UNIVERSITA' DEGLI STUDI DI TRENTO - DIPARTIMENTO DI ECONOMIA

SEMIPARAMETRIC EVIDENCE ON THE LONG-RUN EFFECTS OF INFLATION ON GROWTH

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Semiparametric Evidence on the Long-Run Effects of Inflation on Growth

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Abstract

Two major findings of the empirical literature on the connection between inflation and output growth is that their relationship is non linear and that there exists a threshold inflation level below which inflation has a positive impact on growth and above which inflation has a negative impact on growth. In this paper we adopt a semiparametric estimator and we show that the first finding holds true even dropping the specification assumptions typical of parametric models. We also show that a threshold level does exist and it is around 10% for developed countries and 15% for developing ones. However, below the threshold level inflation does not appear to have a positive impact on growth, rather it does not have any substantial effect on it.

Jel codes: E31, O49, C14.

Keywords: Inflation, Growth.

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1 Aim of the Paper and Literature Review

The aim of this paper is to reassess by means of a semiparametric estimator the issue of the long-run relationship between inflation and economic growth. We think this step is particularly interesting because the relevant empirical literature used spline models in the belief that a threshold level of inflation should exists below which increasing inflation would foster output growth and above which more inflation is harmful to output growth.

However, first, the theoretical literature had considerable difficulties in matching this stylized fact (Temple, 2000) and, second, different empirical contributions have assumed different threshold levels without being able to test their assumptions (with the exception of Kahn and Senhadji, 2001). For instance Fischer (1993) imposes a spline model with two breaks, one at 15% annual inflation rate and the other at 40%. Gylfason and Herbertsson (2001) find that the relationship between inflation and growth is non-linear and the threshold inflation rate to be around 10%. Ghosh and Phillips (1998) assume the kink of the spline to be at 2.5%, whereas Judson and Orphanides (1999) choose 10%.

A threshold effect is found also by Thirlwall and Barton (1971) at an annual inflation rate ranging from 8% to 10%. A similar value is suggested also by Sarel (1996). One notable contribution is Kahn and Senhadji (2001) who find the threshold to be around 1% for industrialized countries and 11% for developing ones. However, the result for the industrialized countries is not completely convincing because, to our knowledge, the only developed country with an inflation rate below 1% is Japan, so it is very likely that the paucity of observations, together with the assumption of the spline model, drives the result.

One other major issue in this literature is the exact specified form of non-linearity necessary to better grasp the relationship between inflation and growth. The log of the inflation rate (Kahn and Senhadji, 2001) has been used as well as the log of 1 plus the inflation rate (Harris, Gillman and Matyas, 2001 and Judson and Orphanides, 1999), the level of inflation rate (Fischer, 1993), $\frac{\pi}{1+\pi}$ and $(1-\gamma)\,\pi^{1-\gamma}$ (Ghosh and Phillips, 1998), where π is the inflation rate.

In order to take better care of these issues, we think that a semiparametric estimator will allow to let as much as possible the data speak shedding further light on both the threshold level of inflation and its non linear relationship with output growth.

2 Model Specification and Data Issues

We test two model specifications both of which follow Kahn and Senhadji (2001). The dependent variable is the growth rate of GDP in constant local currency units. In Specification I controls include the level of inflation, gross fixed capital formation (or gross capital formation when the former is not available) as a share of GDP, the log of *per capita* GDP in PPP adjusted dollars in the initial year of each period and population growth. In Specification II, the growth rate of the terms of trade and their 5-year standard deviation are also included.

Data come from three different sources: the World Bank's *World Development Indicators* (WDI) represents our preferred source. However, as per capita GDP is only reported since 1975, we had to revert to Penn World Tables (PWT) to obtain longer series. Last, terms of trade data are built from export and import unit value series taken from the IMF's *International Financial Statistics* (IFS).

The dataset covers the period 1960–1999, which is the maximum length common to all three data sources, and 167 countries, which again represents the intersection between WDI and PWT. Terms of trade data are available for a smaller set of (mainly developed) countries and they are therefore not included in our baseline specification, but only used as a robustness check.

As customary when focusing on long-term growth (Temple 2000), we divide all series into 8 equal periods of 5 years each and we consider 5-years means (or medians). The actual number of available observations is lower due to the presence of missing data, especially for non industrial countries (whose IFS code is 200 or above). Moreover, we drop from the sample all observations for which the rate of inflation is above 40%. Temple (2000) in fact warns against the risk of pooling together countries with very different inflation dynamics as few extremely high values may well drive the overall results. The 40% cutoff point is also employed in Khan and Senhadji (2001), while Gillman et al. (2004) show that using different truncation points generates negligible differences in the results.

In the end our sample contains 134 countries and 672 observations, 169 of which pertain to the 26 industrial countries. Adding the terms of trade variables substantially reduces the sample size: while industrial countries are almost unaffected, the number of non industrial countries in the sample falls from 108 to 32 (152 total observations).

3 Estimation Method, Results and Conclusions

A semiparametric estimator is one of the tools that it is possible to use when the specified econometric model is thought to be partly linear and

partly non linear:

$$y_i = x'_{1i}\beta + g\left(x_{2i}\right) + u_i \tag{1}$$

where y is the dependent variable, x_{ji} for $j = 1, 2$ are two sets of independent ones, $g(\cdot)$ is a non linear function of unspecified form and i is the subscript for the i-th observation. A candidate estimator for β is:

$$\hat{\beta} = \left[\sum_{i=1}^{n}\left(x_{i1} - \hat{m}_{12i}\right)\left(x_{i1} - \hat{m}_{12i}\right)'\right]^{-1}\left[\sum_{i=1}^{n}\left(x_{i1} - \hat{m}_{12i}\right)\left(y_i - \hat{m}_{2i}\right)'\right] \tag{2}$$

where $\hat{m}_{12i}$ and $\hat{m}_{2i}$ are the kernel-based estimators of $m_{12i} = E\left(x_{1i}|x_{2i}\right)$ and $m_{2i} = E\left(y_i|x_{2i}\right)$. More in detail, the kernel based estimator of m_2 is:

$$m_2 = \frac{\sum_{i=1}^{n} K\left(\frac{x_i - x}{h}\right) y_i}{\sum_{i=1}^{n} K\left(\frac{x_i - x}{h}\right)} \tag{3}$$

where h is the bandwidth and $K(\cdot)$ is the kernel function. Once having $\hat{\beta}$ in hand it is easy to find $\hat{g}\left(x_{2i}\right)$:

$$\hat{g}\left(x_{2i}\right) = \hat{m}_{2i} - \hat{m}_{12i}\hat{\beta} \tag{4}$$

In this contribution, we use a Gaussian kernel and Silverman's optimal bandwidth (Pagan and Ullah, 1999).

Table 1 shows the parameter estimates for the control variables. The results for the inflation-output growth relationship are showed in Figures 1 and 2. The continuous line traces $\hat{g}\left(x_{2i}\right)$, whereas the dotted lines mark the 95% confidence interval. Figure 1 shows the results obtained for the whole sample and for Specification I. Inflation does not appear to be particularly harmful to growth for rates below 15% (which might be consistent with the hypothesis of no effect at all), whereas a marked negative relation appears for higher values. Above 30% a positive relation shows up, but the wide confidence interval suggests this is probably driven by the small number of observations for high inflation countries. Figure 2 shows the results for a number of robustness exercises. We split the sample between developed and developing countries. The threshold level moves to around 10% for developed countries and remains around 15% for developing ones. Using the median instead of the mean, as suggested by Temple (2000), does not appear to affect the results. Specification II manages to close the confidence interval and to have more stable point estimates for both the whole sample and for developing countries. Inflation threshold levels stick to 10% for developed countries and 15% for developing ones.

This paper uses a semiparametric estimator to assess the issue of the non linear relationship between inflation and economic growth and the existence of a threshold effect within it. Our results point to the fact that inflation does not have a substantial effect on economic growth when it is below 15% in developing countries and 10% in developed ones. This confirms that high inflation is detrimental to economic growth, but it highlights that spline models may have overstressed the benefits that can descend from moderate increases in long run inflation values at low inflation levels. Whilst we do not address the issue of the allocative inefficency generated by inflation, our results also suggest that – from the standpoint of its impact on growth – the importance of low inflation targeting may have been overstated.

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Table 1 – Coefficient estimates of the control variables

	Specification I				Specification II		
	All sample	Developed countries	Developing countries	Median	All sample	Developed countries	Developing countries
GDP per head at t_0	-2.72*	-3.77*	-2.72*	-2.85*	-4.46*	-3.85*	-4.41*
t-statistics	(-5.93)	(-3.70)	(-5.11)	(-5.82)	(-5.83)	(-3.63)	(-4.10)
Population growth	1.33*	1.04*	1.41*	0.45	0.84*	1.23*	0.83*
t-statistics	(8.16)	(2.83)	(7.45)	(1.84)	(2.57)	(2.71)	(1.77)
Investment/GDP	0.16*	0.14*	0.17*	0.14*	0.23*	0.11*	0.30*
t-statistics	(7.27)	(2.52)	(6.66)	(6.08)	(7.20)	(1.96)	(5.83)
Terms of Trade Growth	-	-	-	-	0.08*	0.10*	0.08
t-statistics	-	-	-	-	(2.51)	(2.21)	(1.67)
Terms of Trade Standard Dev.	-	-	-	-	0.56	-6.72	0.71
t-statistics	-	-	-	-	(1.39)	(-1.94)	(1.26)

*: significant at the 5% level

Figure 1 – Semiparametric estimation of the effect of inflation on real economic growth

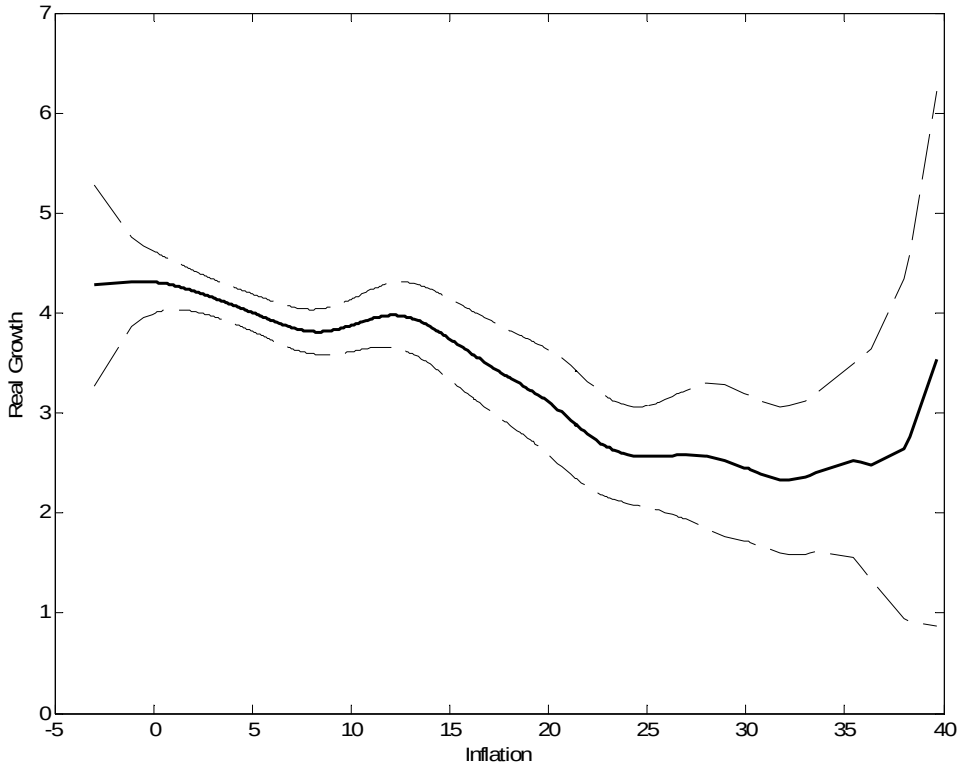
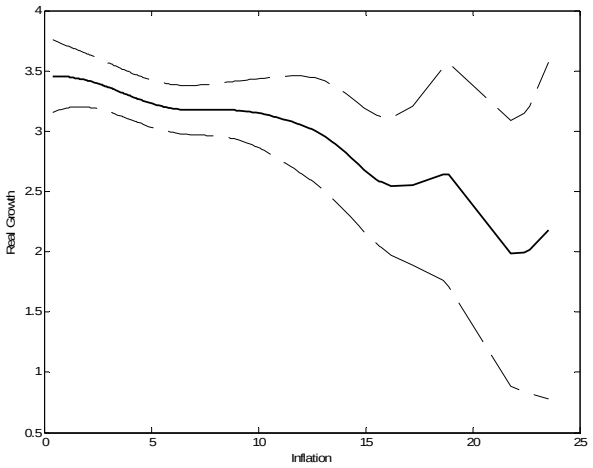
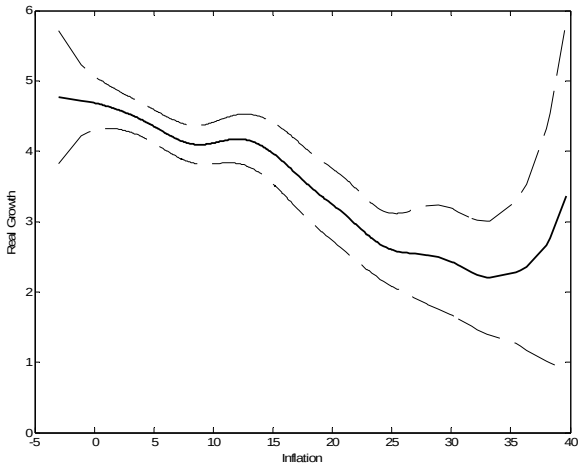


Figure 2 – Robustness checks for the semiparametric estimation of the effect of inflation on real economic growth

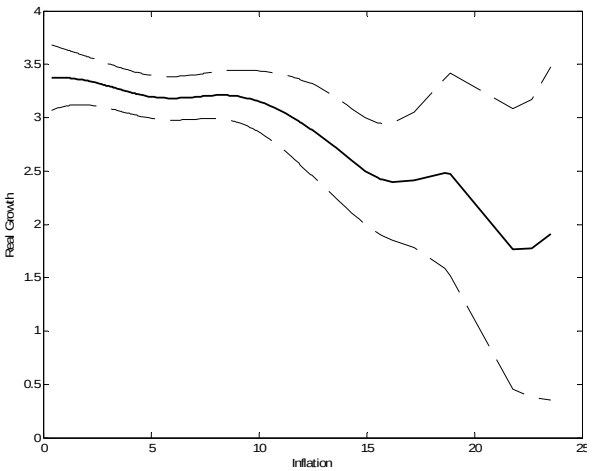
Specification I: Developed Countries



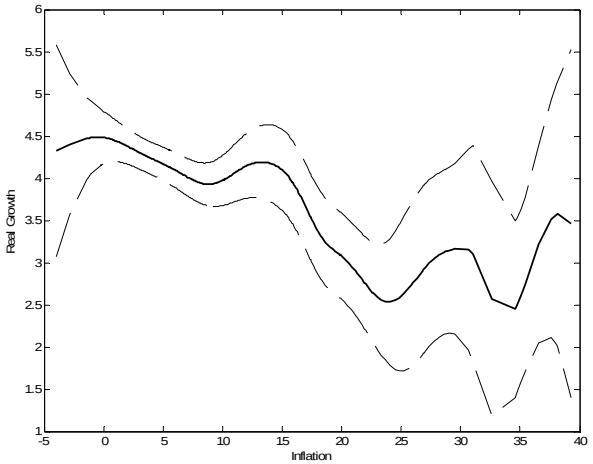
Specification I: Developing countries



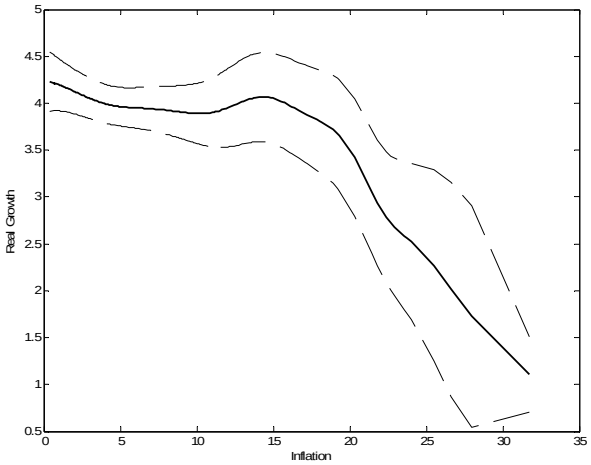
Specification II: Developed Countries



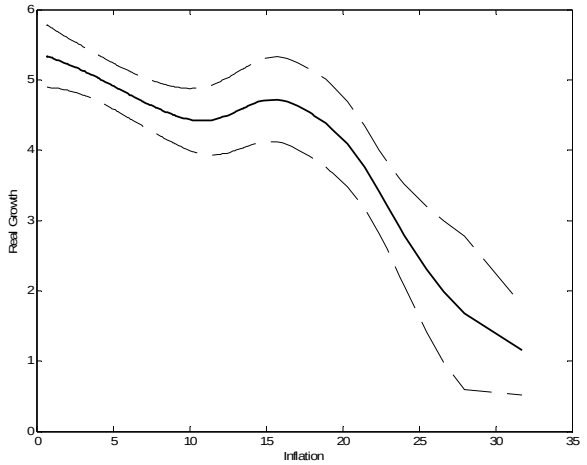
Specification I: Median



Specification II: entire sample



Specification II: Developing Countries



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