union¹⁴. Lucas Papademos (2007), former Vice President of the ECB, underlines how higher unit labor cost does not only trigger higher inflation but it contributes to make the latter more persistent.

“[...] Sizeable and protracted ulc growth in a member country above the euro area average is very likely to be accompanied by a commensurate higher and persistent inflation and a loss of competitiveness that will eventually adversely affect its current account position, economic activity and employment.”

If a shock hitting inflation occurs, the presence of high unit labor cost means that labor is costly for firms and can trigger a stalemate in which the smooth return of prices to their sustainable long-run level is hampered by the high costs faced by firms.

3.1.4 Minimum Wage

The effect of minimum wage on economic performance, in particular on inflation and employment, is a very controversial topic in economic theory, on which there are no generally agreed conclusions. Indeed, although widespread in OECD countries, in some countries, its entrance in force is recent or even national law does not provide it.

In the sample of 20 OECD that this work observes, only 13 countries have minimum wage provisions, among which United Kingdom and Ireland established it at the beginning of the new millennium and Germany introduced it in 2015.

Among the countries without statutory minimum wage, there are Austria, Denmark, Finland, Italy, Norway, Sweden and Switzerland, where rather collective agreements prevail.

Supporters claim that this institution has several beneficial effects on the economy, such as poverty reduction, consumption *stimuli* or decreasing the burden of social welfare programs for governments. On the other hand, aside from the effect on employment and the actual effectiveness on poverty, one of the main arguments of the opponents of the minimum wage is the inflationary effects its presence can have.

Firms are profit-maximizing agents, but paying minimum wage is mandatory; thus, in order to compensate this cost, an increase in minimum wage passes through into higher prices. Therefore, an increase in the minimum wage can be viewed as an exogenous cost shock with the consequent inflationary effect, as in Neumark and Wascher (2008).

¹⁴ See *e.g.* Trichet, J. C., “Economic integration in the euro area,” BIS Review, 2006, 27, 1–7. Speech by Mr. Jean-Claude Trichet, President of the European Central Bank, at the 15th European Regional Conference of the Board of Governors, Tel Aviv University, Paris, 31 March 2006.

Nevertheless, this textbook interpretation relies on several assumptions that may be incompatible with real life. Indeed, an increase in the minimum wage would straightforwardly translate in a price increase if firms pay their workers the maximum amount they can possibly pay and this does not happen. As we discussed above, firms are profit-maximizing agents, thus most likely the wage they pay is the one that minimize their cost of labor; consequently, firms do not actually need to translate into an increase in the minimum wage in higher prices.

Moreover, regarding cross-country difference, the legal minimum wage is often not so distant from the average lowest wage in countries in which is not mandatory. Therefore, it can be hard to believe that cross-country difference in inflation or on its persistence are explainable by the presence of minimum wage.

On the other hand, Neumark and Wascher (2008) suggest that in some countries, minimum wages are indexed to prices or average wages, a link that may hamper the negative effects of a price/wage-increase shock by affecting the unit labor cost. Therefore, even if minimum wage has no direct effect on inflation, this increase in unit labor cost may make the shock more persistent, since high costs for firms hinder the absorption of the shock, passing the latter through future inflation.

Moreover, if a minimum wage increase occurs, the presence of other rigidities in the labor market can hamper the price-adjustment process of firms, slowing down prices' response more than how would have been in countries without such institution.

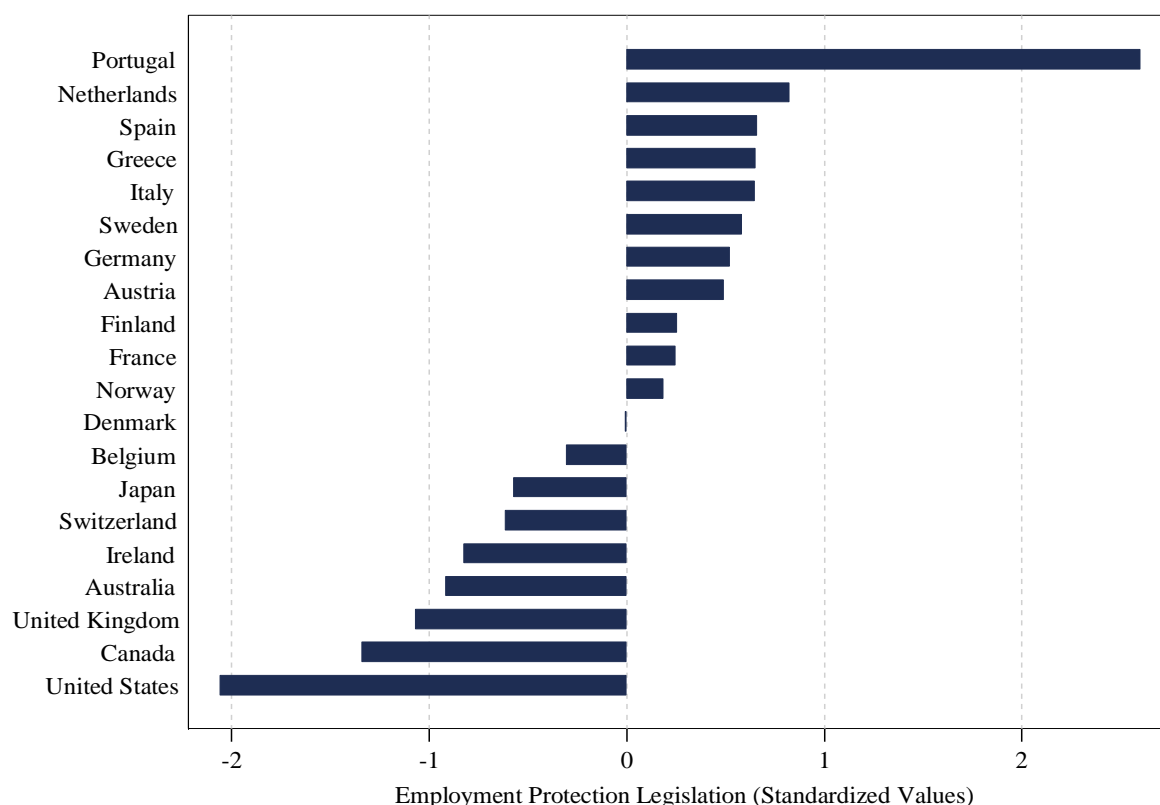
3.1.5 Employment Protection Legislation

Since we discussed about unit labor cost and minimum wage as a determinant of the “price of labor”, it is useful to look to the index of employment protection legislation that measures the procedures and costs involved in dismissing workers and the procedures involved in hiring workers, constituting a proxy of labor market inflexibility.

Figure 8 shows the average degree in employment protection for the countries in the sample and the more noticeable evidence is how this index varies amongst OECD countries, with the two extremes being Portugal and United States.

Southern Europe in particular (Portugal, Spain, Italy and Greece) is characterized by a very strict level of security which, as Karamessini (2008) points out, reflects the authoritarian corporatism and the family-oriented ideology that characterized the history of these countries. Indeed, the less strict legislation can be found in more market-oriented economies such as the United Kingdom, Canada and United States.

Figure 8 - Average Degree of Employment Protection Legislation in OECD Countries - 1980-2012



For which regards the effects of employment protection legislation on economic performances, there is no consensus. A mainstream view of this index entails wage rigidity and the costs of workforce adjustment, thus a strict level of job protection usually translates in inefficient labor market. Since, hiring and firing are costly, they contribute to marginal costs for firms and thus a strict legislation may trigger prices increases that, in an inefficient labor market can persist. Moreover, an extensive literature finds a relationship between employment protection legislation and productivity; overly strict regulation appears to hinder productivity¹⁵. A slowdown in productivity may trigger inflation pressures in the economy, constituting a second channel through which a strict legislation can in turn influence inflation dynamics. A decrease in productivity translates in an increase in the cost of conducting a business, by increasing the unit labor cost; to offset this effect, firms have to raise prices. Workers accepting lower wages in exchange to the high protection may smooth the inflationary pressure but the timing of prices adjustment in a low productivity environment can be long, resulting in persistent inflation.

¹⁵ See *e.g.* Bassanini *et al.* (2009), OECD (2012), Rincon-Aznar and Siebert (2012).

3.1.6 Active Labor Market Policies

The Great Recession of 2008 has seen a general rise in unemployment among OECD countries, bringing the spotlight back on active labor market policies, in order to re-equilibrate domestic labor markets.

“Active labor market policies” refers precisely to the “active” portion of public spending in the labor markets, contrarily to the “passive” spending that concerns out-of-work income and early retirement.

Moreover, “active labor market policies” is an umbrella-term, which refers to three different categories, although all aimed at improving the efficiency of the domestic labor market:

- Public employment services include placement and related services, benefit administration and other expenditure;¹⁶
- Training includes institutional, workplace and alternate/integrated training, as well as special support for apprenticeship¹⁶;
- Employment incentives, includes recruitment incentives, employment maintenance incentives, and job rotation and job sharing¹⁶.

Spending on active labor market policies in OECD varies considerably and it reflects the very peculiarity on these countries. In we look at Figure 9, we see that the highest level of spending in active labor market policies is in Sweden, possibly a reflection of the well-known Rehn–Meidner model¹⁷.

In this model, active labor market policies and, more in general, state intervention and public investments, plays a crucial stabilizer role; as the goals of this model are low inflation and full employment, public spending should maintain aggregate demand stable over the business cycles and ensure labor market stability, in order to avoid wage-price spirals and consequently keeping inflation down.

On the other hand, we find United States and United Kingdom, characterized more market-oriented view of the economy. Indeed, the distribution of active labor market policies amongst OECD countries is consistent with the finding of Nelson (2013), who finds that spending on active labor market policies is positively influenced by the presence of social democratic, left wing parties and strong trade unions.

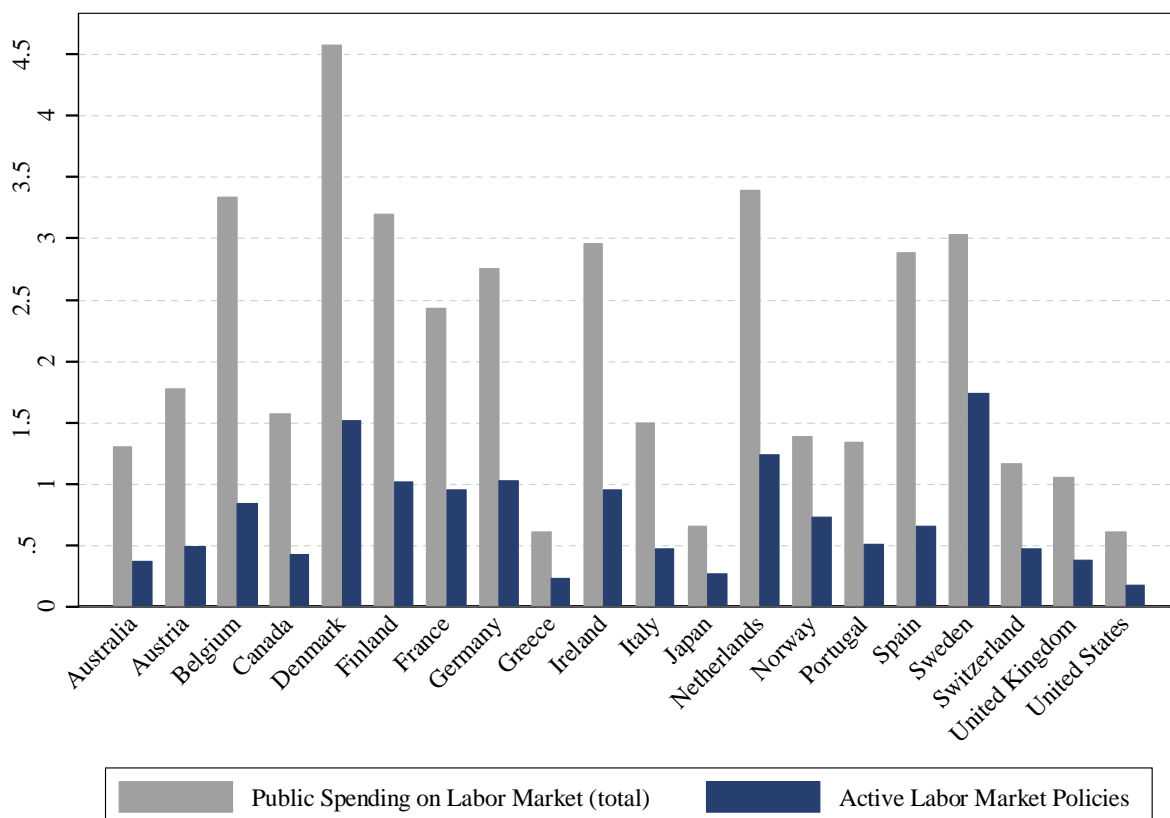
The proportion and the amount of active labor market policies seem to reflect other peculiarity more than a leftist root. By looking at Southern Europe, in particular Spain and Italy, we see

¹⁶ OECD (2016), Public spending on labor markets (indicator).

¹⁷ Meidner and Rehn (1951).

that a large fraction of public spending does not concern active policies, but “passive” policies, namely out-of-work income and early retirement, which reflect a certain degree of inflexibility in the labor market, already underlined in the previous section.

Figure 9 - Public Spending on Labor Markets and Active Labor Markets Policies in OECD - 1980-2012



Literature has extensively looked at the effect that active labor market policies have on employment, but little has been done about inflation, despite these policies may have a strong impact on wages.

As Webster and Summers (2000) discuss, in times of high and persistent unemployment, employers tend to consider long-term unemployed as an unskilled workforce; thus they are less prone to hire new people and much more willing to grant pay increases. Through proper labor market policies, this imbalance can be offset by reversing the de-skilling effect, incentivizing employers to consider the unemployed as substitutes for their current workforce. If they reach this awareness, they will be less willing to grant increases, therefore contributing to maintain nominal wages down.

This wage-restrain effect may help to keep inflation down and it may in turns also affect the responsiveness of inflation, by re-equilibrating wages and making adjustment easier in case of a shock.

Public spending on labor markets accounts also for spending in training, thus another outcome that in an increase in this kind of spending may have is to enhance workers' productivity. An increase in productivity, provided that the increase is faster with respect to an eventual increase in wages, increase the output for firms, which *ceteris paribus*, translates in lower prices.

4. ECONOMETRIC METHODOLOGY

The relationship between labor market institutions and inflation persistence is investigated using data covering 20 OECD countries¹⁸ observed over the period 1980–2012. The model adopted is a backward looking Phillips curve, in line with precedent literature¹⁹ in which inflation is explained by its own lag, macroeconomic variables and labor market institutions. Interactions between labor market institutions and lagged inflation are included in the model in order to understand whether they affect inflation by influencing its persistence.

In particular, the full specification of the estimated model is:

$$inf_{it} = \alpha + \rho inf_{it-1} + \beta_1 \Delta neer_{it} + \beta_2 outputgap_{it} + \beta_3 LMI_{it} + \beta_4 (inf_{it-1} * zLMI_{it}) + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.1)$$

where i denotes a country and t a year from 1980 to 2012.

The dependent variable inf is the annual rate of change in the Consumer Price Index calculated as $\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$ and partly explained by its own lag; given the use of annual data, inflation is modelled as an AR (1).

The model includes the following explanatory variables:²⁰

$\Delta neer$ is the change in the nominal effective exchange rate, the latter being a measure of the value of a currency against a weighted average of several foreign currencies; an increase in the index indicates an appreciation.

$outputgap$ is the output gap calculated as actual GDP less potential GDP as a percent of potential GDP.

LMI identifies several labor market institutions and characteristics that enter in the model; each LMI is introduced as the average effect itself on inflation and then interacted with lagged inflation, $inf_{it-1} * LMI_{it}$. These variables are:

¹⁸ The countries in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

¹⁹ See *e.g.* Bowdler and Nunziata (2007), Correa-López *et al.* (2010), Jaumotte and Morsy (2012).

²⁰ See the Appendix for the Data Sources.

- *ud* is the union density equal the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners²¹; *ud* is a proxy of how powerful unions are, assuming that a higher number of unionized workers is related to a higher influence and trust on trade unions.
- *coord* is an index of the degree of coordination in wage setting and it is based on a set of institutional features of wage setting arrangements. The index lies in the range 1 – 5 where 1 is equal to “fragmented wage bargaining, confined largely to individual firms or plants” and 5 being the highest coordination level, characterized by synchronicity, bargaining by peak associations or a strong monopolistic union confederation.
- *cwb* is the actual level of centralization of wage bargaining, which takes in consideration the predominant level at which wage bargaining takes place, how enterprise bargaining is regulated, presence of general opening clauses in collective agreement and other institutional features.
- *ulc* is the growth rate of unit labor cost, the latter calculated as the quotient of total labor costs and real output.²²
- *nmw* is a dummy variable that takes value of 1 in presence of national minimum wage.
- *epl* is the employment protection legislation index which take into account all types of employment protection measures, whether grounded primarily in legislation, court rulings, collectively bargained conditions of employment or customary practice.²³
- *almp* is the public spending on active labor market policies expressed as a percentage of the GDP.

4.1 ESTIMATION PROCEDURE

The model is estimated *via* OLS with White's heteroscedasticity-consistent standard errors. It allows for country fixed effect μ_i and time fixed effects λ_t , which control for unobserved factors being common among countries and through time; ε_{it} is the error term.

Since Nerlove (1967), it is well known that the use of standard methods of estimation, when applied to dynamic models with fixed effects, produce downward biased coefficients when the coefficient ρ is positive. However, Nickell (1981) shows that, for a first order autoregressive model with fixed effects and reasonably large T, the bias can be approximated as:

²¹ OECD Labor Force Statistics.

²² OECD Annual Indicators Database.

²³ OECD Labor Force Statistics.

$$\text{plim}_{N \rightarrow \infty}(\hat{\rho} - \rho) \simeq \frac{-(1-\rho)}{T-1} \quad (4.2)$$

Through equation (4.2) and several Monte Carlo simulations for different values of ρ , Nickell identifies at $T > 30$ the time threshold that makes the bias negligible.

Since our sample is characterized by $T=33$, the OLS estimator can be adopted; indeed, the findings suggest ρ is around 0.6 thus, following equation (4.2) and for a sample of $N=20$, the bias is equal to -0.021, which can be safely ignored.

Another important issue in panel-data regression models is variables' stationarity that is here assessed through the augmented Dickey – Fuller (ADF) test. For this purpose, variables' stationarity is assessed through a Fisher-Type ADF test. A Fisher-type test combines the p-values from independent tests to obtain an overall test statistic. For which regards stationarity in panel data, a unit-root test is performed on each panel and then p-values are combined in order to obtain an overall test assessing if the panel series contain a unit root. The reason for this choice is that the Fisher-Type ADF allows testing for non-stationarity of not perfectly balanced panel, which is the case of this sample.

A Fisher-Type ADF test can be performed through four different methods, namely the inverse chi-square, the inverse normal (Z), the inverse logit transformation of p-values and a modified inverse chi-square. Here, the rejection of the null hypothesis refers to the Z test, because it is suitable for finite N. Moreover, Choi (2001), who proposed these methods, recommends the use of Z test in empirical applications by showing how, considering the trade-off between size and power, this test performs better than the other proposals.

Table 1 shows the result for the unit root test made on all the continuous variable of the sample and reports only z scores and their associated p-values.

The null hypothesis of non-stationarity can be rejected for all the variables except for union density for which the p-value associated to its z score is equal to 0.25.

However, Table 2 reports results for Levin-Li-Chu test and Fisher-Type Phillips-Perron test, which both reject the hypothesis of a unit root. Thus, also in line with the precedent literature on trade unions, union density is treated as a stationary process. Finally, as in Bowdler and Nunziata (2007), other institutional variables such as *epi* and *coord* are not subjected to unit root tests, since they vary only very slowly through time.

Table 1 - Fisher-type unit-root test based on augmented Dickey-Fuller test

Ho: All panels contain unit roots		Number of panels = 20
Ha: At least one panel is stationary		Avg. number of periods = 33
AR parameter: Panel-specific		Asymptotics: T -> Infinity
Panel means: Included		
Time trend: Not included		
Drift term: Not included		ADF regressions: 1 lag

Variable	Z Score	p-value
<i>inf</i>	-9.786	0.000
Δ <i>neer</i>	-11.951	0.000
<i>outputgap</i>	-9.786	0.000
<i>unemp</i>	-4.456	0.000
<i>ulc</i>	-9.42	0.000
<i>ud</i>	-0.674	0.250
<i>almp</i>	-2.625	0.004

Table 2 - Additional Unit Root Tests on Union Density

Test		Statistic	p-value
Levin - Li - Chu	Adjusted t*	-5.920	0.000
Fisher-Type Phillips-Perron	Inverse Normal (Z)	-1.311	0.095

For which regards interactions, each interaction between *LMI* and lagged inflation is tested by standardizing the *LMI* variable (*zLMI*) in order to make regression results more readable; the coefficient of the interaction term represents how much inflation persistence is affected by a one standard deviation of *LMI*. The same holds for three-way interactions' coefficients, calculated after standardizing both *LMI* variables of interest.

From (4.1), it follows that, in presence of a two-way interaction, the effect of lagged inflation on the current level of inflation is equal to:

$$\frac{\partial inf_{it}}{\partial inf_{it-1}} = \rho + \beta_4 zLMI_{it} \quad (4.3)$$

In case of a three-way interaction, equation (4.1) becomes:

$$inf_{it} = \alpha + \beta_1 \dots + \beta_2 \dots + inf_{it-1} (\rho + \beta_4 * zLMI_{(1)it} + \beta_6 * zLMI_{(2)it} + \beta_8 * zLMI_{(1)it} * zLMI_{(2)it}) + (\beta_3 LMI_{(1)it} + \beta_5 LMI_{(2)it} + \beta_7 (zLMI_{(1)it} * zLMI_{(2)it})) + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.4)$$

From which the total effect of lagged inflation on inflation is given by:

$$\frac{\partial inf_{it}}{\partial inf_{it-1}} = \rho + \beta_4 zLMI_{(1)it} + \beta_6 zLMI_{(2)it} + \beta_8 (zLMI_{(1)it} * zLMI_{(2)it}) \quad (4.5)$$

The drawback in considering three-way interactions is that impedes the estimation of a model in which all labor market institutions and interactions are included to check the robustness of the findings. In this case, this practice may result in an over fitted model, thus interactions are tested separately.

In order to check the robustness of the results, *outputgap* is further substituted either with *unemp*, the rate of unemployment and by *ulc*, the unit labor cost.

The model is estimated also by including a dummy variable *it* that is equal to 1 in years in which a country has taken measure of inflation targeting; this kind of policy may have an anchoring effect on inflation dynamics nullifying the pressures coming from the labor market.

At first, the Cukierman's index of Central Bank Independence (*cbi*) was included in the baseline model, but it turns out to be not significant, despite there is a large precedent literature accounting for it when inflation is the dependent variable. A possible explanation for this finding is that the sample 1980-2012 is characterized by moderate levels of inflation attributable to a general effort in keeping inflation down, regardless the independence of the national central banks. Moreover, models accounting for the relationship between *cbi* and inflation consider samples that include the decades 1960s and 1970s and the effect of *cbi* may be due to events in this period as Bowdler and Nunziata (2007) point out. Indeed, in their study on trade unions and inflation, they include *cbi* obtaining a negative and significant coefficient over time but in splitting the sample to test for model stability, the Cukierman's index loses significance when the sample begins in 1976–1980, in line with the explanation given before; this relationship may not hold in most recent times.

However, since the negative effect of *cbi* on inflation is well documented in the literature²⁴, *cbi* is included as a robustness check, but the main findings remain stable.

An additional robustness check is repeating the estimations by dropping one country at time, in order to evaluate the cross sectional stability of the model; indeed, there may be some outlier which predominantly drives our finding.

The last robustness check is performed to assess the temporal stability of the model by splitting the sample and repeating the estimation for the period 1980-2000 and 1990-2012. The exercise

²⁴ See *e.g.* Crowe and Meade (2008).

is not carried out by splitting the sample in half in order not to use too short series. Therefore, temporal stability is checked on two overlapping sub-samples in order to consider at least twenty years.

This check is very important for the purpose of this work because it can provide additional evidence for the hypothesis that the relationship between labor market institutions and inflation may have weakened through time. However, the limitation of this check has to be acknowledged because it reduces the sample to $T=20$, a time span that does not allow us to ignore the Nickel bias problem. In fact, in case of unstable results, the check can underline how important is for exercises on dynamic models to be based on large enough samples, in order to obtain significant and reliable results.

5. EMPIRICAL RESULTS

This section presents empirical evidences on the relationship between inflation persistence and labor market institutions, obtained by estimating a backward looking Phillips Curve augmented with institutional variables for 20 OECD countries observed over the period 1980–2012.

The first column of Table 3 presents the baseline model without labor market institutions and relative interaction terms; in line with the literature, the coefficient of lagged inflation suggests that the actual prices level is still strongly dependent on past level of inflation.

The coefficient associated to the change in the nominal effective exchange rate is highly significant and correctly signed. *Δneer* allows controlling for shifts in the exchange rate regimes and reflecting the effects of changing in exchange rate on inflation. An increase in the exchange rate translates into an effective currency appreciation, which in turns contributes to lower inflation, for instance because of cheaper imports. The estimated coefficient is coherent with this relationship, estimating that a one-percentage decrease in the nominal effective exchange rate explains approximately one tenth of one-percentage increase in the inflation rate.

The coefficient for the output gap is positive and significant and in line with what economic theory suggests. The output gap serves as a proxy of the degree of inflation pressure in the economy; indeed, a positive output gap means the economy is overheating and that demand exceeds supply, which leads prices to rise. Conversely, a negative output gap identifies situations of economic downturn and the disinflationary effects are the consequences of weak demand. The output gap is thus a key determinant of demand-pull inflation, a phenomenon usually described as “*too much money chasing too few goods*”²⁵; our model also supports this hypothesis, estimating that a unit increase in the ratio between the potential GDP and the actual GDP, account for nearly one fifth of a unit increase of the inflation rate.

Union Density and Coordination

Column (2) and (3) show evidences of the relationship between union density, inflation and inflation persistence. Unlike precedent literature, neither the main effect nor the interaction term, which capture a possible effect of unionization on inflation persistence, turn out to be significant. The usual justification for the inflationary effect of unions is that they seek to secure

²⁵ Barth, J.R. and Bennett, J.T. (1975).

higher wages for workers and the stronger they are the more powerful their bargaining power will be.

Table 3 - Dynamic Model of Inflation for a Panel of 20 OECD Countries – Union Density, Coordination and Centralization of Wage Bargaining

Dependent Variable	Inflation							
	OLS (Robust Standard Errors)							
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>inf(-1)</i>	0.709*** (0.047)	0.703*** (0.051)	0.709*** (0.049)	0.713*** (0.050)	0.708*** (0.049)	0.702*** (0.052)	0.648*** (0.048)	0.636*** (0.043)
<i>Δneer</i>	-0.099*** (0.028)	-0.095*** (0.025)	-0.097*** (0.026)	-0.097*** (0.026)	-0.092*** (0.025)	-0.096*** (0.025)	-0.089*** (0.025)	-0.083*** (0.026)
<i>outputgap</i>	0.170*** (0.058)	0.170*** (0.058)	0.177*** (0.053)	0.180*** (0.051)	0.166*** (0.053)	0.170*** (0.058)	0.198*** (0.047)	0.191*** (0.049)
<i>ud</i>		0.034 (0.047)	0.039 (0.047)	0.044 (0.047)	0.026 (0.045)	0.035 (0.048)	0.051 (0.047)	0.046 (0.049)
<i>inf(-1)*zud</i>			-0.032 (0.033)	-0.037 (0.033)	-0.018 (0.023)		-0.030 (0.030)	-0.010 (0.025)
<i>coord</i>				-0.001 (0.002)	-0.001 (0.002)			
<i>inf(-1)*zcoord</i>				0.011 (0.026)	0.030 (0.021)			
<i>inf(-1)*zud*zcoord</i>					-0.073*** (0.024)			
<i>zud*zcoord</i>					0.002 (0.002)			
<i>cwb</i>						-0.001 (0.007)	-0.004* (0.002)	-0.004* (0.002)
<i>cwb²</i>						0.000 (0.001)		
<i>inf(-1)*zcwb</i>							0.074*** (0.026)	0.078*** (0.020)
<i>inf(-1)*zud*zcwb</i>								-0.057** (0.027)
<i>zud*zcwb</i>								0.003 (0.002)
Constant	0.039*** (0.010)	0.025* (0.014)	0.023 (0.014)	0.024* (0.013)	0.034** (0.013)	0.027* (0.015)	0.039*** (0.010)	0.042*** (0.010)
Observations	633	633	633	633	633	633	633	633
R-squared	0.875	0.876	0.877	0.877	0.881	0.876	0.883	0.885
Number of ID	20	20	20	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As union density is considered a proxy for unions' power, a positive coefficient of this variable on inflation usually reflects this interpretation. A possible explanation for the fact that union

density turns out to be not significant lies in the nature of the sample in analysis. The sample here analyzed considers a time span that goes from 1980 to 2012; as shown in the previous section, this sample is characterized by a worldwide low inflation rate and a general decline in union density, experienced even in the historically high-unionized countries such as the Scandinavian countries. Since high union density is associated with a strong power and influence of unions, conversely the experienced decline in unionization may reflect a loss of power of unions, a loss that unable unions to influence economic performance. Moreover, it is often argued that unions are proving themselves incapable of adapting to structural changes in the economy, resulting in a less effective behavior in facing a labor market that become more and more open, competitive and private-oriented. On the other hand, nowadays central banks are undoubtedly more capable of keeping inflation well anchored to a stable level, making price stability less likely to be undermined by institutions such as unions. As a feature of inflation, similar hypothesis may be advanced for inflation persistence; as central banks are more effective in controlling inflation, shocks are less likely to persist, as evidence on declined persistence suggests and thus less likely to be affected by unions. Thus, if in the last decades, unions were able to affect not only inflation itself, but also its persistence making labor market more inflexible, nowadays their decline and consequent loss of power is even insignificant in affecting economic performance, rather than being one of the reasons for low inflation.

As follow the loss of significance in union density, neither the coordination variable seems significantly explanatory for inflation, as we can see in column (4).

In column (5) however, the interaction between union density, coordination and lagged inflation is negative and highly significant, suggesting that, despite the hypothesis advanced above, these two variables still have some effect on inflation, albeit, singularly taken, they do not.

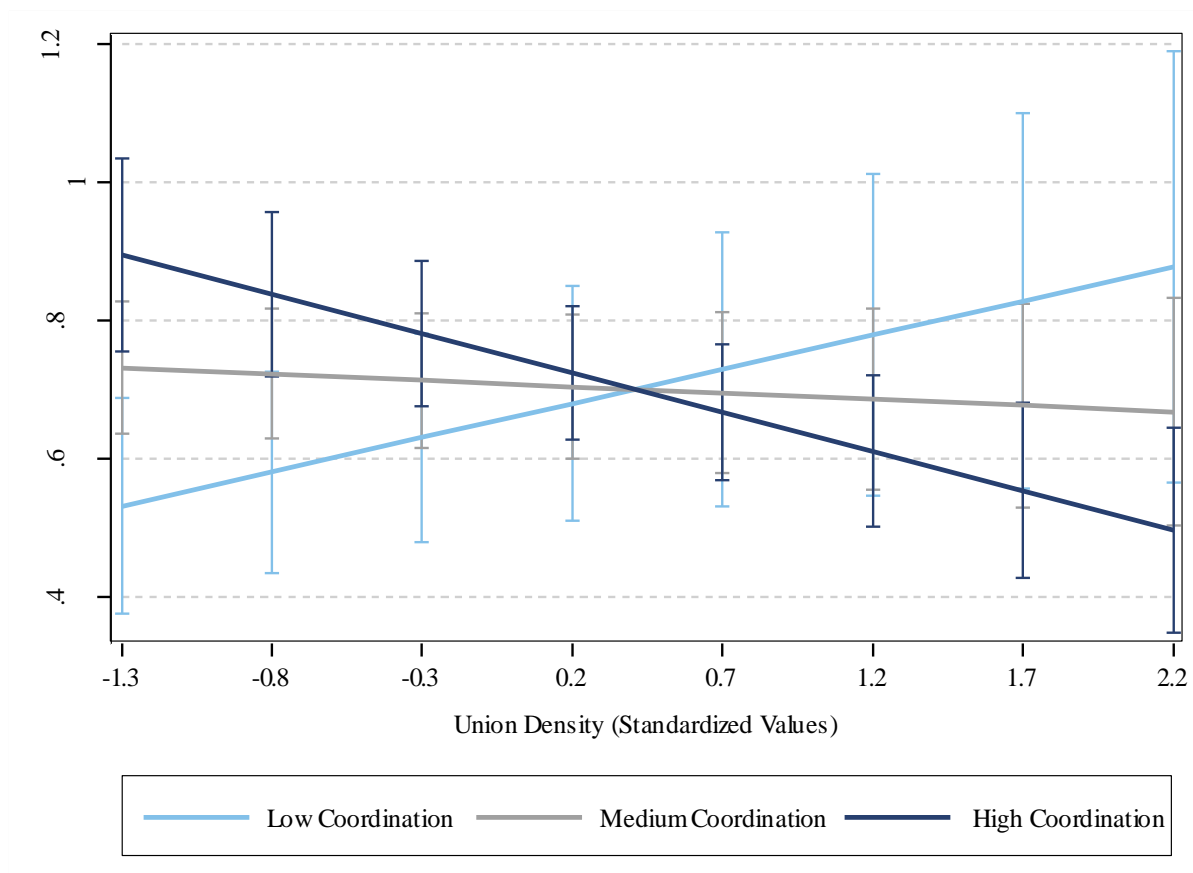
Because the interpretation of a three-way interaction, especially when the main effects are not significant, can be not so straightforward, it can come in handy to plot the relationship.

Figure 10 shows the pattern of our three-way interaction by plotting the marginal effect of lagged inflation on inflation for high, medium and low degree of coordination, as union density rises. What this graph tells us is that there is no overall effect of either union density or coordination on inflation persistence, but there is a crossover interaction. The effect of union density on inflation persistence is opposite, depending on values of coordination. When there is a “fragmented wage bargaining, confined largely to individual firms or plants”²⁶, union density contributes to make inflation more persistent, presumably by seeking to protect

²⁶ Definitions given by Visser (2015) in his dataset, respectively of the lowest and highest degree of coordination.

unconditionally their represented workers without a serious acknowledge of the consequences of their actions.

Figure 10 - Marginal effect of Lagged Inflation for different values of Union Density and Coordination



Indeed, we can see the persistence effect is increasing in union density, suggesting that, a fragmented coordination with relative poor power of unions and confined to isolated cases may do no harm. Nevertheless, if the extent of fragmented unionization increase, it may affect economic performances, by hindering adjustments in the labor market, possibly because uncoordinated unions behave only in a self-interested way.

Contrarily to existing literature, intermediate coordination does not affect significantly and negatively inflation, both for low and for high value of union density.

Interesting instead is the combined effect of powerful unions and high coordination. The highest degree of coordination²⁶ is identified when the setting of maximum or minimum wage rates/increases occurs at:

- a) Centralized bargaining by peak association(s), with or without government involvement, and/or government imposition of wage schedule/freeze, with peace obligation;

b) Informal centralization of industry-level bargaining by a powerful and monopolistic union confederation;

c) Extensive regularized pattern setting and highly synchronized bargaining coupled with coordination of bargaining by influential large firms.

This result is in line with previous literature' finding, although it tells us something slightly different. Bowdler and Nunziata (2007) finds out that coordination does not affect inflation directly but that a higher level of coordination reduces the impact of union density on inflation, as found also by Correa-López *et al.* (2010). The motivation that lies behind this finding is that coordinated unions or a big union confederation are assumed to act *ex professo*, acknowledging that claiming excessively high wages leads to higher inflation; since mostly all economic agents dislike high inflation period, conscious unions recognize this risk and choose to moderate their claims.

However, they both analyze a time horizon that takes in consideration the 60's and the 70's, in which OECD countries experienced both peaks of high inflation and the presence of strong unions. As mentioned above, given the loss of power of unions and the changed economic environment, in these last decades, the way conscious unions affect inflation may be changed. Unions are not more so influential to be able to affect directly inflation, but they certainly may have a role in facilitating an equilibrated adjustment of the labor market.

Union Density and Centralization

In order to investigate the relationship between persistence, union density and the bargaining process' features further, in this section we focus on decentralization. Visser (2015) defines decentralization “*as moving negotiations and decisions over wages and terms of employment closer to the individual enterprise*” which occurs when central or sectoral agreements are combined (if not replaced) with agreements at firm level. The variable *cwb*, tested in columns (6) and (7), is meant to capture this phenomenon; lower value of *cwb* are associated with a decentralized bargaining system. This variable in fact takes in consideration a lot of peculiarities of the bargaining process such as the level at which most bargaining takes place (central, industry or sector, or company), frequency and diffusion of enterprise-level bargaining, the articulation between sectoral and enterprise bargaining and the presence of opening clauses²⁷. It is important to underline that centralization does not mean coordination; for instance, the definition of centralization takes into account features such as government involvement, which

²⁷ A detailed description of the construction of the *cwb* variable is provided in the Data Sources.

coordination does not. Indeed, centralized bargaining system can be uncoordinated and *vice versa*.

Unlike coordination, evidence on centralization is mixed. Decentralization may increase competition among labor suppliers but, on the other hand, as for coordination, the more centralized is the bargaining system, the more likely unions are well aware of the consequences of their bargaining stand. According to this latter interpretation, as follow what suggested on coordination, higher centralization should have a mitigation effect on inflation persistence, since centralization should translate into a more conscious stance by unions on wage and protection claims. Moreover, high centralization means a low number of unions and that, by easing communication amongst them, can have a positive effect on the outcome of the wage-setting process. On the other hand, if decentralization increase the competition among the supply-side of the labor market, this fact may speed up inflation's adjustment process.

This dual effect of centralization has given rise to the view this relationship may be hump-shaped; both statements on centralization may be correct and, since they both translate in wage restraint, a negative effect on inflation may occur either for high or low levels of centralization in wage bargaining.

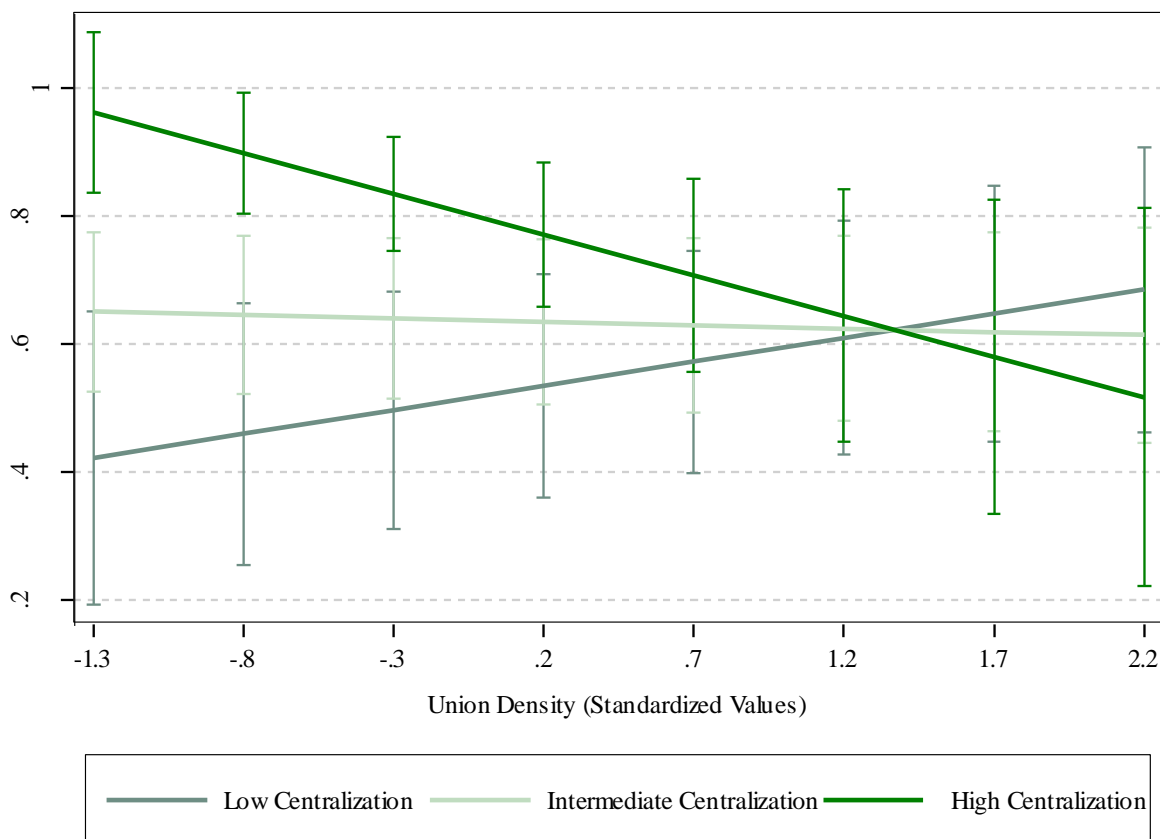
The right side of Table 3 shows evidence about the above-mentioned hypothesis. Column (6) reports evidence about the validity of the hump-shaped relationship, here tested by introducing *cwb* squared, to capture the slope of the curve. The coefficients for *cwb* are not significant and even not correctly signed for the hump discussed. The results do not support the Calmfors and Driffill (1988) hypothesis of a U-shaped relationship between centralization and inflation, thus further reformulations of the model have to be tested.

In column (7), the strategy undertaken in testing coordination is applied for centralization. We can notice that *cwb* coefficient is negatively signed, although not strongly significant. This finding may confirm the hypothesis that a more decentralized system, thus a decrease in *cwb*, may be interpreted as a lack of coordination without common goals by contributing to prices increase, albeit in a very small extent.

However, in column (8) interaction terms enter in the model, giving significant results. As discussed for coordination, the interpretation of the *cwb* coefficient is now not straightforward in presence of interaction. In fact, if one focuses only on the two-way interaction, what the coefficients suggest is that centralization has a reducing effect on inflation but on the other hand, an increase in *cwb* makes inflation more persistent; clearly, it is hard to imagine that a variable can have these contrasting effects on inflation.

Figure 11 shows the marginal effect of lagged inflation as union density increase in low, medium and highly centralized system.

Figure 11 - Marginal effect of Lagged Inflation for different values of Union Density and Centralization



The picture appears now more complete and in line with aforementioned assumption.

In a scenario where unions are not powerful, we can see that the marginal effect of lagged inflation increases as centralization increases while for high level of union density the outcome is significantly different. Thus, if one links *cwb* with coordination, this finding supports the hypothesis that, for a sufficient degree of unionization, the more centralized the bargaining, the more likely unions internalize the effects of their bargaining posture on macroeconomic.

Thus, this finding also supports the hypothesis of a dual effect of the bargaining structure, which varies with the degree of unionization of a country.

Unit Labor Cost

As defined in the previous sections, unit labor cost (*ulc*) measures the average cost of labor per unit of output and it is here calculated as the ratio of labor compensation to real GDP. Compensation represents a significant part of the total cost of production, thus, as economic theory suggests, an increase in this variable leads to accelerating price inflation. Unit labor cost

is thus a proxy of cost-competitiveness and thus it may have a role not only in increasing prices but also in making inflation more persistent. If we define persistence as the speed at which inflation converges to equilibrium after a shock, it is reasonable to suppose that a more cost-competitive labor market may be a key determinant for a quicker adjustment of the economy, by favoring a reduction in the duration of the shock hitting inflation.

In Table 4, column (1) analyzes *ulc* only in the extent in which it can affect inflation.

Table 4 – Dynamic Model of Inflation for a Panel of 20 OECD Countries – Unit Labor Cost

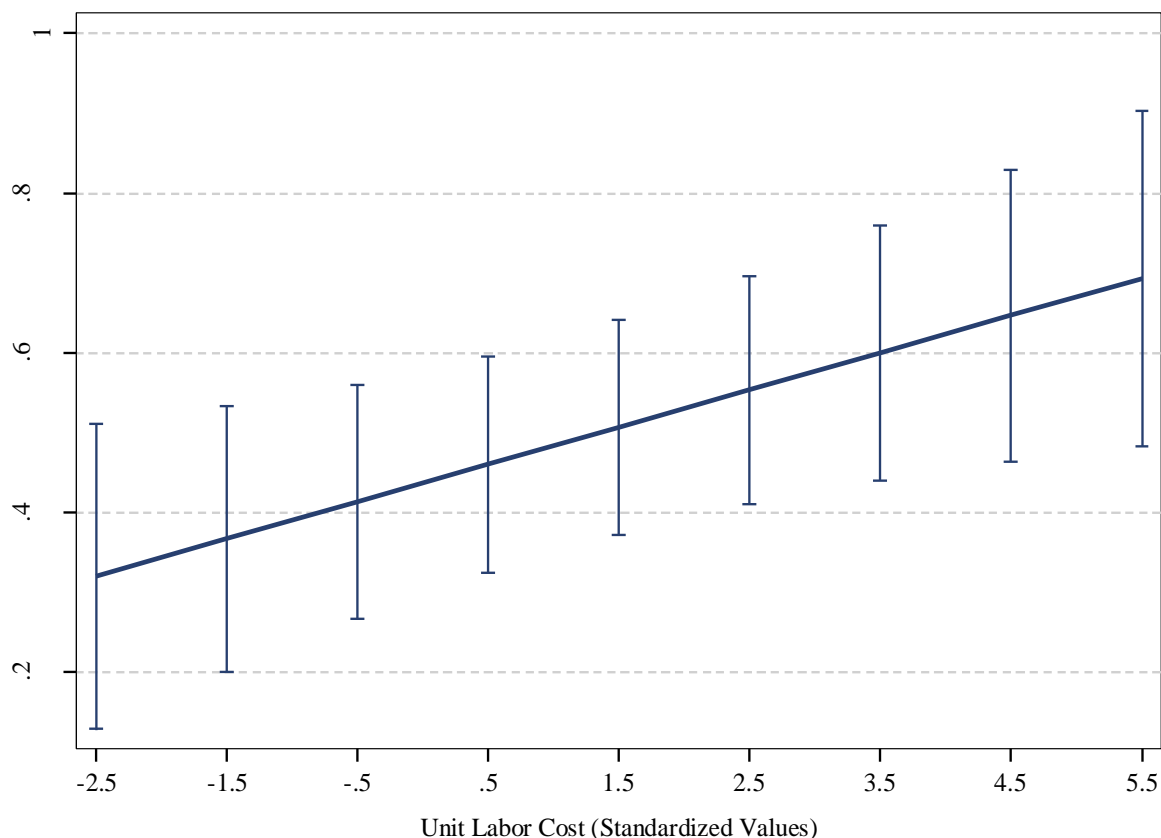
Dependent Variable	Inflation		
Explanatory Variables	OLS (Robust Standard Errors)		
	(1)	(2)	(3)
<i>inf(-1)</i>	0.516*** (0.064)	0.437*** (0.106)	0.438*** (0.103)
<i>Aneer</i>	-0.101*** (0.025)	-0.090*** (0.025)	-0.088*** (0.024)
<i>outputgap</i>	0.074** (0.034)	0.090** (0.032)	0.089** (0.032)
<i>ulc</i>	0.258*** (0.051)	0.179*** (0.031)	0.181*** (0.034)
<i>inf(-1)*zulc</i>		0.047** (0.022)	0.045** (0.020)
<i>ud</i>			0.017 (0.033)
constant	0.032*** (0.007)	0.040*** (0.011)	0.032*** (0.011)
Observations	622	622	622
R-squared	0.903	0.908	0.908
Number of ID	20	20	20
Country FE	YES	YES	YES
Time Dummy	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The finding is strongly positive and significant and the coefficients for the other inflation determinants remain quite stable. In column (2), the interaction term enters in the model and a positive and significant effect is detected. As assumed before, this finding confirms that not only competitiveness is an influent factor in price dynamics but it can also contribute to amplify situations of persistent inflation, since it is difficult for firms to bring prices back to a balanced level if they have to face high staffing costs. We can see the magnitude of this effect in Figure 12, which shows how the coefficient of persistence increase as *ulc* increases.

In column (3), union density is introduced but neither in this case this variable acquires significance, while the other variables' coefficients remain stable.

Figure 12 - Marginal effect of Lagged Inflation for different values of Unit Labor Cost



Minimum Wage

Since *ulc* turns out to be significant, one can argue that the presence of minimum wage may be significant too, since it can be seen as a mandatory cost item for firms. However, as already discussed in the previous section, there is no general agreement on whether or not the presence of a minimum wage legal framework makes a country more vulnerable to inflationary pressures.

In Table 5 the *nmw* dummy enters in the model to test this hypothesis, first as single main effect, and then interacted with lagged inflation to investigate if it affects the persistence feature.

Column (1) and (2) present evidence for our main model, while in the other columns the exercise is repeated by substituting output gap with unemployment and unit labor cost.

In column (1), the presence of minimum wage seems not to affect inflation supporting the assumption that, since firms do not pay their workers the maximum amount they can possibly pay, such norm does not translate into an increase in prices. Moreover, minimum wage is so defined since it represents a subsistence wage to ensure a standard living and it is often not so

distant from an average low wage in a country without this legislation; therefore, it is hard to assume an additional demand-side pressure on prices for these countries. However, in column (2), the interaction between lagged inflation and the presence of minimum wage is positive and significant, as Figure 13 shows.

Table 5 - Dynamic Model of Inflation for a Panel of 20 OECD Countries – Minimum Wage

Dependent Variable	Inflation					
	OLS (Robust Standard Errors)					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
<i>inf(-1)</i>	0.709*** (0.047)	0.572*** (0.085)	0.504*** (0.067)	0.439*** (0.090)	0.690*** (0.035)	0.568*** (0.085)
<i>Δneer</i>	-0.098*** (0.027)	-0.092*** (0.024)	-0.099*** (0.023)	-0.095*** (0.021)	-0.098*** (0.025)	-0.092*** (0.021)
<i>outputgap</i>	0.169*** (0.058)	0.194*** (0.053)				
<i>ulc</i>			0.274*** (0.057)	0.264*** (0.054)		
<i>unemp</i>					-0.101** (0.040)	-0.110*** (0.033)
<i>nmw</i>	0.003 (0.002)	-0.006* (0.003)	0.002 (0.002)	-0.002 (0.002)	-0.000 (0.003)	-0.008** (0.003)
<i>nmw*inf(-1)</i>		0.179** (0.069)		0.095** (0.045)		0.157** (0.072)
Constant	0.038*** (0.010)	0.051*** (0.015)	0.031*** (0.007)	0.038*** (0.010)	0.047*** (0.008)	0.058*** (0.013)
Observations	633	633	622	622	637	637
R-squared	0.875	0.883	0.902	0.904	0.871	0.877
Number of id	20	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES	YES

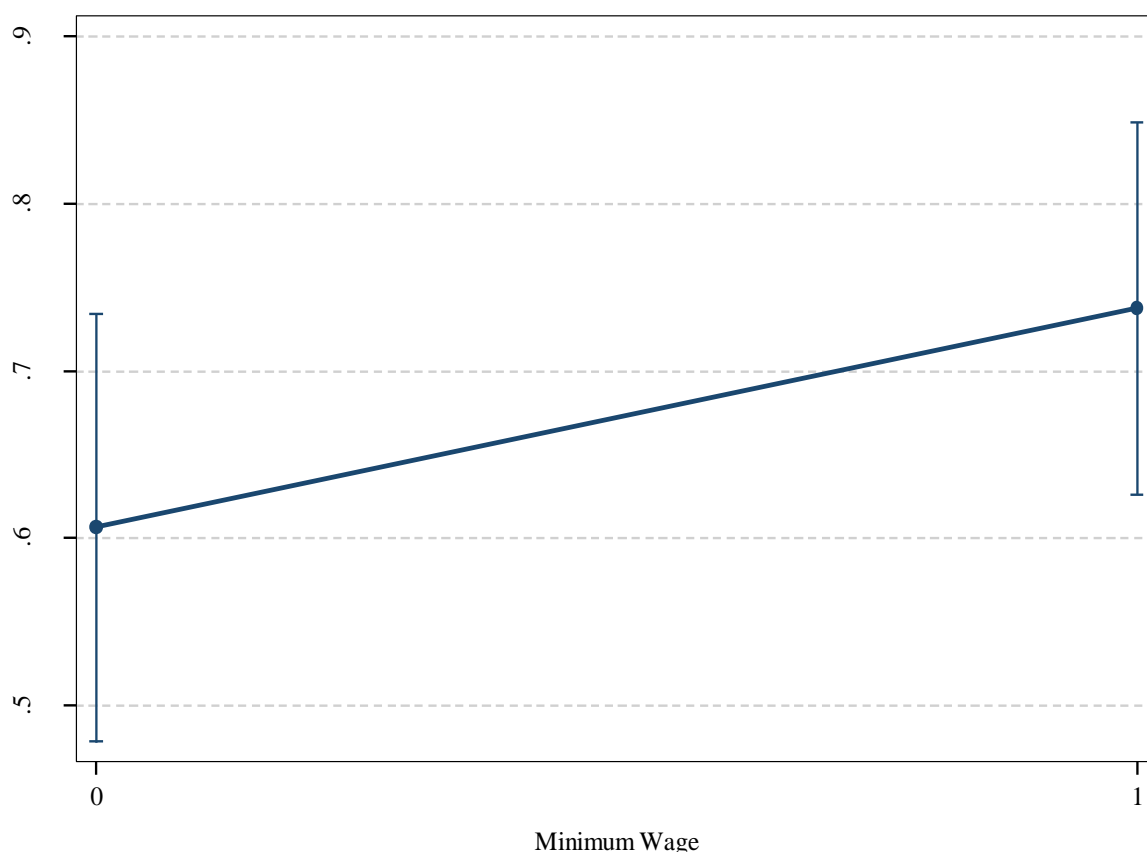
Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This result suggests that minimum wage may not be a major determinant for inflation itself, but that it may contribute in slowing down the absorption of a shock, since firms are legally bound to pay a wage that does not fall below the national minimum, and thus, without this option, it may take more time for prices to re-adjust.

This result supports also what suggested in the previous section; minimum wage is often indexed to prices or to average wages, thus in case of a shock hitting the latter two, the unit labor cost increases more than it would, slowing down the absorption of the shock. Therefore, if hit by a shock, countries with minimum wage legislations may end up with more persistent inflation, with respect to countries without such institution.

Figure 13 - Marginal effect of Lagged Inflation in absence/presence of Minimum Wage



Employment Protection Legislation

Following the reasoning behind testing unit labor cost and minimum wage, since *epl* represents a proxy of labor market inflexibility, it can be a potential source of inflation persistence, even though its effects on economic performances are controversial.

Table 6 shows evidence on the relationship between inflation dynamics and employment protection legislation.

In column (2) *epl* enters in the model only as a single main effect and it turns out to be not significant, suggesting that there is no relationship between the cost of hiring and firing and inflation. In column (3), *epl* is interacted with lagged inflation to investigate if, despite its insignificance toward inflation itself, this channel of inflexibility can contribute to the slowing down of the price adjustment process.

The result seems to reject an effect of this variable on inflation persistence too. However, the *epl* series is available only from 1985, thus in columns (4) and (5), the analysis is repeated with *eplfill*, in which the *epl* from 1980 to 1985 is assumed constant with respect to the first available

value. Variables like *epl* are constant over time for long periods, thus, although strong, assuming constant values can be a safe assumption.

Without missing values and under this strong assumption, the result of no effect of *epl* on inflation remains insignificant. Instead, the interaction term representing the effect of *epl* on inflation persistence acquires significance, providing some evidence that labor market inflexibility may influence the speed at which of prices adjust. However, the finding is not emphasized given the strong assumption of constant values, but it will be further checked in the robustness section.

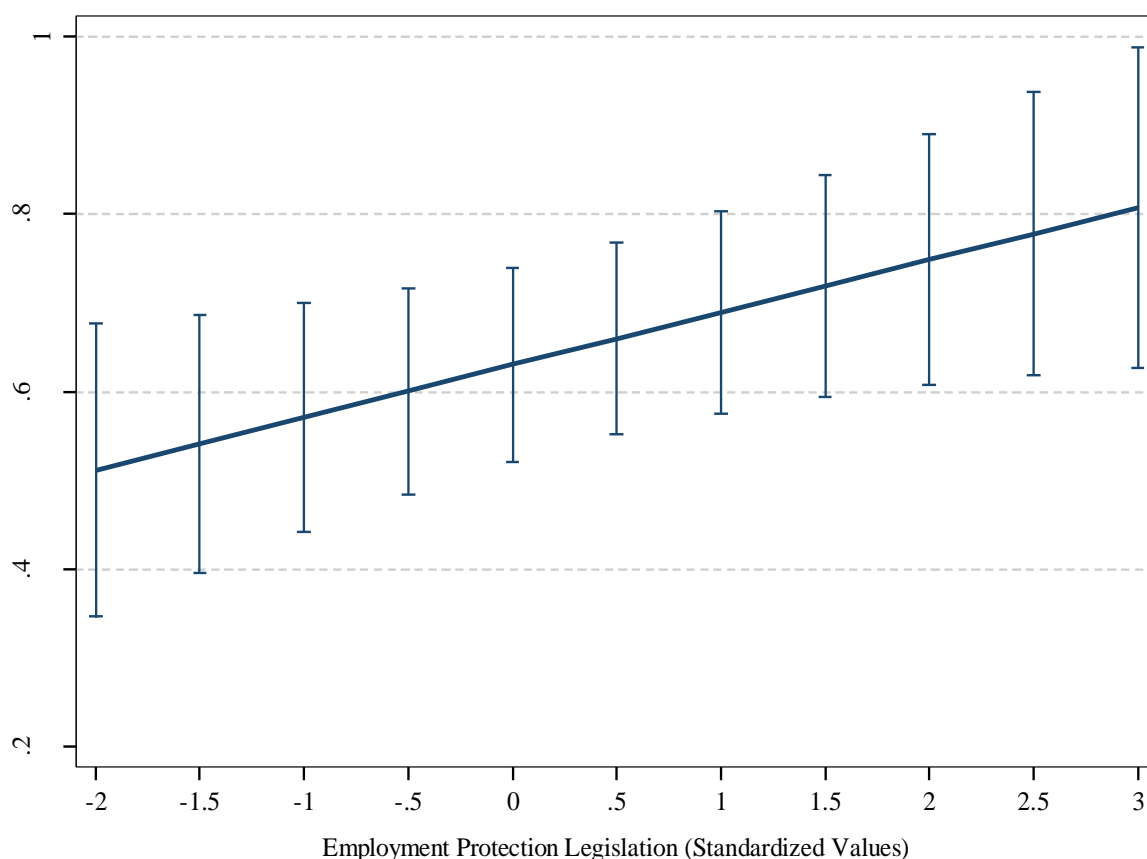
Table 6 - Dynamic Model of Inflation for a Panel of 20 OECD Countries – Employment Protection Legislation

Dependent Variable	Inflation				
Explanatory Variables	OLS (Robust Standard Errors)				
	(1)	(2)	(3)	(4)	(5)
<i>inf(-1)</i>	0.709***	0.695***	0.706***	0.630***	0.630***
	-0.047	-0.071	-0.089	(0.090)	(0.090)
$\Delta neer$	-0.099***	-0.078***	-0.078***	-0.089***	-0.089***
	-0.028	-0.027	-0.027	(0.027)	(0.027)
<i>outputgap</i>	0.170***	0.126***	0.125***	0.176***	0.176***
	-0.058	-0.027	-0.027	(0.050)	(0.050)
<i>epl</i>		0.001	0.002		
		-0.002	-0.002		
<i>inf(-1)*zepl</i>			-0.008		
			-0.025		
<i>eplfill</i>				0.001	0.001
				(0.003)	(0.003)
<i>inf(-1)*zeplfill</i>					0.059***
					(0.014)
Constant	0.039***	0.009**	0.007	0.047***	0.047***
	-0.01	-0.003	-0.006	(0.013)	(0.013)
Observations	633	557	557	633	633
R-squared	0.875	0.811	0.811	0.882	0.882
Number of ID	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 14 - Marginal effect of Lagged Inflation for different values of Employment Protection Legislation



Active Labor Market Policies

This section explores the role of public spending on labor market in affecting inflation dynamics, in particular, taking in consideration active labor market policies as a percentage of the GDP.

The assumption underlying this exercise relies on spending on labor market as a channel of wage moderation, limiting price inflation and affecting in turns also the responsiveness of inflation, given that active labor market policies will re-equilibrate wages making adjustment easier in case of a shock.

As this variable takes into account also public spending in training, part of this effect may be attributable to an increase in workers' productivity, which, all else being equal translates in lower prices.

In Table 7, columns (1) and (2) the above-mentioned hypothesis is tested. Our results do not support a direct effect on inflation, which is not significant in columns (1). In columns (2), the term turns out to be significant but positive when considering the interaction. Moreover, the

coefficient is very close to zero and thus, no conclusions is drawn before looking at how this variable behave through the robustness check of the following section.

Table 7 - Dynamic Model of Inflation for a Panel of 20 OECD Countries – Public Spending on Labor Market

Dependent Variable	Inflation			
Explanatory Variables	OLS (Robust Standard Errors)			
	(1)	(2)	(3)	(4)
<i>inf(-1)</i>	0.591*** (0.031)	0.528*** (0.030)	0.586*** (0.029)	0.526*** (0.030)
<i>neer</i>	-0.078*** (0.023)	-0.070*** (0.020)	-0.075*** (0.024)	-0.068*** (0.021)
<i>outputgap</i>	0.154*** (0.040)	0.174*** (0.039)	0.171*** (0.047)	0.183*** (0.044)
<i>almp</i>	0.000 (0.002)	0.009** (0.003)	0.000 (0.002)	0.008** (0.003)
<i>inf(-1)*zalmp</i>		-0.093*** (0.021)		-0.091*** (0.022)
<i>gdp</i>			-0.005 (0.005)	-0.003 (0.005)
Constant	0.020*** (0.004)	0.017*** (0.004)	0.068 (0.045)	0.045 (0.046)
Observations	511	511	511	511
R-squared	0.754	0.764	0.754	0.765
Number of id	20	20	20	20
Country FE	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES

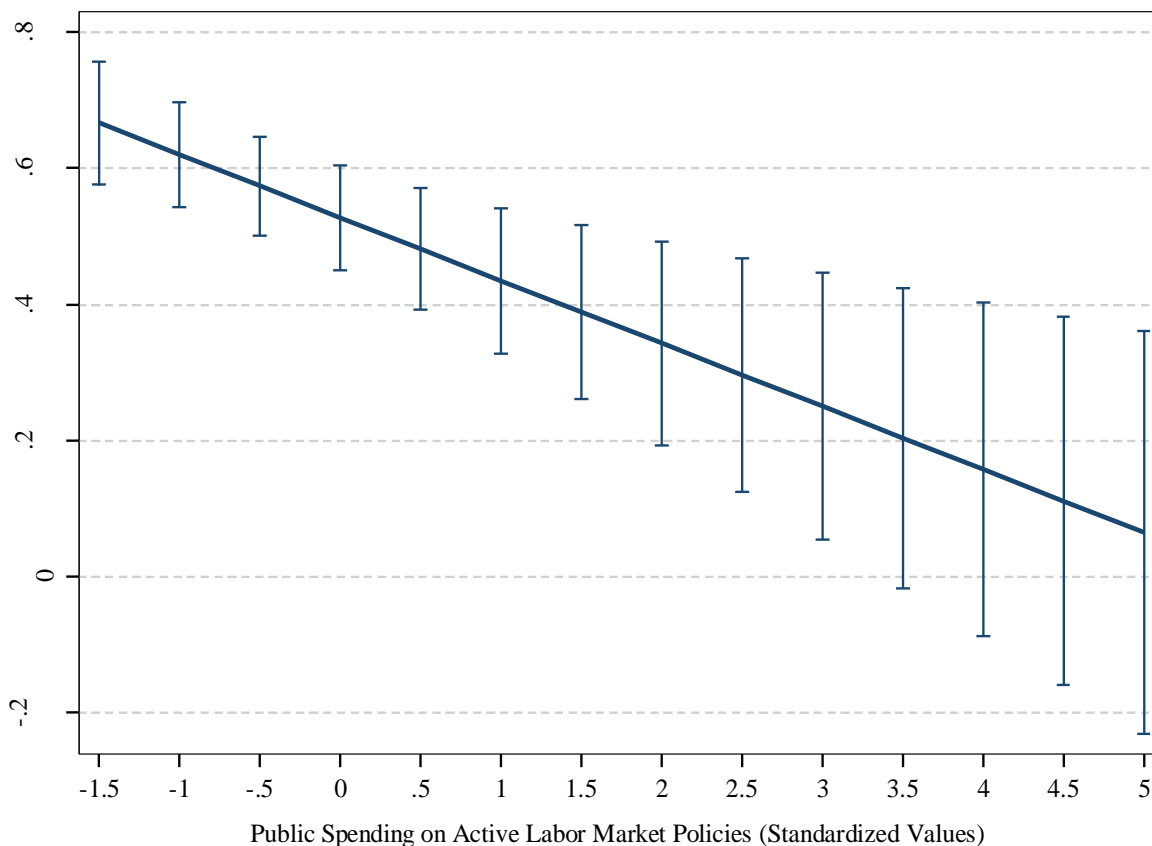
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

However, the interaction term between lagged inflation and active policies on labor market is negative and strongly significant, supporting our hypothesis that a more efficient job-matching process may facilitate the responsiveness of inflation to shocks, thanks to a beneficial wage moderation effect. Nevertheless, given the behavior of the main effect and considering that some series of *almp* have some issues of missing values, the finding is not emphasized before the robustness tests.

In the right-hand-side of Table 7, the results are estimated by controlling for GDP. As this variable expresses active labor market policies as a percentage of the GDP, this detected negative coefficient may actually reflect the relationship between GDP and inflation, as results from past research suggest. For this reason, in columns (3) and (4), the GDP variable enters in the model, to check the validity of the finding. Even after controlling for GDP, the coefficient

of active labor market policies on inflation persistence is still strongly significant, supporting the aforementioned hypothesis on the effects that active policies may induce on the responsiveness of inflation. The main effect remains ambiguous even after this control.

Figure 15 - Marginal effect of Lagged Inflation for different values of Public Spending on Labor Market Policies



5.1 ROBUSTNESS CHECKS

This section reports a number of robustness tests for our regressions, in order to check the validity and the stability of the findings.

In the first check, the estimation is repeated by substituting the output gap variable with unemployment and unit labor cost, in order to check if the results are stable, with a different model designs, in line with past research.

Table 8 replicates the results of Table 3, on the left with unit labor cost and unemployment on the right. The coefficient for these two variables are strongly significant and in line with economic theory, with an increase in one unit of the unemployment rate explaining around one-tenth of a one percentage reduction of the inflation rate.

Part of the literature on inflation dynamics supports the idea that labor costs explain inflation dynamics better than the output gap, and for this reason, unit labor cost is considered as robustness check.

Table 8 - Additional Robustness Check - Changing the main macroeconomic variables

Dependent Variable	Inflation							
	OLS (Robust Standard Errors)							
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>inf(-1)</i>	0.500***	0.500***	0.503***	0.465***	0.681***	0.675***	0.673***	0.624***
	-0.073	-0.075	-0.073	-0.068	-0.042	-0.045	-0.043	-0.046
<i>Δneer</i>	-0.096***	-0.097***	-0.093***	-0.087***	-0.095***	-0.096***	-0.091***	-0.082***
	-0.021	-0.022	-0.021	-0.023	-0.023	-0.023	-0.022	-0.023
<i>ulc</i>	0.273***	0.274***	0.265***	0.264***				
	-0.054	-0.055	-0.054	-0.055				
<i>unemp</i>					-0.121***	-0.139***	-0.131***	-0.124***
					-0.037	-0.039	-0.04	-0.036
<i>ud</i>	0.027	0.029	0.014	0.031	0.054	0.057	0.037	0.058
	-0.034	-0.033	-0.032	-0.036	-0.05	-0.05	-0.047	-0.051
<i>inf(-1)*zud</i>	-0.002	-0.005	0.008	0.011	-0.023	-0.03	-0.011	0.005
	-0.027	-0.026	-0.019	-0.021	-0.037	-0.036	-0.025	-0.027
<i>coord</i>		-0.001	-0.001			-0.002	-0.001	
		-0.001	-0.001			-0.002	-0.002	
<i>inf(-1)*zcoord</i>		-0.001	0.014			-0.008	0.013	
		-0.019	-0.017			-0.026	-0.02	
<i>inf(-1)*zud*zcoord</i>			-0.059***				-0.078***	
			-0.014				-0.022	
<i>zud*zcoord</i>			0.002				0.002	
			-0.001				-0.002	
<i>cwb</i>				-0.003*				-0.004*
				-0.002				-0.002
<i>inf(-1)*zcwb</i>				0.042***				0.059***
				-0.013				-0.019
<i>inf(-1)*zud*zcwb</i>				-0.051***				-0.072***
				-0.017				-0.02
<i>zud*zcwb</i>				0.003*				0.003*
				-0.002				-0.002
Constant	0.020*	0.022**	0.030***	0.034***	0.026*	0.031**	0.041***	0.044***
	-0.011	-0.009	-0.009	-0.008	-0.014	-0.013	-0.012	-0.011
Observations	622	622	622	622	637	637	637	637
R-squared	0.902	0.903	0.905	0.906	0.874	0.875	0.879	0.881
Number of ID	20	20	20	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The unit labor cost, is typically employed in modelling inflation in New Keynesian Phillips Curve, which involves also inflation expectations. Here, we do not consider expectations but the coefficient for *ulc* variable is strongly significant.

For which concerns labor market institutions, the picture presented in Table 3 remains unchanged. The three-way interaction of union density coordination and lagged inflation is still strongly negative signed, supporting the claim of a crossover interaction of union density and coordination on persistence, and the same is true for which concerns the results on centralization.

In Table 9 and Table 10, the robustness of the findings concerning employment protection legislation and active labor market policies is tested.

Table 9 - Additional Robustness Check - Changing the main macroeconomic variables

Dependent Variable	Inflation							
	OLS (Robust Standard Errors)							
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>inf(-1)</i>	0.548*** (0.062)	0.574*** (0.070)	0.503*** (0.068)	0.466*** (0.097)	0.659*** (0.058)	0.671*** (0.072)	0.680*** (0.041)	0.619*** (0.081)
<i>Δneer</i>	-0.080*** (0.023)	-0.081*** (0.024)	-0.099*** (0.023)	-0.092*** (0.023)	-0.077*** (0.025)	-0.077*** (0.026)	-0.097*** (0.026)	-0.088*** (0.025)
<i>ulc</i>	0.200*** (0.014)	0.201*** (0.014)	0.273*** (0.055)	0.264*** (0.049)				
<i>epl</i>	-0.002 (0.002)	-0.001 (0.001)			0.001 (0.003)	0.002 (0.003)		
<i>inf(-1)*zepl</i>		-0.020 (0.019)				-0.009 (0.020)		
<i>unemp</i>					-0.116*** (0.031)	-0.115*** (0.030)	-0.096** (0.036)	-0.094** (0.033)
<i>eplfill</i>			0.002 (0.002)	-0.003 (0.002)			0.008 (0.005)	0.001 (0.003)
<i>inf(-1)*zeplfill</i>				0.037** (0.013)				0.054*** (0.019)
Constant	0.017*** (0.004)	0.012** (0.005)	0.028*** (0.007)	0.044*** (0.013)	0.020** (0.009)	0.018** (0.008)	0.031*** (0.007)	0.053*** (0.013)
Observations	546	546	622	622	557	557	637	637
R-squared	0.838	0.838	0.901	0.904	0.813	0.813	0.872	0.877
Number of id	20	20	20	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results for the *epl* slightly vary after substituting the output gap. The results for the original series remain not significant as in the main model while, for which regard the filled variable, the effect on persistence is still significant. The main effect instead loses significance in both model, thus a direct effect of employment protection legislation on inflation is excluded.

The results for active labor market policies instead are stable, with the interaction coefficient with lagged inflation between -0.08 and -0.1 as in the main model with output gap, supporting the assumption of a beneficial effect of public spending in labor markets, taking place though wage moderation and increasing efficiency, mostly in job-matching. On the other hand, the coefficient of the main effect is still ambiguous.

Table 10 - Additional Robustness Check - Changing the main macroeconomic variables

Dependent Variable	Inflation			
	OLS (Robust Standard Errors)			
Explanatory Variables	(1)	(2)	(3)	(4)
<i>inf(-1)</i>	0.488*** (0.041)	0.432*** (0.033)	0.573*** (0.032)	0.499*** (0.040)
<i>Δneer</i>	-0.079*** (0.021)	-0.070*** (0.018)	-0.074*** (0.022)	-0.066*** (0.018)
<i>ulc</i>	0.185*** (0.019)	0.188*** (0.018)		
<i>unemp</i>			-0.099*** (0.025)	-0.126*** (0.037)
<i>almp</i>	-0.000 (0.001)	0.007** (0.003)	-0.000 (0.002)	0.009** (0.004)
<i>inf(-1)*zalmp</i>		-0.080*** (0.028)		-0.102*** (0.027)
Constant	0.017*** (0.004)	0.014*** (0.003)	0.028*** (0.005)	0.027*** (0.005)
Observations	500	500	511	511
R-squared	0.777	0.786	0.749	0.758
Number of id	20	20	20	20
Country FE	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In Table 11, the model is estimated by considering the index of Central Bank Independence (*cbi*), in line with related literature, which often accounts for it in modelling inflation. As pointed out in the previous section, *cbi* is not significant on this sample, possibly because the

sample is characterized by a general improvement in OECD central banks in keeping inflation anchored, regardless their independence.

However, since there is a large literature linking *cbi* to price stability, the model is estimated by considering it, as a proxy for different feature of national monetary policies and it is useful because it controls also for the establishment of the European Central Bank, an event that may alter our results.

Table 11- Additional Robustness Check – Index of Central Bank Independence

Dependent Variable	Inflation						
	OLS (Robust Standard Errors)						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>inf(-1)</i>	0.699*** (0.054)	0.633*** (0.045)	0.584*** (0.082)	0.437*** (0.105)	0.706*** (0.09)	0.630*** (0.09)	0.525*** (0.032)
<i>Aneer</i>	-0.091*** (0.025)	-0.082*** (0.025)	-0.097*** (0.026)	-0.089*** (0.025)	-0.078** (0.027)	-0.089*** (0.027)	-0.070*** (0.021)
<i>outputgap</i>	0.172*** (0.056)	0.195*** (0.053)	0.203*** (0.06)	0.093** (0.034)	0.125*** (0.028)	0.177*** (0.053)	0.178*** (0.040)
<i>cbi</i>	-0.010 (0.007)	-0.007 (0.007)	-0.008 (0.006)	-0.003 (0.004)	0.00 (0.003)	-0.002 (0.005)	-0.003 (0.004)
<i>ud</i>	0.030 (0.045)	0.050 (0.051)					
<i>coord</i>	-0.000 (0.002)						
<i>inf(-1)*zud</i>	-0.015 (0.025)	-0.009 (0.027)					
<i>inf(-1)*zcoord</i>	0.028 (0.022)						
<i>inf(-1)*zud*zcoord</i>	-0.074** (0.026)						
<i>zud*zcoord</i>	0.001 (0.002)						
<i>cwb</i>		-0.004* (0.002)					
<i>inf(-1)*zcwb</i>		0.076*** (0.019)					
<i>inf(-1)*zud*zcwb</i>		-0.055* (0.026)					
<i>zud*zcwb</i>		0.003 (0.002)					
<i>nmw</i>			-0.005* (0.003)				
<i>nmw*inf(-1)</i>			0.156** (0.067)				
<i>inf(-1)*zulc</i>				0.046** (0.021)			
<i>ulc</i>				0.178*** (0.03)			
<i>inf(-1)*zepl</i>					-0.008 (0.026)		
<i>epl</i>					0.002 (0.002)		
<i>inf(-1)*zeplfill</i>						0.059*** (0.013)	
<i>eplfill</i>						0.000 (0.002)	
<i>almp</i>							0.008** (0.003)
<i>inf(-1)*zalmp</i>							-0.093*** (0.022)
Constant	0.035*** (0.012)	0.043*** (0.009)	0.052*** (0.016)	0.041*** (0.012)	0.007 (0.006)	0.049*** (0.016)	0.019*** (0.005)
Observations	633	633	633	622	557	633	511
R-squared	0.882	0.886	0.882	0.908	0.811	0.882	0.765
Number of ID	20	20	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As Table 11 shows, *cbi* is never significant and the results remain unchanged, supporting the view that, in most recent time, thanks to the efforts and the improved ability of anchoring inflation by national central banks, greater independence does not seem to imply lower inflation.

One of the main explanation of low inflation and decreased persistence in the last decade may be attributed to the widespread implementation of inflation targeting policies in OECD countries, although the evidence is mixed among literature. One segment of the literature supports the correlation between a credible inflation targeting regime and lower persistence; Baxa *et al.* (2014) for example provide evidence on the temporal coincidence between inflation targeting introduction and the decrease in inflation persistence in countries which experienced a long tradition in targeting inflation. On the other hand, Franta *et al.* (2010) show that in both the inflation targeting and non-inflation targeting groups, some countries exhibit high intrinsic inflation persistence.

The relationship between inflation targeting and inflation persistence is still somewhat ambiguous, but as actual and important monetary policy tool, it is likely to have some implication on inflation *inertia*.

For these reasons, in Table 12, an additional robustness check is done by introducing the dummy variable *it* that takes values of 1 if the country adopted inflation targeting measures in a given year. As for *cbi*, neither the presence of inflation targeting policies turns out to be significant, probably because even non-targeting countries experienced inflation decline in the same period of inflation targeting implementation (around early 1990s). Consequently, all the main findings remain stable after the check.

Table 12 - Additional Robustness Check - Controlling for Inflation Targeting

Dependent Variable	Inflation						
	OLS (Robust Standard Errors)						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>inf(-1)</i>	0.706*** (0.051)	0.638*** (0.043)	0.593*** (0.078)	0.438*** (0.107)	0.709*** (0.093)	0.633*** (0.090)	0.525*** (0.029)
<i>Δneer</i>	-0.093*** (0.025)	-0.084*** (0.026)	-0.099*** (0.027)	-0.090*** (0.026)	-0.079** (0.028)	-0.090*** (0.028)	-0.069*** (0.021)
<i>outputgap</i>	0.169*** (0.056)	0.192*** (0.051)	0.202*** (0.058)	0.091** (0.033)	0.128*** (0.029)	0.178*** (0.050)	0.171*** (0.043)
<i>it</i>	0.003 (0.003)	0.002 (0.003)	0.004 (0.003)	0.001 (0.003)	0.001 (0.003)	0.002 (0.003)	0.525*** (0.029)
<i>ud</i>	0.025 (0.044)	0.046 (0.048)					
<i>coord</i>	-0.000 (0.001)						
<i>inf(-1)*zud</i>	-0.012 (0.024)	-0.008 (0.025)					
<i>inf(-1)*zcoord</i>	0.027 (0.020)						
<i>inf(-1)*zud*zcoord</i>	-0.069** (0.025)						
<i>zud*zcoord</i>	0.001 (0.002)						
<i>cwb</i>		-0.004* (0.002)					
<i>inf(-1)*zcwb</i>		0.076*** (0.019)					
<i>inf(-1)*zud*zcwb</i>		-0.056* (0.027)					
<i>zud*zcwb</i>		0.003 (0.002)					
<i>nmw</i>			-0.006* (0.003)				
<i>nmw*inf(-1)</i>			0.152** (0.063)				
<i>inf(-1)*zulc</i>				0.046* (0.023)			
<i>ulc</i>				0.179*** (0.032)			
<i>inf(-1)*zepl</i>					-0.010 (0.028)		
<i>epl</i>					0.002 (0.002)		
<i>inf(-1)*zeplfill</i>						0.057*** (0.015)	
<i>eplfill</i>						0.001 (0.003)	
<i>almp</i>							0.008** (0.003)
<i>inf(-1)*zalmp</i>							-0.094*** (0.021)
Constant	0.032** (0.013)	0.042*** (0.010)	0.048*** (0.014)	0.040*** (0.011)	0.007 (0.006)	0.047*** (0.013)	0.017*** (0.004)
Observations	633	633	633	622	557	633	511
R-squared	0.881	0.885	0.881	0.908	0.812	0.882	0.765
Number of ID	20	20	20	20	20	20	20
Country FE	YES	YES	YES	YES	YES	YES	YES
Time Dummy	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As final robustness checks, the cross-country and temporal stability of the model are assessed.

Table 13 – Additional Robustness Check – Cross-Sectional Stability by dropping one country at the time

Variables	Coefficient	Min	Max
<i>inf(-1)</i>	0.709***	0.656***	0.729***
		Greece	Sweden
<i>Δneer</i>	-0.099***	-0.123***	-0.085***
		Japan	Greece
<i>outputgap</i>	0.170***	0.118***	0.204***
		Portugal	Ireland
<i>ud</i>	0.026	Not Significant	
<i>inf(-1)*zud</i>	-0.018	Not Significant	
<i>coord</i>	-0.001	Not Significant	
<i>inf(-1)*zcoord</i>	0.03	Not Significant	
<i>zud*zcoord</i>	0.002	Not Significant	
<i>inf(-1)*zud*zcoord</i>	-0.073***	-0.071***	-0.037
		United Kingdom	Sweden
<i>cwb</i>	-0.004*	-0.006***	-0.002
		Ireland	Portugal
<i>inf(-1)*zcwb</i>	0.078***	0.06***	0.083
		Portugal	Austria
<i>inf(-1)*zud*zcwb</i>	-0.057**	-0.075**	-0.033**
		Ireland	Sweden
<i>zud*zcwb</i>	0.003	Not Significant	
<i>nmw</i>	-0.006*	Not Significant	
<i>nmw*inf(-1)</i>	0.179**	0.107*	0.17**
		Portugal	France
<i>ulc</i>	0.179***	0.15***	0.19***
		Portugal	Norway
<i>inf(-1)*zulc</i>	0.047**	0.036***	0.077***
		Portugal	Greece
<i>epl</i>	0.002	Not Significant	
<i>inf(-1)*zepl</i>	-0.008	Not Significant	
<i>eplfill</i>	0.001	Not Significant	
<i>inf(-1)*zeplfill</i>	0.059***	0.055***	0.072***
		Japan	Greece
<i>Almp</i>	0.009**	0.006	-0.01***
		Sweden	Portugal
<i>inf(-1)*zalmp</i>	-0.093***	-0.074***	-0.105***
		Greece	Portugal

The exercise is undertaken on the baseline model for *inf(-1)*, *Δneer* and *outputgap*. The coefficients for the labor market institutions instead refer to the most complete regression in which all the interaction terms were included. Only significant coefficients are reported.

Table 13 shows results from assessing the cross-sectional stability of the model, performed by dropping one country at the time and re-estimating the model. This exercise allows us to make sure that the findings are not driven by the influence of one or a group of countries.

Cross-sectional stability is tested for the baseline model without *LMI*, while the coefficients for each *LMI* are from the regression in which each variable is tested as main effect and interacted with lagged inflation. Overall, the main findings perform well and the coefficients vary in a reasonable range, suggesting that some differences in the way labor market institutions affect inflation and its persistence are present but not sufficiently to induce significant biases. An exception occurs in the case of the three-way interaction between union density, coordination and lagged inflation, which loses significance when dropping Sweden. A change occurs also in the value of the coefficient of the three-way interaction involving centralization, in dropping this country; Sweden and the Scandinavian countries have their own particular structure in which unions are particularly strong, and thus they may be the major source driver in a panel study on unions. However, the coefficient of the three-way interaction involving coordination loses significance exclusively in dropping Sweden, while it is robust when dropping all the other 19 countries and it proved very stable in a number of robustness check.

In dropping Sweden, also the coefficient of the main effect of *almp* loses significance, providing another hint on the fact that may be not a robust finding.

Another source of disturbance appears to be Portugal, the country to which major changes in the coefficients are attributable. The coefficient for *cwb* loses significance only when we drop Portugal and it is the cause also of the major deviations for the interactions between *cwb* and lagged inflation, minimum wage and unit labor cost. This influence may be because Portugal is characterized by a particularly inflexible labor market; together with higher inflation rates, in comparison to the other countries, dropping Portugal reduce the influence of labor market structures. However, except for the main effect of centralization (which was not strongly significant in the first place), the coefficients are lower than the original finding but still strongly significant.

The last robustness test performed is to check the temporal stability of the model; this is done by splitting the sample and repeating the analysis on the periods 1980-2000 and 1990-2012.

In particular, the focus is on the exercise undertaken on the sample 1990-2012 because there is a large literature arguing for structural breaks in the inflation series in a large number of countries, and this fact may change estimates regarding persistence. Levin and Piger (2003) for

instance find strong evidence for many countries²⁸ of a break occurring in the late 1980s or early 1990s, thus considering a sample starting in these years is not biased by any break in the series.

Table 14 reports the results from splitting the sample, by comparing the coefficients obtained from the regressions on the full sample and the coefficients for the sub-samples.

Table 14 - Additional Robustness Check – Temporal stability by splitting the sample

Variables	Coefficient	1980 - 2000	1990 – 2012
<i>inf(-1)</i>	0.709***	0.626***	0.726***
<i>Aneer</i>	-0.099***	-0.107***	-0.059***
<i>outputgap</i>	0.170***	0.267***	0.097***
<i>ud</i>	0.026	Not Significant	
<i>inf(-1)*zud</i>	-0.018	Not Significant	
<i>coord</i>	-0.001	Not Significant	
<i>inf(-1)*zcoord</i>	0.03	Not Significant	
<i>inf(-1)*zud*zcoord</i>	-0.073***	-0.189***	-0.060**
<i>zud*zcoord</i>	0.002	0.005*	0.001
<i>cwb</i>	-0.004*	-0.002	-0.005*
<i>inf(-1)*zcwb</i>	0.076***	0.098**	0.080***
<i>inf(-1)*zud*zcwb</i>	-0.060**	-0.087*	-0.057*
<i>zud*zcwb</i>	0.003	Not Significant	
<i>nmw*inf(-1)</i>	0.179**	0.178**	0.197
<i>nmw</i>	-0.006*	-0.002	-0.008**
<i>ulc</i>	0.179***	0.043*	0.140***
<i>inf(-1)*zulc</i>	0.047**	0.195***	0.059
<i>epl</i>	0.002	0.013	0.061**
<i>inf(-1)*zepl</i>	-0.008	Not Significant	
<i>eplfill</i>	0.001	Not Significant	
<i>inf(-1)*zeplfill</i>	0.059***	0.070***	0.063***
<i>almp</i>	0.009**	0.00966**	0.0136***
<i>inf(-1)*zalmp</i>	-0.093***	-0.117***	-0.131***

The exercise is undertaken on the baseline model for *inf(-1)*, *Aneer* and *outputgap*. The coefficients for the labor market institutions instead refer to the most complete regression in which all the interaction terms were included. Only significant coefficients are reported.

Overall, the stability and the validity of the findings hold, with very few exceptions. The interaction between lagged inflation and the minimum wage dummy loses significance in the 1990-2012 sample, as well as the interaction with unit labor cost. This may reflect the fact that

²⁸ For which concerns this sample, Levin and Piger (2003) find evidence of a structural break in the intercept for Australia, Canada, Italy, Sweden, United Kingdom and United States.

in an era of better-anchored inflation, the influence of institutions and norms affecting the marginal costs of firms on inflation and on its speed of adjustment may have become less likely.

Interestingly, the coefficients regarding unions coordination and centralization generally decrease from the 1980-2000 to the 1990-2012 sample. This finding supports the hypothesis that in most recent time, structural changes in advanced economies have led to an environment in which the bargaining power of workers has weakened to the point that it is no longer able to have an impact on economic performances of the same magnitude than in the last decades.

Nevertheless, it has to be pointed out that these samples cover around twenty years that may not be a sufficiently large time span to draw significantly strong conclusions; indeed, it is likely that these estimates are slightly imprecise or downward biased, as follows Nickell (1981). Moreover, the instability exhibited by the estimated coefficients in this robustness check, compared to the previous ones, underlines the importance of undertaking such exercise on a sufficiently extended time span, in order to obtain significant and reliable results.

6. CONCLUSIONS

This work analyses labor market institutions as a possible determinant that can affect inflation dynamics, in particular by making the process more persistent. By estimating a dynamic model of inflation over the last thirty years, this work has tried to answer to two antithetical questions. Given the evidence of a general drop in persistence since the 1990s and the efforts OECD countries have made to make their labor market more flexible, the remarkable stability of prices of the last decades and the decline in the persistence feature may be partially explained by this shift toward more efficient labor markets. The second question is raised precisely from the fact that prices have been remarkably stable. This stability is often attributed to the better-anchored expectations on prices and the great achievement of central banks in keeping inflation down and targeted; in such environment, there may be no more room for labor market institutions to play a prominent role.

The results support the hypothesis that, in an era of better anchored inflation expectations, together with a decline in unions' influence and power, we cannot talk about of a strong and direct relationship between inflation dynamics and countries' unionization. However, if we consider union density, together with the institutional characteristics of wage bargaining, inflation exhibits more or less persistence, depending on both the degree of unionization and coordination and centralization. Indeed, increasing union density contributes to make inflation more persistent, only when there is low coordination, possibly because in presence of strong but uncoordinated unions, it may take time to reach an agreement, with the consequence of slowing the prices adjustment process. On the contrary, increasing union density makes inflation less persistent in presence of both highly coordinated and highly centralized wage bargaining; this finding supports the Calmfors-Driffil hypothesis that coordinated unions internalize the macroeconomic consequences of their decision, by pointing out however, that this is true in presence of strong and influent unions.

Another finding suggests that the degree of competitiveness, here represented by the unit labor cost, not only have a direct effect on inflation but it impacts also its speed of adjustment, possibly because of the difficulties firms face in bringing prices back to a balanced level if they have to face high staffing costs.

Other institutional characteristics, like the presence of minimum wage, labor market regulation and spending on labor market do not affect inflation directly, but they do affect inflation dynamics. In particular, the presence of minimum wage and strict employment protection legislation do not directly increase inflation but they do make it more persistent. On the other

hand, increasing spending on active labor market policies contributes to make inflation more responsive (*i.e.* less persistent), possibly because these policies are aimed at enhancing the efficiency of the labor market. Spending on labor market may have a wage moderation effects, because, by improving the job-matching process, it gives an incentive for firms to hire unskilled workforce instead of increasing wages of their current employees.

The findings are stable after several robustness checks; the only case in which the coefficients exhibit some instability is the case of temporal stability, in which the analysis is carried out by splitting the sample. This evidence highlights how important is, when performing a study on persistence, to consider a sufficiently large time horizon, in order to obtain reliable results.

In light of these results, this work suggests that the answer to our two antithetical questions appears to lie in the middle. Indeed, aside from unit labor cost, no labor market variable has a direct impact on inflation, supporting the hypothesis that the flexibility path undertaken by most of the OECD countries does not drive the stability of the last decades. On the other hand, the findings also suggest that totally ignoring labor market peculiarities in policy-design would be a mistake; indeed, if the labor market structure seems not to directly affect inflation anymore, inefficiencies in the labor market may hamper the absorption of a shock by slowing down the prices adjustment process.

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8. APPENDIX

8.1 DATA SOURCES

inf is the annual percentage of average consumer prices are year-on-year changes, calculated as $\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$.

- The data for the period 1980-2012 are obtained from the World Economic Outlook Database, April 2016 provided by the IMF.
- The data used for the rolling estimates of persistence cover the period 1961-2014 and are obtained from the Main Economic Indicators Database, Volume 2016 provided by OECD.

outputgap is the output gap calculated as actual GDP less potential GDP as a percent of potential GDP. The data for the period 1980-2012 are obtained from the World Economic Outlook Database, April 2016 provided by the IMF.

Δneer is the change in the Nominal Effective Exchange Rate, a measure of the value of a currency against a weighted average of several foreign currencies. The data for the period 1980-2012 are obtained from the International Financial Statistics Database, provided by the IMF

GDP is the log-transformation of the Gross Domestic Product per capita at current prices expressed in U.S. dollars. Data are derived by first converting GDP in national currency to U.S. dollars and then dividing it by total population. The data for the period 1980-2012 are obtained from the World Economic Outlook Database, April 2016 provided by the IMF.

ud is the union density equal the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners. The data for the period 1980-2012 are obtained from the Employment and Labor Market Statistics Database, 2016 from OECD.

coord is the index of coordination of wage-setting that takes values from 1 to 5. In particular:
“5 = maximum or minimum wage rates/increases based on

- a. centralized bargaining by peak association(s), with or without government involvement, and/or government imposition of wage schedule/freeze, with peace obligation

- b. informal centralization of industry-level bargaining by a powerful and monopolistic union confederation
- c. extensive, regularized pattern setting and highly synchronized bargaining coupled with coordination of bargaining by influential large firms

4 = wage norms or guidelines (recommendations) based on

- a. centralized bargaining by peak associations with or without government involvement
- b. informal centralization of industry-level bargaining by a powerful and monopolistic union confederation
- c. extensive, regularized pattern setting coupled with high degree of union concentration

3 = negotiation guidelines based on

- a. centralized bargaining by peak associations with or without government involvement
- b. informal centralization of industry-level bargaining
- c. government arbitration or intervention

2 = mixed industry and firm-level bargaining, with no or little pattern bargaining and relatively weak elements of government coordination through the setting of minimum wage or wage indexation

1 = fragmented wage bargaining, confined largely to individual firms or plants”²⁹

Data are obtained from the Data Base on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts, 1960-2014 (ICTWSS), version 5.0, edited by Jelle Visser, Amsterdam Institute for Advanced Labor Studies, University of Amsterdam.

cwb is “the actual level of wage bargaining, calculated as the sum of:

$$LEVEL - (fAEB + OCG) / 4 (= max\ value) + (Art + DR - 1) / 5 (= max\ value) \quad (6.1)$$

where:

LEVEL: The predominant level (at least two-thirds of the total bargaining coverage rate in a given year and country) at which wage bargaining takes place.

fAEB: Frequency or scope of additional enterprise bargaining

OCG: General Opening clauses in collective agreement

Art: Articulation of enterprise bargaining

DR: Derogation, possibility of deviation from norms established in the higher-order agreement”²⁹

²⁹ ICTWSS Code book definition

Data are obtained from the Data Base on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts, 1960-2014 (ICTWSS), version 5.0, edited by Jelle Visser, Amsterdam Institute for Advanced Labor Studies, University of Amsterdam

ulc is the growth rate of unit labor cost, the latter calculated as the quotient of total labor costs and real output. The data for the period 1980-2012 are obtained from the Annual Indicators Database, from OECD.

nmw is a dummy variable that takes value of 1 in presence of national minimum wage and it is based on own research. In particular:

Country	NO	NMW	Country	NO	NMW
<i>Australia</i>		1980-2012	<i>Italy</i>	1980-2012	
<i>Austria</i>	1980-2012		<i>Japan</i>		1980-2012
<i>Belgium</i>		1980-2012	<i>Netherlands</i>		1980-2012
<i>Canada</i>		1980-2012	<i>Norway</i>	1980-2012	
<i>Denmark</i>	1980-2012		<i>Portugal</i>		1980-2012
<i>Finland</i>	1980-2012		<i>Spain</i>		1980-2012
<i>France</i>		1980-2012	<i>Sweden</i>	1980-2012	
<i>Germany</i>	1980-2012		<i>Switzerland</i>	1980-2012	
<i>Greece</i>		1980-2012	<i>United Kingdom</i>	1980-1998	1999-2012
<i>Ireland</i>	1980-1999	2000-2012	<i>United States</i>		1980-2012

epi is the index of strictness of employment protection legislation, based on individual and collective dismissals. Data are available for the period 1985-2012 and are obtained from the Employment and Labor Market Statistics Database, 2016 from OECD.

almp is the public spending on active labor market policies expressed as a percentage of the GDP. It is an aggregate measure that includes:

- a. Public Employment Services (PES) includes placement and related services, benefit administration and other expenditure.
- b. Training includes institutional, workplace and alternate/integrated training, as well as special support for apprenticeship.
- c. Employment incentives includes recruitment incentives, employment maintenance incentives, and job rotation and job sharing.
- d. Sheltered and supported employment and rehabilitation
- e. Direct job creation
- f. Start-up incentives

Data are available for the period 1985-2012 and are obtained from the Employment and Labor Market Statistics Database, 2016 from OECD

unemp is the unemployment rate expressed as a percent of total labor force. The data for the period 1980-2012 are obtained from the World Economic Outlook Database, April 2016 provided by the IMF.

cbi is the Index of Central Bank Independence and it is taken from Crowe and Meade (2008), who updated the index provided by Cukierman (1999)

it is a dummy variable that takes value of 1 in years in which a country has adopted an inflation targeting regime, in particular:

Country	NO	END ³⁰	Country	NO	END ³⁰
<i>Australia</i>	1993	-	<i>Italy</i>	-	
<i>Austria</i>	-	-	<i>Japan</i>	-	-
<i>Belgium</i>	-	-	<i>Netherlands</i>	-	-
<i>Canada</i>	1991	-	<i>Norway</i>	2001	
<i>Denmark</i>	-	-	<i>Portugal</i>	-	-
<i>Finland</i>	1993	1998	<i>Spain</i>	1995	1998
<i>France</i>	-	-	<i>Sweden</i>	1992	-
<i>Germany</i>	-		<i>Switzerland</i>	-	-
<i>Greece</i>	-	-	<i>United Kingdom</i>	1991	-
<i>Ireland</i>	1980-1999	-	<i>United States</i>	-	-

Data are based on Roger (2010).

³⁰ The presence of inflation targeting is assessed only on the sample of interest, 1980-2012. Eventual inflation targeting policies, started after the 2012, are not reported here.