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The Gibson paradox

The swing of the inflation dynamics across OECD countries

Master in Economics: Empirical Analysis and Policies

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Abstract

In recent business cycles, U.S. inflation has experienced a reduction in inflation volatility, inflation persistence and, a severe weakening of the correlation with nominal interest (Gibson's paradox). This project concludes that the empirical evidence found in the U.S. extends to other OECD countries such as Canada, Australia, the UK and France characterized by having an independent central bank. Furthermore, we examine inflation dynamics in the U.S. with a 4-equation DSGE model augmented with money. Our model qualitatively reproduces the swings in inflation statistics, but lacks sources of nominal and real rigidity to fully capture the Gibson's paradox. In spite of these model´s limitations, we find changes in price stickiness, the monetary policy rule, and the persistence of inflationary shocks as main explanatory factors of the Gibson paradox.

Keywords: inflation dynamics, the Gibson’s paradox, DSGE models.

1. Introduction

The Fisher Hypothesis, one of the cornerstone of the neoclassical theory, states that nominal interest rates is closely linked with expected inflation (implying a high contemporaneous correlation between nominal interest rates and inflation). However, since roughly around 1995, U.S inflation has experienced a weakening in the correlation with the nominal interest rate (Casares & Vázquez, 2018) (Cogley, Sargent, & Surico, 2012), this phenomenon is called the Gibson Paradox and many renowned economist have studied this issue.

Keynes (1930) coined the term "Gibson's paradox" after the economist Alfred Herbert Gibson who was the first economist to observe the weak relationship between nominal interest rates and inflation in a few historical episodes. It was called a paradox since no existing theory could explain the reason for this weak relationship. Keynes (1930) detected Gibson's paradox during 1880-1924 (the gold standard period). Friedman and Schwartz (1982) also concluded that the Gibson's paradox clearly held during the gold standard period, but since the 1960s the correlation between nominal interest rates and inflation has increased. Barsky and Summers (1988) showed that the

Gibson's paradox had vanished by the early 1970s and concluded that this paradox might just be a gold standard phenomenon.

However, if we focus on the empirical evidence from the US, Cogley, Sargent and Surico (2012), using an autoregressive vector model with drift parameters and stochastic volatility, show that the Gibson's paradox has returned in the last business cycles and therefore , this weak correlation between inflation and interest rates may also be observable under a fiat monetary regime. Casares and Vazquez (2018) obtain similar results using a 20-year rolling-window of 4-variables VAR with 4 lags and show that US inflation has experienced a reduction in volatility and a severe weakening of the correlation with the nominal interest rate since 1995.

What does the literature review say about the sources behind of the resurgence of the Gibson Paradox? Barsky (1987) stated that the degree of the inflation persistence is a key factor to explain it, the Gibson paradox appears in periods where the inflation was weakly persistent. Casares and Vázquez (2018), by estimating a DSGE model, conclude that the main sources behind the appearance of the Gibson paradox around the mid-1990s in the U.S are a flatter New Keynesian Phillips Curve (induced by higher price stickiness) and a lower persistence of the wage mark-up. Cogley, Sargent and Surico (2012) come to the conclusion that in the last business cycles since the 1990s there is a more anti-inflationary monetary policy rule and a decrease in the indexation of nominal prices to past inflation.

The main objective of this Master's thesis is to study whether the empirical evidence on inflation dynamics observed in the United States, mainly the weak correlation between inflation and the nominal interest rate since the mid-1990s , is also observed in other OECD countries.

We focus our study on a few OECD countries because each of the countries studied are supposed to have an independent Central Bank monitoring its monetary policy that is not influenced by the pressures of politicians who want to pursue short term policies for electoral gain, despite their possible future losses. Moreover, OECD members are developed countries with a similar level of per capita income and their economy are interconnected in today's globalized economy and therefore, economic cycles occur in these countries in similar time periods (for these reasons could be expected to observe similar swings in these countries). Specifically, we study four countries Anglo-Saxon roots: the United States, the United Kingdom, Canada and Australia, and an European country whose currency is the Euro: France.

In order to conclude whether the resurgence of the Gibson paradox is rather robust or not in the countries studied, we analyse the time-varying statistics of the second moments of inflation for the countries mentioned above (more precisely, we study the correlation between inflation and the nominal interest rates, the persistence of inflation measured by its first-order autocorrelation, and the inflation volatility measured by its standard deviation .

Once we have analysed the empirical evidence in these countries, we estimate a 4-equation DSGE model augmented with money for the U.S.. The purpose is to assess whether a small-scale New Keynesian model featuring fewer sources of rigidity than the model of Smets and Wouters (2007) can satisfactorily explain the second-moment statistics observed in the U.S..

This master thesis is structured as follows. Section 2 shows the empirical evidence found in the countries studied. The following sections focus on the U.S: Section 3 presents the DSGE model augmented with money. Section 4 estimates the small-scale DSGE model with money using Bayesian approach and discuss the empirical results. Section 5 compares the actual and simulated second-moment statistics to assess whether our model replicates U.S. inflation dynamics. Finally, Section 6 concludes.

2. Empirical Evidence

In this section, we will analyse whether the swings in inflation dynamics observed in the United States, where the correlation between nominal interest rates and inflation, inflation persistence and inflation volatility have declined considerably in recent business cycles (Casares & Vázquez, 2018) (Cogley, Sargent, & Surico, 2012) are also observed in France, the United Kingdom, Canada, and Australia. For doing that we will estimate a 20-year(80 quarters) rolling-window 3-variable unrestricted VAR with 4 lags.[1]

[1] We use the method discussed in Hamilton (1994, page. 164-266).

Our VAR considers quarterly data from the first quarter of 1970 to the fourth quarter of 2019 of two nominal variables: the rate of inflation (calculated from the GDP deflator), and the short-term interbank interest rates,[2] with the addition of a real variable: the economic growth rate (calculated from the real GDP). Most of the series that we have used has been downloaded from the Federal Reserve Bank of St. Louis, whereas the rest has been obtained from the OECD databases.

From the estimated rolling-window VAR, we obtain the time-varying second-moment inflation statistics for the countries studied (inflation volatility, inflation persistence and correlation between inflation and the short-term interest rate). These statistics are showed in Figures 1, 2, 4, 5 and 6. The horizontal axes in each figure indicates the first quarter of the corresponding rolling-window (e.g. the inflation statistics associated with the first quarter of 1970 are calculated using a sample period from the first quarter of 1970 to the fourth quarter of 1989). In the next subsections, we analyse the empirical evidence for each country.

2.1. UNITED STATES

Figure 1 shows the U.S. empirical evidence uncovered by Casares and Vázquez (2018), a reduction in inflation variability is accompanied by a fall in the correlation between Fed funds rates and inflation and a milder decrease of the persistence of the inflation in the most recent windows. This fact is in line as well with the results obtained by Cogley, Sargent, and Surico (2012), they conclude that since 1995 there has been a period of low inflation persistence and a weak inflation-nominal interest rate correlation.

[2] These rates are almost perfectly correlated with the short-term rates typically monitored by central banks.

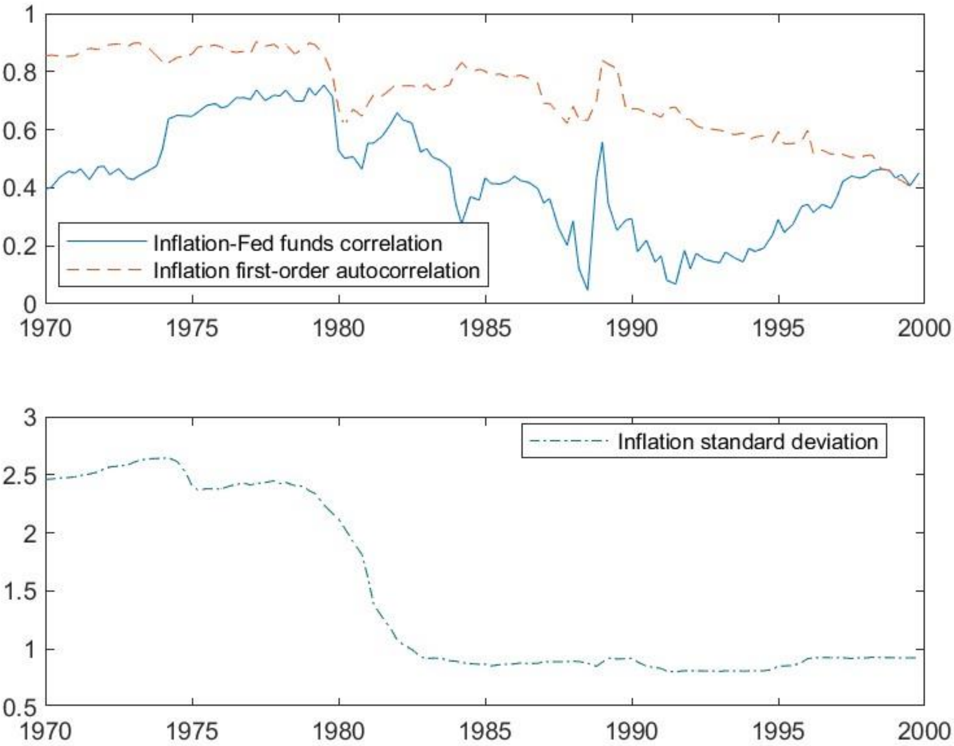

Figure 1: Time-varying second-moment statistics of inflation for the U.S.

Clearly, the resurgence of the Gibson paradox is rather robust in the U.S.. We next analyse whether these swings in inflation dynamics occur in other countries.

2.2. CANADA

Figure 2 shows the empirical evidence found for Canada. The swings in inflation dynamics are fairly similar to those in the U.S.: In recent business cycles, there is a fall in inflation volatility which is followed by a weakening of the correlation between inflation and the nominal interest rate, and a milder decrease in inflation persistence. It is noteworthy that the variability of inflation increases in the subsamples from the 1990s onwards, and this fact is not accompanied by a change in the correlation between the nominal interest rate and inflation (i.e. the correlation coefficient being close to 0). This empirical evidence somewhat challenges some views in the related literature discussed above establishing a link between low volatile (stable) inflation and the Gibson paradox.

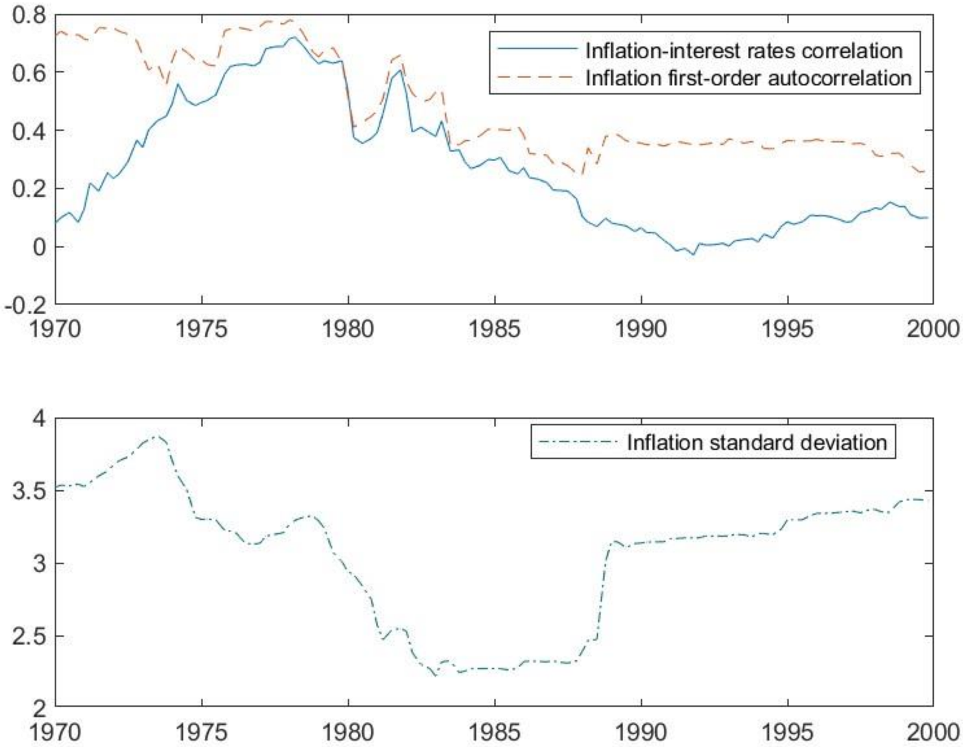

Figure 2: Time-varying second-moment statistics of inflation for Canada

The occurrence of Gibson's paradox is quite synchronized in the U.S. and Canada, as the correlation of the U.S. and Canadian correlation coefficients between inflation and the nominal interest rate computed for all the window-subsamples is very high (0.89) (see Table 1). This comes as no surprise since Canadian interest rates and inflation are highly influenced by the U.S. monetary policies. In particular, Figure 3 shows the time-varying correlation between Canadian inflation and the Fed's nominal interest rates which displays similar dynamics swings as those depicted in Figure 2.[3]

[3] To calculate these coefficients, we use the same 3-variable unrestricted VAR with 4-lags estimation that we have used for the others countries.

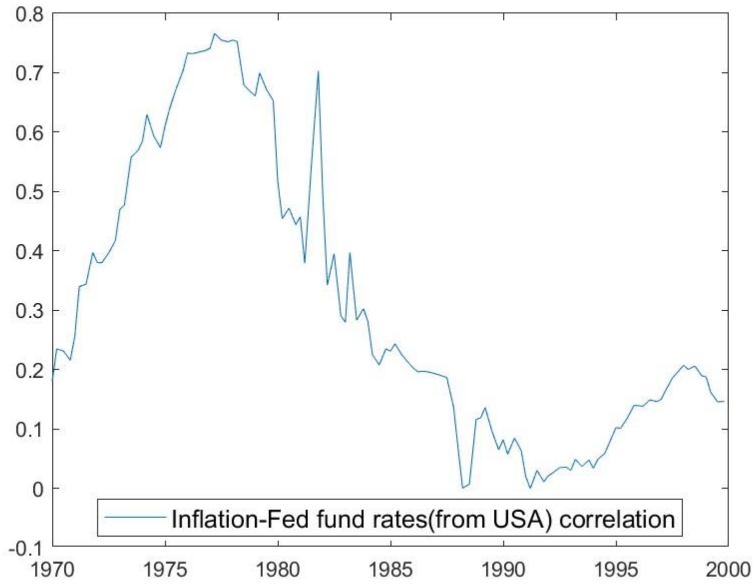

Figure 3: time varying correlation between inflation in Canada and FED fund rates

2.3. THE UNITED KINGDOM

The Fisherian relationship between interest rates and inflation (high contemporaneous correlation between inflation and the interest rate) for the U.K. was not very strong for the rolling-windows starting in the 1970s. However, after having high variability of inflation, the correlation between nominal interest rates and inflation increases and remains stable (around 0.5) in the subsamples starting in the mid-1970s until the subsamples starting in the late 1980s. Apart from these particular oscillations, we observe that the U.K. empirical evidence is similar to that observed in the U.S.: A gradual decline in inflation variability followed by a decline in the inflation-nominal interest rate correlation and a considerable fall in inflation persistence until it becomes negative.

It is noteworthy that, unlike in the U.S. and Canada, the U.K. correlation between inflation and the nominal interest rate is stronger than the persistence of inflation in most rolling-windows (all the subsamples since they start in the end of 1970s). Inflation persistence was weak after the inflationary oil shocks of the 1970s, and became negative with the subsamples starting in the late 1980s, which have a negative trend until the last rolling-window, 2000:1-2019:4 (being the first-order autocorrelation of inflation -0.37).

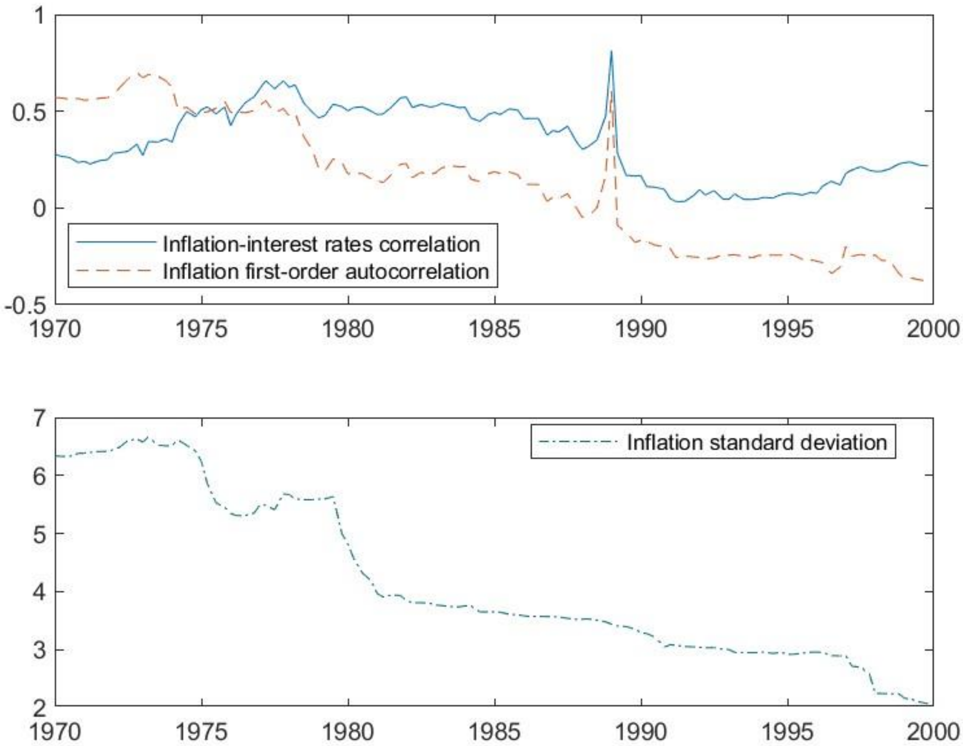

Figure 4: Time-varying second-moment statistics of inflation for the U.K.

Moreover, the variability of inflation is considerably higher in the UK than in the US (i.e. the mean of the standard deviation across window in the UK is 4.18 while it is 1.46 for the U.S.).

2.4. AUSTRALIA

Looking at the second-moment statistics of Australia in Figure 5 for the subsamples rolling- windows) starting in the early 1970s, one can conclude that there is a weak correlation between short-term interest rates and inflation. However, the increase in the variability of inflation in the following rolling-windows is goes together with a stronger correlation between the nominal interest rates and inflation.

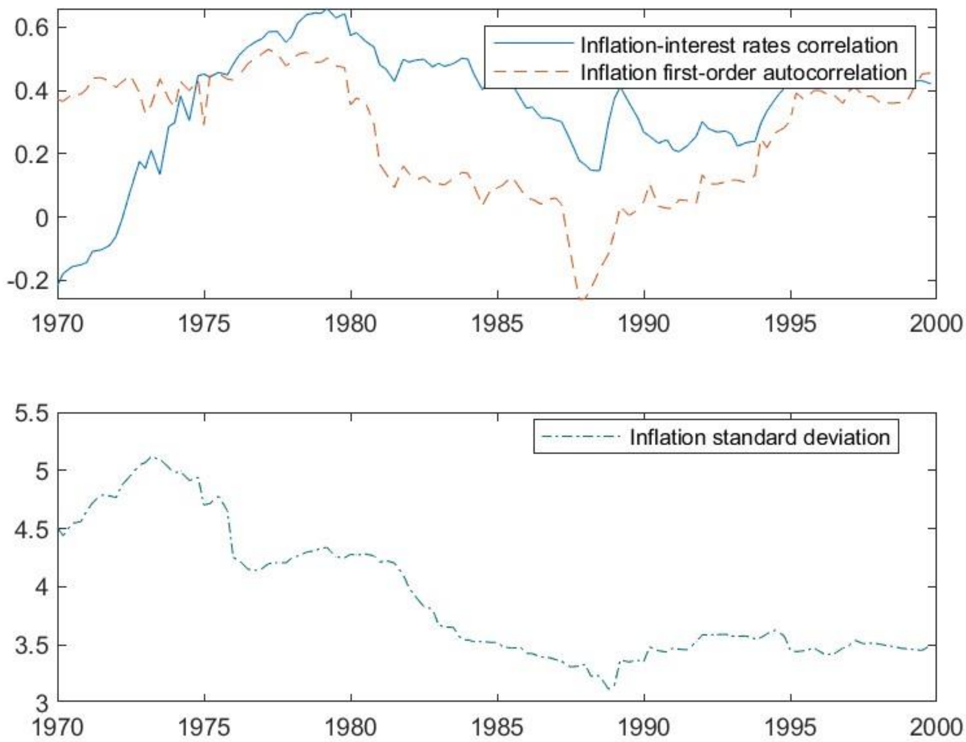

Figure 5: Time-varying second-moment statistics of inflation for Australia

Following this oscillation, Figure 5 shows a pattern similar to the one uncovered by Casares and Vázquez (2018) in the U.S: a reduction in the variability of inflation is followed by a decrease in its autocorrelation and a weakening of the correlation between the short-term interest rate and inflation. However, the return of the Gibson's paradox in Australia is much more diffuse than in the rest of the countries studied. Thus, the Australia-U.S. correlation of the inflation-interest rate correlation coefficients across subsamples is a much lower correlation (0.43) (see Table 1) than that obtained for the other countries studied.

The second moment statistics for inflation in the United Kingdom and Australia follow a similar pattern: inflation persistence is lower than the correlation between inflation and the nominal interest rate in almost all moving windows (the opposite pattern is observed in the United States, Canada, and France). In addition, inflation persistence in Australia is negative in some subsamples, such as in the United Kingdom.

2.5. FRANCE

Figure 6 shows the swings in inflation statistics for France are similar to those observed in the U.S. and Canada: a decrease in the variability of the inflation, a weakening of the correlation between nominal interest rates and inflation and a fall in inflation persistence.

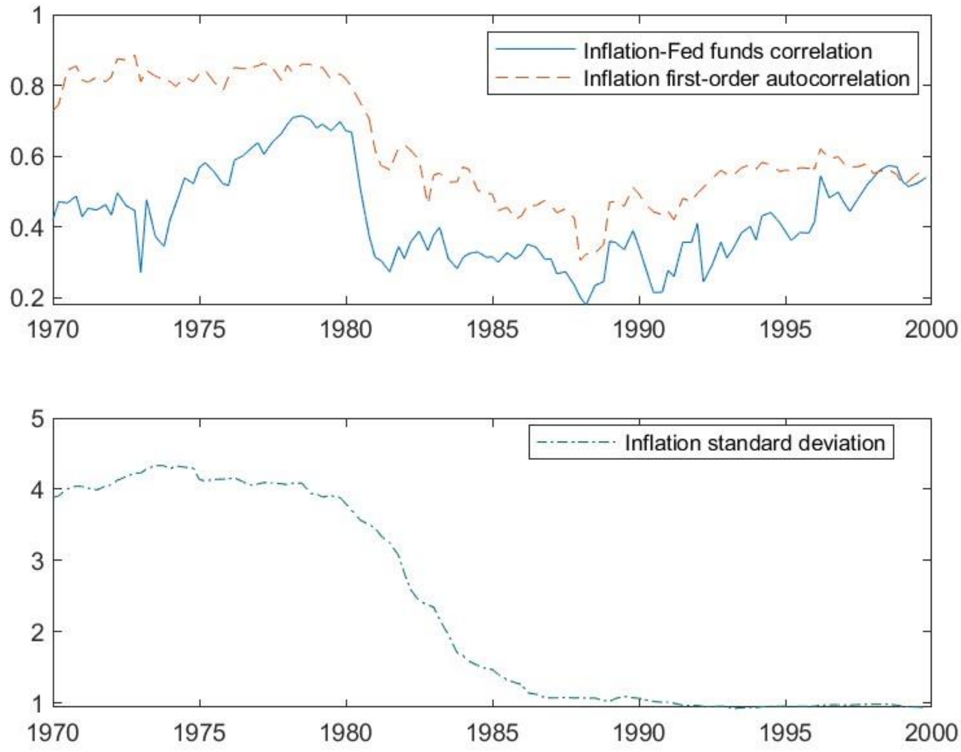

Figure 6: Time-varying second-moment statistics of inflation for France

However, it should be noted that France is the only country among those studied in this thesis that joined the Economic and Monetary Union (EMU)(later European Union). Since the early 1990s, monetary policy has been transferred to another institution, the European Central Bank (ECB), an institution that is more independent from the French government than the Banque de France since, among other considerations, takes into account the economic outlook of the whole EMU in conducting its monetary policy. This could be one of the reasons of why the variability of the inflation has remained very low and stable in the subsamples that start since the mid-1980s.

2.6. The resurgence of the Gibson´s paradox

In all countries studied we observe a similar pattern as the one found for the U.S.. Namely, a weakening of the correlation between the nominal interest rate and inflation. In sum, we can conclude that the re-appearance of the Gibson paradox in the mid-90s is rather robust for all OECD countries studied. Moreover, the cross-country correlation of the time-varying correlation between inflation and the interest rate, we find that all countries, except Australia, have a correlation coefficient above 0.70 with respect to the U.S. (see Table 1), which shows a rather high synchronization in the re-appearance of the Gibson paradox across countries.

Table 1 Crossed-country correlation of the correlation coefficients between inflation and nominal interest rates of all subsample

	US	UK	Canada	Australia	France
US	1				
UK	0.78	1			
Canada	0.89	0.81	1		
Australia	0.43	0.40	0.49	1	
France	0.74	0.38	0.64	0.46	1

In the next sections, we assess the sources driving these time-varying inflation dynamics in the U.S. by considering a (small-scale) 4-equation DSGE model augmented with money. Due to time constraints, we only focus on the U.S. since there is more literature about the Gibson paradox in the U.S., which allows to compare the estimation results in this thesis with those found in the related literature (e.g. Smets and Wouters, 2007; Casares and Vázquez, 2018)

3. The DSGE augmented with Money

We consider a New Keynesian DSGE model to analyse the sources driving the swings in inflation dynamics observed in the U.S. This section briefly explains the DSGE model, see Galí (2007) for a detailed description.

Our model has three types of agent: (i) Households, which consume goods, supply labor, and own bonds and money; (ii) Firms, which hire labor and produce differentiated goods that are sold in monopolistically competitive markets;[4] (iii) Central banks, which monitor the nominal interest rate. We introduce nominal rigidities in price setting by making a crucial assumption: firms have the chance to set an optimal price for their product only when they receive the market signal that appears with a constant probability of $1-w$. Then, w (the price Calvo probability) represents the probability that the price of the firm cannot be changed.

We obtain all the components of a dynamic general equilibrium model that is consistent with the optimizing behaviour from household and firms. We obtain 4 semi-log linear equations that will determine the dynamic behaviour of four endogenous variables: $\tilde{y}_t$ [5](output gap), π_t (inflation), R_t (nominal interest rates) and m_t (real demand for money).

The output gap is determined by the aggregate demand equation (AD). This is the optimizing dynamics IS curve. We have three explanatory variables: the real interest rate, that has a negative relationship with output; a forward-looking pattern on output dynamic evolution: $E_t\tilde{y}_{t+1}$; and a supply-side shock (χ_t), that in case of being positive, gives rise to a negative output gap.

$$\tilde{y}_t = E_t\tilde{y}_{t+1} - \frac{1}{\sigma}(R_t - E_t\pi_{t+1}) - \left(1-\rho_\chi\right)\chi_t \qquad (AD)$$

The aggregate supply (AS) equation is the New Keynesian Phillips curve for inflation dynamics and relates inflation to the output gap. These variables move in the same direction, as an increase in current output above potential output will imply more labour employed, more labour employed implies higher real wages to increase labour supply, higher real wages increase the marginal cost of firms, and finally, firms will pass on the higher costs to prices. The end result of positive output gap is a higher inflation. Moreover, expectations of future inflation have a considerable weight on inflation in the current period.

[4] Firms produce differentiated consumption goods as in Dixit and Stiglitz (1977), they set the selling price while the amount produced meets the monopolistic competition demand function.

[5] The output gap is the fractional deviation of current output from the flexible-price level of output (Woodford, 2003, pages 247-249). The level of potential output is calculated assuming an scenario where the economy were free of normal rigidities and prices would be set optimally by firms.

$$\pi_t = \beta E_t \pi_{t+1} + (\sigma + \eta)(1 - \omega)\left(\frac{1 - \beta\omega}{\omega}\right)\tilde{y}_t + z_t \qquad (AS)$$

The central bank controls the money supply through the interest rate. it sets the nominal interest rate with the objective of stabilizing inflation and the output gap in a systematic way. To do so, it will use a Taylor-type monetary policy rule (MPR) (Taylor, 1993). The central bank considers the past nominal interest rate (R_{t-1}) when setting the current interest rate, thus maintaining some persistence in its monetary policies. And finally, the monetary rule incorporates a AR(1) shock: v_t.

$$R_t = \rho R_{t-1} + (1 - \rho)(\psi_\pi \pi_t + \psi_{\tilde{y}} \tilde{y}_t) + v_t \qquad (MPR)$$

We introduce money in our model as in Casares and Vázquez (2018). The role of money is defined as being the medium-of-exchange to carry out transactions. The stock of real money can be used to save transaction costs.[6] An increase in real money holdings reduces transaction costs, with diminishing marginal returns. The micro-founded semi-log real money demand equation is described by:

$$\widehat{m}_t = \left(\frac{\lambda_m}{\gamma}\right)\widehat{m}_{t-1} + \left(1 - \frac{\lambda_m}{\gamma}\right)\hat{y}_t - \frac{\left(1 - \frac{\lambda_m}{\gamma}\right)(1 - a_2)}{R^{ss}} R_t - a_1\left(1 - \frac{\lambda_m}{\gamma}\right)\varepsilon_t \qquad (Money\ Demand)$$

where $\widehat{m}_t$ and $\hat{y}_t$[7] are the logs of real money balance and output with respect to their steady state values.[8] γ is the steady-state output growth, and R^{ss} is the steady-state nominal interest rate.

In sum, our New Keynesian economy is represented by four semi-loglinear equations: aggregate supply (AS), aggregate demand (AD), monetary policy rule (MPR) and, Money Demand. They determine the dynamic behaviour of the four endogenous

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[6] We use money as a transaction cost technology instead of the way used by Ireland (2003), where money balances yield utility directly. Our method is more flexible to accommodate the observed inflation dynamic shifts.

[7] Taking into account the definition of output gap, the log of output is equal to the sum of output gap and the potential output: $\hat{y}_t = \tilde{y}_t + \hat{\bar{y}}_t$ where potential output is given by: $\hat{\bar{y}}_t = \left(\frac{1+\eta}{\eta+\sigma}\right)\chi_t$.

[8] In our model, for the sake of simplicity, there is neither government nor investment and, therefore, output is equal to consumption.

variables $\tilde{y}_t$ (output gap), π_t(inflation), R_t(the nominal interest rates) and m_t(real demand for money).

4. Estimation results

Our DSGE model with money has been estimated for two subsamples: 1979:3-1999:2 and 1988:3-2008:2. Our decision to select these two periods is because they are those in which, following our empirical analysis in the second section, we find the highest and the lowest correlation between the nominal interest rate and inflation (in the subsample that starts in 1979:3, the correlation rate between inflation and nominal interest rate is 0.753, while in the subsample that starts in 1988:2, the same indicator is 0.05.

The observables series of our model will be: 1. Money with Zero Maturity (MZM) (this definition of money represent more accurately the role of money as medium of exchange than other definitions as the Monetary Base (Casares and Vázquez, 2018); 2. The inflation rate; 3. The federal fund rate; and 4. The output gap. Our estimation follows a two-step Bayesian procedure. We set the same prior distribution as in Smets and Wouters (2007) for the two subsample periods (we do not want our results being affected by assuming different prior), which are shown in the first columns of Table 2.

In the table 2, we observe the estimation results reporting the mean posterior values along with the 10% to 90% credible sets of the posterior distribution for the two subsamples analysed. In general, the estimated parameters are rather similar in both subsamples. However, we can observe some remarkable differences in the estimates of a few parameters: Price Calvo's probability has slightly increase from 0.90 in the first period to 0.95 in the second period, implying that the constant probability of receiving the market signal that allows firms to change price has decreased over the 1988-2008 period. Therefore, there is more price stickiness and that may help to explain the lower variability of inflation in this period.

The inertia parameters in the policy rule (ρ) has increased in the second period, so that the central bank, when setting interest rates, considers to a greater extent past interest rates and to a lesser extent the actual economic outlook (output gap and inflation). Moreover, we find that the money demand inertia is much lower in the second period.

Table 2: Prior and estimated posteriors of the structural parameters

	Priors			Posteriors			
				1979-1999		1988-2008	
Log-likehood				-546.833		-521.042	
	Distr	Mean	Std D.	Mean	10%-90%	Mean	10%-90%
w: *Price Calvo probability*	Beta	0.75	0.1	0.9043	(0.87-0.93)	0.947	0.82-0.97
ρ: *Inertia (policy rule)*	Beta	0.75	0.1	0.631	(0.55-0.70)	0.801	(0.75-0.84
ψ_π: *Inflation, policy rule*	Norm	1.5	0.3	1.427	(1.15-1.68)	1.413	(0.99-1.82)
$\psi_{\tilde{y}}$: *Output gap, policy rule*	Norm	0.125	0.1	0.361	(0.24-0.47)	0.383	(0.27-0.49)
λ_m: *Money demand inertia*	Beta	0.7	0.2	0.965	(0.92-1)	0.741	(0.47-0.99)
a_1: *Transaction cost elasticity*	Beta	0.5	0.2	0.647	(0.38-0.92)	0.665	(0.41-0.92)
ρ_χ: *Persistence of productivity shock*	Beta	0.5	0.15	0.529	(0.39-0.66)	0.709	(0.60-0.80)
ρ_z: *Persistence of inflationary shock*	Beta	0.5	0.15	0.845	(0.78-0-89)	0.652	(0.53-0.77)
ρ_v: *Persistence of money demand shock*	Beta	0.5	0.15	0.291	(0.14-0.43)	0.5723	(0.46-0.68)
ρ_ε: *Persistence of policy shock*	Beta	0.5	0.15	0.374	(0.23-0.51)	0.5212	(0.36-0.69)
σ_χ: *Std. of productivity shock*	Invgamma	0.15	0.15	3.697	(3.09-4.26)	3.192	(2.63-3.71)
σ_z: *Std. of inflationary shock*	Invgamma	0.15	0.15	0.151	(0.09-0.21)	0.222	(0.14-0.29)
σ_v: *Std of money demand shock*	Invgamma	0.15	0.15	0.731	(0.63-0.88)	0.344	(0.29-0.39)
σ_ε: *Std of policy shock*	Invgamma	0.15	0.15	4.301	(2.48-6.35)	7.522	(2.23-12.6)

Many parameter estimates of the shock processes have changed in these two periods: the persistence of inflationary shocks is lower in the second period. More precisely, the persistence of inflationary shocks has decreased from 0.84 to 0.65 in the second period (in particular, the oil shocks characterizing the first period mostly vanish in the second). Whereas the persistence of the productivity shock, the persistence of the money demand shock, and the persistence of the policy shock have increased in the second period. Moreover, the standard deviation of some shocks has considerably changed in these two periods: a decrease in the standard deviation of the money demand shock, and an increase in the standard deviation of the policy shock.

5. Model performance

In this section, we evaluate whether the swings in inflation dynamics in the most recent U.S. business cycles can be replicated by our 4-equation DSGE model augmented with money. Table 3 shows the second-moment statistics of inflation for U.S. data and the estimated model of the subsample with the highest inflation-nominal interest rate correlation (1979-1999) and of the subsample with the lowest inflation-nominal interest rate correlation (1988-2008).

Table 3: Selected Second moments statistics

Standard deviation	1979:3-1999:2		1988:3-2008:2	
	US data	Model	US data	Model
$\sigma(\pi_t)$	2.2454	1.3503	0.8815	0.7908
$\sigma(R_t)$	2.9646	1.6688	1.9318	1.0145
$\sigma(\tilde{y}_t)$	3.0701	3.4805	2.07161	3.3234
Correlation				
$\rho(\pi_t, R_t)$	0.7535	0.6761	0.0466	0.3238
Autocorrelation				
$\rho(\pi_t, \pi_{t-1})$	0.858	0.8323	0.6326	0.6423

In table 3, We observe that the model captures the reduction in variability of the observed variables in the U.S.. In other words, it clearly replicates the decrease in the standard deviation of inflation and the nominal interest rates. However, it falls short in replicating the high variability of inflation and interest rates for the first subsample. In regards inflation persistence, our model does a good job in replicating U.S. inflation persistence. Capturing the reduction in the first order correlation of inflation from 0.85 (0.83) in the period 1979-1999 to 0.63 (0.64) in the period 1988-2008.[9]

Finally, and most importantly, we are interested in assessing whether our model is capable of replicating the re-emergence of Gibson's paradox. We conclude that our model can partially replicate a reduction in the correlation, although it falls short since the actual correlation coefficient for the 1988-1999 period is 0.05 whereas our estimation of that period is higher at 0.32.

Overall, our DSGE model can partly replicate the empirical evidence observed in the U.S. We then miss some nominal and real rigidities, such as the ones considered by Smets and Wouters (2007) and Casares and Vázques (2018) in their medium-scale DSGE models to capture the strong weakening in the correlation between inflation and the nominal interest rate observed in recent U.S. business cycles.

6. Conclusion

Firstly, we have analysed empirical evidence from inflation statistics in several OECD countries: the United States, Canada, the United Kingdom, Australia and France. In all these countries we have observed a decline in inflation variability together with a weakening of the inflation-nominal interest rate correlation and inflation persistence. We can therefore conclude that the return to Gibson's paradox (a weak contemporaneous correlation between the nominal interest rate and inflation) is rather robust in all the countries studied. However, we have found some country-dependent singularities in the second-moment statistics of inflation.

Secondly, we have tried to assess the drivers of recent inflation swings observed in the U.S. through the estimation of a four-equation DSGE model augmented with money. Our new Keynesian model augments the 3-equation textbook New Keynesian monetary model with demand for money obtained from a facilitating-transaction technology as in Casares and Vázquez (2018).

Our model captures the reduction in inflation variability (although it fails to capture the high inflation volatility observed in the period with high correlation between inflation and nominal interest rate). Moreover, the model successfully reproduces the

[9] Between parenthesis are the first order autocorrelation of inflation estimated by our model.

fall in U.S. inflation persistence. But most importantly, it falls short in replicating Gibson's paradox. As shown in Casares and Vázquez (2018), additional sources of real and nominal rigidities, such as those incorporated by Smets and Wouters (2007) are needed, in addition to including explicitly money into the model, to successfully reproduce the very weak correlation between inflation and the nominal interest rates observed in the U.S. in recent times.

Due to its simplicity, our model does not provide a clear interpretation of why Gibson's paradox reappeared. However, we can observe that in the period with the weakest correlation between nominal interest and inflation: price rigidity has slightly increased (the firms receives the signal to change the price less often); monetary policy will take into account to a greater extent the monetary policies carried out in the past period and to a lesser extent the inflation and output gap of the current period, and the persistence of inflationary shocks was weaker. Thus, persistent oil shocks of the 1970´s and early 1980´s have disappeared in most recent decades. However, the current Russia-Ukraine war, resulting in strong energy prices shocks, may lead to new swings in inflation dynamics as we are already observing.

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