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Inflation and Growth: some panel data evidence

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INFLATION AND GROWTH: SOME PANEL DATA EVIDENCE.

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Abstract: this paper analyses on an empirical basis the relation between inflation and growth. The focus is on the effects of human capital variables (introduced by schooling rates and fertility) and on the country pooling. For this last point there is a clear and expected difference between industrialised and non-industrialised countries, among the last groups there is also evidence of structural differences depending on the inflation level. The analysis has been carried out by panel techniques.

Keywords: inflation, growth, panel, human capital.

1. INTRODUCTION.

The relation between inflation and economic growth is arguably one of the most debated issues in the economic literature, in the last two decades a host of articles have been devoted to the theoretical and empirical analysis of the possible links between inflation and growth. The interest of this particular topic lies in the fact that whereas very little controversy exists as to the negative effects that inflation may have on economic growth from a theoretical point of view, the empirical evidence documenting this negative link is not very persuasive.

The roles that inflation, expected and unexpected alike, might play in reducing social welfare are quite consensual as the inefficiencies generated by inflation in the

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allocation mechanisms of the economy are evident: the possible redistributive effects, the increase of the level of uncertainty in the economy leading to distortions in the consumption, saving and investment decisions, the increase in the degree of regressiveness of the tax systems can all lead to a reduction in the overall efficiency of the economy and to a decrease of the growth rate of the economy. Hyperinflations or even high and sustained inflation episodes generate even more radical and severe distortions of the allocative mechanisms[1].

In the growth literature the debate on the role of inflation can be said to be started with the seminal paper by Tobin [1965] who introduced money into a Solow-Swan model as an asset alternative to capital, in this context inflation increases the opportunity cost of money holdings and thus favours capital accumulation and hence growth. An opposite result is obtained including money holdings directly in the utility function as in Sidrauski's [1967] famous contribution in which money results super-neutral. Ambiguous results are obtained in several alternative versions of the Sidrauski model and in many cash-in-advance models[2]. In endogenous growth models the effects of inflation on growth is more defined, in the works of Gomme [1993] and Jones and Manuelli [1995], for example, where money is introduced in the budget constraint in a model of human capital accumulation, an increase in the rate of inflation affects negatively both consumption and labour supply leading to a lower growth rate. In another article De Gregorio [1993] shows that inflation may have relevant effects also on the accumulation of physical capital, in his model money is a means of reducing transaction costs both for consumers and firms, a higher inflation rate induces the agents to reduce their money holdings thus

[1] On the costs of inflation in general see Briault [1995] for a discussion of the costs of high inflation see for example De Gregorio [1992] .
[2] For a detailed analysis of this and other topics see Walsh [1998].

increasing the transaction costs and generating negative effects on investment and growth.

The amount of empirical work done in this field, especially in recent years, is astounding and mostly supports the view that there exists a negative relation between inflation and economic growth, although some authors[3] believe that the lessons to be drawn from these works are far from persuasive. Indeed early works on inflation and growth could not provide clear empirical conclusions, Thirlwall and Barton [1971], for example, reported a positive relationship between low inflation and growth in a cross section of industrial countries during the period 1958-67 and a negative relationship in a cross section of 7 developing countries over the same period. In more recent years, however, the contours of an inverse connection between inflation and growth across countries have begun to emerge from many econometric studies. Barro [1991] for example reports a negative but weak relationship between inflation and the growth rate of real per capita GDP during 1970-1985 in a cross section of 117 countries and he finds that the intensity of this relationship is growing (from 1960-1970 to 1970-1985). Before him Kormedi and Meguire [1985] in a neoclassical growth framework had obtained the same results for a cross section of 47 countries over the period 1950-1977. The early 1990's mark the beginning of a new phase of empirical investigations in this field with the diffusion of endogenous growth theories and of panel data analysis techniques. De Gregorio [1992, 1993] applies this methodology to a panel of Latin American countries from 1950 to 1985, finding a semi-elasticity of per capita growth with respect to average inflation equal to –0,008 and also obtains a negative correlation between the growth rate of per capita GDP and the standard deviation of inflation. Similar results are obtained by Barro [1995], with a sample of 103 countries and by Motley [1993], with a

[3] See for example Judson and Orphanides [1996].

panel of 78 countries. The role of the volatility of inflation is tackled by Judson and Orphanides [1996], who, using an intra-annual rather then an inter-annual measure of inflation volatility, show how the negative relation between economic growth and inflation volatility is robust also after having controlled for the level of inflation. More recently Alexander [1997] finds a strong negative influence of inflation on the growth rate of per capita GDP using a panel of OECD countries.

It would be misleading, though, to suggest that all the empirical literature shares the same conclusions, that is that growth and inflation are negatively correlated at all levels of inflation and in all countries, in particular even recent and sophisticated papers have reached mixed results, Sarel [1996], for example, finds in a panel of 87 countries that inflation seems to influence growth only in a sub-sample of countries whose average inflation is above 8%. Bruno and Easterly [1995] underline the same result, finding a small effect of inflation on growth for those countries with average inflation rates below 40%. Finally, Clark [1997] obtains, in a panel study with 85 countries, that the inverse relationship between inflation and economic growth is not robust with respect to changes in the number of countries in the panel and of the sample period.

The aim of this brief paper is to analyse once more the effects of inflation on economic growth using a new and more updated panel than is the case in most of the literature. In the next two sections we will briefly describe the dataset and the main results we obtained form the regressions. Section 4 will present some of our conclusions.

2. DATA DESCRIPTION.

The panel data we use have been constructed starting from the International Monetary Fund's (IMF) *International Financial Statistics* and from the World Bank's (WB) *World Development Indicators*. We tried to restrict the Panel to those countries for which enough data were available and as a consequence, we could only consider 97 countries out of a total of 171 of the IMF database and 227 in the WB's one. We have observations for the 19 years between 1979 and 1997 also this choice was mainly driven by data availability. The complete list of countries in the panel is reported in the Appendix to this paper.

The variables used in the estimations are the following:

1. **Per Capita GDP Growth Rate (GDPG)**. This is the dependent variable used in all the regressions. It was computed as growth rate of real per capita GDP multiplied by 100[4].
2. **Starting per Capita GDP (LGDP79)**. Is the log of per capita 1979 GDP expressed in dollars.
3. **Inflation (INFL)**. As a measures of inflation we used in the regressions the growth rate of CPI derived from IMF data.
4. **Inflation Standard Deviation (INFLSD)**. This volatility measure has been constructed computing the SD of the quarterly CPI series of the IMF database.
5. **Public Expenditure (G)**. This series is computed as the ratio of Public Consumption to GDP, derived from the WB databank.
6. **Investment (INV)**. Used as a proxy of physical capital accumulation this variable is computed as the ratio of gross investment in fixed capital over GDP.

[4] In what follows all the ratios are to be intended as multiplied by 100.

7. **Direct Foreign Investment (DFI)**. The series is obtained dividing the WB series of Foreign Direct Investment (defined as net inflows aiming at acquiring at least 10% of the capital stock of firms operating in the destination country) by GDP.
8. **Public Deficit (PDEF)**. This is the ratio of Total Public Deficit (Surplus) to GDP (a negative value expresses a deficit).
9. **Foreign Debt (FDEBT)**. It is once more from the WB dataset the Foreign Debt series (debt owned by non-residents and equals the sum of the debt directly issued by the public sector, debt guaranteed by the public sector and of the private sector, both long term and short term) divided by GDP.
10. **Schooling Rate (SCHOOFE and SCHOOMA)**. This proxy for the human capital formation was obtained from the WB series for the secondary school enrolment rate for females and males. The rate is obtained as enrolments over total potential enrolment.
11. **Fertility Rate (FERT)**. From the WB database, it is the number of children for each woman in reproductive age.

3. EMPIRICAL ANALYSIS.

Before starting describing our results some preliminary notes are in order:

- ✓ in all regression performed we used the Huber/White/sandwich correction in the variance-covariance estimator, given the presence of heteroskedasticity in the panel[5];

[5] We have done a simple test of equivalence of variances: under the null hypothesis of equal variances, the test statistics is distributed as a $\chi^2(k-1)$, where (k) is the number of groups (in this case 97 countries) gave as a result 862.09, while the 1%tail of the distribution is about at 131, so the null hypothesis is strongly rejected

- ✓ in all cases (unless differently specified) the parameter estimates are computed with random effect estimators (or GLS);
- ✓ all tables report the following: the value of the estimated coefficient and the significance test in parenthesis[6], the R^2 of the regressions, the number of observations and, in parenthesis, the number of groups, the estimated variances of the country specific effect and of the remainder disturbance, the value of the Breusch-Pagan's test statistic for random effects[7], the value of the Hausman's specification test statistic[8], the value of the pooling test statistic under the two different hypothesis of identical or different (generalised pooling test) variance across the pooling groups[9].

We started out with the investigation of the relation between economic growth (GDPG), the level of inflation (INFLx), the initial level of GDP in logs (LGDP79), other macro variables and some human capital proxies. The initial level of GDP was added to regressions to test the hypothesis of conditional convergence implicit in the growth model[10]. One would expect that countries with lower initial GDP level will have higher growth rates, and hence a negative coefficient on this variable. With this objective we ran regressions on the whole sample of countries and on subsets of countries grouped either by means of economic characteristics or by average inflation. Within these categories we ran pooling tests to verify if the relation

[6] The Student T test statistics is computed with the robust estimate of the standard error

[7] Test for the presence of random effects: the statistics is distributed as a $\chi^2(1)$ under the null hypothesis of fixed effect; rejecting the null hypothesis means that the random effect is the correct estimator.

[8] Under the null hypothesis that country invariant effects are uncorrelated with the explanatory variables the statistic is distributed as a $\chi^2(k)$, where (k) is the number of estimated coefficients; rejecting the null hypothesis means that the model is incorrectly specified, and suggests that estimating the fixed-effect model is preferrable.

[9] In both cases under the null hypothesis of non-pooling the test statistic is distributed as an F(N-NK,NT-NK), where N is the number of pooling groups, T is the number of observations in time and K is the number of regressors plus the constant.

[10] Barro (1991), Barro Sala-I-Martin (1995)

between the dependant variable (GDPG) and the independent variables changes across groups.

Table I report the regressions in the whole sample using as regressors the log of GDP in 1979, the CPI inflation and the public expenditure, used as a proxy for public consumptions. This choice is due to the fact that only these three variables are available for all countries. In table II we added investments and net exports, reducing the sample to 95 countries, discarding Solomon and Samoa Islands. In both table I and II also the regressions for the different pools are reported: G7 vs non-G7, low (less than 10%), medium (between 10% and 30%) and high (over 30%) average inflation, industrialised vs non-industrialised countries (for the latter subgroupings based on the level of inflation were used)[11]. As we can observe in the whole sample regressions all coefficients are significantly different from 0. The negative coefficient for inflation was the expected result. Conditional convergence is not verified, probably due to the heterogeneity of the sample of countries considered. Adding investment we observe a positive expected sign of the relative coefficient, this is the variable which proves to have the highest positive effect on economic growth. In both cases (with or without INV and NX) the R^2 is very low, and the Hausman's specification test suggests moving to a fixed effect model because of a possible correlation between explanatory variables and the country specific effects. Moving to the analysis of the pooling groups, we can identify some changes in the coefficients and signs: conditional convergence is verified within the G7 group, even if not significant, and in the industrialised group (with INV and NX, Table II); the inflation coefficient is always negative, as expected, and significant, but varies across the different groups, possibly meaning that the effect of inflation on growth also on the economic situation of the country (see in particular the values in the pools based on

[11] See appendix for a detailed listing of countries included in each pooling group

inflation); the coefficient on investment is always of the expected sign and significant. As regards the R^2's, we can see that the pooling increase the explanatory power of regressions, especially in the pool of industrialised countries. Even if things seem to imporve, observing the Hausman statistic we see that in all but one cases, it

A DIGRESSION ON THE POOLING ON INFLATION LEVELS.

This pooling choice was suggested by the observation that the effects of inflation on economic growth exhibits some non-linear behaviour. The analysis was performed in a simple graphical way. The graphs in figure 1 to 4 attached to this paper in Appendix B, report the estimated impact of inflation level on economic growth: figure 1 and 2 group countries by average inflation level in 10 different classes, (0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21, 21-24, 24-50, +50%) the only difference between the two is given by the introduction in the regression of a second order variable (specifically squared inflation) to capture eventual non-linear effects. As we can see the relation is almost linear for classes 1 to 8 (up to 24% mean inflation between 1979 and 1997), then assume a non-linear shape, but we have to consider that for mean inflation greater than 24% the sample is formed by a small number of countries. Adding the second order term does not change the shape of the graph but only adds significance to the inflation effect, increasing its negative effect on growth, this means that even within each group the changes in inflation affects economic growth in a non-linear fashion. For simplicity in performing regressions and tests we resorted to grouping countries in only three classes. We are aware, anyway, that in this analysis we do not take care of the biases induced by countries that display a negative inflation rate across the sample period. This countries, with very few exception, most notably Japan and Germany, cannot be safely used in the previous analysis as they can bias the global inflation effect since they alternate periods of disinflation to others of hyperinflation, so that basing the grouping rule on the inflation mean is not the best option. They are ayway included in this work but a more rigorous analysis on this point is called for. These caveats notwithstanding, we computed again the inflation effects and obtained figures 3 and 4. Now the difference in the effect is even more evident thus justifying our pooling strategy.

suggests moving to fixed effect, because the model is probably incorrectly specified. We have discussed the variation of coefficients across pooling groups, but is pooling

actually supported by the data? Pooling tests suggest that only the industrialised vs non-industrialised case is acceptable, both with and without INV and NX. In the other situations the restricted model (non-pooling) is preferred. Thus we can assume a difference in coefficients using the pooling with respect to industrialised vs non-industrialised, grouping the latter with the inflation threshold.

The approach we followed was to correct the model using the results of the Hausman test: we can observe which coefficients give the greater contribute to the test statistics and then substitute the corresponding variable with its deviation from country mean in the observed period. Given this methodology we ran again the same regressions and tests (Table III) substituting the Public Expenditure variable with the deviation (Pub. Exp. D.). In a second moment we adopted the same procedure with investments and net exports (Table IV)[12]. The results turn out to be better: the conditional convergence is verified in all cases where the parameter related to this variable is significantly different from zero, the significance level on the inflation coefficient increases and also the coefficient (in absolute value) is larger, the results on both public expenditure and investment are confirmed, net exports become more significant, R^2 increases in all cases and the Hausman test statistic give us the acceptance of the null hypothesis, i.e. that the model is now correctly specified, although not in all cases. With a overview of the two tables we can affirm that the best results are the one connected with the industrialised vs non-industrialised pooling and subgrouping these latter with respect to average inflation: we can interpret this result viewing the level of industrialisation as a variable that considerably differentiates the endogenous dynamics of economic growth across countries, in particular as far as the links between inflation, investments and growth

[12] In all tables a D. at the end of the variable name means that we used deviation from country mean in the sample period

are concerned. In the case of non-industrialised countries, in particular, the level of inflation greatly influence the structural relation between growth and the other explanatory variables, and it does so to such an extent that most of the structural relation between the rate of growth of the GDP and the explanatory variables can be better captured only after grouping countries according to their inflation levels. Given these results we finally ran the regressions according to this pooling strategy adding all the variables at our disposal for each group.

These results are presented in tables V and VI. In these regressions we also included the Standard deviation of inflation (INFLSD) as an additional explanatory variable to test the effect of inflation volatility on economic growth. As expected the sign of the relative coefficient is negative even if it is not always "significant". We considered separately the effect of inflation and its standard deviation to avoid collinearity problems, this can also be avoided by using squared inflation as a regressor, that would also capture the second order effect on economic growth. Considering first the industrialised countries, we can observe that conditional convergence is satisfied, that the effect of inflation is always negative, and that it increases adding the second order term. The standard deviation of inflation has a negative impact, but is not significant using the fixed-effects method. The other macro variables have the expected signs. For this group of countries we also have some human-capital proxy variables: the fertility rate and the secondary schooling rate for female and male. Adding these to the fixed effect specification will lead to an increase in the R^2 and small changes in the other coefficients. The fertility rate and the male schooling variables have the expected signs (negative and positive respectively) whereas the female schooling variable indicates a negative coefficient, a result which is common in the literature albeit counter-intuitive.

We now turn our attention to Table VI, the one for the non-industrialised countries panel. We have some additional variables yet in this case we do not have unfortunately any human capital variables, we have macro variables that represent a link of this group of economies with the industrialised ones: Foreign Investment, Imports and External Debt. The specification adopted is not standard given the constraints arising from the data availability (note that some countries has been discarded from this analysis) and from the implications of both the Hausman's and Breusch Pagan's tests. Here conditional convergence is not verified, but the coefficients are always non-significant, inflation has again a key impact on economic growth, and also its standard deviation (apart from the case of countries with high inflation whose results are in some sense inconsistent, but for which adding a second order term improves our results). Note that Direct Foreign Investment and Imports are both positively affecting economic growth. The other variables do not exhibit constant signs across groups.

3.1 Dynamic analysis

Given the previously obtained results we tried to extend our study allowing for the presence of dynamic effects in the regressions. We considered dynamic effects only up to 1 lag in the past given the small number of observations. The estimates are carried out via the Arellano-Bond (1991) estimator for dynamic panels. Our results are included in table VII and VIII which represents the dynamic extensions of tables V and VI. In all cases the logarithm of the initial GDP is no more considered as a regressor, this depend on the formulation of the Arellano-Bond estimators, see the cited paper or Baltagi [1995] for details. Focusing on Industrialized countries we can observe that in all cases past GDP growth rate affect positively current growth rate.

For inflation none on the sign are changed, the negative effect remain. A curious result came out from the standard deviation on inflation that seem to positively affect economic growth. All the remaining explanatory variables maintain the same sign and outcome in the regressions, the only difference is in the fertility rate: its coefficient in the dynamic specification has not a stable sign and also is non significant in some cases. Adding dynamics R^2 slightly increase but remain very close to the previous analysis results. Considering now non-industrialized countries pooled by inflation levels we can verify that inflation, and also its standard deviation, have the same negative coefficient in all cases. For the remaining regressors all signs are stable across groups and with the expected coefficient.

4. CONCLUSIONS.

This paper presents an analysis of the links between inflation and growth which conforms to the theoretical priors we have described in the introduction, we have confirmed the results of the previous empirical literature making use of an updated dataset we constructed for the purpose of this paper. Our analysis has also shown that the effects of inflation on economic growth greatly varies with the average level of inflation experienced by different economies and that regressions based on a pooling strategy aiming at grouping countries by the average inflation improves the explanatory power of the regressions themselves. All results are also confirmed adding dynamic effects.

Table I.

RE	Unpooled	Pooling G7		Pooling Inflation level			Pooling Industrialised				
Variables		G7	Non-G7	<10	10-30	>30	Ind.	Non-ind.	N.i. <10	N.i. 10-30	N.i. >30
Log GDP79	0.30463 (2.23)	-1.23522 (-1.51)	0.28664 (1.86)	0.037132 (0.21)	0.51136 (2.00)	0.16877 (0.28)	-1.11457 (-2.02)	-0.12618 (-0.59)	-0.38162 (-1.13)	0.42159 (0.93)	0.16878 (0.28)
Inflation	-0.00076 (-4.92)	-0.08854 (-1.55)	-0.00076 (-4.92)	-0.10951 (-2.27)	-0.05874 (-2.82)	-0.00060 (-4.38)	-0.05825 (-1.50)	-0.00073 (-4.96)	-011901 (-1.90)	-0.06328 (-2.71)	-0.00060 (-4.38)
Public Exp.	-0.11994 (-3.81)	-0.11994 (-2.80)	-0.99229 (-3.05)	-0.17137 (-3.90)	-0.00431 (0.09)	-0.11268 (-2.57)	-0.12551 (-2.30)	-0.08479 (-2.51)	-0.14216 (-2.37)	0.00648 (0.13)	-0.11268 (-2.57)
Var(u)	1.56642	0	1.62605	1.32666	1.29670	1.29451	0.83812	1.55441	1.43768	1.35133	1.29451
Var(e)	4.69969	1.90120	4.85590	4.69271	4.18432	5.35155	2.09078	5.31646	6.0650	4.33232	5.35155
R^2	0.0334	0.095	0.0319	0.0682	0.025	0.0718	0.1356	0.0285	0.0654	0.0208	0.0718
Obs. (gr.)	1725 (97)	133 (7)	1592 (90)	880 (49)	574 (33)	271 (15)	454 (24)	1271 (73)	482 (28)	518 (30)	271 (15)
BP	140.37	1.09	134.50	41.71	27.33	5.47	46.16	71.09	10.80	25.05	5.47
Hausmann	29.64	26.52	26.99	17.79	25.68	11.29	46.38	22.6	6.11	21.98	11.29
Pooling		F(4,30)=0.007		F(8,45)=0.212			F(4,30)=0.142		F(12,60)=5.157		
Pool.Gener.		F(4,30)=2.049		F(8,45)=0.383			F(4,30)=4.326		F(12,60)=2.203		

Breusch-Pagan test is a $\chi^2(1)$, 95% (3.841), 99% (6.635)

Hausmann test is a $\chi^2(2)$, 95% (5.991), 99% (9.210)

Table II.

RE	Unpooled	Pooling G7		Pooling Inflation level			Pooling Industrialised				
Variables		G7	Non-G7	<10	10-30	>30	Ind.	Non-ind.	N.i. <10	N.i 10-30	N.i. >30
Log GDP79	0.13742 (0.98)	-0.92116 (-0.99)	0.075473 (0.49)	0.06273 (0.30)	0.29369 (1.23)	0.16819 (0.24)	-1.72328 (-4.51)	-0.51145 (-2.23)	-0.59898 (-1.38)	0.00904 (0.02)	0.16819 (0.24)
Inflation	-0.00063 (-3.92)	-0.09883 (-2.10)	-0.00062 (-3.88)	-0.12481 (-2.49)	-0.05859 (-2.26)	-0.00053 (-2.94)	-0.03128 (-1.18)	-0.00060 (-3.92)	-0.14208 (-2.17)	-0.05204 (-2.05)	-0.00053 (-2.94)
Public Exp.	-0.12785 (3.60)	-0.24906 (-2.76)	-0.13023 (-3.69)	-0.20619 (-3.06)	-0.05377 (-1.37)	-0.12528 (-3.40)	-0.03817 (-0.86)	-0.12040 (-3.30)	-0.19692 (-1.96)	-0.05208 (-1.29)	-0.15528 (-3.40)
Invest.	0.17493 (6.56)	-0.10205 (-1.18)	0.02750 (6.70)	0.15310 (4.10)	0.16380 (4.91)	0.21935 (2.13)	0.09881 (2.75)	0.19281 (6.45)	0.20255 (4.99)	0.16320 (4.94)	0.21935 (2.13)
Net Exp.	0.03046 (1.77)	-0.18811 (-1.57)	0.03357 (1.96)	0.01556 (0.52)	0.03903 (2.06)	-0.02892 (-0.46)	0.16851 (4.14)	0.04012 (2.26)	0.02875 (0.82)	0.04258 (2.14)	-0.02892 (-0.46
Var(u)	1.22051	0	1.23178	1.01666	0.88309	1.22435	0.46389	0.97729	0.40876	0.89388	1.22435
Var(e)	4.59927	1.90494	4.75638	4.57318	4.00807	5.12460	2.07692	5.22007	5.96554	4.16064	5.12460
R^2	0.1052	0.1311	0.1088	0.1160	0.1041	0.1460	0.2156	0.1121	0.1366	0.0991	0.1460
Obs. (gr.)	1661 (95)	133 (7)	1528 (88)	857 (49)	533(31)#	271 (15)	454 (24)	1207 (71)	459 (28)	477 (28)#	271 (15)
BP	47.89	1.46	40.55	19.69	8.56	4.18	5.67	9.99	0.01	7.35	4.18
Hausmann	22.02	23.16	19.70	39.77	26.76	33.38	65.10	20.22	15.63	24.48	33.38
Pooling		F(6,26)=0.012		F(12,39)=0.136			F(6,26)=0.086		F(18,52)=3.014		
Pool.Gener.		F(6,26)=1.217		F(12,39)=0.224			F(6,26)=2.492		F(18,52)=1.135		

Breusch-Pagan test is a $\chi^2(1)$, 95% (3.841), 99% (6.635)

Hausmann test is a $\chi^2(4)$, 95% (9.488), 99% (13.277)

discarding Sierra Leone and Samoa

Table III.

RE	Unpooled	Pooling G7		Pooling Inflation level			Pooling Industrialised				
Variables		G7	Non-G7	<10	10-30	>30	Ind.	Non-ind.	N.i. <10	N.i 10-30	N.i. >30
Log GDP79	0.15252 ((1.122)	-2.1735 (-3.76)	0.12322 (0.80)	-0.27387 (-1.59)	0.51989 (2.00)	0.39003 (0.68)	-1.61055 (-2.80)	-0.33173 (-1.54)	-0.96488 (-3.64)	0.42556 (0.93)	0.39003 (0.68)
Inflation	-0.00075 (-4.71)	-0.15375 (-3.75)	-0.00075 (-4.71)	-0.10435 (-2.31)	-0.06613 (-3.18)	-0.00060 (-3.99)	-0.07356 (-1.92)	-0.00072 (-4.82)	-0.12033 (-2.05)	-0.06909 (-2.91)	-0.00060 (-3.99)
Pub. Exp. D.	-0.24741 (-2.34)	-1.2252 (-8.12)	-0.24399 (-2.31)	-0.21738 (-0.84)	-0.32704 (-2.63)	-0.25799 (-2.33)	-0.67185 (-4.69)	-0.23845 (-2.34)	-0.20901 (-0.84)	-0.31780 (-2.46)	-0.25799 (-2.39)
Var(u)	1.61042	0.28829	1.66834	1.66239	1.35418	1.30290	0.80373	1.59007	1.73304	1.40558	1.30290
Var(e)	4.69969	1.90121	4.85591	4.69271	4.18432	5.35155	2.09077	5.31646	6.0650	4.33232	5.35155
R^2	0.0376	0.2356	0.0364	0.0259	0.0718	0.0946	0.2294	0.0373	0.0460	0.0649	0.0946
Obs. (gr.)	1725 (97)	133 (7)	1592 (90)	880 (49)	574 (33)	271 (15)	454 (24)	1271 (73)	482 (28)	518 (30)	271 (15)
BP	161.49	0.14	153.1	94.31	31.91	4.50	57.37	77.22	20.80	29.60	4.50
Hausmann	14.33	0.10	12.98	18.68	0.65	3.57	1.35	7.91	4.75	0.59	3.57
Pooling		F(4,30)=0.025		F(8,45)=0.184			F(4,30)=0.182		F(12,60)=5.321		
Pool.Gener.		F(4,30)=2.500		F(8,45)=0.346			F(4,30)=4.500		F(12,60)=2.293		

Breusch-Pagan test is a $\chi^2(1)$, 95% (3.841), 99% (6.635)

Hausmann test is a $\chi^2(2)$, 95% (5.991), 99% (9.210)

Table IV.

RE	Unpooled	Pooling G7		Pooling Inflation level			Pooling Industrialised				
Variables		G7	Non-G7	<10	10-30	>30	Ind.	Non-ind.	N.i. <10	N.i 10-30	N.i. >30
Log GDP79	0.11549 (0.86)	-2.22267 (-3.80)	0.08362 (0.55)	-0.29832 (-1.71)	0.42573 (1.69)	0.43486 (0.75)	-1.61369 (-2.84)	-0.41013 (-2.01)	-0.98248 (-3.54)	0.28638 (0.64)	0.43486 (0.75)
Inflation	-0.00072 (-4.40)	-0.16159 (-1.92)	-0.00072 (-4.40)	-0.12713 (-2.46)	-0.05988 (-2.79)	-0.00049 (-2.96)	-0.07436 (-1.93)	-0.00068 (-4.46)	-0.12729 (-1.98)	-0.05994 (-2.42)	-0.00049 (-2.96)
Public Exp.	-0.26903 (-2.63)	-1.25383 (-4.62)	-0.26596 (-2.60)	-0.29593 (-2.94)	-0.35250 (-2.94)	-0.27219 (-3.63)	-0.57573 (-4.27)	-0.26718 (-2.68)	-0.27043 (-0.89)	-0.34950 (-2.77)	-0.27219 (-3.63)
Invest.	0.14199 (3.59)	-0.02970 (-0.10)	0.14445 (3.63)	0.10147 (1.89)	0.10147 (1.89)	0.36707 (2.78)	0.13225 (1.92)	0.15291 (3.69)	0.15007 (1.70)	0.09700 (1.81)	0.36707 (2.78)
Net Exp.	-0.01416 (-0.53)	-0.14520 (-1.10)	-0.01305 (-0.49)	-0.03319 (-1.05)	0.03319 (1.05)	-0.07862 (-0.97)	0.11299 (1.84)	-0.01758 (-0.64)	-0.04822 (-0.69)	0.03190 (0.97)	-0.07862 (-0.97)
Var(u)	1.60532	0.47952	1.66492	1.54382	1.28911	1.50653	0.68985	1.57495	1.54817	1.36409	1.50653
Var(e)	4.59926	1.90494	4.75638	4.57318	4.00707	5.12460	2.07692	5.22006	5.96553	4.16064	5.12460
R^2	0.0623	0.2438	0.0619	0.0535	0.1011	0.1646	0.2402	0.0691	0.0791	0.0940	0.1646
Obs. (gr.)	1661 (95)	133 (7)	1528 (88)	857 (49)	533(31)#	271 (15)	454 (24)	1207 (71)	459 (28)	477 (28)#	271 (15)
BP	170.07	0.12	161.25	106.17	36.83	7.26	59.45	77.09	22.23	33.50	7.26
Hausmann	15.92	0.13	14.47	28.06	0.35	4.17	2.14	9.34	12.19	12.99	4.17
Pooling		F(6,26)=0.015		F(12,39)=0.138			F(6,26)=0.124		F(18,52)=3.076		
Pool.Gener.		F(6,26)=1.380		F(12,39)=0.212			F(6,26)=2.548		F(18,52)=1.229		

Breusch-Pagan test is a $\chi^2(1)$, 95% (3.841), 99% (6.635)

Hausmann test is a $\chi^2(4)$, 95% (9.488), 99% (13.277)

Table V.[13]

Variables	Industrialised countries				
	RE	RE	FE	FE	FE
Log GDP 1979	-1.64047 (-2.92)	-1.45368 (-2.48)			
Inflation	-0.08277 (-2.14)		-0.12109 (-2.58)		-0.20785 (-1.90)
Inflation squared					0.00131 (1.10)
St. Dev. Infl.		-0.17396 (-1.10)		-0.14808 (-0.93)	
Pub. Exp. D.	-0.56347 (-5.46)	-0.53199 (-5.81)	-0.52717 (-4.40)	-0.51369 (-3.87)	-0.52649 (-4.36)
Invest. D.	0.22866 (3.17)	0.16618 (2.26)	0.28452 (3.53)	0.17055 (2.21)	0.31200 (3.78)
Net. Exp. D.	0.20533 (3.85)	0.21642 (3.90)	0.18352 (2.92)	0.14352 (2.23)	0.17569 (2.74)
Import D.	0.19467 (6.63)	0.17861 (5.61)	0.24713 (5.30)	0.18213 (3.81)	0.26462 (5.60)
Pop. Gr. D.	-1.69507 (-5.49)	-1.74736 (-4.66)	-1.87383 (-4.39)	-1.66778 (-3.77)	-1.98234 (-4.68)
Fert. Rate			-0.38134 (-0.50)	-1.43501 (-1.80)	-0.08586 (-0.10)
School. F.			-0.07225 (-1.46)	-0.06089 (-1.32)	-0.07121 (-1.42)
School. M.			0.07897 (1.44)	0.07653 (1.52)	0.07100 (1.25)
Var(u)	0.73474	0.72143			
Var(e)	1.88649	1.97781			
R^2	0.3487	0.3019	0.3447	0.2786	0.3554
Obs. (gr.)	454 (24)	454 (24)	347 (23)§	347 (23)§	347 (23)§
BP	94.11	78.49			
Hausmann	3.53	0.67			

§ discarding Switzerland

[13] Note that all regression are performed with some variables in deviation from group mean in the sample period; this will affect RE estimation, giving us better result, but have no consequence on the FE estimator.

Table VI.

Variables	N.I.-Infl. <10%		N.I.-Infl. 10%-30%		N.I.-Infl. 10%-30%		
	RE	RE	RE	RE	FE	FE	FE
Log GDP79	0.21720 (0.64)	-0.13395 (-0.33)	0.68948 (1.74)	0.52739 (1.29)			
Inflation	-0.13524 (-2.10)		-0.05595 (-2.10)		-0.00031 (-1.13)		-0.00140 (-3.09)
Inflation^2							5.74e-8 (3.25)
St. Dev. Infl.		-0.78933 (-4.93)		-0.19504 (-3.07)		-0.00013 (-0.65)	
Pub. Exp. D.	-0.57485 (-4.86)	-0.54694 (-4.10)	-0.40295 (-3.99)	-0.36450 (-3.16)	-0.24171 (-2.95)	-0.25768 (-3.55)	-0.20719 (-2.75)
Invest. D.	0.12452 (1.88)	0.14687 (2.66)	0.04769 (1.08)	0.04734 (1.03)	0.32516 (2.37)	0.31103 (2.10)	0.32285 (2.31)
Net. Exp. D.	-0.06409 (-0.70)	-0.07641 (-0.98)	0.05875 (1.80)	0.05097 (1.41)	-0.11713 (-1.65)	-0.12053 (-1.57)	-0.11488 (-1.48)
Extern. Debt	-0.01618 (-2.92)	-0.00418 (-0.50)	-0.00349 (-0.44)	-0.00381 (-0.50)	-0.00309 (-0.75	-0.00473 (-1.03)	-0.00034 (-0.08)
M2 D.	-0.10279 (-3.77)	-0.11148 (-4.25)					
Foreign Inv.			0.11789 (1.60)	0.29598 (2.04)	0.39163 (1.62)	0.45550 (1.65)	0.34247 (1.60)
Import			0.03349 (3.44)	0.05196 (3.13)			
Pop. Gr.	-1.20989 (-2.27)	-1.23605 (-2.29)	-0.43514 (-1.06)	0.05196 (0.12)	-1.59479 (-1.71)	-0.71525 (-0.68)	-1.97847 (-2.07)
Var(u)	1.34945	1.42031	1.08435	1.11899			
Var(e)	4.30886	4.38392	4.02034	4.07733			
R^2	0.2099	0.2394	0.1664	0.1630	0.1818	0.1764	0.2038
Obs. (gr.)	362 (21)#	345 (21)#	434 (26)§	417 (26)§	267 (15)	254 (15)	267 (15)
BP	22.97	6.25	9.15	6.92			
Hausmann	8.59	0.75	3.66	3.36			

discarding United Arabian Emirates, Fiji, Kiribati, Oman, Tonga, Tunisia, Vanuatu
§ discarding Yemen and Maldives

TABLE VII

Variables	Industrialised countries				
	RE	RE	FE	FE	FE
GDP per capita (t-1)	0.10278 (1.68)	0.13543 (2.10)	0.10264 (1.18)	0.11601 (1.29)	0.07917 (1.09)
Inflation	-0.12141 (-4.32)		-0.10177 (-3.92)		-0.06121 (-0.61)
Inflation (t-1)	0.02316 (1.65)		0.03486 (2.37)		
Inflation squared					-0.00034 (-0.35)
St. Dev. Infl.		0.15012 (1.97)		0.21701 (2.60)	
Pub. Exp. D.	-0.99961 (-4.25)	-0.95369 (-3.98)	-0.91640 (-3.52)	-0.90338 (-3.38)	-0.95404 (-3.52)
Pub. Exp. D. (t-1)	0.84735 (4.21)	0.92431 (3.95)	0.75599 (3.67)	0.82155 (3.54)	0.75939 (3.59)
Invest. D.	0.70699 (6.30)	0.70737 (5.93)	0.80353 (5.70)	0.77151 (5.05)	0.78997 (5.47)
Invest. D. (t-1)	-0.50481 (-5.54)	-0.60277 (-6.99)	-0.61049 (-4.94)	-0.70025 (-6.30)	-0.60159 (-4.94)
Net. Exp. D.	0.30801 (6.26)	0.29885 (5.26)	0.29177 (5.18)	0.23418 (3.25)	0.29034 (4.91)
Import D.	0.15028 (5.65)	0.11355 (3.80)	0.18616 (3.98)	0.11848 (2.43)	0.18319 (3.60)
Pop. Gr. D.	-1.83106 (-4.84)	-1.99828 (-4.51)	-1.53029 (-5.04)	-1.42294 (-3.98)	-1.52974 (-4.91)
Fert. Rate			0.21086 (0.15)	-1.0008 (-0.65)	0.00718 (0.00)
School. F.			-0.03707 (-0.71)	-0.03617 (-0.66)	-0.03628 (-0.68)
School. M.			0.02614 (0.48)	0.01614 (0.29)	0.02562 (0.48)
R^2	0.40266	0.38439	0.32031	0.30355	0.31662
Obs. (gr.)	406 (24)	406 (24)	299 (22)§	299 (22)§	299 (22)§

§ discarding Switzerland, Luxembourg and Korea

Table VIII.

Variables	N.I.-Infl. <10%		N.I.-Infl. 10%-30%		N.I.-Infl. 10%-30%		
	RE	RE	RE	RE	FE	FE	FE
GDP p.c. growth	0.10946 (1.07)	0.109888 (1.39)	0.18445 (3.26)	0.19309 (3.37)	0.08527 (1.24)	0.06210 (0.97)	0.07426 (1.08)
Inflation	-0.19938 (-3.85)		-0.05299 (-3.01)		-0.00017 (-0.88)		-0.00099 (-1.94)
Inflation (t-1)	0.08077 (2.13)		0.01933 (0.98)				
Inflation^2							4.19e-8 (2.19)
St. Dev. Infl.		-0.33865 (-1.58)		-0.11741 (-1.81)		-0.00011 (-0.71)	
St. Dev. Infl. (t-1)				0.07606 (1.32)			
Pub. Exp. D.	-0.25536 (-1.20)	-0.30565 (-1.22)	-0.68794 (-3.49)	-0.60781 (-3.15)	-0.25147 (-2.51)	-0.19741 (-2.76)	-0.22289 (-2.25)
Pub. Exp. D. (t-1)			0.65004 (3.00)	0.55830 (2.78)			
Invest. D.	0.11620 (1.75)		0.17720 (1.66)	0.23418 (2.19)	0.70662 (1.89)	0.85658 (2.40)	0.68332 (1.87)
Invest. D. (t-1)	-0.17633 (-1.46)	-0.11309 (-1.17)	-0.21157 (-2.81)	-0.25599 (-3.09)	-0.65720 (-1.81)	-0.71409 (-2.00)	-0.68585 (-1.75)
Net. Exp. D.					-0.06431 (-1.34)	-0.04378 (-0.65)	-0.05875 (-1.12)
Net. Exp. D. (t-1)	-0.13205 (-1.70)	-0.13725 (-1.17)					
Extern. Debt		-0.04801 (-2.49)	-0.04076 (-2.06)	-0.05898 (-2.97)	-0.01577 (-4.28)	-0.01752 (-5.72)	-0.01328 (-3.38)
Extern. Debt (t-1)	0.03101 (1.65)	0.07635 (4.25)	0.05911 (2.34)	0.06451 (2.73)	0.014842 (5.03)	0.01663 (4.39)	0.01439 (5.19)
M2 D.	-0.80494 (-4.26)	-0.66403 (-3.73)					
M2 D. (t-1)	0.73922 (4.15)	0.62434 (3.82)					
Foreign Inv.					0.15511 (0.98)	0.16414 (1.08)	0.13490 (0.94)
Pop. Gr.	-0.87338 (-2.54)	-1.25057 (-2.58)			-0.30897 (-0.20)	1.51947 (0.92)	-0.55094 (-0.36)
R^2	0.1739	0.1490	0.2159	0.2071	0.2139	0.2295	0.2115
Obs. (gr.)	320 (21)#	308 (20)#	397 (26)§	378 (26)§	238 (15)	227 (15)	238 (15)

discarding United Arabian Emirates, Fiji, Kiribati, Oman, Tonga, Tunisia, Vanuatu
§ discarding Yemen and Maldives

APPENDIX A.

The countries included in the panel are:

1. Argentina
2. Australia
3. Austria
4. Bangladesh
5. Belgium
6. Belize
7. Bhutan
8. Bolivia
9. Botswana
10. Brazil
11. Burkina Faso
12. Burundi
13. Cameroon
14. Canada
15. Chile
16. Colombia
17. Congo Dem. Rep.
18. Congo Republic
19. Costa Rica
20. Denmark
21. Dominican Rep.
22. Ecuador
23. Egypt
24. Ethiopia
25. Fiji
26. Finland
27. France
28. Germany
29. Ghana
30. Greece
31. Guatemala
32. Haiti
33. Honduras
34. Iceland
35. India
36. Indonesia
37. Iran
38. Ireland
39. Italy
40. Jamaica
41. Japan
42. Jordan
43. Kenya
44. Kiribati
45. Korea, Rep.
46. Kuwait
47. Lesotho
48. Luxembourg
49. Madagascar
50. Malawi
51. Malaysia
52. Maldives
53. Mauritius
54. Mexico
55. Morocco
56. Mozambique
57. Namibia
58. Nepal
59. Netherlands
60. New Zealand
61. Nicaragua
62. Niger
63. Nigeria
64. Norway
65. Oman
66. Pakistan
67. Panama
68. Papua N. Guinea
69. Paraguay
70. Peru
71. Philippines
72. Portugal
73. Salvador
74. Saudi Arabia
75. Sierra Leone
76. Solomon Islands
77. South Africa
78. Spain
79. Swaziland
80. Sweden
81. Switzerland
82. Syria
83. Tanzania
84. Thailand
85. Tonga
86. Tunisia
87. Uganda
88. United Arab Emirates
89. United Kingdom
90. United States
91. Uruguay
92. Vanuatu
93. Venezuela
94. Western Samoa
95. Yemen
96. Zambia
97. Zimbabwe

Pooling Groups:

- **G7**: USA, UK, Germany, France, Italy, Canada, Japan

- **Low inflation** (less than 10%): Australia, Austria, Bangladesh, Belgium, Belize, Bhutan, Burkina Faso, Cameroon, Canada, Congo, Korea, Denmark, Ethiopia, Fiji, Finland, France, Germany, Japan, Jordan, India, Indonesia, Ireland, Italy, Kiribati, Kuwait, Luxembourg, Malaysia, Morocco, Mauritius, Nederland, Nepal, Niger, Norway, New Guinea, New Zealand, Oman, Pakistan, Panama, United Kingdom, Spain, United States, Sweden, Switzerland, Thailand, Tonga, Tunisia, Saudi Arabia, United Arab Emirates, Vanuatu
- **Medium inflation** (between 10% and 30%):Botswana, Burundi, Chile, Colombia, Costa Rica, Dominican Rep., Egypt, Greece, Guatemala, Haiti, Honduras, Iran, Island, Jamaica, Kenya,

Lesotho, Madagascar, Malawi, Maldives, Namibia, Nigeria, Paraguay, Philippines, Portugal, Salvador, Samoa, Syria, South Africa, Swaziland, Solomon Islands, Tanzania, Yemen, Zimbabwe
- **High inflation** (more than 30%): Argentina, Bolivia, Brazil, Congo Rep. Dem., Ecuador, Ghana, Mexico, Mozambique, Nicaragua, Peru, Sierra Leone, Uganda, Uruguay, Venezuela, Zambia

- **Industrialised countries**: Australia, Austria, Belgium, Canada, Korea, Denmark, Finland, France, Germany, Japan, Greece, Ireland, Island, Italy, Luxembourg, Norway, New Zealand, Nederland, Portugal, UK, Spain, USA, Sweden, Switzerland
- **Non-Industrialised countries, Low inflation (less than 10%):** Bangladesh, Belize, Bhutan, Burkina Faso, Cameroon, Congo, Ethiopia, Fiji, Jordan, India, Indonesia, Kiribati, Kuwait, Malaysia, Morocco, Mauritius, Nepal, Niger, New Guinea, Oman, Pakistan, Panama, Thailand, Tonga, Tunisia, Saudi Arabia, United Arab Emirates, Vanuatu
- **Non-Industrialised countries, Medium inflation (between 10% and 30%):** Botswana, Burundi, Chile, Colombia, Costa Rica, Dominican Rep., Egypt, Guatemala, Haiti, Honduras, Iran, Jamaica, Kenya, Lesotho, Madagascar, Malawi, Maldives, Namibia, Nigeria, Paraguay, Philippines, Salvador, Samoa, Syria, South Africa, Swaziland, Solomon Islands, Tanzania, Yemen, Zimbabwe
- **Non-Industrialised countries, High inflation (more than 30%):** Argentina, Bolivia, Brazil, Congo Rep. Dem., Ecuador, Ghana, Mexico, Mozambique, Nicaragua, Peru, Sierra Leone, Uganda, Uruguay, Venezuela, Zambia

APPENDIX B.

The following figures present the different effects of inflation on economic growth at different levels of average inflation.

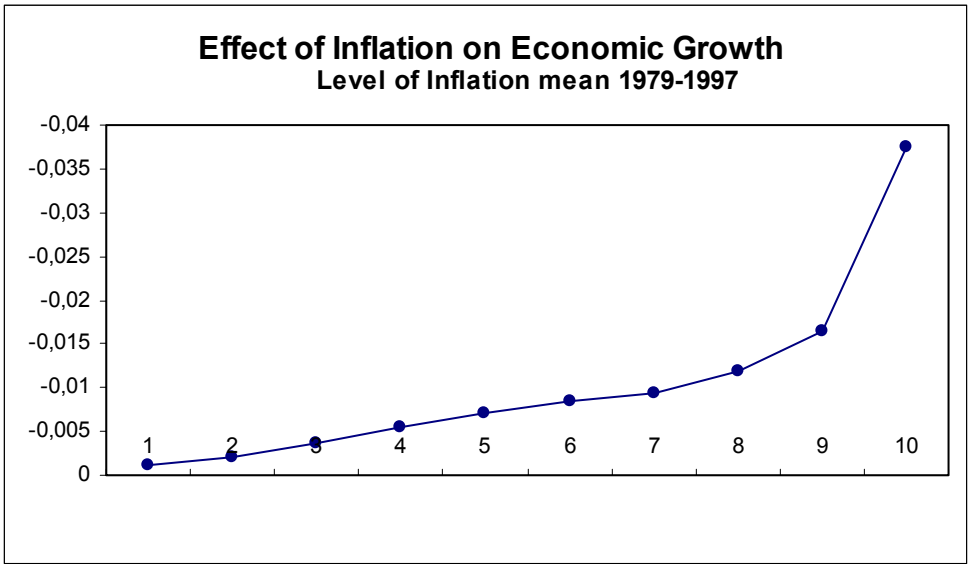

Figure 1.

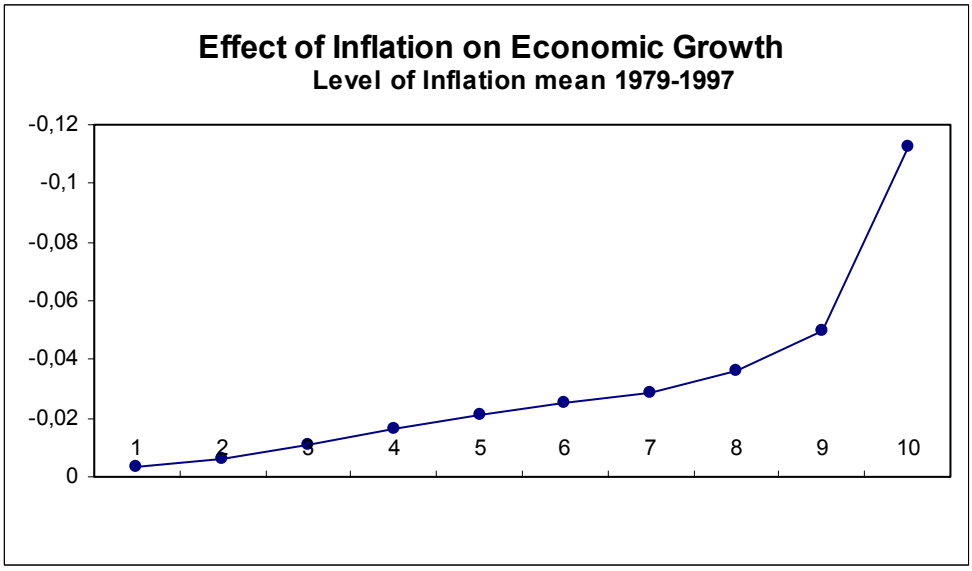

Figure 2.

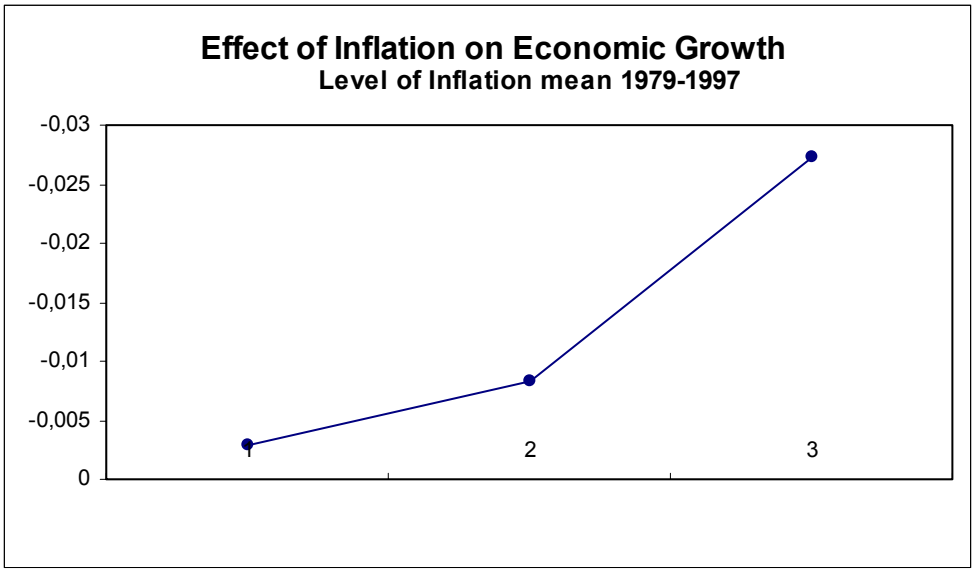

Figure 3.

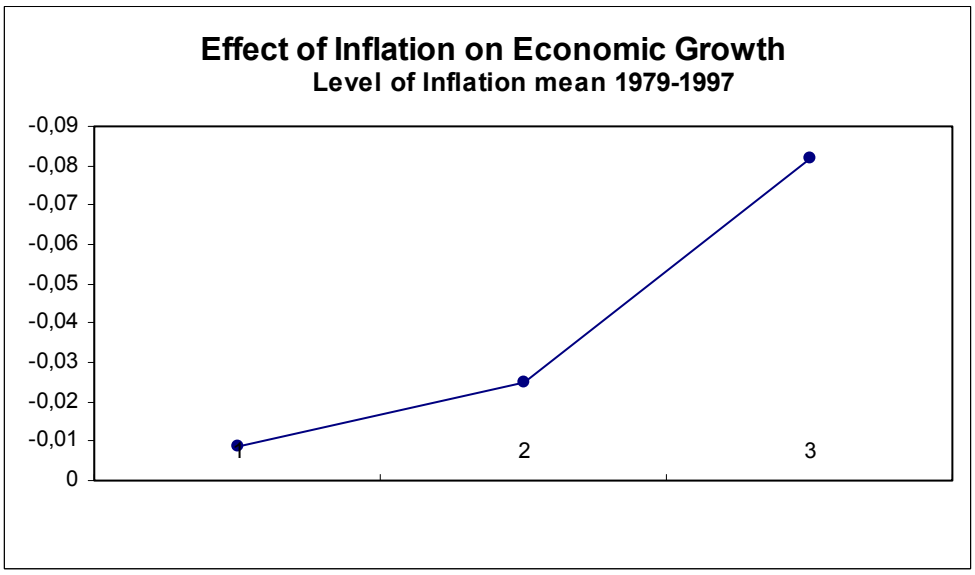

Figure 4.

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