Explaining Inflation-Growth non-linearity through Factors Reallocation

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Abstract: This paper tries to explain inflation-growth non-linearity through factors reallocation using a large panel dataset of 104 countries. Our empirical results, based on instrumental variable 2SLS model, substantiate the view that inflation (weakly) enhances the accumulation of physical capital and reduces the accumulation of human capital. This indicates the presence of 'Tobin effect' for physical capital accumulation and substitution effect (between work and education) for human capital accumulation. Moreover, this relationship is non-linear since these effects get reverse once inflation crosses certain thresholds. Finally, different macroeconomic conditions i.e financial development, trade openness and democracy can alter the sensitivity of relationship between inflation and (both physical and human) capital accumulation.

JEL Classifications: E31, E22, J24

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1) Introduction:

Since long, economists have been seeking to comprehend the nature and directions of inflation effects on long run economic growth. Notwithstanding the existence of an enormous theoretical and empirical literature on the inflation-growth relationship, discussion still lacks consensus regarding the robust inflation effects on growth. Recent empirical work has; however, overwhelmingly supported the view that the overall relationship between these two variables is negative and non-linear; albeit, country specific thresholds are yet to be determined. More precisely, inflation effects on growth are considered to be positive at mild inflation rates, strongly negative after certain thresholds and weakly negative in hyper inflation episodes (See i.e Omay and Kan, 2010 and López-Villavicencio and Mignon, 2011 and their references for empirical evidence on it) [1].

This dynamic behavior of output growth at alternative inflation rates can be explained by various factors i.e credibility of central banks at different inflation levels, signaling channel that explains producers' response to variable prices and price indexation in high inflationary environment etc. One principal factor that has been identified in the literature is the realignment of factors of production in response to inflation changes (Gillman and Nakov, 2003). To this view, agent's decision to accumulate both human and physical capital is heterogeneously affected by inflation and hence factors reallocation takes place in inflationary environment. This factors' reallocation and its impact on the long-run accumulation of both human and physical capital can possibly explain inflation-growth dynamics.

In the previous literature, several possible mechanisms have been identified to show the interaction between inflation and (both human and physical) capital accumulation. First, regarding the accumulation of human capital, high inflation can accelerate human capital accumulation by reducing its opportunity cost. Since real wages fall in inflation[2], the accumulation of human capital becomes more attractive for the young agents (Heylen and Pozzi, 2007). Conversely, the same lower real wages can force the agents to allocate more time to work and less to human capital development; making the inflation and human capital accumulation relationship negative (see i.e Binder, 1999). In this case income effect of inflation dominates the substitution effect to influence the human capital accumulation. This

[1] Gillman et al (2001) show how adverse effects of additional inflation decrease with increasing level of inflation, more precisely, the higher the inflation the lower the impact on output growth.

[2] The adverse effect of inflation on effective real return of labor is shown by Carmichael (1989), in a model where consumption takes place one lag after the income.

last possibility; nevertheless, can be altered by the depth of financial institutions. In a well developed financial system, if an agent gets loan to smooth his consumption and to improve his human capital then this relationship between inflation and human capital development can, again, turns into a positive one (See i.e Becker, 1975 and Harris and Sakellaris, 2003).

Similarly, regarding the inflation effect on physical capital accumulation, two opposing views have been advanced in the literature. Tobin (1965) observes a positive impact of inflation on the long-run physical capital accumulation. To him, at a very low inflation rate, price changes reduce the real interest rate compared with the real wage (although both decrease in net term). Both these changes influence factors' realignment; capital intensity increases vis-à-vis the labor, causing a higher accumulation of physical capital (see i.e Rapach and Wohar, 2005)[3]. Besides, higher inflation variability (essentially attached with high inflation) can also stimulate capital accumulation by increasing the precautionary savings of the agents (Dotsey and Sarte, 2000). By contrast, inflation can also reduce the accumulation of capital due to the substitution effect between consumption and capital accumulation. As increasing prices make money worth today than tomorrow, agents increase consumption and reduce savings. Accordingly, inflation also shortens the planning horizon of the entrepreneurs by increasing uncertainty about future costs and effective demand. The fact that most of the long run investment decisions are both flexible with respect to time and irreversible in nature; entrepreneurs hesitate to make long run investment projects in high inflationary regimes (see Chirinko, 1996 and Dixit and Pindyck, 1994). Finally, as capital formation is usually channelized by financial institutions, accelerating inflation impairs the efficient functioning of the financial institutions (as discussed above) and thus makes the capital formation more difficult.

Interestingly, the previous research indicates that these competing possibilities of inflation effects on factors' realignment appear systematically as inflation increases. For example, an overwhelming amount of theoretical literature indicates the adverse effect of inflation on human capital accumulation supporting the overall domination of income effect (lower real wages and more work) and a negative relationship between the two variables. While, at the same time, some studies i.e Heylen and Pozzi, 2007) show that high inflationary

[3] Rapach and Wohar (2005) indirectly support Tobin effect by showing a negative relationship between inflation and real interest rate. However, Gillman and Kejak (2011) argue that real interest rate can also be low (compared with real wage) if agents prefer leisure over work. In this case both real interest rate and investment will be lower and hence inflation will not necessarily increase capital accumulation.

shocks[4] can be supportive for human capital development. These desirable effects of high inflation on the accumulation of human capital can be a possible interpretation of why inflation is less costly when it crosses certain threshold level[5] (see i.e Levine and Zervos, 1993). To sum up, a positive inflation-growth relation explained by the previous literature can be supported by the existence of Tobin effect[6] in low inflationary environment. At a moderate inflation rate accumulation of both types of capital reduces and hence inflation-growth relationship becomes strongly negative. Finally, at very high inflation levels, an increase in the accumulation of human capital can partially offsets the negative inflation effects thus explaining a weak adverse inflation effects on output growth.

In this paper, we empirically test these effects using a large panel data set of both developed and developing countries. To the best of our knowledge this paper is the first attempt to empirically investigate this possible mechanism behind inflation-growth non-linearity. More precisely, our paper tries to address few basic questions concerning the inflation and capital accumulation relationship. First, we try to empirically test whether inflation influences the behavior of agents for their accumulation of human and physical capital. Secondly, we want to see whether this relation remains linear in all ranges of inflation or there exists (theoretically advanced) threshold that can possibly explain the inflation-growth non-linearity. Moreover, we are also interested to see if certain macroeconomic developments of a country can facilitate this realignment decision of the agents in inflationary environment. For example, whether the depth of financial institutions, strength of democratic intuitions and the degree of trade openness can influences the nature or the sensitivity of inflation effects on capital accumulation. Lastly, we want to see the effect of inflation volatility on both human and physical capital accumulation. The objective is to see whether it is the level of inflation or the resulting volatility that impacts factors realignment.

Our main findings can be summarized as follows. Inflation positively influences the accumulation of physical capital and adversely impacts the accumulation of human capital.

[4] Theoretically all these positive effects of inflation on the accumulation of human capital usually depend upon two assumptions; first, inflation is transitory phenomena and second, it is unpredictable by the agents. However, there are more and more studies in the literature that show a long-run effect of inflation on labor supply decisions of the agents (see i.e Graham and Snower, 2008 and their references).

[5] Besides, there are some other explanations of lower output response to price changes in high inflation environment. One among these is the fact that signaling channel of prices becomes less effective. Any further price changes do not incite the producers to increase their output since they assume no real impact of these changes on their returns.

[6] It is important to note that in various theoretical studies the existence of Tobin effect only shows high capital intensity (compared with labor) and not the capital accumulation. Capital intensity can increase in an environment where the overall investment is decreasing (Gillman and Kejak, 2011).

This supports Tobin's view regarding the effects of inflation on the accumulation of physical capital and the existence of substitution effect (from education to work/leisure) for the accumulation of human capital. Both these relations are, however, non-linear since the effects become reverse at higher inflation rates. Moreover, the effects of inflation volatility are negative for both human and physical capital accumulation, explaining an indirect channel through which inflation can repress factors accumulation. Finally, all these relations are being influenced by the depth of financial institutions, democracy and trade openness in an economy.

Rest of the paper is organized as follows. Section 2 presents a very brief summary of the theoretical and empirical advancements on inflation and capital accumulation relationship. Section 3 describes the data set and the econometric model used in the study. Section 4 provides our main results and some discussion. Finally, section 5 concludes.

2) Theoretical Background:

2.1) Inflation and Physical capital accumulation:

Earlier growth models (i.e Solow, 1956) assumed saving rate as a constant proportion of income and hence ignored the role of money in the process of capital accumulation. Tobin (1965) assumes a substitution from money to physical capital (due to lower real interest rate in inflation) and hence shows a positive effect of inflation on the capital accumulation; a phenomenon that is named as 'Tobin effect' in the subsequent literature. Studies on the existence of a permanent 'Tobin effect' include Ahmed and Rogers (2000), Gillman and Nakov (2003) and Gillman and Kejak (2011), among others. More precisely, Ahmed and Rogers (2000) manipulate a Vector Error Correction Model (VECM) over the long term U.S data (of more than 100 years) and find a positive impact of unanticipated inflationary shocks on consumption, investment and output.

Endogenous growth model of Gillman and Nakov (2003) assumes two changes in the agent's behavior due to inflation; it causes an increase in the use of leisure compared to labor and the use of credit good (produced again by labor) compared to money. Both these changes reduce labor time for goods production and hence increase real wages compared to real interest rate; Tobin effect. Gillman and Kejak (2011) expand this framework by introducing a substitution of consumption between current and future period which, as a result, increases savings and capital accumulation in inflationary environment. However, this relationship is

non-linear since at a very high inflation rate savings again decline due to income effect and hence real interest rate rises (an anti-Tobin effect).[7] Overlapping generation framework of Mino and Shibata (1995) also supports Tobin's view due to redistributive effects of inflation from one generation to another. More availability of capital to the young generation fastens capital accumulation in the economy. In Paal and Smith (2001), banks hold reserves in the form of money and physical capital. When inflation increases, opportunity cost of holding monetary reserves rises, resulting in a positive effect of inflation on the capital accumulation.

However, cash-in-advance (C.I.A) model of Stockman (1981) indicates an inverse-Tobin effect since inflation reduces the amount of cash available for capital accumulation. Walsh (1998) also criticizes Tobin for his Solow (1956) based exogenous growth assumptions of fixed saving rate and the role of money being confined only to financial capital stock. Hence, to Walsh (1998), Tobin effect is temporary since inflation (only) increases the consumption and capital stock along the transition path while the steady state effects of inflation on the capital accumulation are negative. An anti-Tobin effect is also shown by models where financial intermediation plays a role to channelize savings and hence capital accumulation (see i.e Ireland, 1994, Chari et al, 1996 and Haslag, 1998 among others). Inflation, under these settings, reduces the capital accumulation by increasing the reserve requirements of financial institutions.

Notwithstanding the opposing theoretical views on the relationship between inflation and capital accumulation, empirical substantiation to this issue has not been advanced sufficiently. This is at odds with the fact that need of empirical work has been stressed since long by Summers (1981, p. 193).[8] One apparent reason for this insufficient empirical treatment is unavailability of data on the capital accumulation as indicated by Crosby and Otto (2000; footnote 1). Crosby and Otto (2000) use a structural VAR estimation approach to examine the relationship between inflation and capital accumulation for 34 countries. Their study, however, does not find any robust relationship between these variables.

2.2) Inflation and Human capital accumulation:

Importance of human capital in growth process has been highlighted since long in the literature (see i.e Mincer, 1958). Accordingly, factors influencing its accumulation, including

[7] A parallel stream of literature also supports the 'Tobin effect' by showing a direct negative relationship between inflation and real interest rate (see, for example, Rapach, 2003; Rapach and Wohar, 2005).

[8] As can be noted from the above citations, most of the previous work is based on the country specific data confined mostly to the U.S.

inflation, have gained a considerable attention in the previous work. However, most of the previous literature considered human capital accumulation complementary with physical capital and hence analyzed the overall effects of inflation on both types of capital accumulation[9]. Wang and Yip (1992), for example, present an endogenous growth model where money serves the transaction purposes and then analyze the role of anticipated inflation on the accumulation of human and physical capital. Their results show non-significant effects of inflation on both types of capital accumulation. Pecorino (1995), however, opposes these results in a model where physical capital works as an input in the production of human capital. Inflation tax, under these conditions, reduces the demand for real balances and hence the accumulation of both types of capital. In Gomme (1993), labor is used as an input for both production and human capital accumulation under the assumption of free mobility between these two sectors. Lower real wages in both sectors, due to inflation, adversely affect human capital accumulation.

Several theoretical settings in the subsequent literature have complemented this negative impact of inflation on the accumulation of human capital. Gillman and Nakov (2003), for example, analyze the impact of inflation on the distribution of time between leisure and work efforts using a cash-in-advance (C-I-A) technology. Their study shows a negative impact of inflation on the human capital accumulation due to the substitution of agent's time from work to leisure activities. This behavior of the representative agent translates into higher real wages compared to real interest rate. All this ends up with a Tobin effect for the accumulation of physical capital and an anti-Tobin effect for the accumulation of human capital. Gillman and Kejak (2005) advance a model that nests several theoretical possibilities i.e AK model, AH model and a combined model and show separate effects of inflation in different cases. Generally, their findings support the conventional view by showing the presence of Tobin effect in the AK model and an anti-Tobin effect in the AH model. Accordingly, their results for the combine model follow the same pattern.

Nevertheless, models based on overlapping generations framework (i.e Bhattacharya and Haslag, 2001) show a positive effect of inflation on the human capital accumulation due to its redistribution effects between old and young generations. Inflation, under these conditions, reduces the net savings of the old generation and the net borrowing of the young generation. This redistribution enables the later group to enhance their learning and hence

[9] This joint treatment of both factors is theoretically motivated by Nelson and Phelps (1966), Romer (1993) and empirically tested by Grier (2002, 2005).

increases capital accumulation. This view has also been supported by some empirical country specific studies where the process of human capital development is shown to be positively affected by high inflation. For example, Duryea and Arends-Kuenning (2003) show that high inflation accompanied by recurring financial crisis exerts a positive influence on the human capital accumulation in Brazil.

Surprisingly, despite these plausible links between inflation and the human capital accumulation advanced by a variety of models, empirical literature on the subject is (like physical capital) very scarce. Only two studies of the recent literature can be considered as exceptions. These include the paper of Heylen and Pozzi (2007) which tests the impact of high inflation episodes on the accumulation of human capital. The study uses a panel data set for 86 countries in 1970-2000 and confirms a positive impact of inflation crisis on human capital development. Nevertheless, the study is confined to high inflation episodes only and hence overlooks the overall relationship between these variables at different inflation levels. Besides, Yilmazkuday (2012) analyzes how inflation influences certain macroeconomic variables i.e financial development, government size, human capital and trade openness and hence reduces output growth. The study shows that, among the other channels, a positive effect of human capital on growth is present (only) when inflation is below 15%. The effect of human capital on growth becomes insignificant when inflation crosses this level.

2.3) Country specific characteristics and inflation-capital accumulation relationship:

All above mentioned effects of inflation on capital accumulation can also be influenced by some specific macroeconomic developments in an economy. More precisely, the direct inflation and capital accumulation relationship can be appeased or intensified by some other developments that can vary among countries. These country specific characteristics can be called conditional variables and are different for human and physical capital, as shown by the previous literature. For instance, the adverse inflation effect on human capital can be weakened by the strong democratic institutions in an economy. Indeed, democratic institutions ensure property rights of innovations, discourage nepotism and hence motivate agents to invest in human capital development. Barro (1996) observes that the overall negative effects of democracy on growth (found in the literature) can be partially compensated if we include its indirect effects appearing through human capital accumulation. The direct positive relationship between democracy and human capital accumulation has also been empirically supported by Tavares and Wacziarg (2001) and Grier (2005), among others.

However, the evidence on the relationship between democratic regime and inflation is not concrete. One view states that inflation is usually high in autocratic regimes due to the rent seeking behavior of the ruling class and hence it decreases with democratization of an economy (see i.e Bates and Kruegger, 1993). This view has been empirically supported by Shanker and Subramanian (2007) for 70 countries in 1960-2003. On the other hand, 'populist approach' to democracy states that democratic regime has to meet public demands and hence imposes inflation tax to finance its heavy public size (see i.e Nelson, 1993). In Desai et al (2003) democracy causes high inflation in the countries suffering from unequal income distribution since poor majority wants redistribution through inflationary tax. Finally, there exists some literature supporting a lack of robust relationship between inflation and political regimes (see i.e Mijiyawa, 2011 and references there in). In the presence of competing views on democracy and inflation and a robust democracy-human capital accumulation nexus, an interesting way to analyze the whole scenario is to test whether the inflation effects on human capital accumulation are appeased in democratic regimes.

In the same way, for the physical capital accumulation, financial development plays a pivotal role. A sound financial system helps a country to mobilize savings, allocate them efficiently and facilitate risk management. All this results in a rapid capital accumulation for an economy (see i.e Benhabib and Speigal, 2000). Levine (2004) identifies several channels through which financial development can enhance capital accumulation in an economy. To author, financial institutions mitigate the transaction and information cost for the agents. A well developed financial system can also influence the savings rate and investment decision of entrepreneurs. Moreover, and among many other things, financial development improves monitoring of the projects and develops corporate governance along with funds allocation for projects (Cesar and Liu, 2003). Now concerning the effects of inflation on financial development, relationship is found to be negative due to the misallocation of credit in inflationary environment (see i.e Khan et al 2006 and Yilmazkuday, 2011). With this strong financial development-capital accumulation nexus and the adverse effects of inflation on financial development, Tobin effect is expected to be weak in well developed financial systems.

Finally, a common interaction variable between inflation and both types of capital accumulation is trade openness. Open economies tend to receive more physical capital and ideas from abroad than their closer counterparts. The previous literature supports a higher flow of FDI in open economies that consequently increases both types of capital

accumulation (see i.e Moosa and Cardak, 2006). Besides, trade openness increases specialization and hence improves the marginal productivity of capital. Moreover, a higher supply of imported capital in open economies also increases the demand for skilled labor due to complementarities between capital and skilled labor. This further augments wage premium of skilled labor compared with unskilled labor and thus enhances human capital accumulation (see i.e Crag and Epelbaum, 1996). Like the previous interacting variables, our objective here is to analyze the sensitivity of inflation effects on human and physical capital accumulation at various degrees of trade openness.

3) Data and Empirical Approach:

For our empirical analysis, we have selected annual data of 104 countries over the period of 1971-2010.[10] To remove the business cycle effects and measurement errors from our estimated results, five-year average data has been used. As some observations of the included variables are missing for developing countries, this makes our dataset an 'unbalance panel' and thus we never had complete 104 countries in our econometric models. Our estimated models take human and physical capital accumulation as dependent variables. Regarding the control variables, accumulation of physical capital is strongly influenced by financial development of a country (as discussed before). Moreover, GDP growth of a country can directly impact capital accumulation as high growth generates surplus income to invest in capital stock (Keynes consumption theory). High population growth, on the other hand, reduces the existing stock of capital per worker (Solow, 1956). Our next two covariates, trade openness and democracy are expected to positively affect the capital stock. For the human capital accumulation model, government expenditures on education are also taken as covariate.

[10] Data sources and calculations are given in Appendix. Selected sample consists of Algeria, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo. Dem. Rep., Congo. Rep., Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt. Arab Rep., El Salvador, Fiji, Finland, France, Gabon, Gambia. The, Germany, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Hong Kong. China, Hungary, Iceland, India, Indonesia, Iran. Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Kenya, Korea. Rep., Kuwait, Lesotho, Libya, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Papua New , uinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela. RB, Zambia.

Given the sound theoretical reasons to believe that human and physical capitals are jointly determined, analyzing the accumulation of one factor requires the inclusion of the other in the system. This causes a potential endogeneity problem, making the OLS estimates biased and inconsistent. To avoid these problems instrumental variable (i.e two-stage least squares) technique has been actualized for our econometric estimation. Physical capital is instrumented by its first lag and real exchange rate volatility. As capital is mobile across the world, exchange rate volatility is directly linked with capital accumulation (see i.e Servén, 2003). However, real exchange rate volatility does not directly influences human capital accumulation. In the same way, human capital accumulation is instrumented by its first lag and education expenditures (or/and overall public size in some cases). Physical capital accumulation is essentially independent of education expenditures in an economy. Country and time fixed effects are used to control for country heterogeneity and the effects of common growth shocks across countries.

Our panel equations for the human and physical capital accumulation can be expressed as:

$$\Delta H_{it} = \alpha_0 + \alpha_1 \pi_{it} + \alpha_2 Z_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (1)$$

$$\Delta K_{it} = \alpha_0 + \alpha_1 \pi_{it} + \alpha_2 Z_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Equation (1) is human capital accumulation model where ΔH_{it} represents a change in five year average human capital accumulation and π_{it} stands for inflation. Z_{it} contains a set of covariates including trade openness, financial development, democracy, population growth, GDP growth, public expenditures on education and overall public size. Last two parameters α_i and λ_t represent country and time fix effects, respectively. Equation (2) replicates model (1) for physical capital accumulation. Subsequently, in order to see how inflation uncertainty affects the accumulation of both physical and human capital, we repeat the same analysis with inflation volatility variable.

To analyze the role of macroeconomic conditions, an interaction term is included in the above models and the resulting equations become;

$$\Delta H_{it} = \alpha_0 + \alpha_1 \pi_{it} + \alpha_2 Z_{it} + \alpha_3 \pi_{it} . X_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (3)$$

$$\Delta K_{it} = \alpha_0 + \alpha_1 \pi_{it} + \alpha_2 Z_{it} + \alpha_3 \pi_{it}.X_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (4)$$

The interaction variable X_{it} represents democracy in equation (3) and financial development in equation (4). Finally, as discussed before, trade openness is also included in both equations to see how the effects of inflation on human and physical capital accumulation change with increasing degree of openness in an economy.

4) Results and Discussion:

Table (1) presents our main results that have been actualized by our IV-2SLS model. Since both human and physical capital accumulations have not been precisely measured in the literature, we used two measures for each of them to see if our results are robust with respect to the variable choice (see Appendix). To start with specification (1), here inflation is positively affecting the accumulation of physical capital which supports Tobin's view regarding the effect of inflation on physical capital accumulation. Inflation reduces the real interest rate which, consequently, results in more physical capital accumulation. These findings complement the empirical results of Ahmed and Rogers (2000) for the U.S. Bayoumi and Cagnon (1996) argue that for open economies inflation works as a tax on consumers from their nominal interest rate earnings. Consumers pay higher taxes on their high (nominal) interest rate earnings while corporations get tax deductions because of their high payments on (nominal) interest rate. This results in high capital flows from low to high inflation countries, making the relationship between inflation and capital accumulation positive for open economies.

Regarding the other covariates, financial development is enhancing the accumulation of physical capital. This supports the theoretically advanced role of financial development to encourage savings, allocate them efficiently and to facilitate risk management. Same is the case with GDP growth, high GDP growth leads to a rapid accumulation of physical capital as marginal propensity to save increases with income. Negative sign on population growth variable explains lower per-capita capital stock in high population growth countries. These Solow model predictions have also been confirmed by Mankiw et al (1992) where population growth difference, among the other factors, is responsible behind the large cross country income difference across the world. Hence our estimated coefficient measures the effect of overpopulation burden on the accumulation of physical capital.

Our next covariate, democracy is adversely affecting the accumulation of physical capital. Theoretically, democracy can exert either positive or negative impact on the capital

accumulation, depending upon the preferences of the democratic regime. On the one hand, democratic regimes do legislation to secure property rights and facilitate investors. This encourages investors and results in higher capital accumulation. On the other hand, democratic regimes also tend to focus on the demands of masses to lower inequality and better access to public goods. All this requires an increase in taxes which, consequently, reduces capital accumulation. Our findings support the second view which is also consistent with the findings of Tavares and Wacziarg (2001) for their panel data analysis. Finally, our Hansen test statistics show validity of our instruments.

In the next step, we tested the robustness of our results using the second measure of physical capital. Generally, our results remained unchanged with respect to the choice of indicator for physical capital. In addition to the other covariates, trade openness is significantly influencing the physical capital accumulation. Its positive sign highlights the role of capital flows for the capital accumulation in open economies. In short, Tobin effect of inflation on physical capital accumulation remains robust in both cases.

Our next model (specification 3) measures the effect of inflation on human capital accumulation along with the other determinants of human capital. Our main findings indicate a negative and significant impact of inflation on human capital accumulation. This supports the 'income effect' hypothesis that inflation reduces the real wages and hence forces the agents to work more. The same 'income effect' of lower real wages instigates the agents to compromise on their education in inflationary environment. Moreover, as indicated by Gillman and Nakov (2003), this relationship can also be negative if agents prefer leisure over human capital accumulation in an inflationary period.

In addition to this, physical capital accumulation has also positive influence on the accumulation of human capital; albeit, insignificant in some cases. This implies complementarities between physical and human capital accumulation, as indicated by Grier (2005). Higher physical capital means better wage premium for the skill workers and hence larger incentive to accumulate human capital. The effect of democracy on human capital accumulation is positive which is widely supported by the earlier literature (i.e Barro, 1996). Our next model (specification 4) replicates model 3 with enrollment rate as an indicator of human capital. Here inflation is insignificant while Government expenditures on education are significant and positive. It highlights the crucial role of public finance for education. The last two specifications of table (1) test the existence of possible non-linearity in the inflation effects on human and physical capital accumulation.

Table (1) : Instrumental Variables Capital Accumulation regressions1971-2010

VARIABLES	(1) Physical Capital (1)	(2) Physical Capital (2)	(3) Human Capital (1)	(4) Human Capital (2)	(5) Physical Capital (1)	(6) Human Capital (2)
Primary Enrolment	0.441	0.000			0.543	
	(0.384)	(0.001)			(0.376)	
Inflation	10.639*	0.026*	-0.249***	0.430	72.592*	-14.283*
	(6.306)	(0.014)	(0.079)	(1.666)	(39.766)	(8.653)
Financial Development	0.892***	0.004***			0.856***	
	(0.220)	(0.001)			(0.221)	
GDP Growth	0.690**		0.010***		0.651**	0.148
	(0.335)		(0.002)		(0.322)	(0.092)
Population Growth	-15.135**		-0.226***		-14.226*	-3.663*
	(7.693)		(0.046)		(7.402)	(2.127)
Democracy	-38.158***	-0.039	0.427***	8.918**	-35.187***	9.085**
	(13.961)	(0.028)	(0.134)	(4.447)	(12.918)	(3.667)
Trade Openness		0.001***		0.091		0.039
		(0.000)		(0.057)		(0.051)
GDP Growth(t-1)		0.004**				
		(0.002)				
Physical Capital (1)			0.001	0.042**		0.057***
			(0.001)	(0.020)		(0.021)
Education Expenditure			-0.034	2.156**		
			(0.021)	(0.986)		
Inflation Square					-21.214*	5.041*
					(11.974)	(2.719)
Observations	360	351	338	303	360	362
R-squared	0.176	0.508	0.609	0.461	0.191	0.475
Number of Countries	66	68	55	55	66	59
Hansen statistic	0.711	4.118	0.884	1.084	0.785	0.763
Hansen p-value	0.701	0.128	0.347	0.298	0.675	0.382

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

we added an interaction term, inflation square, in the previously estimated models. The objective is to analyze the effect of additional inflation on capital accumulation. Specification (5) shows the results for physical capital accumulation. Here our additional variable (inflation square) is negative and significant showing the anti-Tobin effect of inflation on the accumulation of physical capital after certain thresholds. At excessively high inflation rate, income effect forces the agents to reduce their savings and this lowers capital accumulation. Specification (6) shows the positive effect of additional inflation on human capital. This implies that agents consider high inflation as a transitory phenomenon and substitute work for the human capital accumulation. These results are also complemented by Heylen and Pozzi (2007) where the effects of inflation on human capital are positive when it crosses 40% level (see also Duryea and Arends-Kuenning, 2003 for Brazil).

Effectively, it is not only the average level of inflation that influences capital accumulation but also higher inflation variability that is positively associated with it (Friedman, 1977). Hence it becomes imperative to test the effects of inflation uncertainty on the capital accumulation. To do this, we have generated a variable of inflation uncertainty from quarterly inflation data (details in appendix) and then tested its effects on both human and physical capital accumulation. Table (2), presents the results of different models with inflation volatility. The effect of inflation volatility on both human and physical capital accumulation is negative whenever it appears significant. In line with Friedman's views, high inflation variability mars the signaling channel of prices changes which, consequently, lowers investment in human and physical capital. All other covariates retain the same signs and significance as they appear in Table (1).

Lastly, in order to see if our results are robust with respect to the level of education, we used secondary enrollment and secondary education attainment data of Barro and Lee (2010). We tested the effects of both inflation and inflation volatility on these human capital indicators. Our results are significant for enrollment data with negative effect of inflation and inflation volatility on human capital accumulation. The effects of Government expenditures, trade openness and GDP growth are positive while financial development and population growth match with the previous estimates. However, the results with Barro and Lee (not shown here) were insignificant for both inflation and inflation volatility.

Certainly these direct inflation effects on human and physical capital accumulation are not same for the economies working under different macroeconomic conditions. To analyze the role of some theoretically justified conditional variables, we have tested equations (3) and (4) and the results are presented in table (4). For example, as discussed in section (2.3),

Table (2) : Instrumental Variables Capital Accumulation Regressions, 1971-2010

VARIABLES	(1) Physical Capital (1)	(2) Physical Capital (2)	(3) Human Capital (1)	(4) Human Capital (2)	(5) Secondary Enrollment	(6) Secondary Enrollment
Physical Capital (1)			0.001**	0.021	0.017*	0.025**
			(0.001)	(0.025)	(0.010)	(0.010)
Democracy	-27.697**		0.309***			
	(12.988)		(0.101)			
Inf. Volatility	0.749	-0.001*	-0.003**	0.022		
	(0.734)	(0.000)	(0.001)	(0.055)		
Education Expenditures			-0.035	3.091***	0.944	1.454**
			(0.024)	(1.195)	(0.618)	(0.595)
GDP Growth			0.009***		0.101**	0.100***
			(0.002)		(0.041)	(0.036)
Population Growth			-0.190***		-2.231**	-2.234***
			(0.045)		(0.949)	(0.828)
Human Capital (2)	0.217	0.000				
	(0.315)	(0.001)				
Financial Development	0.917***	0.003***				
	(0.178)	(0.001)				
Trade Openness	0.374	0.002***		0.120*		
	(0.227)	(0.000)		(0.065)		
Inflation					-10.774*	
					(5.937)	
Inf. Volatility$_{(t-1)}$						-0.063**
						(0.031)
Observations	409	390	308	276	328	430
R-squared	0.201	0.472	0.561	0.424	0.668	0.662
Number of Countries	71	70	52	51	57	79
Hansen statistic	0.115	1.198	0.0364	0.995	1.181	3.986
Hansen p-value	0.734	0.274	0.849	0.608	0.277	0.136

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

Tobin effect of inflation on the physical capital accumulation should be lower for a country with a higher level of financial development since inflation obstructs the efficient functioning of the financial system. This is what we extract from our results of specification (1) in Table (4). Tobin effect of a given level of inflation is weak in strong financial systems. In the same way, specification (2) explains the moderating role of democracy for inflation and human capital accumulation nexus. Specification (3) shows that adverse inflation effects on physical capital accumulation are more severe in open economies. Finally, specification (4) shows that trade openness moderates the adverse inflation effects on human capital. Globally, harmful inflation effects on human capital are less severe in more open and democratic regimes. Given that all these interaction variables are continuous, the net impact of modifying variable and its statistical significance cannot be directly judged based on the coefficients. To get some more precise results, we followed Brambor et al (2006) and estimated the marginal effects of inflation change on capital accumulation conditional upon the level of financial development.

The results are shown in Figure (1.a). The results with 95% confidence interval show that Tobin effect disappears for economies with M3/GDP ratio higher than 20%. More interestingly, same level of inflation yields an anti-Tobin effect for economies with M3/GDP ratio higher than 80%. Stated differently, the marginal effects of inflation on physical capital accumulation are positive (Tobin) when M3/GDP < 20%, insignificant when 20% < M3/GDP < 80% and negative afterwards. Similarly, in figure (1.b) democracy significantly moderates the adverse effects of inflation on human capital accumulation. The incentive provided by the democratic regimes for human capital accumulation nullifies the undesirable effects of inflation on the later.

In the next two parts of the figure (1.c) and (1.d), the moderating role of trade openness on the accumulation of human and physical capital is analyzed. Here again, the Tobin effect of inflation is conditional upon the degree of trade openness in an economy (1.c). For the same inflation level, a change in inflation can lead to a Tobin effect for a close economy and an anti-Tobin effect for an open economy. Tobin effect is vanished for economies with trade to GDP ratio higher than 40%. This can be explained by the fact that in more open economies, real interest rate reductions, induced by inflation, can cause capital outflows. However, an anti-Tobin effect appears for very extreme values of trade openness with trade/GDP ratio above 300%. Figure (1.d) also identifies the significant role of moderating variable to change the inflation-human capital relationship for economies with trade to GDP ratio above 50%. The overall results indicate that Tobin effect for physical capital is

sensitive to country specific macroeconomic conditions (i.e financial development and trade openness) while the adverse effects of inflation on human capital are dependent upon the political regime and country's exposure to international trade.

Table (4): Macroeconomic Environment and Inflation effect 1971-2010

VARIABLES	(1) Physical Capital	(2) Human Capital	(3) Physical Capital	(4) Human Capital
Physical capital		0.001**		0.045**
		(0.001)		(0.020)
Inflation	30.313**	-0.586***	0.070***	-7.166*
	(13.072)	(0.194)	(0.019)	(4.002)
Democracy		0.028***	-0.009***	
		(0.009)	(0.002)	
Inflation*Dem		0.052*		
		(0.030)		
Education Expenditure		-0.049**		2.108**
		(0.023)		(0.976)
GDP Growth	0.742**	0.009***		
	(0.339)	(0.002)		
Population Growth	-16.363**	-0.207***		
	(7.788)	(0.048)		
Trade Openness		-0.003	0.002***	0.066
		(0.002)	(0.001)	(0.057)
M3/GDP	0.971***			
	(0.231)			
Inflation*M3	-0.637**			
	(0.260)			
Democracy	-35.917***			8.721**
	(13.720)			(4.447)
Inflation*Trade			-0.001**	0.201**
			(0.001)	(0.086)
Observations	360	320	353	303
R-squared	0.183	0.649	0.410	0.466
Number of countries	66	52	64	55
Hansen statistic	0.957	0.120	0.686	1.076
Hansen p-value	0.620	0.729	0.710	0.300

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

Figure (1.a)

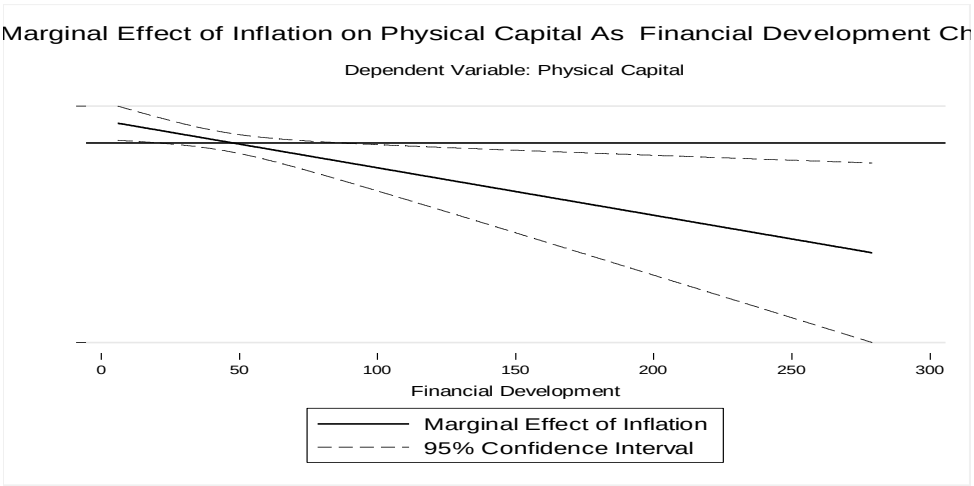


Figure (1.b)

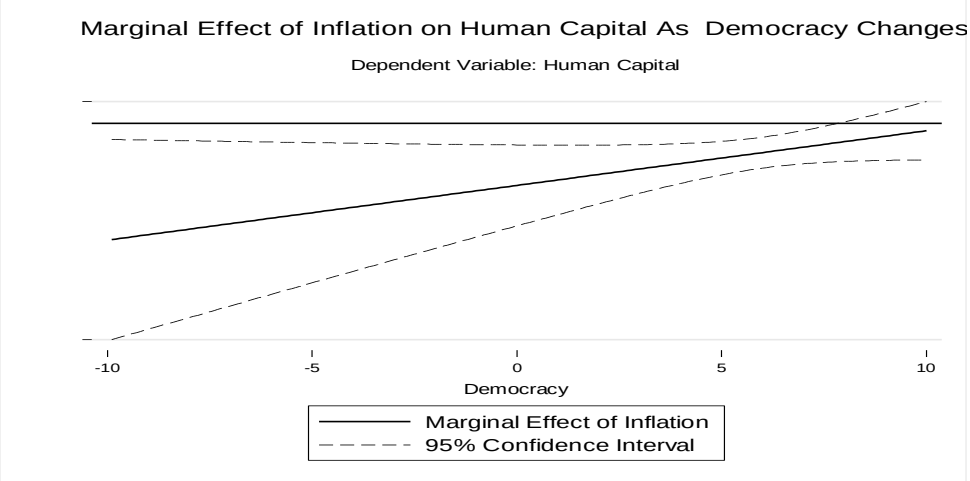


Figure (1.c)

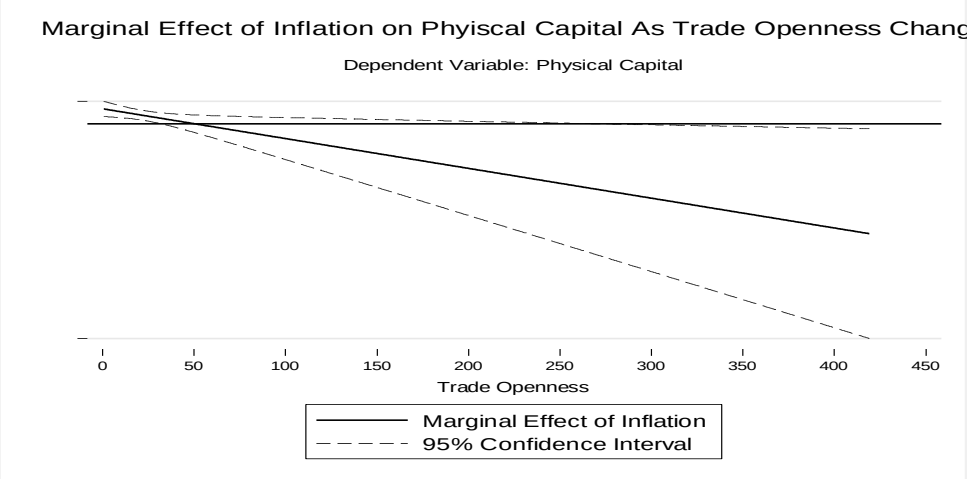
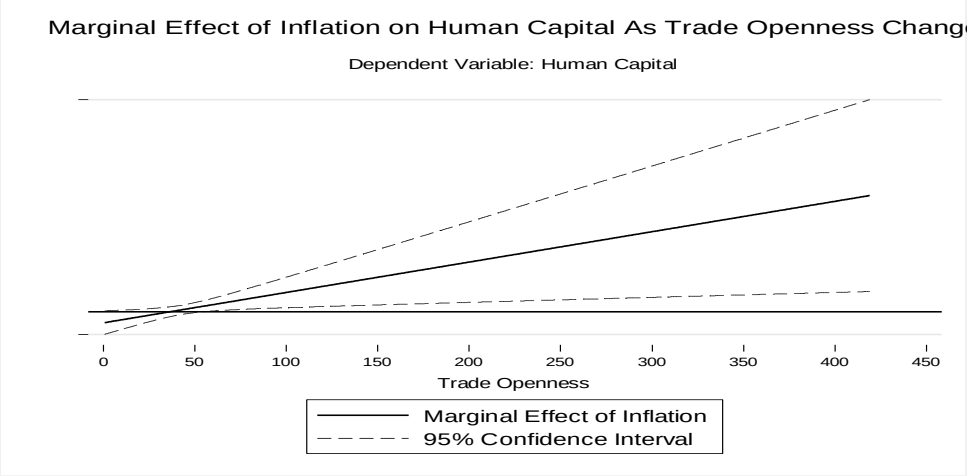


Figure (1.d)



5) Conclusions and policy implications:

A bulk of recent literature has identified that inflation and output growth relationship is negative and non-linear. The literature also finds that the intensity of these adverse effects of inflation on growth reduces as inflation rate increases. Gillman and Nakov (2003) argue that this dynamic response of output to inflation changes reflects the factors' realignment that takes place in inflation. Our paper brings some empirical substantiation to this view and probes into the existence of 'Tobin effect' and several other theoretical possibilities in a large panel data set.

Our main results confirm the theoretical views that inflation positively affects the accumulation of physical capital and adversely influences the accumulation of human capital. This supports Tobin's view for physical capital accumulation and the existence of substitution effect (from education to work) for human capital accumulation. These findings are in accordance with the theoretical results of Gillman and Kejak (2005). However, these effects are non-linear and get reverse once inflation crosses certain thresholds. In other words, after certain inflation level, the accumulation of human capital becomes interesting for the agents while further physical capital accumulation is avoided. These findings explain a plausible mechanism behind inflation-growth non-linearity. Rapid accumulation of physical capital in low inflationary environment accelerates growth till the level where inflation retards investment decisions and thus reduces growth.

Our empirical results imply that the adverse effects of any level of inflation are country specific and depend upon the factor endowments of that economy. As the role of inflation tax is significantly different in countries with heterogeneous factor endowments and production technologies, any policy to curb inflation must take into account these factors. The welfare implications of the same level of inflation can be different across countries with these structural differences. A more clear distinction is made when we study some macroeconomic developments, possibly influential for this relationship. Here we find that the Tobin effects of inflation on physical capital accumulation are only relevant for close economies working under lower level of financial development. For open economies with a well developed financial system, the direct negative effects of inflation on the disruption of financial system nullify the Tobin effects and hence any positive effect of inflation on physical capital accumulation disappears. This also explains why Romer's (1993) optimal level of inflation

decreases with the degree of trade openness. Indeed the use of inflationary finance becomes a sub-optimal choice for an open economy.

In the same way, strong democracies modify the adverse effects of inflation on human capital accumulation. Even if the task of controlling inflation becomes harder in some populist regimes, its welfare implications are not extremely severe due to a rapid accumulation of human capital in democratic regimes. More precisely, although our estimated results do not contain any message for the optimal inflation rate, they only enable us to say that the existing empirical inflation-growth literature has emerged in a close environment and should be treated in a broader horizon. At best, these findings, along with some other results of the recent literature (i.e Ylimazkuday, 2012) state that the optimal inflation rate depends upon several macroeconomic developments and institutional quality of a country and hence optimal inflation rate changes with these dynamics.

Appendix: Descriptive Statistics, Data Definitions and Sources

Definition of the variables and Data sources

Human Capital (1)	Average years of schooling for the population of age 15 and older. Table (3) shows secondary education attainment using the same criteria. These data have been taken from Barro and Lee (2010)
Human Capital (2)	Average Enrollment data is also used as another indicator of human capital development. This data set is taken from United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics.
Physical Capital (1)	Physical capital accumulation data set has been retrieved from Penn-World Tables 7.1
Physical Capital (2)	Our second indicator of physical capital accumulation is estimations are based on the capital stock data from Penn-World Tables 7.1 and using the method described by Barro and Lee (2010, footnote 10). The basic difference between the two indictors is their depreciation rates and stationarity conditions.
Π_{5yt}	Average annual consumer price inflation (π) in the period of 5 years before t. Inflation is calculated as $\Pi=\log(1+\pi)$. Data set is retrieved from World Development Indicators (online data bank). The indicator for inflation variability is generated from quarterly inflation of International Financial Statistics (IFS, 2011).
$VINF_{5yt}$	Inflation variability is indicated by 5-years standard deviation of inflation of quarterly observations. Ten windows of 20 observations each (i.e 1971Q1-1975Q4) are generated and then inflation variability is calculated as VINF=log(1+sd(INF)).
GE_{5yt}	Average annual real per capital government expenditures on education (as percentage of real GDP) in the five year before t. This data set has been obtained from UNESCO online data source: http://www.uis.unesco.org/i_pages/IndPGNP.asp.
$DEMOC_{5yt}$	Dummy variable for democracy is taken from Cheibub, Gandhi and Vreeland

website: https://netfiles.uiuc.edu/cheibub/www/DD_page.html. The data set consists of dummy variable which is averaged to match the frequency with the other variables. Since democracy does not change its value quickly, most of the dummy values remain in integers after averaging the dataset. The data set ended at 2008 and hence our last observation is three years average.

T. Open — Trade openness is represented by the ration of export plus import to GDP, data is taken from World Development Indicators (WDI)

$Pop.Gr_{5yt}$ — Average annual population growth data is retrieved from World Development Indicators (WDI).

$Fin.\ Dev_{5yt}$ — Ratio of liquid liabilities (i.e M3) to GDP is taken as an indicator of financial development.

$GDP.Gr_{5yt}$ — The effect of GDP growth on the accumulation of physical and human capital accumulation is controlled by including the 5-years average GDP growth.

Table (4): Descriptive Statistics

Variable	Mean	Std. Dev	Minimum	Maximum
GDP Growth	3.383	48.853	-12.105	1408.18
Pop. Growth	1.919	2.426	-6.222	62.889
Trade Open	75.566	50.987	0.418	419.038
M3/GDP	47.351	35.449	6.276	280.211
Human Cap (1)	4.129	1.668	0.379	7.921
Human Cap (2)	41.219	35.706	0.029	149.224
Physical Cap (1)	345.82	130.24	30.65	1029.47
Physical Cap (2)	3.853	0.659	2.197	5.108
Inflation	0.138	0.293	-0.042	4.192
Education. Exp	3.841	1.598	0.356	10.051

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