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SECTION 1 Macroeconomic Processes and Regional Economies Management

The Influence of Inflation, Volatility of Inflation and Imports on Investment: A Panel Data Approach

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Abstract

The paper investigates the response of the share of domestic investment in GDP to changes in the level of inflation rate, the volatility of inflation rate and the ratio of imports to GDP using panel data analysis for a sample of Central and East European countries and for the period of 1995-2003. The choice of correct specification of the econometric model for each panel regression is based on the results of specification tests that include Hausman, Lagrange Multiplier and F tests. The main findings are the following: 1) Both the level of inflation rate and its volatility have exerted negative effects on the share of domestic investment in GDP. Even though the estimated effects are statistically significant, they can be characterized as 'economically weak'. 2) The estimated effect of the ratio of imports to GDP is both highly significant in statistical sense and also economically strong.

Key words: Domestic investment, inflation, volatility, imports.
JEL Classification: F4.

1. Introduction

The specification of the behaviour of aggregate investment naturally depends on the model chosen out of a variety of alternatives, including Tobin's q, the neoclassical, the accelerator and the profits models, among others. The fact is that the choice of a specific model reflects the subjective judgements of the researcher. Furthermore there is always the possibility that the independent (explanatory) variables could be highly correlated. Under these circumstances, some authors have suggested that when the main motivation of the study is to investigate the qualitative and quantitative nature of the effects of specific independent variables on the dependent variable (such as growth rate of GDP or investment share of GDP), it may be preferable to run simple regressions for each independent variable separately (Kormendi and Meguire, 1985; Desphande, 1997; Garibaldi et al., 2002; Chubrik, 2005). This is the approach we adopt in this study which aims at investigating the response of the share of domestic investment in GDP to changes in the level of inflation rate, the volatility of inflation rate and the ratio of imports to GDP using panel data analysis for a sample of Central and East European countries.

The impact of higher inflation on long-run growth rate has been studied extensively. Numerous authors have produced evidence of a negative relationship between the two variables (Fischer, 1993; Briault, 1995; Kormendi and Meguire, 1985; Barro, 1991, 1996; Guerrero, 2003). This finding is also consistent with some of the theoretical arguments that suggest that 'lower inflation' allows for reductions in 'real cost of production' leading to higher rate of growth of total factor productivity, simply because it enables economic agents to perceive the actual prices correctly so that they can make rational investment decisions (Harberger, 1998). The implicit argument behind Harberger's hypothesis is that lower inflation leads to higher rate of economic growth by improving the efficiency of resource allocation which has been supported by the evidence produced by Fischer (1993). On the other hand, Fischer and Modigliani (1978) suggested that higher inflation is

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likely to lower not only the economic efficiency but also the level of investment by discouraging long-term contracts and increasing the risk premium on interest rates through the increased future uncertainty it causes. Barro (1995), based on a cross-sectional study of the experience of 103 countries, reported that an increase of 10% in inflation rate leads to a reduction in the ratio of investment to GDP by 0.4-0.6 percentage points annually. However, some others have been able to report the same negative relationship between inflation and investment only for private investment and not for total investment (Kirmanoglu, 2001).

Similarly the empirical work investigating the effects of volatility of inflation on investment are mixed and contradictory: Aizenman and Marion (1996) have produced evidence of negative effects of alternative measures of volatility (which include a fiscal, monetary and real exchange rate measures of volatility and a composite index of volatility based on the weighted average of these three) on private investment. However, they reported that volatility has no effect on total investment. Another study which has been unable to find negative relationship between inflation volatility and total investment is that of Al-Marhubi (1998), who suggested that inflation volatility affects economic growth negatively by lowering the productivity of investment and not by lowering the level of total investment.

Harchaoui et al. (2005) investigated the effects of the exchange rate on investment behaviour of Canadian manufacturing industries; their results suggested that the positive impact of a given depreciation of the exchange rate on investment could be strong or very weak depending on whether the exchange rate volatility is low or high and the nature of the investment response depends on the type of industry. Their results indirectly imply that the impact of the higher inflation or higher volatility of inflation on investment could be more complex than it looks and may vary between different sectors, countries or samples of countries. On the other hand the impact of increased level of imports or the ratio of GDP on the rate of investment has not received much attention in the literature analysing the behaviour of domestic investment.

Lawrence and Weinstein (1999) have produced some evidence in favour of the argument that, in case of Japan and Korea, contrary to popular belief, their growth experience was import-led instead of being export-led. Their results suggested that increased availability of imports has had positive effect on total factor productivity and growth of these countries. Furthermore, they argue that the rate of investment must have been positively affected by the increased availability of imported capital goods and specialized inputs. The significance of a higher degree of import penetration on growth was also pointed out by Balassa (1988) not only in relation to its positive technological and efficiency effects on domestic producers, but also in relation to its contribution to the flow of new ideas and accumulation of stock of knowledge leading to positive externalities in terms of production of new range of products both for home and global markets. Intuitively the increased flow of new ideas leading to production of new range of products implies a possible increase in the rate of investment as well.

In light of the above discussion, our goal in this study is the investigation of the effect of each one of the following macroeconomic indicators on the share of domestic investment in GDP using panel data for a sample of nine Central and East European countries;

a) the level of inflation rate
b) volatility of inflation rate;
c) the ratio of imports to GDP.

The sample period of our panel data is 1995-2003 and the 'correct specification' of the econometric model for each regression is made based on the results of specification tests given by Hausman, Lagrange Multiplier (LM) and F tests. The organization of the rest of the paper is as follows: The next section briefly explains the empirical methodology used in determining the correct specification of the econometric model for each panel regression and also states the source of data. The results of specification tests from panel regressions and the estimates obtained from the models

preferred by the specification tests are summarized in section three. Section four is devoted to the interpretation of empirical results and the last section concludes with a brief summary of results.

2. The Model Specification and Empirical Methodology

The general specification of the model we used for panel regressions of investment behaviour of the countries included in our sample of Central and East European countries (which we identify at the end of this section) is given by equation (1) below:

$$y_{it} = a_i + b' x_{it} + \varepsilon_{it}, \quad (1)$$

Where:

i = 1, ……., n (n – the number of countries)
t = 1,…….., T (T – the number of years (periods))

y_{it} = The share of domestic investment in GDP for country *i* for year *t* (the dependent variable),

x_{it} = The vector of *k* regressors (independent variables),

b' = The vector of *k* coefficients representing marginal effects for x_{it} (common across *i* and *t*),

a_i = Intercept for country *i* which represents country-specific (or individual) effect which is constant over time,

ε_{it} = Error term for each observation distributed normally with 0 mean and constant variance – $\varepsilon_{it} \approx N(0, \sigma_\varepsilon^2)$.

As argued in the introduction section when the independent variables are highly correlated and/or the fundamental motivation of the study is to investigate the nature of the effect of each one of the specific independent variables on the dependent variable (such as economic growth or investment rate), it may be preferable to run simple regressions separately for each one of the independent variables. We adopt the same approach in this study, which implies that in eq. (1), the number of regressors is one (i.e. k = 1). However, there is further complication regarding the econometric specification of the model, which is related to the correct specification of the nature of the country specific (or individual) effects captured by the intercept term (a_i) which is assumed to be constant over time.

Given the assumption that a_i is constant over time, there are three distinct possibilities for the values of a_i across countries (cross sectional units): (A) They are "fixed" and (in statistical sense) "different" from each other; (B) They are randomly drawn from a normal population distributed with 0 mean and constant variance; (C) They are "fixed" and "common" across the countries. The models described by cases (A), (B) and (C) are referred to as "Fixed Effects", "Random Effects" and "Pooled Classical Regression" models which are specified below by equations (2), (3) and (4):

(A) Fixed Effects Model

$$y_{it} = a_i + bx_{it} + \varepsilon_{it}, \quad (2)$$

(B) Random Effects Model

$$y_{it} = a_0 + bx_{it} + \varepsilon_{it} + u_i, \quad (3)$$

where a_0 is a constant term and u_i is the error (random) component of country specific (individual) effect for country i which is assumed to be distributed normally with 0 mean and constant variance;

$u_i \sim N(0, \sigma_u^2)$,

(C) Pooled Classical Regression Model

$$y_{it} = a_0 + bx_{it} + \varepsilon_{it}. \quad (4)$$

The correct specification of the model for panel regressions (for each independent variable separately) involves applying statistical tests known as Hausman, Langrange Multiplier (LM) and F tests and choosing the appropriate model out of the three models specified above as (A), (B) and (C) (Hausman, 1978; Breusch and Pagan, 1979; Greene, 1997). The empirical methodology in applying these specification tests is briefly as follows: After estimating all three models and the relevant test statistics, Hausman test is applied to make a choice between "Fixed Effects" and "Random Effects" models. If Hausman test preferred the "Fixed Effects" model, then F test is applied to determine whether or not the individual (country specific) effects given by a_i are common across countries. In case F test suggests the presence of "common intercepts" across countries (i.e. $a_1 = a_2 = \ldots\ldots = a_n$), the correct specification is given by the "Pooled Classical Regression" model. Otherwise, the appropriate model is the "Fixed Effects" model. On the other hand, if the preferred model as a result of Hausman test is the "Random Effects" model, then LM (Lagrange Multiplier) test is applied to choose the "Random Effects" and "Pooled Classical Regression" models.

The source of all the data used in our study is "World Bank Database of World Development Indicators"[1]. The share of domestic investment in GDP (which is the dependent variable in our panel regressions) is listed as "the share of gross capital formation in GDP" in the source. The inflation rate is the annual percentage change in consumer price index. The measure of "volatility of inflation" that we used in our study is the (absolute) deviation of the inflation (of country i for year t) from its long-run mean (for country i). The data for the ratio of imports to GDP for all the countries and years included in our sample are taken directly from the same source.

We note that due to missing data, the number of data in our panel set is 78 for all 3 panel regressions and our panel data can be characterized as an "unbalanced panel". As Stock and Watson (2003) note, an 'unbalanced panel' is also capable of yielding informative estimates[2].

As noted earlier, the main motivation of our work is to investigate the nature of the effect of each one of the three macroeconomic indicators, namely the level of inflation rate (IR), the volatility of inflation rate (VIR) and the ratio of imports to GDP (MGDP) on the share of domestic investment in GDP (IGDP) of an average country in a sample of nine Central and East European countries; these countries are Hungary, Slovakia, Czech Republic, Poland, Slovenia, Romania, Bulgaria, Croatia and Macedonia. Except the last two, all of them joined EU either in 2004 or in 2007. Due to the possibility of structural shift in coefficients of the indicators (independent variables) specified above, we limited the panel data analysis to period prior to EU membership. Also limitations regarding the availability of reliable data for certain countries prior to 1995 made us choose 1995-2003 as the sample period. Finally, we note that to deal with the possible problem of heteroscedasticity we applied the White's correction for heteroscedasticity so that the estimated standard errors are heteroscedasticity-robust and the corresponding t-statistics are heteroscedasticity consistent (White, 1980).

3. The Empirical Results

The results of regressing the dependent variable (IGDP) on each one of the independent variables (IR, VIR, and MGDP respectively) separately for all three models specified in the second section, and then carrying out the specification tests stated in the same section are summarized below in Table 1.

[1] The World Bank Database: http://devdata.worldbank.org/dataonline/
[2] Software we used is LIMDEP 8.0 student version.

Table 1

The Impact of Selected Macroeconomic Indicators on the Share of Domestic investment in GDP

Indicator (Ind. Variable)	Ha	Fb	LM	Specification d (Model)	Coefficient e	Intercept e
IR	0.14		111.07f	Random Effects	-0.009 (-3.17)f	24.33 (16.71)f
VIR	0.33		86.85f	Random Effects	-0.009 (-2.42)g	24.03 (17.1)f
MGDP	3.13		94.89f	Random Effects	0.15 (3.12)f	15.6 (5.33)f

[a] Hausman test statistic.
[b] F statistics are not reported simply because Hausman and LM tests preferred the "Random Effects" (R.E) model for all three regressions.
[c] Lagrange Multiplier (LM) statistics.
[d] Model selected as a result of specification tests.
[e] Values in parentheses under coefficient and intercept estimates are heteroscedasticity consistent t-statistics. And the estimated intercept corresponds to the non-random (fixed) component of the true intercept for each country which is common for all the countries in the sample.
[f] Significant at 1% level.
[g] Significant at 5% level.

4. Interpretation of Results

As the results presented in Table 1 show, Hausman and LM tests suggested that the correct specification of the model for estimation of the relationship between the dependent variable (the share of domestic investment in GDP) and each one of the three variables is the "Random Effects" model. The estimates obtained from the "Random Effects" model for the first case where the independent variable is IR (the level of inflation rate) suggest that the dependent variable (IGDP) has been positively affected by the decreases in inflation rate over the sample period; the estimated coefficient suggests that a 10% decrease in the level of inflation rate (of an average country in the sample) has led to approximately 0.09 percentage points increase (annualy) in the share of domestic investment (of that country). We note that this estimate is much smaller than the range of estimates provided by Barro's cross-sectional study that was referred to in the first section (Barro, 1995).

The estimate that we obtained in this study for our sample of Central and East European countries implies that the dramatic decrease in the average (annual) inflation rate of these countries from 22.6% in 1995 to 4.3% in 2003 raised the (average) investment rate only by 0.16% annually (Source: Authors' computations). This is also supported by the fact that the average share of domestic investment in GDP (of all the countries in our sample) increased by only approximately 1.6 percentage points (from 22.36% to 23.94%) between 1995 and 2003 despite the substantial reduction in the rate of inflation over the same period. This result is consistent with our earlier findings that suggested that over the same time period the decrease in the (average) inflation rate exerted "statistically significant" but "economically insignificant" positive effect on the (average) growth rate of GDP of the same sample of countries; for every 10% reduction in inflation rate, growth rate was found to have gone up by approximately 0.1 percentage points annually for the average country in the sample (Ciftcioglu and Begovic, 2006) .

The regression results obtained from the estimation of the "Random Effects" model for the relationship between the dependent variable (IGDP) and the volatility of inflation rate suggested that the response of IGDP to changes in volatility was identically the same as its response to changes in the level of inflation rate. The estimated value of the coefficient of VIR (independent variable) is -0.009 and it is statistically significant at 5% level. In other words, even though the investment rate responded positively to reductions in inflation volatility, the magnitude of the response seems to

be "economically insignificant or weak"; a 10% reduction in inflation volatility led on average to (annually) 0.09 percentage points increase in the share of domestic investment in GDP of an average country in our sample. However, considering the fact that most of the previous research has been unable to detect a statistically significant effect of neither the level of inflation rate nor its volatility on "total investment", we believe that our results support our initial contention that the nature of the response of domestic investment to changes in inflation rate or its volatility may vary between individual countries or sample of countries.

As one can see in Table 1, the specification tests revealed that the best specification for panel regression of IGDP (the dependent variable) on MGDP (independent variable) is also the "Random Effects" model. The regression results based on "Random Effects" specification of the model suggest that the share of domestic investment in GDP was significantly affected by the changes in the size of imports relative to GDP not only in statistical sense but also economically: The estimated coefficient of the independent variable (MGDP) is statistically significant at 1% level and its numerical value (0.15) implies that over the sample period, the investment rate (IGDP) of an average country in the sample went up by approximately 1.5 percentage points (annually) for every 10% increase in the ratio of imports to GDP. This result suggests that trade liberalization policies that allow for increases in the volume and degree of penetration of imports in the domestic economy can have growth enhancing effects, not only by increasing the total factor productivity through the increased competitive pressures it generates for domestic producers, but also by leading to an increase in the rate of investment. As argued in the introduction section the main channels through which this effect operates are likely to be the increased availability of imported capital goods and specialized inputs, the increased range of products that can be produced by domestic producers and the general increase in the rate of new ideas flow and stock of knowledge of the domestic economy.

5. Conclusions

The results of previous literature on the effects of the changes in the level of inflation rate and the volatility of inflation on domestic investment are mixed at best. While some theoretical work suggested a negative effect of inflation on the level of investment, some others argued that the main adverse effect of higher inflation on economic growth operates through its negative effects on productivity of investment and total factor productivity. Similarly, while the results of some of the empirical work on the subject supported the latter hypothesis, the others have produced some evidence in favour of adverse effects of inflation particularly on private investment. On the other hand, the impact of "import openness" of an economy on the behaviour of aggregate investment has not received much attention in the literature, possibly because of the lack of strong theoretical arguments relating the two variables.

In this paper we used panel data from a sample of nine Central and East European countries for the period of 1995-2003 to investigate the nature of the effect of the changes in the level of inflation rate, the volatility of inflation rate and the ratio of imports to GDP on the share of domestic investment in GDP. The specification tests showed that the correct specification of the econometric model for all three cases investigated is the "Random Effects" model. The main findings obtained from the estimation of "Random Effects" type of specification of panel regressions are as follows:

1. Both the level of inflation rate and its volatility negatively affect the share of domestic investment in GDP.
2. The increases in the ratio of imports to GDP have exerted (may be surprisingly) not only statistically highly significant but also "economically relatively strong" impact on the share of domestic investment in GDP of an average country in our sample over 1995-2003.

What do our results suggest for the policy makers? First of all, higher inflation or its volatility are likely to lead to lower share of domestic investment in GDP, which is one of the most important determinants of economic growth. In other words, higher inflation or its volatility negatively affect

the willingness of firms to invest in productive assets and therefore leading to a decrease in the rate of physical capital accumulation this is probably due to the fact that higher inflation or its volatility increases the degree of uncertainty about the future real returns from investment in additional physical capital stocks. This in turn increases the degree of risk associated with each level of investment and therefore leads to a decrease in the rate of investment.

The conventional wisdom in the past largely argued that the negative effects of higher inflation or its volatility on economic growth largely operates through their adverse effects on productivity of investment; higher inflation or its volatility reduces the efficiency with which resources are allocated in a free market economy. Our results suggest that in addition to this adverse effect on "efficiency of resource allocation", also the total amount of resources allocated for investment in productive assets decreases due to higher inflation volatility. Therefore policy makers when evaluating the potential benefits and causes of disinflaniotary policies should take into account the positive growth enhancing effects that may result from the likely increase in the rate of investment.

And finally our results showing that higher share of imports in GDP positively affects the rate of domestic investment provide new evidence in favour of import liberalization policies. Import liberalization which allows for a variety of foreign capital and consumer goods to be imported into a country can positively affect the rate of investment. First of all, increased availability of new imported (foreign) capital goods that embody new technologies is likely to increase the expected rate of return on new investment. In addition an import of new range of consumer and intermediate goods also increases the stock of ideas for domestic entrepreneurs for the production of new range of products. And this implies an increase in the rate of investment and economic growth. The message for policy makers is clear: import liberalization that involves reduction in import taxes and quotas and other kinds of barriers for imports is beneficial for long-term growth.

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