The relationship between inflation and economic growth in OECD countries

Master Thesis

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Abstract

In modern world, economic growth is the main object of many countries. And the rate of inflation is another central subject for the macro economic policy in many countries and it is an important criteria to measure whether the macro economy in a country works steadily and healthy. So the relationship between these two indexes—economic growth rate and the inflation rate—is always debated.

There are three possible relations between the two variables: positive, negative and no effect. And many theories and empirical results are carried out to test the relationship.

This paper analyses the relationship between inflation and gross domestic product (GDP) in OECD countries while at the same time considering the influence of variables such as: investment rate, trade balance, fertility rate, direct foreign investment and tax. The main object is to assess the effect of inflation on economic growth. The second aim is to check the effect of tax rate on the economic growth rate. Tax is also important for the economy. Econometrics techniques for panel data are used for the analysis.

**Keyword:** Inflation, GDP, tax, panel data
Acknowledgments

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Thanks to all my friends who help me find some data and information of my project when I was confused and trapped!

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The relationship between inflation and economic growth in OECD countries

I Introduction

1. Background

Currently, most countries of the world seem to be paying more attention to the economic issues. Some countries want to become the “giant” in the globe market through the fast economic growth. To sustain rapid economic growth seems to be a main objective in most countries. The rate of inflation is another central subject of the macro economic policy in many countries. Inflation is also an important indicator for assessing the balance between the overall demand and supply in a country; in a way the rate of inflation can be thought of as indicating whether the macro economy in a country is steady and healthy. Hence, the relationship between these two fundamental variables ---inflation and economic growth, is always an arguable topic for all the countries in a long time.

Numerous studies using different frame works have been carried out to clarify the relationship between inflation and growth\(^1\). But since the relationship is complex there are still different opinions about the relationship between inflation and economic growth.

2. The purpose and the outline of the paper

The main purpose of this paper is to investigate the potential negative relationship between inflation and economic growth by means of current data. I use the data of 28 OECD countries (except Czech Republic and Slovak Republic) and in a period of 23 years from 1985 to 2007. A second aim of this paper is that I would like to test whether the tax rate has a direct effect on the economic growth. Many papers analyzed the relationship between inflation and economic growth from the aspect of "inflation tax"---a hidden tax. Many economists consider the inflation tax not that strong in the real market. They think that the inflation tax maybe only affect people in the middle and lower level, although it do really bring the troubles to people's normal lives. The inflation tax impels people to hold more real assets than the monetary assets. So the tax rate would decrease the income of people and also prevent the positive effect that inflation exerting on the economic growth. Hence, here I pick it out to test its effect and significance in the market. However, due to the different time periods as well as different countries, I do not completely follow the models used in my replication paper “Inflation and Growth: some panel data evidence” and Robert J. Barro and Xavier Sala-i-Martin’s book. But I do follow their panel techniques for this analysis. Thanks to the constraint of time and knowledge obtained during the course, in this research, I will only focus on smaller numbers of countries but with more

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2 They separate in the 1993, but our data set starts from 1985. Since there are a lot of data missed for these two countries and the results would be affected by the missing data. So I delete these two countries in our data set.

3 The paper will be introduced specifically in the third part.
updated data.

In the paper, I will introduce some different theories and empirical studies to demonstrate the relationship between inflation and economic growth. These empirical studies have attempted to examine whether the relationship between inflation and long-run growth is linear; non-linear; casual or non-existent. Ultimately, I will test that whether the inflation has a negative effect on the economic growth and also the new independent variable tax has any significant effect on the economic growth rate in OECD (Organization of Economic Cooperation and Development) countries. The rest of the paper is structured as follows: Section 2 will review the theories and empirical literature of inflation and growth. Section 3 provides a data description of the explanatory variables which will be used in the later regressions. Section 4 is the empirical setup. Section 5 is the empirical results from the study. Section 6, I will give a conclusion and discussion of the paper.

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II Earlier theoretical and empirical studies

We will review some of the theoretical concepts and empirical models about the inflation and economic growth. The theories and models are appearing in the history and modern society.

1. Theoretical Constructions

Generally speaking, there are three opinions in the western economic theory on the relationship between inflation and the economic growth.

i The positive relationship

The first one is the positive relationship. It means that the inflation can stimulate the investment and consumption. So it may ease the unbalance between producing and consuming to some extend and then promotes the economy of a country. Considering the Traditional Keynesian Theory in the short run, the inflation and economic growth initially have a positive effect because of “time-inconsistency problem”, which appears in the model of Aggregate Demand (AD) - Aggregate Supply (AS). The model includes an upward sloping curve AS and a downward sloping curve AD. In the short run, there is an “adjustment path” produced by the two curves.

And it shows that the positive relation of inflation and economic growth in the short run. For example, firms may have already made the contracts with their customers a few months ago. The price rises when inflation happens. At the same

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time, the firms should cut the output. But the output still increases as firms need to complete their agreements signed before. But the relationship is negative in the long run. This is also the concept of Blanchard and Kiyotaki [1987].

The Phillips curve is from the statistics of the unemployment rate and money wage changes rate in United Kingdom. It depicts the relationship between the unemployment rate and the rising rate of money wages. The curve means that when the unemployment rate is low, the wages rising rate is high and when the unemployment rate is high, the rising rate of money wages is low. The wages change rate can be considered as the inflation rate according to the cost-push theory. So the curve could also be described as the relationship between the unemployment rate and inflation rate. If the unemployment rate is high, the inflation rate is high and the economy is under the depression. If the unemployment rate is low, the inflation rate is low and the economy is growing.

**Figure 1 Phillips Curve**

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Moreover, Tobin, a neoclassical economist [1965], set a new model by developing the Mundell’s Model. While, the concept of Tobin effect is that a higher inflation will reduce the return of money, and people will substitute away from the money. He first combined monetary factor with the economic growth and then get a portfolio of cash and real assets. When the inflation goes in the moderate level, the cost of holding money will rise. People will put their money into the real financial assets to get more profits. On the other hand, the higher inflation will increase the level of output, and the income level will also grow to achieve a higher steady state. In all, the inflation causes people to change the money into other assets, so it leads to real capital accumulation and increases the economy in the short run. So the portfolio will turn to an asset-demand function.

For the Government, it could get revenue from the inflation to cover the deficit. At the same time, issuing additional currency is just like imposing an “inflation tax” to the people. Inflation will increase the nominal income which can drive up the level of tax for labors. For example, if you earn less than $50000 one year before, you may pay about $1000 for the tax, but, in the inflation period, your income may rise to more than $50000 one year, and then you need pay about $6000 for the tax. It is easy to find that the tax has been pushed by 5 times than before. So the revenue of the government will increase through the tax. And in the bond market, the actual value of government bond is reduced when the market is in inflation. Since the actual rate is higher than nominal rate, the market value of the government bond is less than the face value. So the government will
get more profits from the bond in fact. At last, the government can throw the “extra” money into the country’s development. The employment rate and the amount of production also increase when inflation occurs. Because when inflation is not expected, and the prices rise faster than people’s wages, producers will increase investment so that the output increases and the employment increases. When inflation is expected, the opportunity cost of holding cash would increase. People would like to change cash into real assets, which may result in a higher capital return ratio. Eventually it would lead to economic growth. Inflation can induce the relative price of some commodity to a new level. And the resources will flow to the high-profit industries.

11 The negative relationship

The other one is the negative relationship. For example, the Classical Theory, which is the basic growth theory, implies that the relationship between inflation and economic growth is negative. Because the profit of the companies will decrease when labor costs increase.

The neoclassical economist Stockman [1981] finds that the steady state and the output will decrease when inflation increases. However, the analysis of the neoclassical model shows that there are different thoughts when considering the relationship between inflation and economic growth.

The works of Lucas [1980] and Stokey [1987] or McCallum and Goodfried [1987] in Endogenous Growth Theory demonstrate that the inflation tax charging on the capital would affect the wages and welfare of the labor force. And then it
would affect the scale return rate and the growth rate of economy. In the works of Gomme [1993], Jones and Manuelli [1995], they introduce the budget constraint in a model of human capital accumulation. Inflation increase negatively affects consumption and labor supply. It leads to a lower growth rate. After their studies, the framework of Maquis, Reffert [1995] and Haslag [1995] examines that when the inflation rate increases, the real rate of interest will decline and the capital accumulation will also decline. But the lower rate of the economic growth rate in Marquis, Reffert and Haslag's research is considerably higher than the one estimated in the Gomme's framework.

The studies in this part point out that inflation could not promote economic growth. However it will destroy the stability of economy and bring about low efficiency in economic activities. The bad effect would spread in the whole society finally. For the long periods, this damage of inflation exerting on country's development would grow bigger. At last, the hyperinflation seriously damages the economy, since inflation could increase investment risks and uncertainty of the future. Additionally, inflation encourages the import, curbs the export, and deteriorates the balance of the international trade. When inflation goes on, the market price mechanism will suffer a serious damage. Firms and residents will make the wrong decisions to disarrange the resource allocation and then economic growth will be affected. If the inflation has appeared for a long time, part of people would anticipate that the inflation may finish recently, and then they will produce or buy more in a litter lower price. At the moment, it would
drive the producing cost to a higher level than before and cause the collapse of the economy. Oppositely, if some people assume that the inflation would keep longer, they would also produce more or buy more to avoid another higher price. So the economy would decrease afterward. In this case, maybe the rich people become richer or some poor people turn into the millionaire suddenly. The allocation of income would become more unfair and have a bad effect to the economic growth.

iii No relationship and some complicated conditions

The third one of researches is no relationship and relationships under some market conditions. The former means that inflation and economic growth do not correlate with each other. The view is that there is no significant relation between inflation and economic growth, because of the neutrality of money. When the money supply or the supply growth rate changes, the price level will change the same way. So the inflation does not have an impact on the actual output. Just like the Keynesians redefines, the real price, the employment, and the real GDP are set by the goods supply and demand in the real market. And these factors have nothing to do with the money supply. The nominal price is controlled by the money supply. When the supply of money doubled, the nominal price will also rise in the same proportion. But the real price would not be affected. And the supply and demand of the consumption keep constant.

Some Rational Expectation School economists support this theory, such as Friedman. Milton Friedman creates the term “Monetarism” which “expands” the
Phillips Curve. But Friedman suggested that there are two theories included in “Monetarism”: the Quantity Theory of Money and the Neutrality of Money. In the theory, the total money for consumption in the economy is equal to the amount of money that the whole economy has. The inflation rate is larger when the velocity of the money supply exceeds the speed of the economic growth rate. Since the prices of goods are decided by the growth rate of money, the economic growth will not be affected the in the long run.

Another neoclassical economist Sidrauski [1967] shows that the steady state would not be affected by the inflation. And neither the output nor the economic growth would suffer the effect of rising inflation.

Additionally, there are also many studies about the threshold of the inflation rate. It means that the positive or negative effect between inflation and economic growth depends on the level of the inflation rate or other conditions.

In the Neo-Keynesian Model, there are three phenomena: first, if GDP is higher than the actual one that labors produce in the best conditions and the unemployment rate is lower than the natural rate of unemployment, keeping others constant, inflation will continue going up to drive the price to a higher level. Second, if GDP is lower than the actual one that labors produce in the best conditions and the unemployment rate is higher than the natural rate of unemployment, keeping the rest equal, inflation is controlled and the output and price of the commodity would decrease finally. Third, if both GDP is equal to the actual one that labors produce in the best conditions and the unemployment rate
is equal to the natural rate of unemployment, the inflation will stay at a certain level. All these phenomena happen under the condition which is NAIRU, the non-accelerating inflation rate of unemployment. It means that there is a level of GDP, when the elements of productions are all used and the economy is in its optimal period. At the same time, there is a level of unemployment rate in relation to this optimal economy.\footnote{See Vikesh Gokal and Subrina Hanif’s Working Paper 2004/04 Relationship Between Inflation and Economic Growth.}

2. Empirical studies

i. The Solow and Swan model and Ramsey model\footnote{Here we will not descript the all the mathematic derivations of the Ramsey model. We just look through simply his model and economic concept for our work.}

In last part, I just looked through roughly of the theories. In this part, I will firstly introduce the Solow and Swan model where the investment (saving) rate, technology progress rate and the population growth rate are exogenous.

In 1956, Robert Solow published a seminar paper “A contribution and to the Theory of Economic Growth” to show the two equations of a production function and a capital accumulation equation. Here, the production function will be illustrated. In the constant returns to scale function, \( Y = F(K, L, T) = L^*(FK/L, 1, T) = L*f(k) \) where \( k=K/L \) is capita per worker, \( y=Y/L \) is output per worker and the function will be redefined to \( F(k, 1, T) \). This is the intensive form of the production function, especially in per worker and per capita form. It rewrites as \( y = f(k) \). It means that the production function shows no “scale effect”: product per...
person is determined by the amount of physical capital each person has accesses to, holding constant \( k \), having more or fewer workers does not affect total output per person. (Robert J. Barro and Xavier Sala-i-Martin" Economic Growth)

The Cobb-Douglas model is always a sensible and simple function of the production function to describe real economy.

\[
Y = A K^{\alpha} L^{1-\alpha}
\]

Where \( A > 0 \) is the level of the technology and \( \alpha \) is some number between 0 and 1. The intensive form of the Cobb-Douglas function is \( y = A k^\alpha \) which is satisfied all the properties of the production function.

![Figure 2 A Cobb-Douglas Production Function](image)

**Figure 2 A Cobb-Douglas Production Function** (Robert J. Barro and Xavier Sala-i-Martin" Economic Growth)

The last equation indicates that the output per worker is correlated with the capital per worker and technology (other factors). So the output growth rate is also the function of the technology and capital.

The other equation of Solow Swan model is capital accumulation equation.
In the equation, $\dot{K}$ is the capital stock changing over time. $\dot{K} = K_{t+1} - K_t$.

$sY$ is the amount of gross investment and $dK$ is the amount of depreciation in the production process (Chapter I, Jones, 2001, P22).

In order to observe the effect of the elements impacting on the output per worker, we can divide $L$ by both sides and get:

$$\dot{k} = s \cdot f(k) - (n + d) \cdot k$$

Where $\dot{k} = \frac{d(K/L)}{dt} = \dot{K}/L - nk$, $n = \dot{L}/L$.

![Figure 3 The Slow-Swan model](Robert J. Barro and Xavier Sala-i-Martin “Economic Growth”)

From this equation, the capital per worker $\dot{k}$ is affected by three factors. The capital per worker $\dot{k}$ will increase as the investment (saving) per person
increases. At the same time, the capital per person \( \dot{k} \) will decrease as the depreciation for the capital-labor ratio rises and the number of population rise at rate \( n \).

In the Ramsey model, the saving rate is calculated out as the endogenous variable. Frank P. Ramsey is the economist and mathematician who investigate the relation of consumption and saving by analyzing the optimal economic growth in the dynamic environment. In the model, Ramey maximizes the supply side, the demand side and the utility function to get the Euler equation \( r = \rho \frac{u'(c)c - u''(c)c'}{u'(c)c'} \) under the budget constraint.

Where \( \rho \) is the time preference. That is the utility of something is not give people more happiness as the time goes by and \( u(c) \) is the utility function.

It illustrates how much part of the output would contribute to the consumption and how much part of the output would distribute to the saving (investment) to expand the further output and consumption.

### ii Some other empirical theories

In empirical works, Meguire [1985] obtains a negative but weak relationship between economic growth and inflation for a cross section of 47 countries from the periods 1950 to 1977. Barro [1991] also reports the same result when researching a cross section of 117 countries from 1970 to 1985. He found that the intensity of this relationship was growing.
Fischer [1993] proves that the inflation impacted a significant negative effect on the economic growth by running a cross-sectional time series regression. He finds that the investment rate as a percentage of GDP is not so significant with the inflation. Comparing with the absolute value of the inflation, the standard deviation and the moving average of 7 years of inflation rate also explain the negative relationship between inflation and economic growth. He still finds that the inflation rate has a negative effect on the capital stock and productivity growth rate. And the inflation is divided into three parts: high inflation, moderate inflation and low inflation in his article. And keeping the steady of the inflation rate is very important even in the low inflation period. The study also mentions that the correlation is not all the cause and effect. There may be other factors which are response for the high inflation and low economic growth rate even as the test results deny this assumption.

Another Barro, Robert J. Barro [1995] exploits 30 years data from 1960 to 1990 of 100 countries. His work suggests that if some available determinates keep constant, the real economic growth rate will decrease by 0.2-0.3 when the average inflation rise 10 percent every year. Moreover, using both the linear and non-linear methodologies, Atish Ghosh and Steven Phillips [1998] find that there is a strong relationship between inflation and economic growth and it is negative. They also dig out a threshold of 2.5 percent. Above this level, inflation has a significant effect on the economic growth.

Pantaik and Joshi [1998] show that in the fixed nominal rate system, the real
rate has a significant positive correlation with the economic growth. However, when the variable of inflation is added, the coefficient on the real rate becomes not so significant. In the opposite, the coefficient of the inflation is significant negative. This reflects that the positive relation between the real rate and the economic growth is the substitution of the negative relation between inflation and economic growth. And in some Asian countries, small change in the inflation will not affect the economic growth obliviously. If the inflation rate is blow the 20%, the macro economy will be stable when keeping this rate in the long run.

Some researchers also show that there are different effects of inflation on economic growth depending on inflation levels. Michael Sarel and Peter Wickham [1995] show in their paper that there is a structure break at the point of 8 percent of inflation. They use the data set for 87 countries form 1970-1990. Below this point, there is not a linear relationship between GDP growth and inflation, or even a weak positive one. And above 8 percent, the negative effect is statistically significant and robust. Barro [1996] makes the empirical test and finds that the inflation is not the significant determinant for the economic growth when it is under 20 percent. When the inflation is higher than 20 percent, it has a negative effect on the economic growth. When the standard deviation of the sample was added in the regression, the coefficient of the average inflation rate is not affected, and the coefficient on the Standard deviation is almost zero. So it illustrates that the standard deviation has nothing to do with the economic growth. After it, Mohsin S. Khan and Abdelhak S. Senhadji [2001] also find a
threshold that inflation would have a negative effect on economic growth, even the negative effect is statistically significant by using the data from 1960-1998 and 140 countries. On the other side, when the inflation rate is lower than the threshold, the inflation would exert no effect on the economic growth. Especially, the authors also pointed out that the threshold for the developed countries is 1-3 percent and for the developed ones and 11-12 for the developing ones.

Girijasankar Mallik and Anis Chowdhury [2001] find the evidence of a long-run positive relationship between GDP growth and inflation when examining annual data of four South Asian countries [Bangladesh, India, Pakistan and Sri Lanka]. They also conclude that moderate inflation is helpful to faster the economic growth. M.Bruno and W. Easterly [1995] get a conclusion that there is no evidence of consistent relationship between growth and inflation at any frequency. They exclude countries with high inflation rates which are more than 40 percent. For the lower inflation rate, the influence between inflation and economic growth is caused by the disturbance appearing in the demand and supply. Brian Motley [1993] focuses on the effect that inflation reduces the economic welfare. And his work showed that persistent inflation would lead to a reduced growth rate of real GDP in the long run.

It is found that one of the general opinions is that high inflation retards against economic growth. And a widespread belief amongst policy makers is that zero or low inflation is an essential or at least a very important condition for high and sustained growth. There is not a certain conclusion whether the relationship
is positive or negative in the past, and literatures reported both results in empirical studies.

Recent years the researches showed that a slight negative relationship between economic growth and inflation, but until now, there is very little controversy in theoretical but much more in empirical analysis to support this negative effect though they are not persuasive.

In one of our replicating literatures, “Inflation and Growth: some panel data evidence” written by M. Caporin and C. Di Maria, published on GRETA Working paper on December 2002, using a panel data study in 97 countries for 19 years from 1979 to 1997 with dynamic effects in the regression form. The authors concluded that the relation between inflation and economic growth greatly varies according to the different levels of inflation which are below 10%, from 10% to 30% and over 30% experienced by numerous countries. They also ran regressions based on a pooling strategy aiming at grouping countries by the average inflation improved the explanatory power of the regressions themselves. And finally, they added dynamic effect to again confirm the sound results derived before.
### Data Description

All the data are collected from Organization for Economic Co-operation Development (OECD) website (http://stats.oecd.org), the International Monetary Fund’s (IMF) website—Data and Statistics and from the World Bank’s (WB) World Development Indicators and its website—Quick Query.

Data are arranged into Panel form with seven variables as inflation, GDP growth rate per capita, Investment, Trading Balance, Fertility Rate, Direct Foreign Investment and Tax Rate. We also impose inflation standard deviation for further research, pooling the dataset into groups by period and country, as well as grouped the data according to different inflation levels. Basing on the availability of the data and its continental-coverage nature, our paper only covers 28 OECD countries out of the 30 countries, during 23 years, from 1985\(^{10}\) to 2007, including: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the United States and United Kingdom not including Czech and Slovak. All data are in annual and percentage basis, except for the standard deviation of inflation and the fertility rate. Details of variables using are as follows:

1. **GDP per capita Growth rate (gdppercapitagr):** This is the dependent variable, and it is real annual GDP per capita growth rate in percentage. It is

\(^{10}\) Since the data is from 1985 and most of OECD countries are staying a good developing situation and the bad economic situation countries are few, so we do not consider the convergence effect and the log (85) is not used here.
calculated by the stata using the GDP per capita. The GDP per capita is obtained from the OECD web site.

2. **Lagged GDP Growth rate per capita (l.gdppercapitagr&l2.gdppercapitagr):** This is the lagged variables for the models to show a much deeper effect of the dependant variable of last period. In the paper, I include two lagged variables of GDP per capita growth rate. One is the lagged variable for one period (year) and the other is for two periods (years). The data are calculated by the stata.

3. **Inflation rate (INFL):** As a measurement of inflation, GDP deflator is derived from dividing an index of GDP measured in current prices by a chain volume index of GDP (see OECD database). The main result we want to get from the work is to find out the relationship between this variable and GDP variable.

4. **Investment rate (INVT):** Used as a proxy of physical capital accumulation. This variable is computed as the ratio of gross investment in fixed capital over GDP.  
5. **Trading balance (TRAD):** exports of goods minus imports of goods, in billion US dollar and then calculated as a percentage of GDP for every country each year.

6. **Fertility Rate (FR):** It is obtained from the World Bank Group and selected from the World Development Indicators. It is the number of children that each woman has. As in the Barro’s book, we want in particular to design a model

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11 See M. Caporin and C. Di Maria “Inflation and Growth: some panel data evidence”.
that mimics some empirical findings (Robert J. Barro and Xavier Sala-i-Martin” Economic Growth P408), so here we would build a growth model by using the fertility rate also.

7. **Direct Foreign Investment (DFI):** It is calculated as the ration of Direct Foreign Investment over the GDP. And the Direct Foreign Investment is the net DFI from the World Bank for OECD countries.

8. **Tax Rate (TAX):** This series is obtained from the OECD. Stat. It is a percentage that the total tax revenue divided by the amount of GDP.

9. **Inflation standard deviation (INFLSD):** I derive this variable by computing the standard deviation of inflation for each 8-year. All the yearly data are from OECD database. This variable will be used for the further illustrating figure---average GDP movement in each 8-year. This variable will not be used in the regression process.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita</td>
<td>633</td>
<td>21724.81</td>
<td>10162.75</td>
<td>4180</td>
<td>79793</td>
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<tr>
<td>Inflation rate</td>
<td>644</td>
<td>8.365994</td>
<td>28.44357</td>
<td>-4</td>
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<tr>
<td>Investment rate</td>
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<td>21.56288</td>
<td>3.788193</td>
<td>14.9</td>
<td>38.9</td>
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<tr>
<td>Trading balance</td>
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<td>1.522574</td>
<td>6.145425</td>
<td>-17.97967</td>
<td>30.55714</td>
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<tr>
<td>Fertility Rate</td>
<td>642</td>
<td>1.767913</td>
<td>0.5729457</td>
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<td>4</td>
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<tr>
<td>Direct Foreign Investment</td>
<td>621</td>
<td>6.141587</td>
<td>34.89364</td>
<td>-15.10334</td>
<td>524.8771</td>
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<tr>
<td>Tax rate</td>
<td>628</td>
<td>34.91672</td>
<td>8.42146</td>
<td>11.5</td>
<td>52.2</td>
</tr>
<tr>
<td>GDP per capita Growth rate</td>
<td>605</td>
<td>4.942904</td>
<td>3.000267</td>
<td>-6.49671</td>
<td>21.08725</td>
</tr>
</tbody>
</table>

Table 1

The sum of all the variables

Tabl1 is the sum of all the variables in the regressions except the lagged variables as they are computed by the stata. It includes the mean, the standard deviation, the minimum and the maximum number of all the data which can be observed.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean1</th>
<th>Mean2</th>
<th>Number of Countries</th>
</tr>
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<tbody>
<tr>
<td>1985-1992</td>
<td></td>
<td></td>
<td>28 (19)</td>
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<tr>
<td>Inflation</td>
<td>6.79</td>
<td>4.09</td>
<td></td>
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<td>Stand Deviation of Inflation</td>
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<td>2.42</td>
<td></td>
</tr>
<tr>
<td>1993-2000</td>
<td></td>
<td></td>
<td>28 (19)</td>
</tr>
<tr>
<td>Inflation</td>
<td>14.32</td>
<td>2.07</td>
<td></td>
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<tr>
<td>Stand Deviation of Inflation</td>
<td>45</td>
<td>1.75</td>
<td></td>
</tr>
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<td>2001-2007</td>
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<td></td>
<td>28 (19)</td>
</tr>
<tr>
<td>Inflation</td>
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<td>2.07</td>
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<tr>
<td>Stand Deviation of Inflation</td>
<td>5.39</td>
<td>1.55</td>
<td></td>
</tr>
</tbody>
</table>

Table 2

The mean and median of inflation and Standard Deviation of Inflation

The standard deviation of inflation is showed in the table 2 to illustrate the variability of the inflation. All the variables are separated into three parts by every 8 years, which is from 1985-1992, 1993-2000, 2001-2007\(^{13}\), and mean 1 and mean 2.\(^{14}\) Form the volume mean2, where we get rid of the extraordinary inflation rate, the numbers in the parentheses is the number of countries without extraordinary ones. The extraordinary ones are the countries which have the inflation rate larger than 15% from 1985-2007. In order to observe the trend more clearly, we exclude these countries in the paper.

\(^{12}\) The numbers in the parentheses is the number of countries without extraordinary ones. The extraordinary ones are the countries which have the inflation rate larger than 15% from 1985-2007. In order to observe the trend more clearly, we exclude these countries in the paper.

\(^{13}\) Since we have the data set of 23 years in total, the last part is seven years from 2000-2001.

\(^{14}\) Mean 1 includes all the inflation rates, but mean 2 does not include the inflation rate beyond 15 percent.
the inflation rates are decreasing in the three parts and also the standard deviations of the inflation in three parts are falling. It demonstrates that when the inflation rate falls, the inflation variability goes down either.
IV Empirical Analysis

In the paper, I use a whole section to look through many theoretical and empirical studies. And the theoretical studies give us different causalities between inflation and economic growth and other determinants. At the same time, the empirical studies also give us the different results by the statistical correlations of these variables. In fact, the conclusions both from theoretical studies and from the empirical studies all make the sense. The conclusions may have some inflictions because of different periods, different economic communities or different variables; however, they all provide the useful information to the future researchers. The models in the paper are not all perfect ones, but I will try my best to modify them. For example, I add the lagged variables in the models to check the lagged effect of the inflation and the economic growth. In the paper, I mainly investigate the relationship between the GDP growth rate per capita (GDP percapitagr) and the inflation rate (INFL) and also the other instrument variables such as investment rate (INVT), trading balance (TRAD), Lagged GDP Growth rate per capita (l.gdppercapitagr&l2.gdppercapitagr), fertility rate (FR), direct foreign investment (DFI) and tax rate (TAX). It is expected that there will be a negative coefficient of the GDP growth rate per capita on the inflation rate (INFL), because of the negative effect inflation implementing on the economic growth proved by some theories and empirical estimation before. With this important object, a regression is running on the whole dataset not comprising the dynamic
panel data to get the rough trend of the coefficient. For sensitivity analysis, I pooled the data into two groups by inflation levels to do the regression. And the groups consist of the low-inflation country group and the high-inflation country group. The purpose of this method is to check whether the relation will vary from low level to high level inflation rate, and if yes, how the difference would be.

Additionally, a new variable, the tax rate is joined to the regression to test the effect it makes on the GDP growth rate per capita and other variables. Dose the tax rate act as a positive determinant for the GDP growth rate per capita or a negative one for the growth rate? Will it turn out to be a statistically significant variable in the regression? And will it affect the coefficients of other variables? For all the questions, a regression without the tax rate is running to give us a clear result. Finally, another two dynamic models are formed to show the effect of the lagged instruments on the economic growth.

The models will be used in the most regressions are the fixed effect model, in which we use the country as one dummy variable and the year as the other dummy variable. But there are still some ones are not. Generally speaking, for all the original data set and the pooled data set, the basic regression is as follows:

\[
GDP \text{ per capita Growth rate}_i = \alpha_i + \beta_2 \text{INFL}_{it} + \beta_3 \text{INVT}_{it} + \beta_4 \text{TRAD}_{it} + \beta_5 \text{FR}_{it} + \beta_6 \text{DFI}_{it} + \beta_7 \text{TAX}_{it} + e_{it}
\]

Where \( i = 1, 2... 28 \) which is the individual index (COUNTRY)
t = 1, 2 ... 23 is the time (YEAR) index

α_t is the intercept

ε_{it} is the error term. It is assumed that ε_{it} = μ_{it} + ν_{it}, in which μ_{it}
is country specific and ν_{it} is time specific.

In order to test the data---tax rate, another regression is also run as follow:

GDP per capita growth rate_{i}=

α_t + β_1_{INFL_{it}} + β_2_{INVT_{it}} + β_3_{TRAD_{it}} + β_4_{FR_{it}} + β_5_{DFI_{it}} + ε_{it}

Where i = 1, 2...28 is the individual (COUNTRY) index

i = 1, 2...23 is the time (YEAR) index

ε_{it} is also the error term as above

We can see from the two regressions that the tax rate (TAX) has been deleted in the second one. It will help us to detect the variation on the coefficients more clearly.

The third part of our models is the regression of dynamic models. The regression formulas are:

(1) GDP per capita growth rate_{i} =

α_t + β_1_{L.GDP_{it}} + β_2_{INFL_{it}} + β_3_{INVT_{it}} + β_4_{TRAD_{it}} + β_5_{FR_{it}} + β_6_{DFI_{it}} + 
β_7_{TAX_{it}} + ε_{it}

(2) GDP per capita growth rate_{i} =

α_t + β_1_{L.GDP_{it}} + β_2_{L2.GDP_{it}} + β_3_{INFL_{it}} + β_4_{INVT_{it}} + β_5_{TRAD_{it}} + β_6_{FR_{it}} + 
β_7_{DFI_{it}} + β_8_{TAX_{it}} + ε_{it}
Where \( i = 1, 2 \ldots 28 \) is the individual (COUNTRY) index

\( t = 1, 2 \ldots 23 \) is the time (YEAR) index

\( \epsilon_{it} \) is also the error term as above

As the data are grouped for the different inflation levels, the fixed effect model and random effect model are used to control for most common effects. However, we may only use the variables which are more significant ones for this test.
V Empirical Results

1. Full set of original data

Firstly, a correlation test of all the independent variables is made to show that there are no more apparent correlations between every two variables. It could find that the correlation coefficients in table 3 are not greater than 0.5 percent besides the correlation coefficient between the investment and the lagged (1) investment which is about 0.95 and the correlation coefficient between the inflation rate and lagged (1) inflation rate which is about 0.93. Since the correlation coefficients of investment and the lagged (1) investment and the inflation rate and the lagged (1) inflation rate are so great that maybe bring the problem\(^\text{15}\) to the t value and the significance of the variables. The lagged investment and lagged inflation would not be considered as our instrument anymore.

Then the simple regression on full original dataset is run at first. It is made to get the main coefficient between GDP per capita growth rate and inflation (INFL) rate, and the coefficient of GDP growth rate per capita on the TAX rate showing in Table 4. At the same time, it is also necessary to consider the other coefficients between GDP growth rate per capita and investment (INVT) rate, TRAD balance, Fertility (FR) rate and direct foreign investment rate (DFI). After the regressions, I

\(^{15}\) There are two criteria for the correlation level. One is the absolute value form 0—0.4 is the low correlation, form the 0.5—0.7 is the middle level and above is the high level. Another one is from 0—0.5 is the low level, and from 0.6—0.8 is the middle level and above is the high level.
did the Hausman test under the null hypothesis and some of them showed that the results reject the null hypothesis. And I also did Lagrange multiplier tests (Breusch and Pagan) for the regressions. In the end, it also obtains a very low p-value which strongly implicates the presence of fixed effect or random effect.

<table>
<thead>
<tr>
<th></th>
<th>L.</th>
<th>L2.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
<th>L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita Growth rate</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged1 GDP Growth rate per capita</td>
<td>0.3304</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lagged2 GDP Growth rate per capita</td>
<td>0.1325</td>
<td>0.3333</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation rate</td>
<td>-0.0212</td>
<td>0.0286</td>
<td>-0.0002</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1.Inflation rate</td>
<td>-0.0125</td>
<td>-0.0239</td>
<td>-0.032</td>
<td>0.9255</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.2093</td>
<td>0.2899</td>
<td>0.3171</td>
<td>0.054</td>
<td>0.0145</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1.Investment rate</td>
<td>0.0693</td>
<td>0.2148</td>
<td>0.3136</td>
<td>0.068</td>
<td>0.0288</td>
<td>0.9482</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.0651</td>
<td>0.0629</td>
<td>0.0182</td>
<td>-0.1455</td>
<td>-0.1489</td>
<td>-0.2039</td>
<td>-0.1735</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>-0.0021</td>
<td>0.0201</td>
<td>-0.0023</td>
<td>0.4414</td>
<td>0.4381</td>
<td>-0.1795</td>
<td>-0.184</td>
<td>0.1848</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.0731</td>
<td>0.0365</td>
<td>0.0393</td>
<td>-0.0361</td>
<td>-0.0425</td>
<td>-0.028</td>
<td>-0.0204</td>
<td>0.4055</td>
<td>0.0548</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tax rate</td>
<td>-0.0976</td>
<td>-0.1046</td>
<td>-0.1067</td>
<td>-0.4258</td>
<td>-0.4217</td>
<td>-0.373</td>
<td>-0.3745</td>
<td>0.2722</td>
<td>-0.1411</td>
<td>0.0651</td>
<td>1</td>
</tr>
</tbody>
</table>

Table3 The correlation of all the original variables
<table>
<thead>
<tr>
<th>GDP per capita Growth rate</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P &gt; t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>-0.069649</td>
<td>0.0142755</td>
<td>-4.88</td>
<td>0</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.2540358</td>
<td>0.0557698</td>
<td>4.56</td>
<td>0</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.1090327</td>
<td>0.0505886</td>
<td>2.16</td>
<td>0.032</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>0.1343247</td>
<td>0.4730034</td>
<td>0.28</td>
<td>0.777</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.0054859</td>
<td>0.0105151</td>
<td>0.52</td>
<td>0.602</td>
</tr>
<tr>
<td>Tax rate</td>
<td>-0.113081</td>
<td>0.0591463</td>
<td>-1.91</td>
<td>0.056</td>
</tr>
<tr>
<td>year</td>
<td>-0.040004</td>
<td>0.022002</td>
<td>-1.82</td>
<td>0.07</td>
</tr>
<tr>
<td>_cons</td>
<td>83.31141</td>
<td>43.34108</td>
<td>1.92</td>
<td>0.055</td>
</tr>
</tbody>
</table>

Table 4

Regression with tax rate

Table 4 shows that the results which I obtained by regressing the whole original data set. It is the fixed effect. It is obvious that the coefficient between the GDP per capita growth rate (gdppercapi~r) and the inflation (INFL) rate is negative. It is just like the results appearing in most theories. Especially, from its t value -4.88 and P value, we can observe that it is the one of the most statistically significant determinants among all the instruments. It means that when the inflation rate increase 1%, the economic growth rate will decrease by about 0.07%,
holding other explanatory instruments constant. At the same time, a finding of
the positive relationship between the investment (invt) and GDP per capita
growth rate is detected. While the variable---investment rate is also the
statistically significant determinant in this regression, since its t values is 4.56 and
then its p values is 0. The coefficient illustrates that when the investment rate rises
by 1 percent, the economic growth rate would increase about 0.25 percent. This is
really a high promotion for the countries' economy since the investment can
propel the development of economy and technology. Regarding as the trading
balance, it seems not to be a significant independent variable in the regression,
although it do bring a positively incentive effect to the economic growth. The
economic growth rate would be drive up by 0.11 percent when the trading
balance rate rises 1 percent.

For the other variables, it is estimated that both the fertility (FR) rate and
direct foreign investment (DFI) have the positive effect on the economic growth.
When direct foreign investment increases, the market of a country is more open
to the outside, and the firms in the local country would gain more return through
the sale of goods and services. But, surely, we can find that the p values of these
two instruments are higher enough, so they are not significant in this regression.

For another independent instrument we want to study, the tax rate, it implies
a negative effect on the economic growth. In the regression its t value is -1.91 and
its p value is 0.056. Holding other statistical instruments unchanged, the
economic growth would reduce by 0.11 percent if the tax rate increases 1 percent.
Although it is not the significant one in the regression, it is really a large number for restricting the economic growth. Tax is always the main method of controlling the macroeconomic market for the government. In the following part, another regression is made to study whether it has other effects for the regressors.

Fortunately, the main coefficient of inflation on the economic growth is significant and negative as expected and this supports Caporin and Maria’s study as well as other modern researchers. The coefficient of tax on the economic growth has been also computed out to give us a direct result in this regression.

2. The data set without tax rate

Second, another regression on the original data set excluding the tax rate is carried out to give us much more information of how the tax acts on the economic growth. There is a table below to show the difference of the coefficient with and without the tax rate.

<table>
<thead>
<tr>
<th>GDP per capita Growth rate</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>-0.069412</td>
<td>0.0142533</td>
<td>-4.87</td>
<td>0</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.2739404</td>
<td>0.0543547</td>
<td>5.04</td>
<td>0</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.1415813</td>
<td>0.0470225</td>
<td>3.01</td>
<td>0.003</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>0.1753037</td>
<td>0.4717184</td>
<td>0.37</td>
<td>0.71</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.004361</td>
<td>0.0105006</td>
<td>0.42</td>
<td>0.678</td>
</tr>
<tr>
<td>year</td>
<td>-0.052075</td>
<td>0.0204374</td>
<td>-2.55</td>
<td>0.011</td>
</tr>
<tr>
<td>_cons</td>
<td>102.9384</td>
<td>40.99947</td>
<td>2.51</td>
<td>0.012</td>
</tr>
</tbody>
</table>
Table 5

Regression without TAX RATE

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita Growth rate</td>
<td>Coef.</td>
<td>Coef.</td>
<td>P&gt;t</td>
<td>P&gt;t</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>-0.069649</td>
<td>-0.0694124</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.2540358</td>
<td>0.2739404</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.1090327</td>
<td>0.1415813</td>
<td>0.032</td>
<td>0.003</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>0.1343247</td>
<td>0.1753037</td>
<td>0.777</td>
<td>0.71</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.0054859</td>
<td>0.004361</td>
<td>0.602</td>
<td>0.678</td>
</tr>
<tr>
<td>year</td>
<td>-0.040004</td>
<td>-0.0520749</td>
<td>0.07</td>
<td>0.011</td>
</tr>
<tr>
<td>_cons</td>
<td>83.31141</td>
<td>102.9384</td>
<td>0.055</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Table 6\(^{16}\)

From these two tables 5 and table 6, we can find that the coefficients in the regression without the tax rate have some changes. Foremost, the three significant independent variables, inflation rate, investment rate and the balance trade are almost the same although some of the values have some adjustment. The inflation rate is still negative on the economic growth rate, which proves that the inflation has a negative effect on the economic growth again. But without the tax, the coefficient of the inflation over the economic growth seems to become a

\(^{16}\) In the table 6, the title named 1 means that the coefficient and p value are of the regression with the tax rate and 2 means that the coefficient and the p value are of the regression without tax rate.
little smaller, that is, when the inflation rate rises 1 percent, the economic growth rate would fall about 0.0694 percent. And also its standard deviation turns out to be a little smaller, which implies that the inflation rate as a determinant is more stable. The other significant one, the coefficient of the investment rate on the economic growth rate is a little greater than it is in the regression with tax rate. At the same time, the effect of the trade over the economic growth becomes a little greater from about 0.11 to 0.14. But, trading balance is still an insignificant variable in the regression since its p value reduces from 0.032 to 0.003. For the foreign direct investment, it is almost the same as it acts in the regression with tax rate. In all, the movement of the three significant factors is not great and disordered. The economic growth rate still increases while the fertility rate increases this time. It is a little curious. But, it is not significant yet.

Comparing these two figures in table 6, our main objection that the relationship between inflation and economic growth is negative has been approved by our regressions with new data and new variable. And the tax rate has played an important role on the economic growth. And it is a negative coefficient as most people assumed in the daily life. In the model of current study in this paper, the inflation and the tax do create some troubles for the economic growth in macro system and also in the real market, which need us to pay more attention to them in the future studies.

3. Grouped data by inflation levels

In order to study the sensitivity of the relation when inflation rate changes,
we pool the data into 2 groups depending on the inflation level, and do the regression for each group. Group one contains data that have inflation level above 8.36\textsuperscript{17} percent and group two is the data whose inflation rate is below 8.36 percent. Hausman test and Breusch and Pagan Lagrange multiplier test for each model are carried out again, to check whether it is suitable to use the fixed effect model or the random model. Then we get the result of grouped data, see table 7 and table 8 below. In the above regressions, I used the full original data set and the data set except tax rate, obtaining the result is that the inflation rate (INFL), investment rate (INVT) and the balance trade (trad) are the three most important regressors. And also the tax rate is negative to the economic growth rate per capita. So this time, we have another chance to check whether these three variables are still significant in the two groups data set and the negative effect of tax rate appearing in the first regression still exist. The two groups with different inflation level also stand for the two main economic situations in the OECD countries. One is the comparatively stable and developed economic situation and the other is the turbulence and developing economic position. Hope this will give us a more deep way to observe the sensitivity in different economic conditions. For the first group, it covers 6 original countries and the second group includes 22 countries.

\textbf{Group data}

\textsuperscript{17} It is estimated by the average of the inflation rate of the whole data set including 28 countries and 23 years for every country. In total, 8.36 is the average of 644 observations of inflation rate.
<table>
<thead>
<tr>
<th>GDP per capita Growth rate</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>-0.041257</td>
<td>0.0189496</td>
<td>-2.18</td>
<td>0.032</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.4480814</td>
<td>0.1522509</td>
<td>2.94</td>
<td>0.004</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.1438342</td>
<td>0.0963248</td>
<td>1.49</td>
<td>0.138</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>-1.038244</td>
<td>0.7018032</td>
<td>-1.48</td>
<td>0.142</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>-0.142427</td>
<td>0.0974942</td>
<td>-1.46</td>
<td>0.147</td>
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<td>Tax rate</td>
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<td>0.0604208</td>
<td>-1.62</td>
<td>0.107</td>
</tr>
<tr>
<td>year</td>
<td>0.0339886</td>
<td>0.0712593</td>
<td>0.48</td>
<td>0.634</td>
</tr>
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<td>_cons</td>
<td>-65.83083</td>
<td>142.3685</td>
<td>-0.46</td>
<td>0.645</td>
</tr>
</tbody>
</table>

Table 7

The regression of high inflation countries

<table>
<thead>
<tr>
<th>GDP per capita Growth rate</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>z</th>
<th>P&gt;z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>0.2696772</td>
<td>0.0513872</td>
<td>5.25</td>
<td>0</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.1237773</td>
<td>0.0426659</td>
<td>2.9</td>
<td>0.004</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.0944452</td>
<td>0.0323056</td>
<td>2.92</td>
<td>0.003</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>0.5526669</td>
<td>0.3513851</td>
<td>1.57</td>
<td>0.116</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.0002659</td>
<td>0.0037648</td>
<td>0.07</td>
<td>0.944</td>
</tr>
<tr>
<td>Tax rate</td>
<td>-0.031795</td>
<td>0.0256264</td>
<td>-1.24</td>
<td>0.215</td>
</tr>
<tr>
<td>year</td>
<td>-0.005098</td>
<td>0.0199926</td>
<td>-0.25</td>
<td>0.799</td>
</tr>
<tr>
<td>_cons</td>
<td>11.59941</td>
<td>40.04288</td>
<td>0.29</td>
<td>0.772</td>
</tr>
</tbody>
</table>

Table 8 The regression of low inflation countries
Considering table 7 and table 8, there are a few differences both in coefficient and significance. We can see from the results that no matter the inflation above or below 8.36 percent, we get the same one important consequence. The coefficients of the tax rate over the economic growth rate per capita in two cases are both negative. It implies the same trend: GDP growth rate per capita and tax (tax) rate have a negative but weak correlation, especially in the high inflation countries. But the tax rate is not a significant instrument for both the high inflation countries and the low inflation countries. For another important instrument--- inflation rate, the effect of the inflation rate implementing on the economic growth rate is opposite in these two regressions. In the table7, the coefficient is negative that is if the inflation rate increases by 1 percent, the economic growth rate per capita would decrease by 0.041 percent in the high inflation countries. However, it appears that the economic growth rate per capita would rise by 0.27 when the inflation rate increases 1 percentage in low inflation countries. The inflation has a positive effect on the economic growth in the low inflation countries. It demonstrates that the inflation propels the economy development in the low inflation countries in the research years. It is obvious that the inflation is still the significant variable in the group regressions. GDP and investment still have a positive and strong relationship in these two groups as the p value in the table 7 and table 8 are so smaller. The effect of the investment is greater in the high inflation countries than in the low inflation countries. It seems that the investment for the developing countries in the construction aspect is
more important than the development countries. And trade appears to have the positive and significant effect to GDP growth in low inflation countries. Because developed and stable countries would much more prefer to communicate with others to gain more profits. They also have more chances and choices to earn more in the international trade market. So trade is still important for the low inflation countries such as United State. But in developing countries, trade is not that important for it maybe constrain some industries in the developing countries. And the fertility rate is the same as the inflation to the economic growth but not significant. It assumed that in the low inflation countries population still not become the problems which can obstruct the economic development comparing with the high inflation countries. In addition, another insignificant variable direct foreign investment has the opposite results in two models. It is supposed that foreign investment in other countries is sometimes with the intention of using other countries' nature resources, cheap labors and capturing the market shares. These actions actually do not bring the huge profit for the unstable and developing countries. Maybe it will deteriorate some local industries.

The results from high inflation regression are derived from the random effect model and also the results from low inflation regression are derived from the random effect model. It is actually obvious that in the first group, where numbers of countries and observations reduce roughly to 6 from 28. Unfortunately, most of the coefficients are not statistically significant to be able to make any credible conclusion. Explaining for these weaknesses, the reasons are supposed to be
limited data and so on. However, the trend of relations studied remains unchanged, negative for tax and inflation (in high inflation countries) and positive for investment rate. Basing on this sensitivity analysis, two-effect of inflation on economic growth is set up. But for the whole OECD it is still negative on the economic growth.

Comparing with replicating paper, where inflation rate was divided into 3 groups, below 10%, from 10% to below 30% and above 30%, one similar conclusion is obtained as our two groups test above. The effect changes from group to group, according to the level of inflation rate. But in general, it reflects previous literatures' findings as mentioned in the introduction part.

4. The dynamic models

At last, I do some regressions with the lagged variables to detect the dynamic effect. These lagged instruments are taken from the Arellano-Bond (1991) and M. Caporin and C. Di Maria “Inflation and Growth: some panel data evidence” variables for the dynamic model. In the paper, two lagged variables are used: lagged GDP per capita Growth rate for one period and lagged GDP per capita Growth rate for two periods. Lagged inflation and lagged investment do not be used in the regressions since the correlations of inflation and lagged inflation and investment and lagged investment are too high which are showed in the table 3---the correlation of all the variables. So sometimes there is difference between statistical correlations and causality we think in day life. The results are as follows:
<table>
<thead>
<tr>
<th></th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita Growth rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged1 GDP per capita Growth rate</td>
<td>0.1523463</td>
<td>0.0440497</td>
<td>3.46</td>
<td>0.001</td>
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<tr>
<td>Inflation rate</td>
<td>-0.052621</td>
<td>0.0152439</td>
<td>-3.45</td>
<td>0.001</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.1640348</td>
<td>0.0611904</td>
<td>2.68</td>
<td>0.008</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.067279</td>
<td>0.0540633</td>
<td>1.24</td>
<td>0.214</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>0.6045015</td>
<td>0.5143691</td>
<td>1.18</td>
<td>0.24</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.0062395</td>
<td>0.010414</td>
<td>0.6</td>
<td>0.549</td>
</tr>
<tr>
<td>Tax rate</td>
<td>-0.073538</td>
<td>0.0610459</td>
<td>-1.2</td>
<td>0.229</td>
</tr>
<tr>
<td>year</td>
<td>-0.034087</td>
<td>0.0231275</td>
<td>-1.47</td>
<td>0.141</td>
</tr>
<tr>
<td>_cons</td>
<td>70.46042</td>
<td>45.5771</td>
<td>1.55</td>
<td>0.123</td>
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</tbody>
</table>

Table 9

Regression with the lagged GDP per capita Growth rate
Table 10

Regression with the lagged GDP per capita Growth rate and lagged2 GDP per capita Growth rate

The table 9 and table 10 are the dynamic models. From these two tables, it is obvious that the significant variables are almost the same except for the lagged GDP growth rate per capita for two periods added in the second regression. The lagged GDP per capita growth rate for one period has a positive effect on the dependant variable GDP per capita growth rate. That is, if the last period (year)'s GDP per capita growth rate increases 1 percent, the GDP growth rate per capita of

<table>
<thead>
<tr>
<th>GDP per capita Growth rate</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita Growth rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged1 GDP per capita Growth rate</td>
<td>0.1573903</td>
<td>0.0452331</td>
<td>3.48</td>
<td>0.001</td>
</tr>
<tr>
<td>Lagged2 GDP per capita Growth rate</td>
<td>-0.128082</td>
<td>0.0446688</td>
<td>-2.87</td>
<td>0.004</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>-0.07769</td>
<td>0.0191228</td>
<td>-4.06</td>
<td>0</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.2327287</td>
<td>0.0658764</td>
<td>3.53</td>
<td>0</td>
</tr>
<tr>
<td>Trading balance</td>
<td>0.0691709</td>
<td>0.0564745</td>
<td>1.22</td>
<td>0.221</td>
</tr>
<tr>
<td>Fertility Rate</td>
<td>0.7336155</td>
<td>0.5639224</td>
<td>1.3</td>
<td>0.194</td>
</tr>
<tr>
<td>Direct Foreign Investment</td>
<td>0.0066703</td>
<td>0.0104016</td>
<td>0.64</td>
<td>0.522</td>
</tr>
<tr>
<td>Tax rate</td>
<td>-0.070343</td>
<td>0.0649912</td>
<td>-1.08</td>
<td>0.28</td>
</tr>
<tr>
<td>year</td>
<td>-0.038411</td>
<td>0.0247088</td>
<td>-1.55</td>
<td>0.121</td>
</tr>
<tr>
<td>_cons</td>
<td>77.99125</td>
<td>48.7055</td>
<td>1.6</td>
<td>0.11</td>
</tr>
</tbody>
</table>
this year would rise by 0.15 percent. Since the economy of most countries is always appearing an upward trend, the GDP growth in this year will construct a good foundation for the GDP in the next year. However, the lagged GDP per capita growth rates for two periods exerts a negative effect on GDP of two years later. Maybe the GDP per capita growth rate rising too earlier would trigger the inflation and other problems. And it also reminder us that the statistic correlation is not always the same as we think it should be in theoretical. For the inflation, it also has the same effect which is negative and significant as in the table before. The investment rate and the tax rate are as well as the simple regression. The investment is still positive and significant to the GDP growth rate per capita and the tax rate is negative to the GDP per capita growth rate.

In the dynamic models, our results are from the fixed effect though the Hausman test and Breusch-Pagan Lagrange Multiplier test. And the main purpose of testing the negative relationship is obtained also in the dynamic models. The tax rate in the dynamic models shows its significant result. As we all know, some economic behaviors have the lagged effect. This model is also used to demonstrate the lagged effect. And the lagged effect will appear in the future. So we should pay more attention to the lagged effect in the reality.
VI Discussion and Conclusion

Following the preceding studies on the relationship between inflation and growth, this paper presents an analysis on new, updated panel data and a new variable. It is recognized that there is a negative and significant relation between inflation and economic growth in the OECD countries. This relationship is appearing in the regressions of simple and dynamic models, with tax rate and without tax rate models and high-level models. It is a positive independent variable for the low-level inflation countries according with the economic situation in the low-level inflation areas. Surprisingly, investment is always such a positive, significant impact on the economic growth that every country should pay more attention to this factor. Additionally, tax as another parameter I want to test gives us a clear result that it does have negative effect on the economic growth in most of our models.

From all the regressions made for this empirical study, the results confirm the main object of the paper which is finding a significant negative inflation-growth effect in Caporin and Maria’s study as well as other researchers. And the tax also proved to be a negative and important variable in our study. In general, inflation, tax and GDP growing rates per capita have an opposite trend, and this tendency seems clearer when inflation rate goes up in some developing countries of the OECD countries we research. The lagged instruments are added to the models to help us comprehend some dynamic changes of the relationship between the lagged GDP per capita growth rate and the GDP per capita growth rate. The
lagged variables such as the lagged GDP per capita growth rate and the lagged inflation rate are so important in the real market and sometimes can influence the government's economic policies.

However, considering that one of our replicating papers prefers the random effect model for most of their cases (supporting by their Hausman test statistics\textsuperscript{18}), I do want to carry out some tests to select the best model for this working case. Unfortunately, this job includes both fixed effect model and random effect model. I suppose and hope the fixed effect model is also the most proper one for some regressions made in this paper, though it may lead to insignificances for some coefficients somewhere. And I also expect that due to lack of data for some variables and countries in a few years, the results will still be constructive and helpful for the researchers on their further studies in the future. Since the limitation for the process of some data searching, I just make an 8-year interval average to get a better direct study measuring the volatility of inflation average change comparison to the original data. And the variables which we think should affect the models are not included in some functions because of the statistic correlation. So I hope this would not influent the results too much. Thanks to the updated data, for further researches, the results derived should have a certain contribution to modern study.

\textsuperscript{18} See details in “Inflation and Growth: Some panel data evidence” – Caporin and Maria 2002
References


management theory”.
