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Assessment of inflation in China and the role of international food prices

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Sammanfattning

I den här uppsatsen syftades det till att undersöka vilka faktorer, och i vilken utsträckning, som påverkar inflationen över tid i Kina samt effekten av importerad inflation genom internationella matpriser. Genom att skapa ett samband mellan inflation i KPI och de drivande faktorerna genom en OLS-regression kunde en modell tas fram vilken i stora drag beskrev inflationens rörelser. Genom den framställda modellen kunde man se sambandet att produktionsgapet, huspriser, reella effektiva växelkursen och internationella matpriser alla påverkade inflationen i positiv riktning. Å andra sidan medförde en överflödig likviditet att inflationen påverkades negativt. Produktionsgapet förklarade den största delen av inflationsrörelserna och internationella matprisers påverkan var påtaglig och direkt. Importerad inflation genom högre matpriser gör det svårt för de styrande i Kina att hålla inflationen på en eftersökt nivå vilket kan påverka den ekonomiska tillväxten negativt.

Abstract

This paper aims at describing the drivers of long-run consumer price inflation in China as well as determining the role of imported inflation through changes in international food prices. The study was conducted with an OLS-regression on a Two-Pillar Phillips curve theoretical framework. Analysis of year-on-year growth data concludes that the main drivers of CPI inflation are: output gap, house prices, real effective exchange rate and international food prices, which all have a positive effect on inflationary levels. On the other hand, excess money growth proved to have an opposite effect. Output gap proved to be the main driver, yet the role of international food prices was significant and instantaneous. Inflationary pressure from international food prices makes it hard for policy makers in China to address the situation of increasing consumer prices, refraining domestic economic growth.

Key words: China, inflation, international food prices

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List of abbreviations

CPI	–	Consumer price index
EMG	–	Excess money growth
GDP	–	Gross domestic product
HP	–	House prices
IFP	–	International food prices
MNC	–	Multinational Corporation
NBS	–	National Bureau of Statistics of China
OG	–	Output gap
OLS	–	Ordinary least square
PBOC	–	People's Bank of China
QoQ	–	Quarter on quarter
REER	–	Real effective exchange rate
RMB	–	Renminbi (currency) ¥
StP	–	Stock prices
YoY	–	Year on year

1. Introduction

The Peoples Republic of China (hereafter China) has had an astonishing journey since major economic reforms were kick-started by Deng Xiaoping in late 1978. A process that slowly turned the centrally planned system into a market-oriented economy with an expanding private sector. Resulting in an enormous impact on technological development and economic growth, these reforms made China the fastest growing economy in the world in the last 25 years. In recent GDP figures, the most widely used measure of economic power, China surpassed Japan as the second largest economy in the world, becoming only second to USA.

Along with the rapid growth and economic progress, the credible days has resulted in soaring inflation levels, a subject which has been widely discussed lately. In most segments, price levels have increased, making goods more expensive and creating headaches for the central planners. Leadingly, being able to determine what lies behind the movements in inflation is crucial in managing it. For policy makers, this also implies establishing the connections between the determinants in order to successfully reach inflationary targets and aims.

Along with the mounted inflation levels, Chinese citizens have experienced a staggering increase in food prices, affecting negatively on poverty reduction and making food an expensive and often exclusive commodity. More specifically, pork prices, a base in many Chinese cuisines, has soared over the past years. However, little research has tackled the role of international food prices on consumer price inflation. Some studies have focused on the determinants of Chinese inflation, but what is the complimentary role of international food prices in domestic inflation? Can part of the rising price levels be explained by imported inflation through rising food prices on an international scope?

The rate of inflation[1] based on the consumer price index (CPI) has sailed up to be one of the most closely watched macro-economic indicators and barometers worldwide. Understanding the cause of price rises is fundamental for central banks

[1] Inflation is generally described as a rise in the general level of prices of goods and services in an economy over a period of time.

and policy makers in controlling inflation. The task of determining the drivers of inflation has been undertaken for a long time and is constantly shifting shapes, resulting in a plethora of prospective explanations. Commonly, differences in assumptions on market efficiency as well as on economic development are plausible causes of this puzzlement. In particular, the dynamic connections between excess liquidity, asset prices, monetary instruments, global price levels on commodities and domestic consumer prices have drawn much focus.

A question to ask is whether these increased food prices have any effect on the inflation, could there in fact be any correlation? This leads to the main question of this thesis:

- What are the main drivers of inflation (CPI) in China?
- Can ordinary domestic drivers of inflation explain the inflation in China or could it also be explained by imported inflation through rising food-prices worldwide? If so, to what extent does international food prices affect the price levels in China?

There are plenty of interactions between microeconomic conditions and macroeconomic management that influence inflation performance, but which are difficult to identify separately. The paper is seeking direct evidence of international food prices' role in the inflation process.

If the result is that the inflation is created inside of China due to domestic factors; it can be managed by the government whom can purposely tackle the inflation. On the other hand, if it turns out that inflation is caused, or partly caused, by global food prices there is not much the policy makers in Beijing can do.

Being accustomed to high rates of economic growth and triple digit growth in the number of private enterprises, the reform era has expanded China's wealth and global influence immensely. Strong consumer demand domestically as well as a strong growth of exports has been main bricks in the foundation of building the reshaped country. Backed by a substantial and cheap work force, investments into manufacturing and commodity industries have fueled much of the economic

expansion so far. But with a tightening of China's labor market, an unprecedented reflection of the supply of young people entering the work force falling (Kroeber 2011), along with an increasingly unstable global economic climate and consumption demand, redirection towards a consumption-led economy will be necessary as a precaution to maintain its current growth path. A transition is crucial as the cost of capital and relative returns to labor presumably will rise, causing investment-led growth to find cheaper and more suitable regions to haven. Stressing possibility, there is still much room form multinational corporations (MNCs) to grow in the Chinese consumer segment. A recent study made by The Economist Intelligent Unit (EIU, 2011) reveals that MNCs are counting on an increased demand from the Chinese customers. As for the majority of the researched MNCs, China accounted for less than 10% of global revenue. Moreover, more than a fifth of the companies expect China to be their biggest market in 5-10 years, which indicates a widespread belief by global companies that the Chinese market will develop and grow in the near future as its citizens' wealth increases, possibly fueling inflationary levels further.

China's inflation, measured in consumer price index (CPI) change, has had a remarkable ride since the economic reforms in the late 1970s. The inflation has endured both times with immense increases but also periods with disquieting deflation. Observed over the long haul, the rate of inflation was higher and more volatile in the 1980s and 1990s than it has been in recent years. This change coincides with China's increased implementation of monetary policy reforms since the late 1990s (Zhang, 2010).[2] These reforms eased up the domestic money markets and improved conditions for lending and trading. Being able to closely maneuver monetary policies has proven valuable as the Chinese policy makers purposely play its weapons, such as its currency the renminbi (RMB), to favor its agenda. The superiority of the government enables it to take prompt actions in times of crisis as well as managing long-term governance through far fed horizons, such as the five-year plans.

[2] Influential reforms are e.g. establishments of interbank money markets and bond markets in 1995–1996 and the gradual opening of domestic market operations in 1998, where monetary policy was transferred from direct credit quota control to indirect adjustment with both quantity- and price-based instruments.

In the wake of the 1998 Asian crisis, inflation shifted around zero until the domestic growth, fueled by an increasing demand for Chinese goods, really took off in 2003. Spiking in early 2008, the inflation was alarmingly high with a year-on-year (YoY) growth rate of over 8 % (see figure 1). The People's Bank of China (PBOC) reacted with a number of tightening measures; including increases in reserve requirements, appreciation of the currency and direct control over bank credit (Huang et al., 2010). Accompanied with a decrease in global economic growth, freezing credit markets and falling commodity prices, the inflation in China promptly fell during the financial crises, once again resulting in price deflation. In the midst of the global recession the PBOC, in line with many of its central bank counterparts, successfully launched an enormous stimulus package, US$ 586 billion, in order to get the economy back on track again and boost growth. (Maidment, 2008)

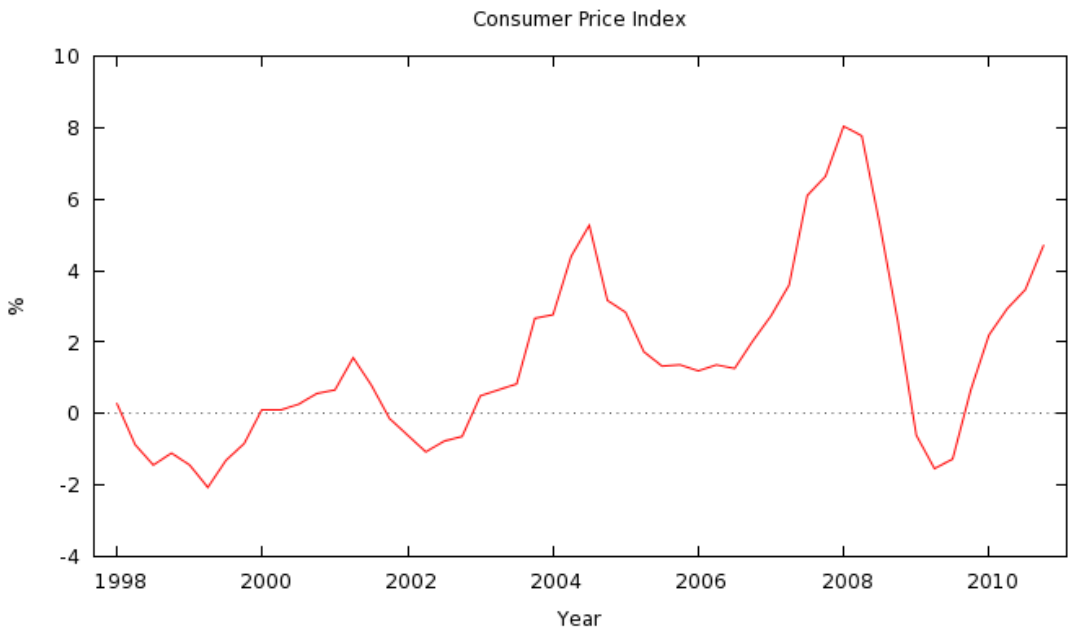


Figure 1, CPI growth in China, January 1998 - December 2010 (% YoY)

In 2011, the path of rising inflation rates continued, resulting in CPI inflation hitting a 37-month high of 6,5 % in July. The growing inflation was monitored closely by the Beijing policy makers, which led to rigorous monetary tightening actions in the first half of the year. These austerity measures put downward pressure on the CPI growth closer to the government's full year inflation control target of 4 %, as the CPI rose 5,5 % on a yearly basis in January-November according to official figures.

Interestingly, in late 2011, the PBOC chose to lower its bank reserves requirement for the first time in years in an attempt to stimulate lending amid nervousness about the country's economic condition and fears of a new credit crunch and potential house bubble burst, preventing interbank lending from drying up. Incentives for fine-tuning its policies followed official data illustrating the Chinese manufacturing sector contracting in November for the first time since the financial crises. Previously soaring house prices has started to stagnate, if not fall, in many parts of the country, including cities as Shanghai and Qingdao (Olsson, 2011). Following this action, fears arise that easing capital requirements will cause a lending spree like the one that helped rescue China from the previous crises, possibly putting more weight on the already debt laden banks, as well as boosting domestic inflation from its already high levels.

Advanced economies have a history of employing generally one policy instrument for reining the inflation; short-term interest rate or money supply. Albeit, China's monetary authority PBOC applies tools of both quantity and price. In fact, from a macroeconomic point of view, the Chinese central bank can utilize three kinds of instruments to affect money aggregates: interest rates, required reserves and base money supply. Chinese authorities have traditionally supported money supply as the foremost policy instrument in recent decades, with the role of short-term interest rate playing a less prominent role. However, with numerous reforms in the Chinese monetary system, the role of interest rates has increased in the last few years. The PBOC thus historically tend to make a more active use of a price-based policy, yet raised focus have been put on the interest rate tool by the monetary authority.

In this paper we can conclude that the consumer price inflation to a large extent can be described through a Phillips-curve type of model with a significant role of international food prices. The soaring levels of global food prices put upward pressure on inflation. Asset prices, such as house prices, do affect CPI inflation where as stock prices has little or no significant impact. The output gap plays a dominant role in determining the inflationary trajectory and affects price levels positively. On the other hand, excess money growth proves to be of negative connection to CPI growth.

The study is conducted as follows. In section 2, a theoretical framework with key economic theory and earlier studies will be presented with description of the model used and its variables. This follows by section 3, where empirical results and description of the data will be deduced. Throughout this study, there will be included summaries on some previous findings on literature and research regarding drivers of inflation, both on an international level, yet mainly on a Chinese level. Section 4 & 5 are left for analysis and conclusion respectively. An appendix is conducted to clarify applied theory, calculations and perceived results.

2. Theoretical framework

In determining the drivers of inflation, a reverse model of the Phillips curve is often used as a framework. In the midst of the 20th century Great Britain, Phillips (1958) stated through analysis of almost a century of data that inflation in wages and domestic unemployment was negatively correlated. In short, the main argument was that in a weak economic climate, where unemployment is assumed to be present, employees accept a lower wage, and vice versa in times with a blooming economy. Hence, when the wages grow faster than the production, the inflation increases and unemployment is low. On the other hand, when there is large unemployment, inflation decreases as a cause of large competition for work and employees thus demanding less compensation.

Although showing previous momentum, the model met critique from monetary view skeptics such as Friedman; questioning whether changes in nominal variables could affect the real economy. Soon enough, periods with stagflation during the 1970s' oil crisis proved the skeptics right, where presence of the correlation between inflation and unemployment partly seemed absent. Following this, the Keynesian type of Phillips curve was adjusted to view the correlation between inflation and unemployment as a short-run model, pointing out that unemployment returns to its equilibrium state in the long-run. The renewed model saw inflation as a function of expected inflation (π^e), unemployment's divergence from the long-run equilibrium ($u-\bar{u}$) and a shock in supply (s).

$$\pi = \pi^e - \beta(u-\bar{u}) + s, \beta>0 \qquad (1)$$

Through Okun's law[3], this formula can be rewritten as a function depending on the GDP rather than unemployment, where (y-y*) denotes the output gap, in other words the difference between actual and potential production.

$$\pi = \pi^e + \beta(y-y^*) + s, \beta>0 \qquad (2)$$

Moreover, following the quantity theory of money, inflation can be argued to be a causation of money supply growth that exceeds the GDP growth, later called excess money growth (ECB, 2001). According to Gerlach (2004), excess money growth can replace the expectation of future inflation, hence, an inclusion of a monetary part in the Phillips curve. The result is the Two-Pillar Phillips Curve, which is often used as a foundation in determining whether or not the money supply is a long-term indicator of inflation. Following the laws of supply and demand, more money demanding the same set of goods will reflect in an adjustment to higher price levels. In the case of China, this is preferably applicable since official figures on estimated inflation are scarce, if present at all.

Accordingly, the model for inflation can now be written:

$$\pi = \beta_1 EMG + \beta_2 OG + s \qquad (3)$$

where π denotes inflation, β are constants, EMG is the excess money growth, OG is the output gap and s is a shock in supply, e.g. international food prices. To simplify, inflation develops constantly over time in response to aggregate demand factors, which are captured by the output gap, along with aggregate supply chocks, which are captured by the term s.

With this framework we can build a more specified model with the indicators stated in chapter 2.1 in determining the drivers of CPI inflation. Along with this, a

[3] Okun's law is a correlation between unemployment and production. At times with high unemployment, the aggregated production is low and vice versa during times with low unemployment. $(u-\bar{u}) = -g(y-y^*)$

regression model can be derived in order to econometrically compute the CPI changes.

2.1 Consumer price index as a proxy for inflation

The consumer price index (CPI) is produced by the National Bureau of Statistics of China (NBS) and is the most frequently used proxy for inflation. The change in CPI is calculated as the increase in the cost, or price level, of a constant quantity of a certain good, or a fixed basket of goods. Besides this, CPI is used as a deflator in national account estimates for converting values at current prices (nominal) to values at constant prices (real) (ILO, 1999).

In this study, an examination of the impacts of output gap, excess money growth, asset prices, monetary instruments and international food prices on the CPI inflation will be conducted. The first two independent variables are conventionally believed to cause inflation. Inclusion of asset prices is a result of the last decade's sharp increase in house and stock prices (especially in China with its debated housing bubble), leading up to the recent credit crisis, possibly fueling inflation on its way in some economies. Monetary policy instruments are used by many central banks in their battle of hitting inflationary targets and hence are included as an independent variable. At last, the role of imported inflation through international food prices has been included since it has been scarcely covered in recent literature, yet a plausible cause of CPI inflation. If imported inflation is present, the PBOC has little control of this global price level booster floating over on domestic price levels, altering already soaring food prices. However, there has long been controversy in its accuracy, possibly giving understated or overstated views of the actual inflation in China.

2.2 Output gap

As a measure for an economy's production performance, the output gap (also named GDP gap) can be used. It is solely the difference between actual GDP and potential GDP,

$$\textit{Output gap} = Y - Y^* \qquad (4)$$

where Y denotes actual GDP and Y* denotes potential GDP. If the output gap is bigger than zero, it indicates that the growth of aggregate demand is outpacing the growth of aggregate supply, presumably fuelling inflationary levels through increased production and labor costs. Vice versa, a negative output gap may imply overcapacity problems. The potential GDP is not given in official statements and has to be estimated. This is done with a Hodrick-Prescott filter (HP-filter) in order to separate the cyclical component of a time-series from raw data into a smooth line (Hodrick and Prescott, 1997).

A possible link between the output gap and inflation is found in the pattern of periods with deflation in China. During these time periods, there were large dips in the external demand and worsening of overcapacity problems, followed by a CPI decline (Huang et al., 2009).

Moreover, in a recent study, Huang et al. (2010) concluded that output gap clearly has a positive effect on the Chinese inflation and should be reckoned as one of the key ingredients in its foundation. Besides this, there proves to be no direct evidence of higher uncertainty in output growth leading to an increased average inflation rate (Narayan et al., 2009).

2.3 Excess money growth

In the mid 1950s, the famous quantity theory of money was freshened-up and modernized, stipulating that excess liquidity (also known as excess money growth) should be highlighted as a major cause of inflation (Friedman, 1956). In short, it describes that money supply relative the volume of output has an instant, yet proportional, relationship with price levels. The formula describing the theory is as follows,

$$M \times V = P \times Q \qquad (5)$$

where M denotes the total amount of money in circulation, V denotes the velocity of money, P denotes the corresponding price level and Q is an index of the real value

of final expenditure. Theoretically, this should imply that a growth in excess money corresponds to an increase in price levels. Excess money growth can be written as follows,

$$EMG = MS' - GDP' \qquad (6)$$

where EMG denotes the difference between growth in money supply (MS') and growth in gross domestic product (GDP').

The theory has been invigorated by the monetarist school of economics but is loudly challenged by those in assertion of the Keynesian view on inflation. This indicator reflects to what extent the growth of money supply has exceeded the economy's demand for the currency. Factors being suspects of causing this excess of capital base are both said to be of internal and external nature. On the internal causation side, the increasing gap between the savings and loans in financial institutions, the rapid growth of public revenue as well as a low consumption rate paired with high savings rate are named as plausible factors. Externally, the rapid rise in exports, the continued growth of foreign exchange reserves and the increased ratio of foreign currency funds in financial institutions are highlighted. (Jiao and Ma, 2007)

The effect of excess money growth on inflation has both yea-sayers and nay-sayers. At a global level, studies have both showed a correlation (Rüffer and Stracca, 2006), (Baumaister et al., 2008) between the variables as result, as well as neglected a significant permanent relationship (Belke and Orth, 2007). By Chinese scholars, one of the main arguments against the presumed correlation is that during the recent credit crisis, unprecedented bank credit growth was perceived, but it was reflected by a steep dive in consumer prices, leading to deflation (Zhou, 2009). However, over the long haul, there seems to be a connection between an overload of liquidity and inflation in China, although some studies present contrary results (Huang et al., 2010).

2.4 Asset prices

There are a number of ways that asset prices may spillover on inflation. These may be changes in aggregate demand, e.g. consumption and investment, or changes in expectation of future inflation (Wague, 2005). Since the money invested in assets often is tied up, one can presume that a rise in asset markets will spillover on inflation with a lag.

Two of the main types of assets are house prices/property prices and stock prices. Interestingly, Vickers (2005) states that house prices' effect on inflation may take different forms. First off, an increase in house prices may suggest an increase in life time wealth for those who own properties, which is suggested to be followed by an increase in consumer spending. On the other hand, those who do not own houses would plausibly decrease its expenditures, which may have a downward pressuring influence on inflation.

As of 1999, with the gradual opening-up process of the housing market and implementation of tax-cut policies, the housing prices of most Chinese cities began to rise significantly. In an attempt to control the rising house prices, the Chinese government has chosen to roll out a series of policies, e.g. increasing down-payment ratios. Hence, the issue of soaring house prices, affecting negatively on people's livelihood, has attracted the attention of many academics, policy makers and economic agents at large. (Lu and Ye, 2010)

Previous studies on the effect of asset prices on inflationary levels are ambiguous. There are both empirical studies presenting results in favor, or against, the hypothesis that asset prices in have a pushing effect on inflation. Quite recently, Yu (2008) showed that housing prices in China had a stronger rising effect on inflation than stock prices, yet mutually positive. Similarly, Huang et al. (2010) confirms that there is a positive link between both of the asset classes and inflation. Moreover, in a study on Chinese inflation and stock prices, Han et al. (2008) pointed out that stock returns indeed have an effect on inflation, but the effect varies over time to be positive or negative.

On a global level, many critics are suggesting that asset prices have no impact on CPI growth directs their arguments towards the economic situations in Japan in the 1980s and Britain in the 1990s. During these periods, critics claim asset prices had insignificant correlation with the corresponding price levels.

A concluding remark is that China have relative scarce records of official data on stock market activities. Shanghai Composite is the oldest and foremost index concerning trading activity of Chinese stocks and dates back to 1991.

2.5 Monetary instruments

An inclusion of a monetary instrument, the real effective exchange rate, should provide an overview of how effective this tool is in directing the inflationary trajectory in a desired way.

A rise in the real effective exchange rate will imply a stronger RMB compared to its peers, hence making it more expensive for businesses to import goods and services from China. This can also be stated as a change in the country's terms-of-trade. In theory, this will indirectly put downward pressure on the price levels within China. Whether or not the monetary policy conducted by the Chinese government actually affects the consumer price inflation is widely discussed. According to recent studies on the Chinese economy, results indicate that a link between changes in inflation dynamics and monetary policy shifts has been present (Kim & Kim, 2008), (Zhang et al., 2008), (Zhang & Clovis, 2009). However, the role of this monetary instrument is still in much debate and may have little, or no, effect on the inflation in China (Huang et al., 2010). Moreover, in financial theory, "the escape to quality" is a saying that applies to times with a harsh economic climate. Investors then seek to haven its capital in strong currencies, putting pressure on weaker currencies and countries with small economies (Hultkrantz & Söderström, 2009). Progressively, the RMB is getting increasingly attractive to investors, making it less adherent to depreciation in economic turmoil.

In the interest rate system, a major change in the interest rate has significant effect on the output, consumer prices and house prices respectively (Lu and Ye, 2010).

This indicates that the interest rate, as a monetary policy tool, has an impact on the economy. Since it majorly affects other variables used in this study, consequently, it will be left out from the model and in the regression analysis. Although, as previously stated, it is a tool that is likely to be used even more in the future in the aim of taming the inflation.

2.6 Imported inflation

With increased price levels on essential global commodities, such as food, follows higher import prices. This will fuel the domestic price levels, e.g. as the cost of production increases, which rises as a direct consequence of the higher import prices.

Food prices have seen a sharp rise globally since the early 1990s. Mainly, this is due to an increased demand through a growing world population, along with speculation on food commodities and unfortunate weather conditions. Looking at the yearly growth rates of IFP and CPI in China we see a similar path since the late 1998, which may indicate that there indeed is a link (see figure 6).

One may argue that a big country like China to a big extent would be immune against globally rising food prices due to its vast agricultural industry. On the other hand, the world today is not what it was during chairman Mao's era and countries and industries are presently much more linked and intertwined than ever before. Following this, there are also arguments stating that since China is such a major force in the global markets, domestic price levels within China in fact influence international commodity prices.

A sign of that the policy makers in China take the issue of imported inflation as a serious treat can be found in its urge to keep import prices down as a step in cooling down the large growth in price levels to its aimed safety threshold of 4 % (Wills, 2011). The country's top economic planner, the National Development and Reform Commission, also blamed inflated import prices of pushing up rising production costs for Chinese firms, making it hard for the government to reach its inflationary target level.

Another viewpoint comes from the Asian Development Bank, which claims that China in fact will gain from rising food prices since it is a net exporter[4], stating gains in real income will follow from the internationally mounted price levels. Accordingly, this will indeed fuel the domestic inflation. (ADB, 2008)

3. Empirical analysis

In order to draw some conclusions on whether or not the stated indicators[5] effect the CPI inflation, we have to model and estimate it. This is done through an OLS-regression with CPI_{Π} as the dependent variable, where CPI_{Π} denotes the consumer price inflation[6], derived from equation 3. Hence, equation 7 below illustrates the change in consumer price index and is denoted in yearly growth:

$$CPI_{\Pi,\,t} = \alpha + \beta_1 OG_t + \beta_2 EMG_t + \beta_3 HP_t + \beta_4 StP_t + \beta_5 REER_t + \beta_6 IFP_t + \varepsilon_t \qquad (7)$$

$$CPI_{\Pi,\,t} = (CPI_t / CPI_{t-1}) - 1 \qquad (8)$$

By using a number of possible independent variables in equation 7, the statistical validity of the model can be assured. Since inflation is a complex topic, it would be too trivial to explain its movement through just one determinant, e.g. the output gap in a simplified Phillips model, which has been indicated by many economists and is stated in the literary briefings above. In this sense, connection is between the determinants and the dependent variable. In order to find an appropriate fit for the model, significance levels are used.

3.1 Data

The time-series data set used for this research is secondary data and mainly gathered from the National Bureau of Statistics of China (NBS). Additional data is

[4] China is currently transitioning into being a net importer of food
[5] See set of independent variables in 2.1 or 3.1
[6] Consumer price inflation, change in CPI and CPI growth are all denotations of CPI inflation

assembled through Bloomberg, Bank of International Settlements (BIS), International Monetary Fund (IMF), Organization for Economic Co-Operation and Development (OECD).

The data set consists of a number of indicators, including consumer prices (CPI), output gap (OG), excess money growth (EMG), house prices (HP), stock prices (StP), real effective exchange rate (REER) and international food prices (IFP).[7] These are chosen from previous studies in the subject as well as from applicable theory, such as the Two-Pillar Phillips curve, to serve the purpose of this study. The intention of this is to explain the relationships in the model and implicitly check its validity.

For the function of this study, quarterly observations are used for the period January 1998-December 2010. The time scope of the study is chosen as a reflection of the available data for each given indicator above. The NBS has little or no non-annual data on some of the indicators above before 1997, hence the year after this deducts the starting point in the study (since growth terms are used). The data is in year-on-year (YoY) change terms as it proves to be a good foundation on which to build estimates of the long-run momentum. The data has been treated in Excel according to established econometric standards. Certain data, which have been reported in monthly levels, have been converted to quarterly observations by averaging the monthly levels for each quarter respectively where upon growth figures have been calculated on a YoY-basis. This is done in order give the time-series the same structure and make it reliant for future modelling. A study of the quarter-on-quarter (QoQ) growth data is not conducted since a QoQ analysis will mostly model seasonal variations and short-run fluctuations, hence it will not serve the purpose of giving the research question reasonable long-run results.

Moreover, the validity of the officially reported data has been widely discussed lately. In order to make a credible study of the inflation, relevancy and authenticity are key factors that make the research trustworthy and applicable. Therefore, all data has been reviewed. Especially, GDP figures have caught the eye of many

[7] See appendix 1 for a more detailed description of the variables

critics who directs concerns of its accuracy and authenticity. Rawski (2001) argues that the figures have been highly exaggerated and claims the reported levels to be unreliable. A plausible cause of this is according to Wang and Meng (2001) insufficient deflation of nominal figures. However, Zheng (2001) defends the quality of the official statistics and claims the figures to be dependable. For the purpose of this study, the official figures will be used.

The real GDP, which is part of the OG, has been seasonally adjusted due to large seasonal differences in reported levels.[8] This was conducted with an X12-ARIMA model, a commonly used technique in adjusting time-series with seasonal variations. The aim of this is to acquire a more justified picture of the OG. The potential GDP used in the output gap is estimated with a HP-filter.

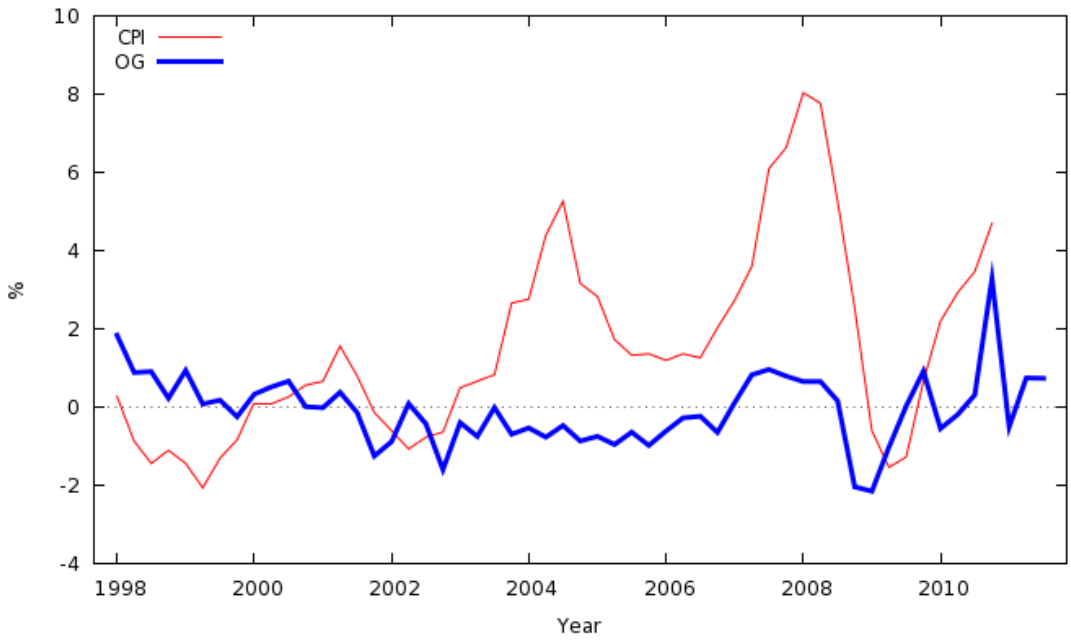


Figure 2, Growth in CPI, and OG, 98Q1 - 10Q4 (% YoY and % resp.)

When looking at the OG it can be seen that it follows the CPI growth fairly well, hence indicating that there might be correlation between them. The OG fluctuates closely around zero, with a main stretch between 2003 and 2007 where the OG was almost constant. This coincides with a blooming economy and high inflationary levels. Viewed from 2008 and forth, the OG has started to become more volatile in

[8] See figure in appendix 2

its movement, possibly caused by the global turmoil following the recent financial crisis.

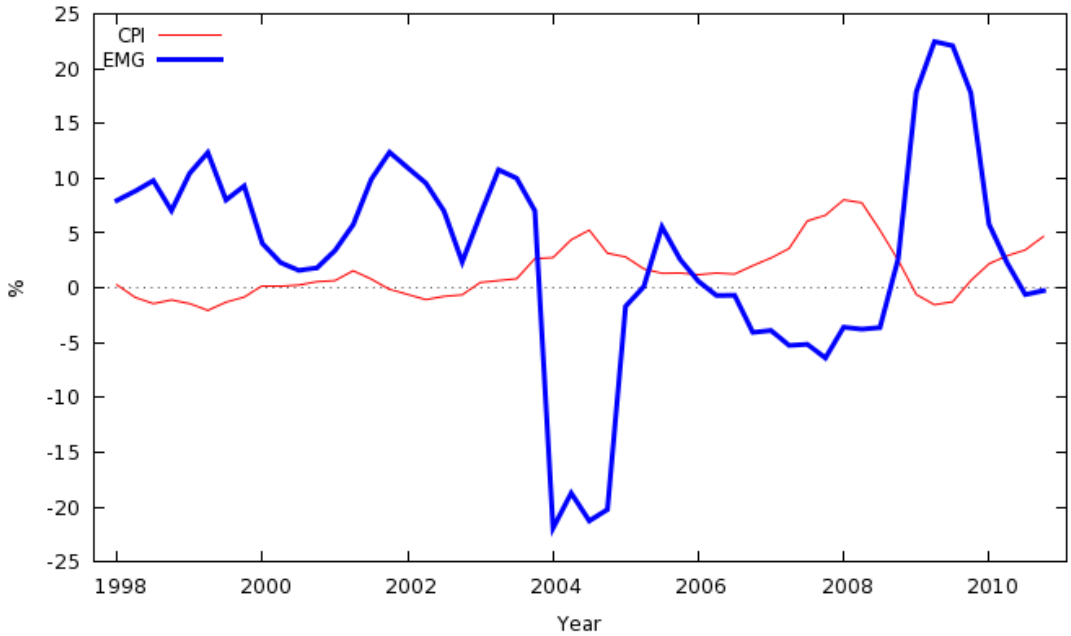


Figure 3, Growth in CPI, and EMG, 98Q1 – 10Q4 (% YoY and % resp.)

The money base in China has expanded steadily during the last decades, most of the times faster than the growth in GDP. However, there is a period between late 2003 and 2005 where the EMG was significantly negative, which is illustrated in figure 3. This was due to a tightening of the money supply growth along with a sharp increase in production, fueled by a blooming economy following the Asian crisis and some preceding modest years. During the recent financial crisis, the Chinese central bank launched a gigantic stimulus package that saw the EMG rise quickly. When the global markets vitalized and returned to safer waters, so did the EMG. Rejuvenated and increased global demand for Chinese goods helped a lot in doing so.

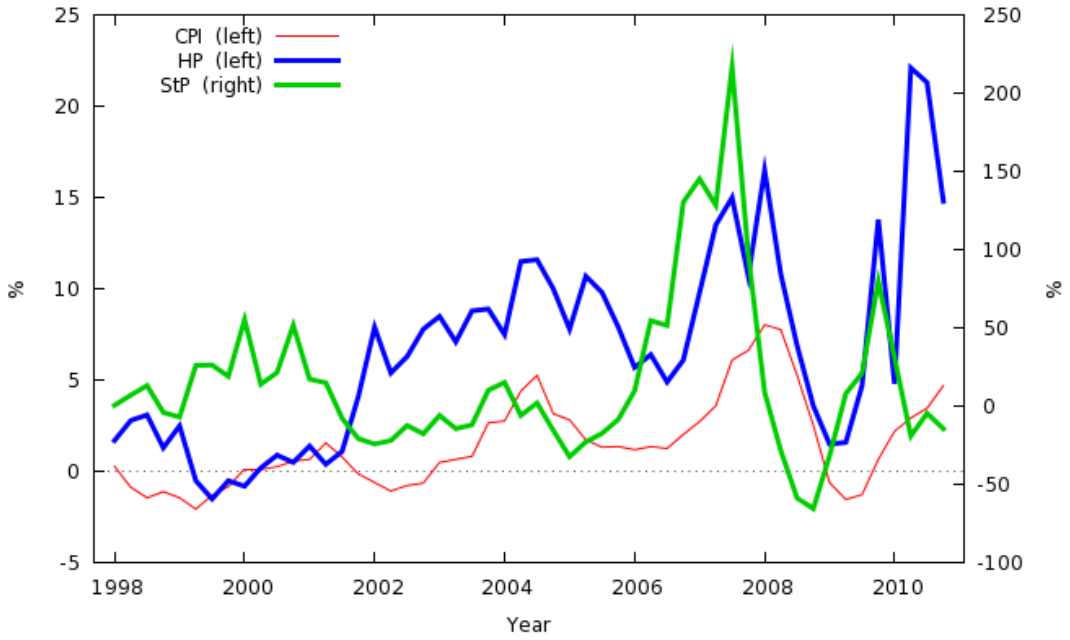


Figure 4, Growth in CPI, HP and StP, 98Q1 - 10Q4 (% YoY)

Asset prices are in this paper denoted as HP and StP. As seen in figure 4, the YoY-change in both HP and StP were positive for almost the whole observed time period. Especially house prices and prices of land has soared in China, fueled by a sharp increase in newly rich, a growing middle class and speculation. As stated before, asset prices will spill over on inflation with a lag. Presumably, regression results will gain from working with lags on these variables. Yet both positive, StP growth was far more volatile than HP during the time period emphasized in this study.

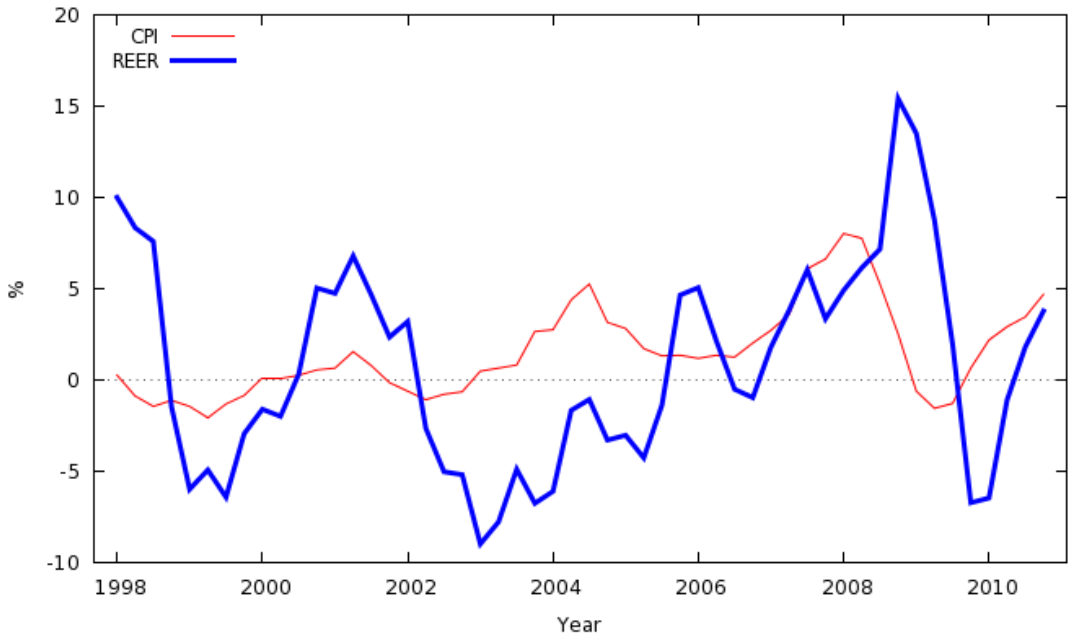


Figure 5, Growth in CPI and REER, 98Q1 - 10Q4 (% YoY)

The REER times series follows CPI inflation roughly, with dips coinciding with the Asian crisis in 1998, export led expansion in the early 2000s and the global financial crisis. The Chinese currency, RMB, is getting increasingly market oriented with a loosening of the hard grips from the government as a result.

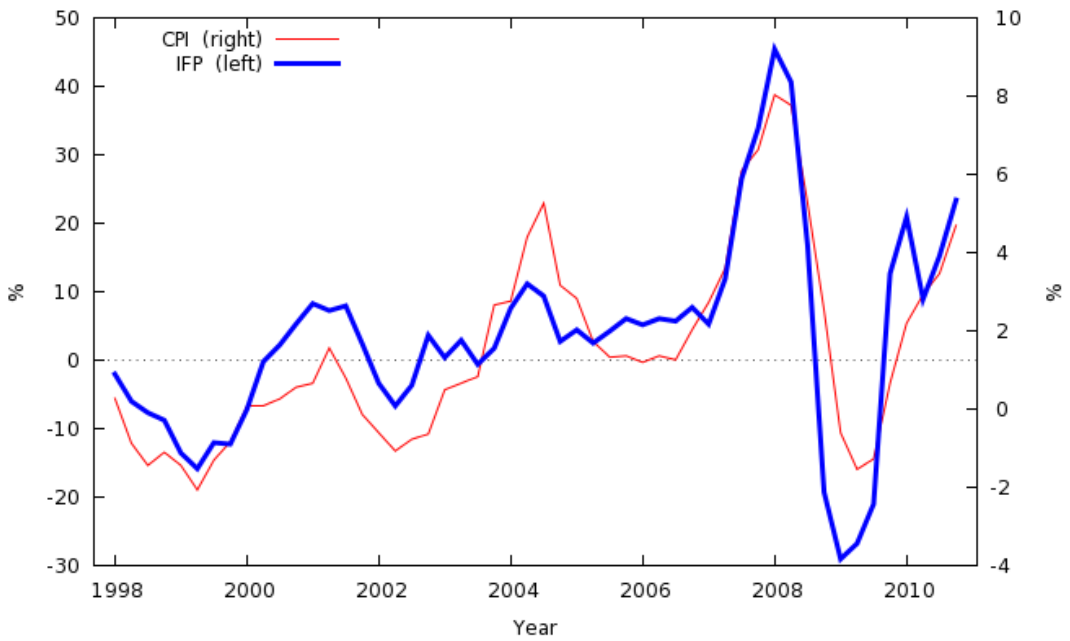


Figure 6, Growth in CPI and IFP, 98Q1 - 10Q4 (% YoY)

International food prices' time-series clearly resembles the movement in CPI growth. Noteworthy is that the changes in IFP fluctuate more than CPI growth, which is reasonable since food prices are plausibly more volatile than a basket of consumer prices. Looking at the correlations matrix[9], there is a significant connection between the variables. With a correlation of over 80 % there can be assumed to exist a link between international food prices and the CPI inflation. Illustrated in figure 6, the dip around 2009 coincides with the global financial crisis. Following a period with extreme rises in commodities prices, the crisis abruptly transitioned a staggering growth into a crash-like situation.

3.2 Regressions

As a first step, a quick way of looking at the fundamental dynamics and interactions of the model is to address a pale regression. Yet before the model is computed, the time-series have to be checked for unit roots or non-stationarity. In order to check for stationarity in the time-series variables, an ADF-test is performed. The ADF-test is conducted with a constant and is tested down from a maximum lag length of 4 (1 year). Consumer price inflation is assumed to be stationary in the long-run since prices are in a steady environment, partly through government interventions, keeping it at an aimed interval. However, if a small number of observations are used, the CPI inflation may show signs of non-stationarity. To a big extent, macro economical variables tend to be non-stationary, which gives the model some implications since the regression analysis conducted assumes that the variables are stationary. In the test, OG showed significant signs of stationarity. However, the other variables hinted of non-stationarity, which can be a cause of the relative small number of observations used in the model. In order to perform the regression below, these variables are left undifferentiated, hence should be looked upon with some caution.

Below we have a system of coefficients, or betas, β, for the regression, with CPI inflation as the dependent variable. Our aim in the study with the regression model is to achieve a plausible, understandable and significantly correct model for CPI

[9] See correlations matrix for model 1 in appendix 3

Inflation, with a high R^2-value and few dependent variables. There are four models conducted below. Model 1 takes into account the regression model in equation 7, which is denoted as the standard model in this paper. Model 2 expands the previous model with four lag periods (1 year) for every variable, which is conducted in order to get a better fit.[10] Since the effects of these variables should be pretty quick, four lag periods should be enough in determining CPI inflation. Model 3 is conducted with a lag in house prices and without stock prices due to its poor performance in the earlier regression results. Model 4 is an extended version of model 3, now with time lags up to a year for international food prices.[11]

Table 1, Coefficients for different OLS-models with CPI_{Π} as the dependent variable and explanatory test values for model suitability with standard errors in brackets

OLS	Model 1	Model 2	Model 3	Model 4
CPI_{Π}	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
constant	0,627 (0,251) **	-0,127 (0,514)	0,466 (0,210) **	0,543 (0,230) **
OG_t	-0,162 (0,165)	-0,076 (0,393)	0,365 (0,161) **	0,449 (0,164) ***
OG_{t-1}		0,365 (0,403)		
OG_{t-2}		0,006 (0,318)		
OG_{t-3}		-0,385 (0,346)		
OG_{t-4}		-0,120 (0,418)		
EMG_t	-0,079 (0,017) ***	-0,029 (0,030)	-0,068 (0,014) ***	-0,070 (0,014) ***
EMG_{t-1}		-0,048 (0,035)		
EMG_{t-2}		-0,006 (0,034)		
EMG_{t-3}		0,052 (0,034)		
EMG_{t-4}		-0,022 (0,028)		
HP_t	0,106 (0,031) ***	0,068 (0,071)		
HP_{t-1}		0,036 (0,063)		
HP_{t-2}		-0,008 (0,069)		
HP_{t-3}		-0,016 (0,077)	0,175 (0,030) ***	0,163 (0,039) ***
HP_{t-4}		0,156 (0,075) *		
StP_t	-0,0001 (0,003)	-0,006 (0,007)		
StP_{t-1}		0,002 (0,006)		
StP_{t-2}		0,010 (0,007)		
StP_{t-3}		0,015 (0,009)		
StP_{t-4}		-0,002 (0,009)		
$REER_t$	0,103 (0,024) ***	0,052 (0,066)	0,080 (0,021) ***	0,065 (0,030) **
$REER_{t-1}$		-0,005 (0,091)		
$REER_{t-2}$		0,058 (0,080)		
$REER_{t-3}$		-0,118 (0,080)		

[10] See appendix for tables.
[11] For the paper most significant results are shown in the above four models. The rest of the results, with other variable settings, were left out.

$REER_{t-4}$		0,032 (0,062)		
IFP_t	0,094 (0,014) ***	0,010 (0,034)	0,089 (0,011) ***	0,080 (0,018) ***
IFP_{t-1}		0,030 (0,041)		0,010 (0,026)
IFP_{t-2}		-0,016 (0,047)		0,029 (0,029)
IFP_{t-3}		-0,026 (0,045)		-0,051 (0,027) *
IFP_{t-4}		0,032 (0,039)		0,038 (0,018) **
Adj. R^2	0,855	0,899	0,905	0,908
Durbin-Watson	0,899	1,113	1,130	0,939
Jarque-Bera	0,225	0,429	2,059	3,125
White's test (LM)	25,753	-	15,726	18,352
Sample size	52	48	49	48
Level of acceptance: *** = 1 %, ** = 5 %, * = 10 %				

According to the R^2-value, the regression is a fairly good fit in all four models. However, these models need to be examined and validated since it might be nonsense regressions. By decreasing the number of variables, the model gets more easily tangible and has more degrees of freedom.

First off, result wise, the OG is positive in the last two models (the models with highest R^2), which is in line with most scholarly findings. On the other hand, EMG seems to be negative, which should imply that excess money growth actually contracts CPI inflation, which is a result not commonly seen in many studies. A reason for this may e.g. be a too narrow sample size. House prices have more effect on CPI change than stock prices, presumably due to the steady growth that has been seen in property prices during the last decade. Following this, we see that REER has positive correlation with inflation, meaning that a relative increase in the RMB actually will steam the domestic CPI growth. Also this challenges what is much of a conventional belief that a weak currency boosts exports and investments and hence increases inflation. Imported inflation through food prices has positive correlation to inflation, matching theoretical suggestions. Whether or not these connections hold or not are up for testing. Since StP performed poorly in the initial regression, the author chose to conduct further studies without this variable.

Noteworthy is that the coefficients in model 3 are the only ones that can be statistically ensured at a desired level, namely 5 %. All the other models have

variables that are not significant at even a 10 % level, which should be handled carefully.

Given the results above, model 3 can be assumed to be the most appropriate fit for this paper. In order to validate if the model is suitable, essential assumptions about the OLS-model have to be verified. First off, the residuals have to be normally distributed.[12] With a Jarque-Bera test conducted, there seems to be appropriate normality of the residuals since the test result value is less than the critical value (χ^2-critical), 2,059 < 5,99[13].

In order to check for heteroskedasticity, White's test is performed. The result from this test indicates that heteroskedasticity seems to be present. The LM (Lagrange Multiplier) value in White's test is bigger than the critical value (χ^2-critical), 15,726 > 9,49[14]. This means that the standard errors need to be corrected in order to achieve a fitting model for changes in CPI. These heteroskedasticity-consistent standard errors are derived further on in this chapter in order to get the correct standard errors for the OLS model.

Furthermore, autocorrelation can be a problem in econometric modelling. In order to check for this, a Breusch-Godfrey or a Durbin-Watson test can be conducted. In the Durbin-Watson test, the received value should be higher, or possibly lie in an interval between, dl = 1,164 and du = 1,587 for n = 49 observations. Since our value is just less than dl we can conclude that autocorrelation presumably is present. This deduction is enhanced by the results in the Breusch-Godfrey test. Hence, the results above hint that there might be autocorrelation present, which presumably is a cause of the use of a linear model in explaining the data or that seasonality in the time-series. Lastly, tests for collinearity show that no such is present.

[12] A more detailed view can be found in appendix 4 on all tests
[13] The χ^2-critical value for 2 degrees of freedom on a 5 % significance level is 5,99. The degrees represent one degree of freedom for skewness and one for kurtosis.
[14] The χ^2-critical value for 4 degrees of freedom on a 5 % significance level is 9,49 and is commonly used in White's test for heteroskedasticity.

To summarize the tests above on model 3, it indicates that heteroskedasticity and autocorrelation is present. In order to make the model suitable for the purpose and create good statistical inference with the OLS model, correction with the Newey-West developed method of a HAC-estimator[15] is conducted. This estimator corrects and adjusts the standard errors in order to fit them better to the actual model, hence making them more appropriate in the regression. With corrected standard errors and the most suitable variables and time lags, the adjusted regression model, 3*, now is denoted as in equation 9.

$$CPI_{\Pi,\,t} = \alpha + \beta_1 OG_t + \beta_2 EMG_t + \beta_3 HP_{t-3} + \beta_4 REER_t + \beta_5 IFP_t + \varepsilon_t \qquad (9)$$

With coefficients, β, and standard errors as follows, the model should be both heteroskedasticity and autocorrelation consistent.

Table 2, Coefficients for preferred model with CPI_{Π} as dependent variable with standard errors in brackets

OLS	Model 3*
CPI_{Π}	*Coefficient*
constant	0,466 (0,185) **
OG_t	0,365 (0,144) **
EMG_t	-0,068 (0,015) ***
HP_{t-3}	0,175 (0,031) ***
$REER_t$	0,080 (0,022) ***
IFP_t	0,089 (0,009) ***
Adj. R^2	0,905

The R^2 value, which can be seen as an explanatory value of the regression's movement, is over 90 % (0,905). This is a good fit, indicating that the model can explain 90 % of the changes in CPI inflation. Hence, the main drivers of inflation can be assumed to be present in the stated model in equation 9, with coefficients and standard errors as in table 2.

The test results above indicate that the model is appropriate for modelling CPI and satisfies the objective of the research question.

[15] The HAC-estimator is a heteroskedasticity and autocorrelation consistent estimator and is conducted in order to get the "true" standard errors

To further highlight the effect of international food prices, table 3 shows how much IFP affects CPI_{Π} each observation from Q1 2008 to Q4 2010. By using the estimated *β*-parameter for IFP from table 2, an estimate of how much IFP impact on CPI_{Π} can be conducted by multiplying the estimated *β*-value, 0,089, with the observation growth-data for each time point. Comparing this with the observed CPI inflation, it is possible to deduce how much of the changes in domestic price levels were caused by international food prices. For example, if the effect is 4 % at a given time point, then a 4 % increase in CPI_{Π} can be explained by IFP.

Table 3, Effect of IFP on CPI_{Π} from 08Q1-10Q4, in % (CPI inflation in brackets)

IFP effect on CPI inflation	
Month	*Effect on CPI_{Π}*
2008-1	4,04 % (8,03 %)
2008-2	3,62 % (7,77 %)
2008-3	1,48 % (5,27 %)
2008-4	- 1,71 % (2,53 %)
2009-1	- 2,58 % (- 0,60 %)
2009-2	- 2,38 % (- 1,53 %)
2009-3	- 1,87 % (- 1,27 %)
2009-4	1,13 % (0,67 %)
2010-1	1,86 % (2,20 %)
2010-2	0,80 % (2,93 %)
2010-3	1,36 % (3,47 %)
2010-4	2,08 % (4,70 %)

Worth of note here is that the *β*-value is estimated for the whole time period, with variance present, so these numbers should be taken with some caution. Also, a 1 % increase in IFP should imply a 0,089 % increase in CPI_{Π} level.[16] Following the results above, international food prices clearly has had a big impact on Chinese inflationary levels in recent years.

[16] According to results in table 2, see coefficient, *β,* for IFP

4. Analysis

Inflation has been a present risk for the Chinese economy for many periods following the major reforms in the late 1970s. With alarmingly high levels in recent years, as well as times with deflation, it has put the issue of consumer price inflation at the center of attention in the policy debates. Consequently, it may hurt the growth of the world's second biggest economy. The aim of this essay is to analyze the drivers of inflation in China and the role of international food prices in determining the CPI inflation.

In creating the model, a Two-Pillar Phillips curve framework, refined by Gerlach (2004), was used. With common economic theory used as a backbone along with previous studies on inflation, both on a Chinese and an international level, a set of variables for the model was denoted. By looking at the results in the previous chapter, the model in equation 9 seems to be a good fit for the inflationary trajectory (with coefficients as in equation 10). With an explanatory R^2 value of over 90 %, the conclusion is that the model represents the changes in CPI in a good way. However, in the original model both heteroskedasticity and autocorrelation was present. By using the HAC-estimator developed by Newey-West, the standard errors in the residuals were adjusted to better suit the true movement in the CPI path.

After some testing with different models and approaches, the final model can be denoted with the following setting of variables and parameter estimations:

$$CPI_{\Pi,\,t} = 0{,}466 + 0{,}365*OG_t - 0{,}068*EMG_t + 0{,}175*HP_{t-3} + 0{,}080*REER_t + 0{,}089*IFP_t \quad (10)$$

Indicating that an increase with 1 % in e.g. OG, the CPI_{Π} variable will increase with the β-value, 0,365 %. All the above-denoted variables are significant at a 5 % level or 1 % level. The fairly high β-values are reflected in the adjusted R^2 value, which is at a good level.

The output gap was the most dominant variable in the equation. The result of output gap being a profound driver of inflation is in line with prior studies in the subject. Although, one should bear in mind that the potential GDP, used in the derivation of the output gap, is a filtration of the real GDP with a HP-filter and is by no way an official figure. Hence, the accuracy of this variable should be considered with some extra attention.

In an open economy, a growth in the money base that exceeds growth in production should intuitively fuel inflation. Opposite to this, the result in the regression performed above show that there exists a negative connection between excess money growth and CPI. This is possibly due to the small number of observations used in the modelling, hence affecting validity of the long-run motions. Especially, the downward spike around 2004, shown in figure 3, may hint of this. A solution to this would possibly be to use a dummy variable in order to better reflect the long-run course. However, in some studies accounted for in this paper there is no connection between excess money growth and consumer price inflation, indicating that the results achieved in this paper in fact may represent a valid picture of the true impact of the variable.

Asset prices on the other hand show ambiguous results. While house prices accounted considerably in the movement of CPI, the impact of stock prices were almost insignificant and were left out in the final model. This can be argued to be a cause of prices showing less volatility in the housing markets. Another explanation may be found in inaccurate assemblage of daily stock market data in order to perform quarterly observations. Stock markets, however, may to a big extent be more of a proxy for global sentiment, hence reflecting more of the international climate than the domestic. Asset prices spill over on inflation with a lag as was presumed in the denoted theory. However, the data on house prices to some extent include land prices. These can be exaggerated and doubtful in validation since the official figures on property and land prices have been scarce in the past.

Affecting the terms of trade, the real effective exchange rate is a proxy of the currency's, and intuitively the production's, attractiveness. If the currency is undervalued, which many skeptics claim, Chinese goods are cheaper on the

international markets compared to its counterparts. Hence, if the Chinese currency appreciates the demand for its goods theoretically should fall, easing inflation. In this study, a growth in the real effective exchange rate affected positively on CPI growth. This may be due to that a bigger growth in the production, fueled by large investments, outpaced the appreciation of the currency in the time period used for this study. In addition, there was an inevitable appreciation of the undervalued currency following the rapid economic growth. For Chinese policy makers, with the currency used as a weapon on the international markets, they were effectively able to control its path to match the domestic growth.

International food prices have soared over the past decade. A continuous unstable sentiment in the world economy, along with increased speculation, pushes commodities to new highs and increasing volatility as a cause. In the model conducted above, imported inflation through international food prices accounted for a significant part of the movement in CPI levels. A conclusion drawn above is that the impact of IFP on CPI inflation has been big in recent years, following higher prices globally for the commodity. E.g. in Q1 2008, IFP contributed to a 4,04 % increase in CPI inflation, following skyrocketing prices of food. There seems to be a link with global price levels on food, although one can argue that food price inflation is partly created within the country. For example, one argument can be that CPI is a proxy for the economic climate in China and the food prices correlates with global demand for goods. Hence, the commodity's prices spills over on Chinese GDP. On the other hand, there is no such study conducted up to this date proving the connection. Along with this, some skeptics claim that China is such a major player in the food market that its domestic climate actually will affect the food prices on a global level. However, in recent years China shifted from being a net exporter to becoming a net importer of food. Shortage of available farmland, a growing population and abundance of farmers acts as constraints on production. The correlation with CPI growth is over 80 %, which is high and could possibly indicate some presence of multicollinearity. Moreover, there might be influences on food import prices by the exchange rate, not accounted for in this model. Stressing diligence, more analysis is needed in order to conclude the role of REER on IFP.

Comparing model 3* and 4, the lagged time periods in the model has little effect on CPI_{Π}. Leadingly, the final model was conducted without lagged variables for international food prices, arguing that it affects CPI inflation instantaneously as a result. Along with this, the aim of keeping the model as simple and observable as possible was a factor of this decision. To summarize the effect of international food prices on consumer price levels, there are convincing indications of a link. Although, there is need for more studies to be conducted in this subject to reveal the actual connections and effects.

A direct limitation of the study is the scope of the data set and its validity. Although the data used for this study catches the Asian crisis in the late 1990s (a time with deflation present), the growth period following this crisis in the mid-2000s as well as the recent financial crisis (again a time with deflation present) and its aftermaths, a longer time period could be of interest. Also, the fact that the Chinese economy is somewhat interfered by the Chinese government, making it a socially planned market economy, adds caution to the analysis. Along with this, one should bear in mind that there could be variables affecting each other, as stated before with REER possibly affecting IFP. Finally, the issue with stationarity of the time-series could have affected the regression results. Hence, the results concluded in this paper should not be taken as an absolute reflection of price level movements in China but should instead work as indicators of the CPI inflation trajectory.

5. Conclusion

This paper was aimed at determining the drivers of consumer price inflation in China and assessing the effect on it by international food prices. In doing so, an econometrical approach was conducted, laying focus on identifying the drivers, and examining its impact on consumer price levels. Using this framework, a thorough analysis of the potential drivers was done through a multiple variable OLS-regression with corresponding tests for applicability of the estimated model.

By taking into account the data availability and reliability problems concurrent in Chinese official figures, the model was deducted with a simple Two-Pillar Phillips

curve framework. In order to determine the drivers of inflation, or in other words the variables in the model, previous studies and common economic theory was used. This resulted in a model with CPI_{Π} as dependent variable with explanatory variables including output gap, excess money growth, house prices, stock prices, real effective exchange rate and international food prices. A main aim of this paper was to find the long-run relationships governing the inflation in China. In doing so, the coefficients for the model were derived.

The results showed that the output gap, house prices, real effective exchange rate and international food prices all had positive impact on change in inflation. On the other hand, excess money growth proved to have a negative impact on inflation. Stock prices had little, or no, affect and were left out in an early stage of the modelling. These are results that mainly are in line with previous studies accounted for in this paper and denote the main drivers of inflation.

However, the role of imported inflation through international food prices in China has not previously been covered. The result of this study is that international food prices affected changes in consumer price significantly. Looking at correlations, we conclude that CPI_{Π} and international food prices are correlated over 80 %. In addition, looking at the figure for CPI change and change in international food prices, a similar change pattern can be observed. Conclusion in this paper is that the latter have an impact on the prior. Lagging observations of international food prices in time did not offer any significant difference in the results and can therefore not be assumed to be of constructive use in this model.

Given the high level of R^2-value, significance level of coefficients and successful tests for suitability for the model, equation 9 is a good model for CPI inflation. Accordingly, the purpose of this study is fulfilled since the main drivers of inflation in China are found and the role of international food prices has been examined.

Further studies needs to be conducted in this topic. Foremost, a longer time span with more observation, covering additional business cycles, would be necessary to further examine the affect of imported inflation through international food prices. In

addition to this, a study of the short-run impact of international food prices on CPI inflation would give more insight in the inflationary process in China. Using monthly observations would plausibly give an even more detailed view of the situation, extending the conclusions in this paper with additional valuable analysis tools. In addition, a study with a more sophisticated theory framework, backed up with more in dept parameters, would presumably give this type of assessment extra solidity. In final, the increasing amount of data published, along with an increased level of validity offered to the public by Chinese official figures, will open up to more possibilities to studies of this kind.

APPENDIX

Appendix 1

List of Variables

CPI_{Π} – The consumer price index, change from same period previous year, in %

OG – Difference between log. real GDP and log. potential GDP (seas. Adj.)

EMG – Difference between growth in Money supply and growth in nominal GDP

HP – Change from same period previous year, in %, from Property price index

StP – Change from same period prev. year, in %, from Shanghai Composite Index

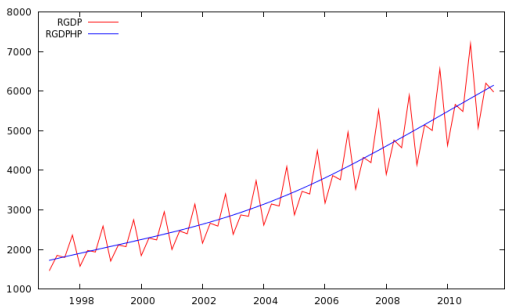
REER – Change from same period prev. year, in %, from REER index (averaged monthly data)

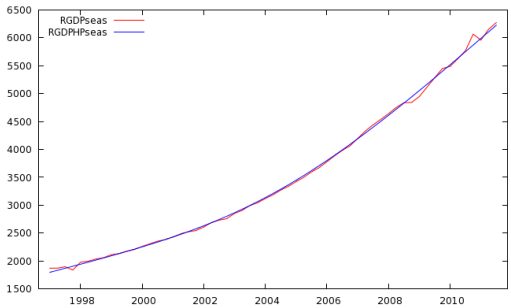
IFP – Change from same period prev. year, in %, from Food Price index, (averaged monthly data)

(Non-cumulative)

Appendix 2

Non-seasonally adjusted vs. seasonally adjusted real GDP





Appendix 3

Correlations matrix for Model 1 variables

Correlation coefficients, using the observations 1998:1 - 2010:4
5% critical value (two-tailed) = 0.2656 for n = 52

CPI_{Π}	OG	EMG	HP	StP	REER	IFP	
1.0000	0.2002	-0.6890	0.6750	0.1836	0.1765	0.8446	CPI_{Π}
	1.0000	-0.0221	0.1331	0.3123	0.0651	0.3779	OG
		1.0000	-0.4127	-0.1622	0.0820	-0.5487	EMG
			1.0000	0.1167	-0.1012	0.6141	HP
				1.0000	-0.0228	0.2598	StP

1.0000	-0.0129	REER
	1.0000	IFP

Appendix 4

Detailed data for the different models used

Model 1: OLS, using observations 1998:1-2010:4 (T = 52)

Dependent variable: CPI_{Π}

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.626779	0.250556	2.5016	0.01607	**
OG	-0.161668	0.164881	-0.9805	0.33207	
EMG	-0.078727	0.0170427	-4.6194	0.00003	***
HP	0.106748	0.0308555	3.4596	0.00120	***
StP	-0.000719546	0.00272995	-0.2636	0.79331	
REER	0.103033	0.0235213	4.3804	0.00007	***
IFP	0.0939623	0.0138853	6.7670	<0.00001	***

Mean dependent var	1.514487	S.D. dependent var	2.465173
Sum squared resid	39.72711	S.E. of regression	0.939587
R-squared	0.871820	Adjusted R-squared	0.854729
F(6, 45)	51.01126	P-value(F)	1.87e-18
Log-likelihood	-66.78535	Akaike criterion	147.5707
Schwarz criterion	161.2294	Hannan-Quinn	152.8071
rho	0.547948	Durbin-Watson	0.899504

Model 2: OLS, using observations 1999:1-2010:4 (T = 48)

Dependent variable: CPI_{Π}

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
const	-0.127407	0.513697	-0.2480	0.80709
OG	-0.0759531	0.392537	-0.1935	0.84887
OG_1	0.364564	0.402553	0.9056	0.37779
OG_2	0.00554083	0.318048	0.0174	0.98630
OG_3	-0.385379	0.346359	-1.1127	0.28134
OG_4	-0.120076	0.417552	-0.2876	0.77715
EMG	-0.0287399	0.0303528	-0.9469	0.35698
EMG_1	-0.0483964	0.0352134	-1.3744	0.18717
EMG_2	-0.0055291	0.0339073	-0.1631	0.87239
EMG_3	0.0518239	0.0333334	1.5547	0.13843
EMG_4	-0.0218097	0.0280304	-0.7781	0.44722

HP	0.0678971	0.0706159	0.9615	0.34978	
HP_1	0.0356811	0.0629287	0.5670	0.57812	
HP_2	-0.00775894	0.068612	-0.1131	0.91129	
HP_3	-0.0159323	0.077104	-0.2066	0.83875	
HP_4	0.155698	0.0747421	2.0831	0.05265	*
StP	-0.00625174	0.00667353	-0.9368	0.36198	
StP_1	0.00145059	0.00630068	0.2302	0.82066	
StP_2	0.0104905	0.00732795	1.4316	0.17039	
StP_3	0.0149238	0.00882257	1.6916	0.10898	
StP_4	-0.00162312	0.00855724	-0.1897	0.85181	
REER	0.0522042	0.0658455	0.7928	0.43880	
REER_1	-0.00474405	0.0913432	-0.0519	0.95918	
REER_2	0.0575181	0.0798026	0.7208	0.48086	
REER_3	-0.117689	0.0795555	-1.4793	0.15734	
REER_4	0.0315609	0.0621885	0.5075	0.61832	
IFP	0.0103262	0.0338144	0.3054	0.76378	
IFP_1	0.0298878	0.0412891	0.7239	0.47899	
IFP_2	-0.0156365	0.0471	-0.3320	0.74396	
IFP_3	-0.0262175	0.0453949	-0.5775	0.57114	
IFP_4	0.0316717	0.039027	0.8115	0.42828	

Mean dependent var	1.705694	S.D. dependent var	2.464459
Sum squared resid	10.40037	S.E. of regression	0.782168
R-squared	0.963566	Adjusted R-squared	0.899271
F(30, 17)	14.98654	P-value(F)	1.92e-07
Log-likelihood	-31.40441	Akaike criterion	124.8088
Schwarz criterion	182.8161	Hannan-Quinn	146.7298
rho	0.438388	Durbin-Watson	1.113400

Model 3: OLS, using observations 1998:4-2010:4 (T = 49)

Dependent variable: CPI_{Π}

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.465788	0.210245	2.2155	0.03207	**
OG	0.365006	0.160831	2.2695	0.02831	**
EMG	-0.068484	0.01403	-4.8813	0.00001	***
HP_3	0.175227	0.030277	5.7875	<0.00001	***
REER	0.0795658	0.0213049	3.7346	0.00055	***
IFP	0.0894495	0.0106532	8.3965	<0.00001	***

Mean dependent var	1.648435	S.D. dependent var	2.471371
Sum squared resid	24.90724	S.E. of regression	0.761077
R-squared	0.915041	Adjusted R-squared	0.905162

F(5, 43)	92.62553	P-value(F)	6.83e-22
Log-likelihood	-52.94977	Akaike criterion	117.8995
Schwarz criterion	129.2505	Hannan-Quinn	122.2061
rho	0.428490	Durbin-Watson	1.129786

Model 4: OLS, using observations 1999:1-2010:4 (T = 48)

Dependent variable: CPI_{Π}

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.542896	0.23027	2.3577	0.02364	**
OG	0.448835	0.163893	2.7386	0.00934	***
EMG	-0.0695775	0.0143969	-4.8328	0.00002	***
HP_3	0.162789	0.0388199	4.1934	0.00016	***
REER	0.0654399	0.0295653	2.2134	0.03295	**
IFP	0.0797997	0.018067	4.4169	0.00008	***
IFP_1	0.00994433	0.0258661	0.3845	0.70278	
IFP_2	0.0291256	0.0290854	1.0014	0.32298	
IFP_3	-0.0513721	0.0270987	-1.8957	0.06562	*
IFP_4	0.0383701	0.0181688	2.1119	0.04133	**

Mean dependent var	1.705694	S.D. dependent var	2.464459
Sum squared resid	21.29428	S.E. of regression	0.748583
R-squared	0.925403	Adjusted R-squared	0.907735
F(9, 38)	52.37811	P-value(F)	1.12e-18
Log-likelihood	-48.60275	Akaike criterion	117.2055
Schwarz criterion	135.9175	Hannan-Quinn	124.2768
rho	0.522661	Durbin-Watson	0.938924

Tests for model 3

White's test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 15,726

with p-value = P(Chi-square(20) > 15,726) = 0,733

```
White's test for heteroskedasticity
OLS, using observations 1998:4-2010:4 (T = 49)
Dependent variable: uhat^2

             coefficient    std. error   t-ratio   p-value
  -------------------------------------------------------
  const       0.257822      0.498269      0.5174   0.6089
  OG          0.178773      0.799944      0.2235   0.8248
  EMG        -0.0198286     0.0756002    -0.2623   0.7950
  HP_3        0.0831582     0.162219      0.5126   0.6122
  REER        0.0120002     0.113609      0.1056   0.9166
  IFP         0.0111526     0.0598124     0.1865   0.8534
  sq_OG       0.0752121     0.180940      0.4157   0.6808
```

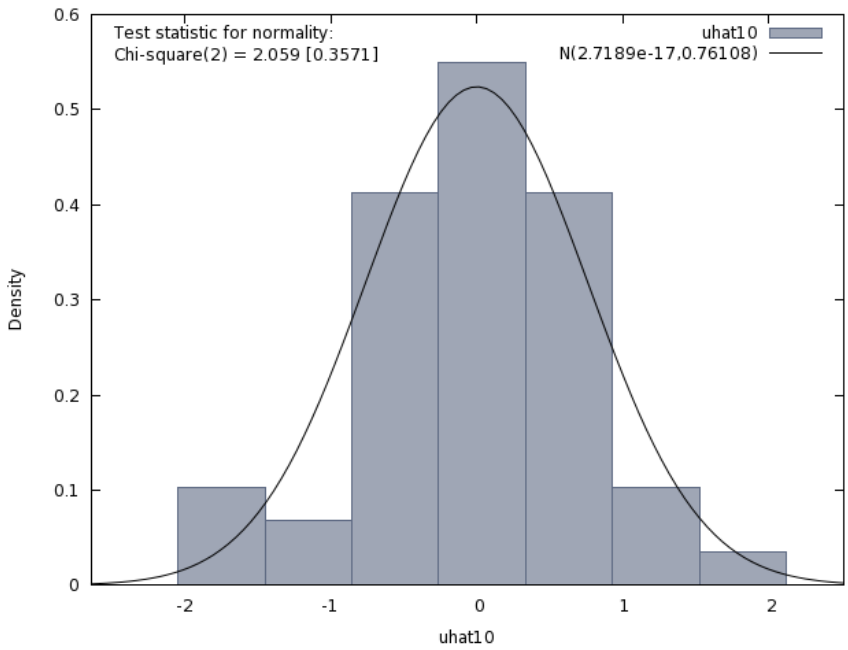
```
  X2_X3       -0.00593408    0.0560553    -0.1059   0.9164
  X2_X4       -0.0759117     0.0992216    -0.7651   0.4506
  X2_X5        0.0486064     0.0559943     0.8681   0.3927
  X2_X6       -0.0180967     0.0313681    -0.5769   0.5686
  sq_EMG       0.000835141   0.00267619    0.3121   0.7573
  X3_X4        0.00728943    0.0119645     0.6093   0.5473
  X3_X5       -0.00269871    0.00690777   -0.3907   0.6990
  X3_X6       -0.000927526   0.00407696   -0.2275   0.8217
  sq_HP_3     -0.00570837    0.0124966    -0.4568   0.6513
  X4_X5        0.00713283    0.0123748     0.5764   0.5690
  X4_X6        0.00249209    0.00669497    0.3722   0.7125
  sq_REER     -0.00401808    0.00842294   -0.4770   0.6370
  X5_X6       -0.000818043   0.00548753   -0.1491   0.8826
  sq_IFP      -0.000802541   0.00160174   -0.5010   0.6203

  Unadjusted R-squared = 0.320941

Test statistic: TR^2 = 15.726115,
with p-value = P(Chi-square(20) > 15.726115) = 0.733464
```

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 2,059

with p-value = 0,357



Test for autocorrelation

```
Breusch-Godfrey test for autocorrelation up to order 4
OLS, using observations 1998:4-2010:4 (T = 49)
Dependent variable: uhat

             coefficient    std. error   t-ratio    p-value
  ---------------------------------------------------------
  const       0.0329458     0.181309      0.1817    0.8568
  OG         -0.0508347     0.141448     -0.3594    0.7212
  EMG         0.000588601   0.0120809     0.04872   0.9614
  HP_3       -0.00892819    0.0263866    -0.3384    0.7369
  REER       -0.000949259   0.0181726    -0.05224   0.9586
  IFP        -0.000665901   0.00909478   -0.07322   0.9420
  uhat_1      0.363234      0.148611      2.444     0.0191  **
  uhat_2      0.227312      0.171815      1.323     0.1935
```

```
  uhat_3      0.203778      0.174701      1.166     0.2505
  uhat_4     -0.462889      0.164080     -2.821     0.0075  ***

  Unadjusted R-squared = 0.341646

Test statistic: LMF = 5.059653,
with p-value = P(F(4,39) > 5.05965) = 0.00221

Alternative statistic: TR^2 = 16.740634,
with p-value = P(Chi-square(4) > 16.7406) = 0.00217

Ljung-Box Q' = 17.5102,
with p-value = P(Chi-square(4) > 17.5102) = 0.00154
```

Test for collinearity

```
Variance Inflation Factors

Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

             OG    1.678
            EMG    1.560
           HP_3    1.584
           REER    1.123
            IFP    2.105

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient
between variable j and the other independent variables

Properties of matrix X'X:

 1-norm = 17514.421
 Determinant = 4.2702711e+16
 Reciprocal condition number = 0.00059499596
```

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