China's monetary sterilization and it's economical relationship with the European Union

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The author examines China's monetary policy in the light of the sterilization process of the excess liquidity caused by the permanent foreign exchange rate intervention. The tools of the neutralization of the monetary oversupply, its effectiveness and its costs are also investigated. With the help of Two-stage least squares (2SLS) regression method it is demonstrated that the sterilization process of the yuan has been almost a total success on the level of the monetary base, and has been partially effective on the level of the M2 supply in the past 15 years. With a cost-benefit analysis it is highlighted that the practice of the monetary sterilization – which is thought to be loss-making in the literature – has been a profitable operation of the central bank up to date.

After the demonstration of the monetary sterilization, the economic relationship between China and the European Union is investigated. It is pointed out that China's role as a global importer and a global investor has been significantly appreciated. Thanks to China's active economic presence in the European market during the crisis, the recession of the European economies were probably much moderate.

**Keywords**: China monetary sterilization, 2SLS, European Union, crisis

1. Introduction

The continuous managing of the exchange rate of the Chinese currency puts serious challenges to China's central bank, The People's Bank of China (hereinafter referred to as PBC), on a daily basis. In the last three years – presupposing 250 trading days per year – it has daily purchased 1.9 billion USD for yuan in the Shanghai foreign exchange market, and as a result, it has doubled its reserves since the beginning of 2008.[1] Given that one of the focal points of social tensions has always been the mass impoverishment caused by inflation, the Chinese party leadership takes fighting against inflation extremely seriously. In the light of this, the monetary policy gives high priority to neutralizing the monetary oversupply.

In foreign exchange purchase, the central bank chooses between the options of purchasing at the expense of increase in the monetary base and financing the purchase by decreasing the net domestic assets. The latter is made possible by the sale of available government bonds, the auction of bonds and swap and repo operations. However, the monetary authority is able to sterilize the liquidity increasing effect of foreign exchange inflows not exclusively on the level of the monetary base. Raising the required reserve ratio through the multiplier effect is also able to reduce the supply of broader monetary aggregates.

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[1] At the closure of the study, 30th June 2011, the PBC foreign exchange reserves increased by 30.3%, to 3197 billion USD in one year. It equals approximately to six hundred thousand billion in HUF!

Figure 1: The components of China's balance of payments, the tendency of foreign exchange reserves and yuan exchange rate, 1990-2010, in million USD
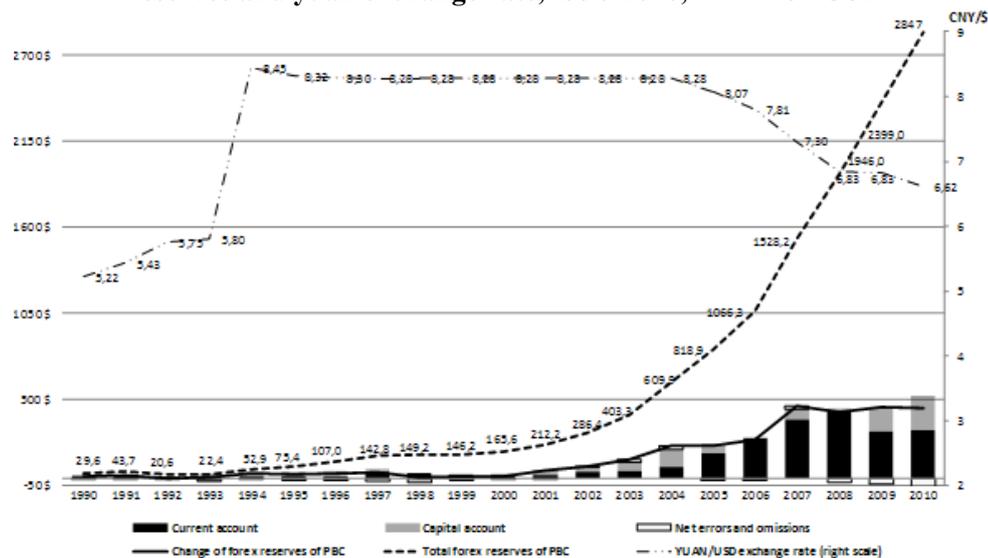
Source: CEIC (2011), SAFE

China's economic policy has indeed become the focus of international research after joining the World Trade Organization in 2001. Just at the time when the growth in the central bank reserves started to accelerate (Figure 1). The Chinese reserves have been impetuously increasing as a result of the twin balance of payment surplus[2] ever since. A considerable part of the increase is caused by the current account sufficit, which has an amount only of 12 billion USD in 1990 and 426 billion USD in 2008.[3] In the past years, however, the net capital inflow has been playing an increasingly important role within the balance of payment sufficit. Last year the 226 billion surplus of the capital account was the highest value of all time! Knowing all this, a double cause can be identified underlying China's unique reserve growth dynamics. On the one hand, it can be explained by the objectives of the Chinese economic policy pursuing a strictly managed exchange rate policy and supporting de facto export. Many analysts claim that for maintaining competitiveness China fixes the exchange rate of its currency undervalued by 30-40%[4] against USD.[5] The weak yuan is advantageous both for the export sector and for the investments of multinational companies in China. The former increases the current account sufficit, the latter the capital account sufficit.

On the other hand, we emphasize the speculative demand aimed at the future strengthening the Chinese currency. The one-way bet of short-term profit oriented investors on exchange rate strengthening is able to move huge amount of foreign exchange. Since the hot money can be extremely harmful concerning an emerging economy, China's decision makers try to prevent this type

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[2] Gábor's (2010a) article contains a detailed analysis on the causes behind China's irregular twin balance of payment surplus and the development of twin sufficit.
[3] If we examine the components of the current account, we can see that the trade sufficit – including the export of goods in particular – is responsible for the most part, 77% of the sufficit.
[4] These views are represented mainly by the noted economists of the American *Peterson Institute for Economics* (Bergsten, 2010; Cline et al., 2009; Goldstein et al., 2006), and by Paul Krugman, who was the recipient of the Nobel Prize in Economics in 2008.
[5] I make a note here that there are experts who consider the nature of the global financial tensions different. The economists of the global monetarist view, McKinnon and Schnabl (2011) claim that the international disequilibrium is only a temporary state. They think that in the case of the rising Asian economies the fixed exchange rate is "needed" for the stabilization of the Asian region.

of capital flow with strict capital and administrative requirements.[6] Despite all this, in the past nearly one decade there has been increasing volatility in the short-term capital flows (capital account) and on the net errors and omissions account of the balance of payment, which implies the limit of the efficiency of capital controls. Without foreign exchange market intervention, the intensive capital inflow would result in the uncontrollable strengthening of the USD exchange rate of the yuan, which would be incompatible with the objectives of China's mercantilist trading policy. The regular foreign exchange purchase, however, would induce intense increase in money supply and in inflation (real exchange rate appreciation), which would make the realization of the previously mentioned objective and the plan to put an end to poverty uncertain. Maintaining the status quo necessitates the immediate neutralization, sterilization of the liquidity increasing effect of foreign exchange purchase.

We intend to describe as follows the sterilization techniques applied by the PBC through examining the items of the central bank balance sheet.

Table 1: Schematic balance of payments of the People's Bank of China

Assets	Sources
Foreign assets	Monetary base (cash in circulation + deposits of commercial banks)
Claims on government	Deposits of government
Claims on depository corporations	Foreign liabilities
Claims on and other financial and non-financial corporations	Issued bonds
	Equity capital
Other assets	Other liabilities

Note: **Net foreign assets** = Foreign assets – foreign liabilities
Net domestic assets = Claims on financial and other financial and non-financial institutions + Claims on government + Other assets – Issued bonds – Deposits of government – Other liabilities = **Monetary base** – **Net foreign assets** + Equity capital of central bank

Table 1 demonstrates the simplified form of the PBC balance. The net domestic assets (hereinafter referred to as *NDA*) and the net foreign assets (hereinafter referred to as NFA) can be easily calculated. Based on this, the basic equation of the central bank's balance of payment can be formulated, according to which the sum of the net foreign and the net domestic assets is equal to the sum of the monetary base and the equity capital.[7] If the NFA, i.e. approximately the central bank reserve increases, it results in increase in the monetary base for lack of open market sterilization.

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[6] The active control of the arbitrage capital is needed in order to avoid the damage in the monetary independence of the central bank beside the strictly managed exchange rate regime. The "impossible trinity" of economic policy, which is frequently referred to as monetary trilemma by the literature, does not allow the simultaneous realization of monetary independence, fixed exchange rates and international capital flows. Consequently, the problem and the conflict of the simultaneous realization of internal economic and external economic objectives, that is the objectives of inflation and exchange rate, emerge (Triffin dilemma). Since for China both objectives have similarly high priority, the controlling authorities have a very considerable role in the "coordination" of the processes of "social market economy" – from bank lending to controlling factor prices.
[7] Since the PBC equity capital – which has had an unchanged value since 2003 – has a negligible amount in the ratio of the balance sheet total (21.9 billion yuan ~ 3.3 billion USD), we disregard this balance sheet item in our calculations.

Provided the central bank intends to stem the growth in monetary supply, it can do so by decreasing the net domestic assets and by raising the required reserve ratio. According to the quarterly published Monetary Report, the two main sterilization tools of the PBC are the open market operation and the control of required reserve ratio, both having different effects on money supply. Table 2 shows the effect mechanism of the two methods.

Table 2: Sterilization tools

Method	Process
Open market operations (issuing bonds and repos)	1. NFA increases by ΔNFA
	2. MB = NFA + NDA increases by ΔNFA
	3. NDA decreases by ΔNDA, MB returns to original level
	4. M2= MB * mm constant
Raising the required reserve ratio	1. NFA increases by ΔNFA
	2. MB increases
	3. mm decreases through raising required reserve ratio
	4. M2= MB * mm constant

Note: mm is the abbreviation of monetary multiplier, MB stands for monetary base.

While by the open market operation, excess liquidity can be directly withdrawn from the market, raising the required reserve ratio can reduce oversupply through decreasing the money market multiplier. It can be generally established that the sterilization with required reserves is a cheaper solution for the monetary authority, since it entails considerably lower interest burden than market rates.[8]

The most frequently applied open market sterilization techniques are the bond issue and the short-term – mainly 91-day – security repurchasing, so-called repo transactions.[9] The third tool of sterilization is the *window guidance (moral suasion)*. This latter practically means verbal intervention, in which the central bank forces that the operation of commercial banks and through them the monetary supply should develop by keeping the nation's interest in view (e.g. it sets the credit ceilings). Since the quantification of the latter method is quite problematic, it is not incorporated in our study.

The neutralization of the monetary oversupply was implemented through selling the government bonds of the central bank until 2002. However, due to the shortage of bonds, the central bank has been sterilizing excess liquidity by issuing own bonds (*central bank bill*, CBB) since 2003. The first issue took place in April 2003, since then bond auctions have been held on a weekly basis.

The three-month and the one-year bills are the bonds of the most frequent maturity, but six-month bonds were auctioned on several occasions before 2006, while bonds of three-year maturity are periodically issued.[10] The sterilization bonds of financial institutions expanded to 4.800 billion yuan in

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[8] The increase in required reserve ratio is an implicit taxation form, which increases the interest margin between deposits and credits through the decreasing profitability of the bank sector and has a reducing effect on competition. Árvai's (1995) work deals with the welfare loss and controlling role of the reserve ratio increase in greater detail.

[9] The central bank of China has also been trying to stem the monetary oversupply with swap operations since 2005. However, we do not have related data series, since the PBC does not make the details of swap transactions public.

[10] From April 2010 until the end of the year, due to the concerns over the increasing inflation, bonds of 3-year maturity for more than a thousand billion yuan were issued for eight months.

five years – by October 2008 –, then it lessened to 3.500 billion yuan by the beginning of 2011. The shrinking of open market operations is reinforced by the fact that the proportion of bonds to the central bank reserves has considerably decreased, from 40% to 18% in the past four years (Figure 2).

Figure 2: Open market sterilization of PBC, 2002-2010
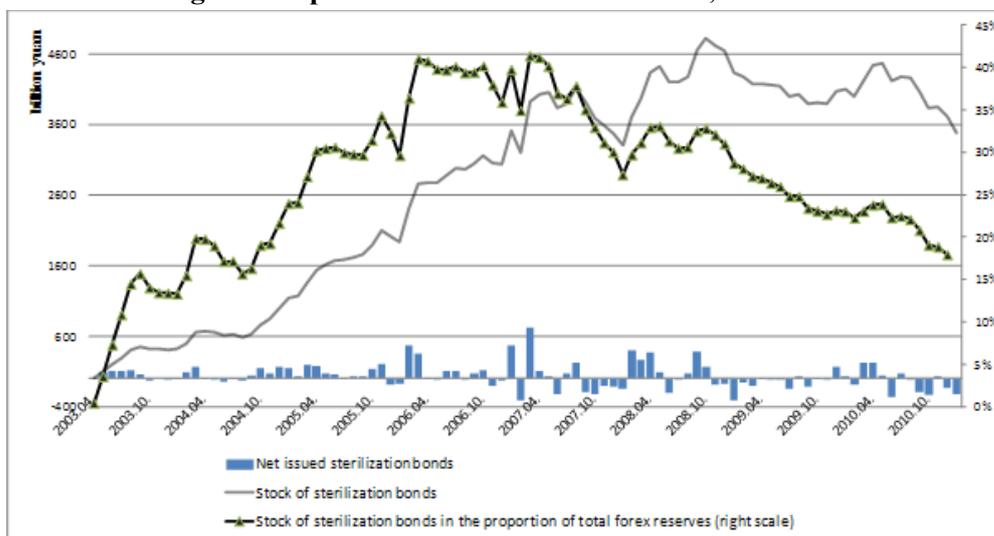
Source: CEIC (2011), China Monetary Policy Report

Although the regular rise of the required reserve ratio has significant distorting effect on markets[11], China's monetary authority still employs this practice with growing regularity after the second half of 2000s in order to control monetary supply. Until the closure of the article, July 2011, the central bank raised the reserve rate required after deposits to 21.5% (Figure 3). Despite the fact that the gradual increase in required reserves already began in 2003, the total reserve ratio – which contains the excess reserve besides the required – decreased from 2006 12.3% to 10.6% until the mid of 2006! This could be realized by that commercial banks rearranged the required deposits charged on the excess reserves. In the light of this, the sterilization function of raising the required reserve ratio remained ineffective up until the first half of 2006.[12]

The initial high level of excess reserves can be traced back to a double cause. On the one hand, due to strict capital controls and the immature and not prudent financial intermediary system the central bank deposits did not have a serious alternative. On the other hand, the PBC paid an equal, 1.89% interest payments on both the required and the excess reserves.

In the course of our research we aimed to examine the effectiveness of monetary sterilization[13] with regression-analysis of the changes of central bank's balance sheet data and the macroindicators on the

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[11] The rising countries – e.g. Malaysia, Korea, the Republic of the Philippines – regularly took the advantage of the reserve ratio increase in order to neutralize the increasing monetary oversupply caused by intensive capital inflow in the 1990s (Takagi and Esaka, 1999).

[12] The reduction of the initial high level of the excess reserves lowered the decreasing effect of the increasing reserve ratio on the money multiplier until the first half of 2006. According to our calculations, the average 4.6 value of the M2 multiplier between September 2003 and June 2006 did not decrease despite of the 1.5% increase of the required reserve ratio. In our opinion, these changes can be explained not only by the rearrangement between the excess-required reserves but also by the institutional changes, occurring in currency holdings.

[13] In the quantification of the effectiveness of monetary sterilization, we started out from the MB=NDA+NFA equation. We examine the extent of the net domestic assets decrease that follows the net foreign assets (foreign exchange reserves) increase. Performing a similar analysis between the monetary base and the NFA would be problematic because, on the one hand, the PBC does not publish the distribution of required and excess reserves within the central bank deposits, on the other hand, with the change of economic cycles other changes which

level of monetary base and M2 supply, furthermore, to quantify the costs of the sterilization practice. After outlining the literature studying the effectiveness of sterilization, we describe the methodology we have chosen and the processed data series. In the next stage – relying on the estimated parameters of the regression model – we draw inferences about the effectiveness of neutralizing the Chinese monetary oversupply. Finally, we examine by comparing the sterilization costs and the yields earned on foreign assets that what costs today's practice of exchange rate policy imposes on monetary policy, furthermore, we make assumptions in connection with the sustainability of the current practice.

Figure 3: The amount of money neutralized in monetary sterilization, tendency of reserves and required reserve ratio, 2003–2011, billion yuan
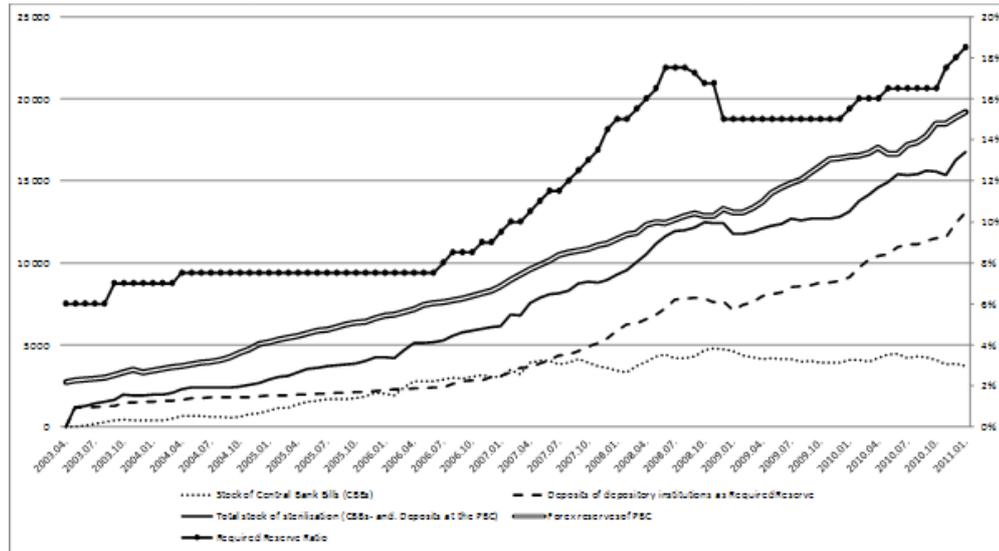
Source: CEIC (2011)

2. Methodology

Many studies deal with the central bank reaction to foreign capital inflow, and its effect on the monetary and economic environment. In the past two decades, the number of researches which focus on the monetary reaction function of the Asian countries, especially of China, has been multiplied.

One of the most popular methods of examining the relationship between the NFA and NDA is the regression analysis. This method is built on the estimations of the linear regression of two structural equations, in which the subject of study is what kind of effects the independent variables involved in the model have on the examined dependent variable, i.e. to what extent they can predict it. The regression equation is the following in general:

$$y_i = \beta_0 + \beta_1 \cdot x_{i1} + \beta_2 \cdot x_{i2} + \ldots + \beta_m \cdot x_{im} + \epsilon_i \qquad (1)$$
$$i = 1,2, \ldots, n \text{ and } m + 1 < n < N$$

,where y_i is the dependent variable of the model, x_i is the independent vectors, β_m is the coefficients of the explanatory variables, and ϵ_i is the random error of the model. The coefficient of the NFA is the *sterilization coefficient*, which shows the extent and direction of change that the unit increase of foreign exchange reserves causes in the net domestic assets of the central bank. If its value is -1, it

cannot be related to sterilization may also occur in the required reserve deposits, which would distort the outcome of the analysis.

means the total neutralization of excess liquidity, 0 means the total absence of sterilization. The other named coefficient is the *offset coefficient*, which indicates how the foreign capital flow reacts to the changes of the domestic monetary environment. The -1 value of the coefficient refers to perfect capital mobility, while the value 0 refers to total capital control.

Aizenman and Glick (2009) featured the quarterly GDP change as control variable in their model, in which it received -0.6 and -1.4 values for the sterilization coefficient. Wang (2009) also ignored the phenomenon of endogeneity emerging between the net capital flow and the net domestic assets in his analysis. In the course of analysis, he received a value of -0.3 for the offset coefficient, and -0.96 for the sterilization coefficient.

The basis of the regression is the method of *ordinary least square*, hereinafter OLS, whose condition is that the model is homoscedastic and autocorrelation and multicollinearity do not emerge in the model. The estimation with OLS is problematic because it does not take into account the fact that the net capital flown has a simultaneous effect on the net domestic assets of the central bank, and this latter has repercussion on the a foreign exchange flow. Since the dependent variables are defined in an exogenous way, the method of ordinary least square does not render it possible to examine the interaction effects. Due to the problems the applicability of the OLS entails other regression techniques may come into prominence (Brissimis et al., 2002; Kim, 2003; Ouyang et al., 2010; Wang, 2009). For instance, the 2SLS, i.e. the two-stage least squares method[14], which examines the effect of independent variables on dependent variables by simultaneous structural equations, in addition to eliminating the problem of endogeneity. This technique is used when the random errors of the dependent variable correlate with the explanatory variables. The basis for applying the 2SLS may be that one explanatory variable (NFA) correlates with the random error (u), thus the estimation of the regression coefficient (β_1) will be distorted.

$$\Delta NDA = a + \beta_1 \Delta NFA + \beta_i X_i + u \qquad (2)$$

In the first step, the variable considered endogenous (NFA) is regressed on the instrumental[15] variable or variables (z):

$$\Delta NFA* = a + \beta_1 z + v \qquad (3)$$

In the second step, the equation is formulated with using the value predicated in the equation (3) (ΔNFA*) instead of the endogenous variable (ΔNFA):

$$\Delta NDA = a + \beta_1 \Delta NFA* + u \qquad (4)$$

The greatest challenge of the 2SLS method is to select the instrumental variables correctly, which allows us to take account the simultaneous interactions of the changes of the NDA and NFA. Ouyang et al (2010) used government expenditures as the instrument of the NDA, while real effective exchange rate as the instrument of the NFA. The β sterilization coefficient takes on value -1.02 in his model in the period of 2000–2008, which implicates total neutralization of excess liquidity. Our assumption that government expenditures do not have a direct effect on foreign capital inflow is questionable. Taking this into consideration, the unbiased of the estimation can also be queried. The

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[14] In our research, we calculated with the help of LeSage's (1999) JPL Econometrics Toolbox in Matlab: http://www.spatial-econometrics.com/

[15] Instrumental variable (z) is the variable which does not correlate with the random error of the original regression equation (u), [Cov(z,u) = 0] at the same time it correlates with the variable (ΔNFA) which correlates with u according to the assumption, that is: [Cov(z, ΔNFA) ≠ 0]

fiscal expansion produces yield decrease on the government securities market, which certainly has an effect on the direction and intensity of the capital flow. Kim (2003) also claimed that the high budget deficit has a negative effect on international capital inflow.

Zhang (2010) chose the volatility of exchange rate as the instrumental variable of the NFA, while in the case of the NDA he selected a dummy variable[16]. Nevertheless, no coefficients of the instruments had significant explanatory force; in addition, the coefficient of the dummy variable took on a sign contrary to his expectations.

In our research we chose the 2SLS method as the analytical framework, in the course of which we modified the set of regressor and instrumental variables used in the literature, in this way we tried to estimate the effectiveness of sterilization on a more robust manner. We aimed to select such indicators as predictive variables in the model that, on the one hand, have an effect on the movement of foreign capital flow, on the other hand, have decisive momentum in the decisions of the monetary policy. In addition to the explanatory variables applied in the literature (Brissimis et al., 2002; Kim, 2003; Ouyang et al., 2010) we also used regressors that in our opinion increase the predictive capability of the estimation.

We chose the 12-month volatility of the yuan exchange rate and the quarterly change of the Shenzhen Composite Index as instrumental variable. The volatility of the exchange rate is exogenous with regard to the changes of the net domestic assets, while it moves together with the net foreign assets in a slightly positive direction. Furthermore, while no correlation can be shown between the indicator of the stock index and the foreign exchange, the stock index moves in the opposite direction to the change of the net domestic assets.

We describe in this chapter how the particular control variables are able to grasp the movers of capital flows and the direction of monetary policy.

The literature concerned with the Chinese sterilization generally points out that the neutralization of monetary oversupply by authorities started after 2000. In the course of our analysis, however, for the better interpretability of the explanatory force of the estimated coefficients we processed the data of a longer period. Since the shortest breakdown of the GDP data published by the National Bureau of Statistics of China is a quarter, in our analysis we built the model on the quarterly data of the period between 1995Q3 and 2010Q4[17]. The CEIC (2011) China Premium Database, the PBC and the BIS website served as the source of the input data series. Table 3 contains the short definition, formula and sources of the variables.

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[16] The dummy variable took on value 1 in every fourth quarter, while 0 in the rest. Zhang (2010) started out from the purchasing habits of the Chinese. As the new year comes, the commercial banks increase their reserves for greater liquidity. His basic assumption is that the arrival of the new year does not have any kind of effect on foreign capital flow.

[17] The input data set consists of 62 columns. It satisfies the quantity criteria necessary for the regression calculation, but the values of the coefficients have to be interpreted with proper caution. It would have been more practical to start out from monthly data, but the required monthly GDP was not available.

Table 3: Description, formula and source of the used explanatory variables

Variable	Description	Mode of calculation	Source
NFA_t	Forex reserves of PBC in USD minus central bank foreign liabilities	$Foreign\ assets_t * e_t^{(RMB/\$)} - Foreign\ liabilities_t$	IFS
ΔNFA^*_t	The extent of change in the assets of NFA, corrected by the yield on foreign assets and exchange rate effects; in the ratio of GDP	$\dfrac{\Delta\left\{NFA_t - \left(\frac{e_t - e_{t-1}}{e_{t-1}}\right)NFA_{t-1} - \frac{i_\$}{4}\left(\frac{NFA_t + NFA_{t-1}}{2}\right)\right\}}{GDP_t}$	PBC, CEIC
ΔNDA^*_t	The extent of change in the assets of NDA in the ratio of GDP	$\dfrac{\Delta MB_t}{GDP_t} - \Delta NFA^*_t$	CEIC
mm_t	M2 money market multiplier	$M2_t\,/\,MB$	CEIC
Δmm_t	Change of multiplier	$Ln\,(mm_t) - Ln\,(mm_{t-1})$	CEIC
ΔRR_t	Change of required reserve rate	$Ln(RR_t) - Ln(RR_{t-1})$	CEIC
ΔCPI_t	Delayed change of consumer price index	$Ln(CPI_t) - Ln(CPI_{t-1})$	CEIC
ΔNEX_t	Change of net export in the ratio of GDP	$\dfrac{(NEX_t - NEX_{t-1})}{GDP_t}$	CEIC, IFS
ΔG_{t-1}	Change of government expenditures in the ratio of GDP	$\dfrac{G_{t-1} - G_{t-2}}{GDP_{t-1}}$	CEIC
$\Delta SZSE_t$	Change of the Shenzhen Composite Index in value	$Ln(SZSE_t) - Ln(SZSE_{t-1})$	CEIC
$\Delta REER_t$	Change of real effective exchange rate	$Ln(REER_t) - Ln(REER_{t-1})$	BIS
$\Delta R_{\$t}$	Change in three-month yields of the American money market	$Ln(i_{\$t}) - Ln(i_{\$t-1})$	CEIC
y_{ct}	Cyclical GDP. Deviation from the quarterly GDP trend (HP trend)	$\dfrac{GDP_t - GDP_t^T}{GDP^T}$	CEIC
$vol\_exch_{t-12,t}$	Volatility of USD exchange rate of yuan	$\dfrac{\sum_{i=0}^{12}\left(e_{t-i} - \overline{e_{t-12,t}}\right)^2}{12}$	PBC

We examined the change of the NFA, NDA, NEX and G in the ratio of the GDP produced in the given period, while the majority of the other variables were defined in logarithm. We used Hodrick–Prescott filter[18] to determine the long-term trend of the real GDP, with the help of which we calculated the cyclical GDP.

For defining the net foreign assets of the monetary authority, similarly to the literature, we did not start out from the data of the foreign assets in the central bank balance sheet, but we based on the values of the foreign exchange reserves published by the IMF IFS. Furthermore, we took account of those kinds of changes of the NFA which cannot be related to the in- and outflow of the foreign capital. Adapted from Aizenman et al. (2008) we filtered out the changes of foreign exchange reserves produced by exchange rate revaluation according to the following: $NKE_{t-1}(\frac{e_t - e_{t-1}}{e_{t-1}})$, where e_t is the nominal exchange rate of yuan-USD at period t. [19] In addition, we corrected the NFA by the yield earned on the central bank's foreign investments. In the course of calculation, for the sake of simplification we assumed that the foreign exchange reserve was in its entirety put in a 10-year American government

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[18] The HP filter is a popular smoothing technique in the econometric toolbox. It gives the estimation of the long-term trend component of a time series. For smoothing we used λ=1600.

[19] Since the PBC does not publish public data regarding the composition of the foreign exchange reserves, it is not possible to exactly filter out the exchange rate effects. The literature estimates that the dominant part of the reserves – more than 70% – is USD-based, thus we made a simplification in our calculations by considering the total reserves as based on USD assets.

bond investment.[20] The quarterly yield was calculated as the product of the value of the average NFA and the value of the American government bond yield projected to quarter.

The value of the corrected NFA* was calculated with the following formula:

$$\Delta NFA *= \frac{\Delta\left\{NFA_t - \left(\frac{e_t - e_{t-1}}{e_{t-1}}\right)NFA_{t-1} - \frac{i_\$}{4}\left(\frac{NFA_t + NFA_{t-1}}{2}\right)\right\}}{GDP_t} \qquad (5)$$

The ΔNDA asset is the difference of the change of the monetary base and the changes of the net foreign assets.

Our equations are the following:

$$\Delta NFA = \alpha_0 + \alpha_1 \Delta NDA + \alpha_2 \Delta mm_t + \alpha_3 \Delta RR_t + \alpha_4 \Delta CPI_t + \alpha_5 \Delta NEX_t + \alpha_6 \Delta G_t +$$
$$\alpha_7 \Delta REER_t + \alpha_8 \Delta R_{\$t} + \alpha_9 y_{ct} + \alpha_{10} vol\_exch_{t-12,t} + \epsilon_t \qquad (6)$$

$$\Delta NDA = \beta_0 + \beta_1 \Delta NFA + \beta_2 \Delta mm_t + \beta_3 \Delta RR_t + \beta_4 \Delta CPI_t + \beta_5 \Delta NEX_t + \beta_6 \Delta G_t +$$
$$\beta_7 \Delta REER_t + \beta_8 \Delta R_{\$t} + \beta_9 y_{ct} + \beta_{10} \Delta SZSE_t + \eta_t \qquad (7)$$

,where Δmm is the M2 money market multiplier, ΔRR is the required reserve ratio, ΔCPI is the consumer price index, ΔNEX is the net export, ΔG is the government expenditures, $\Delta REER$ is the yuan real effective exchange rate, $\Delta R_\$$ is the change of the three-month American money market interest rate, and y_c is the cyclical GDP. The instrumental variables are the vol_exch, the 12-month volatility of the yuan exchange rate, and the $\Delta SZSE$, which shows the change of the composite index of the Shenzhen Stock Exchange.

In the case of the β_1 sterilization coefficient we expect a negative value, since the neutralization of the excess liquidity generated by capital inflow by open market operations has a reducing effect on the central bank's net domestic assets. According to Ouyang et al. (2010), an offset coefficient near 0 and a sterilization coefficient near -1-hez indicate the higher independence of the monetary policy.

In the case of the *money market multiplier*'s a_2 coefficient, a minus sign is probable. The increasing multiplier indicates expansive economic policy and decreasing required reserve rate, which can result in capital outflow through the lower yield levels. In the case of β_2 the situation is less unequivocal. The effect of the multiplier on the net domestic assets depends on whether the monetary restriction is implemented by open market operations or by raising the required reserve ratio. In the case of the former, the β_2 takes on a minus sign, i.e. the NDA decrease, while in the latter case the NDA may as well increase (cf. Table 2 above). In addition, the accelerating increase in the money supply may generate the introduction of bank credit ceilings and stricter capital controls, which may result in the move of the β_2 in negative direction.

Raising the *required reserve ratio* brings about the increase in interest surcharge on one side, which motivates the inflow of foreign capital, and it increases the monetary base on the other side. We expect the coefficients of the RR – α_3 and β_3 – to be slightly positive.

The danger of the runaway of *inflation* has been hanging over the head of the central bank like the sword of Damocles for decades. Therefore the monetary authority uses all possible means to stop

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[20] This assumption does not stand far from reality, because according to the annual statement published by the American Ministry of Foreign Affairs, the total value of the American investment possessed by China was 1611 thousand billion USD on 30 June 2010, the 92% of which was deposited in long-term assets.

inflation. Consequently, the coefficient (α_4) is probable to have a minus sign in the case of equation (6), since the fear of devaluation and capital loss usually urges the foreign investors to withdraw capital. The question in both cases is that how large is the time frame between the inflation and the economic-political and investor reactions it produces.

While in the case of increase in *net export*, thus in the export income the rise of NFA can be prognosticated, its effect on the NDA is not unequivocal. However, taking account of China's export-oriented economic policy, the excessive increase in export as one of the signs of economic exaltation may as well generate restriction measures on the part of economic policy.

Due to the government's overspending the risk premium of the country will probably increase, which results in a rising yield environment. In the light of higher yields, an increasing proportion of commercial bank sources are deposited in the central bank, which induces the shrinkage of the net domestic assets (negative β_6 coefficient). Although the increasing yields induce capital inflow on the other side, the deterioration of country risk – which results in outflow – is a much more powerful factor in making investment decisions. Consequently, we expect a decrease in the case of the foreign exchange assets (NFA) as well.[21]

According to our assumptions, the effect of the *real effective exchange rate* on the central bank reserves can be two-directional. On one side, the strengthening of the exchange rate can bring about the decrease in foreign exchange reserves through the deteriorating current account, while on the other side, in the light of the intensifying expectations of exchange rate appreciation[22] – and with the acceleration of the hot money inflow – it can bring about increase in reserves. Since the appreciation of a country's foreign exchange rate can be counteracted by economic expansion, i.e. by the expansion of domestic money supply, we expect plus sign in the case of the β_8.

The effect of *foreign (dollar) yield increase* can be estimated in the knowledge of uncovered interest parity conditions. The more advantageous foreign investment possibilities created by rising American interest rates result in capital outflow,[23] i.e. it probably has a reducing effect on the NFA. The central bank can respond to it with interest rate increase and monetary restrictions, which may result in the reduction of the NDA.

The effect of the *cyclical income*[24] on central bank reserves – similarly to the real exchange rate – can be dual. The real GDP growth caused by economic boom impairs the current account balance through the income effect, which may lead to the reduction of capital inflow. At the same time, the real economic expansion can increase the investors' trust in the Chinese economy, which can motivate

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[21] However, it also can occur that the increase of both the foreign exchange assets and the central bank's source side happen simultaneously as a consequence of the increasing financial demand of the state, e.g. in the case of government currency credit.

[22] The offshore forward exchange rate of the yuan (NDF, non-deliverable forward) showed a significant premium in contrast to the spot exchange rate in the slipping revaluation periods as well. This means that the revaluation tension does not decline in the course of the revaluation process.

[23] Instead of the American money market yields, it could have been justified to present the spread of the Chinese – American yields as explanatory variables in the model. However, it was not practical for two reasons. On the one hand, the role of the Chinese monetary policy is still authoritative in the development of domestic interest levels through defining the directive deposit and credit interest rates. On the other hand, the strict administrative capital controls in force reduce the latitude of the free flow of arbitrage capital, which limits the fulfillment of the interest parity conditions. As a consequence of these two factors, the comparison of the Chinese yields with the American yields can be problematic. Wang (2009) points out that the coefficient of the interest rate spread is often not significant or takes on wrong direction in the regression.

[24] Cyclical income means the positive or negative deviation from the long-term trend of the economic growth.

capital inflow. The economic prosperity generally results in restrictive measures on the part of the monetary policy, thus a negative coefficient is expected in the other case.

3. Empirical results

We checked the stationarity of variables with Augmented Dickey-Fuller (ADF) test. In order to decrease the unit-root problem, we examined the first-degree differentials – i.e. the changes of the value between t and t-1 period – for the majority of the vectors in the model. We employed delay in certain cases in order to reduce the autocorrelation of random errors and to increase the explanatory force of the model. The delay of the particular explanatory variables was received as a result of an optimization procedure. We carried the optimization out in MATLAB (LaSage, 1999). We examined the effect and significance level of the coefficients of all the eight exogenous variables from zero retroactively to three-period delay. We chose the size of delays by model from the 4^8=65536 possible combinations in a way that in addition to minimizing the occasional autocorrelation problem (Durbin-Watson taking on 2 near values), we have the best possible explanatory force (R^2 should be larger than 70%), and the most significant coefficients (significance level should reach value 1%, 5% or 10%). Thus we got the following delays: delays employed in the case of NFA equation: NEX: -2 period; CPI and yct: -1 period. In the case of NDA equation REER, RR, CPI and yct: -1 period; while NEX: -3 period.

The explanatory force of both equations is well above the threshold of 70% suggested for economic modeling. While in the 6th equation the R^2 takes on 0.875, it takes on 0.962 in the 7th equation.[25] Accordingly, the exogenous variable set predicts the change of the NFA and NDA assets in 87.5% and 96.3% respectively. For testing the autocorrelation we relied on the output of the Durbin-Watson test[26]. In the case of the ΔNFA regression the value of DW is 1.69, for the ΔNDA it is 1.92. Accordingly, the autocorrelation is negligible in the case of the former and it can be completely ruled out for the latter.

Table 4 contains the beta (α, β) coefficients received in the course of regression, their standard errors and the applied delays. The β_1 sterilization coefficient is significant and takes on a value of -0.945, which shows a very high degree of neutralization of the monetary oversupply during the examined period. Our received estimation is nearly identical to the similar types of results in the literature. However, our offset coefficient, whose value is -0.897 by a significance level of 1%, considerably differs from the numbers of similar studies. While Wang (2009) received a value of -0.3022 for the coefficient quantifying the flexibility of capital flow as well, Zhang (2010) received a value of -0.65, and Ouyang et al. (2010) received values between -0.63 and -0.71. The offset coefficient near -1 means the fast and flexible reaction of the foreign capital to the changes occurring in China's monetary environment. The difference presumably originates from that the model we examine processes a longer period, lasting until the end of 2010. The smaller coefficient can mean the mitigation of the presence of the state's strict regulators, the approvers of transactions, which can be partly acknowledged in the light of the new priorities of the Chinese monetary policy following the crisis.[27]

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[25] R^2 is the *multiple determination coefficient*, which shows the explanatory force of the model. It indicates the strength of the relationship in relation to the extent in which the independent variables predict the dependent variable.

[26] With the help of the Durbin-Watson test we can test the primary autocorrelation of the residuals. In the case of autocorrelation, the assumption that the observations are independent injures.

[27] After the global economic crisis, from the summer of 2010, China's monetary authority placed the continuation of financial integration in the focus. The official and unofficial statements of the central bank's decision makers all reveal that the medium-term aim is the realization of the total convertibility of the yuan, i.e.

However, the extent of the negative difference of our offset coefficient from the similar values of the literature cannot be entirely explained by the changes in the objectives of the monetary policy. According to our assumptions, the speculations related to the one way bet on the currency revaluation may account for the greater capital mobility. Goodfriend and Prasad (2006) pointed out that the efficiency of the Chinese capital controls erodes in the course of time as the domestic and international investors find the channels with which the barriers become evaded.[28]

Table 4: The estimated coefficient parameters of the 2SLS model

		6. equation	7. equation
	Explanatory variables	ΔNFA_t	ΔNDA_t
	constant	0,047*** (-0,003)	0,042* (-0,023)
endogen variables	ΔNFA_t	- -	-0,945** (-0,402)
	ΔNFA_t	-0,897*** (-0,240)	- -
exogen variables	Δmm_t	-1,137*** (-0,253)	-1,222*** (-0,104)
	ΔRR_t	0,071* (-0,038)	0,001 (-0,072)
	ΔCPI_t	-0,307 (-0,221)	-0,132 (-0,241)
	ΔNEX_t	0,062* (-0,139)	-0,268* (-0,151)
	ΔG_t	-0,191*** (-0,073)	-0,268* (-0,146)
	$\Delta REER_t$	-0,065 (-0,120)	0,108 (-0,104)
	$\Delta R_{\$t}$	-0,026* (-0,013)	-0,032*** (-0,010)
	y_{ct}	-0,122*** (-0,046)	-0,181** (-0,082)
R-square	R2	0,875	0,962
	Durbin-Watson test	1,66	1,922

Note: A (*),(**),(***) are the signs of the 10%, 5% and 1%-os significance levels.
Delays applied in the case of the 6th equation: NEX is 2, while the CPI and yct is 1 period. In the 7th equation it is 1 for the REER, RR, CPI and y_{ct}, while NEX is 3 periods.

In addition to the high R-square, the applicability of our model is reinforced by that a considerable proportion of the coefficients received in the case of regressor variables is significant. By 10%

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the liberalization of the capital account in addition to the 1996 opening of the current account. In the light of the continually increasing inflation concerns, in summer 2010, after a 2-year break, China changed over again to the crawl-like exchange rate peg from the de facto fixed exchange regime. This may be the first step on the way to eliminate the restrictions on the capital account items. Gábor's (2010b) article contains a more detailed description about the historical development of China's capital controls.
[28] The increase of a country's trade openness increases the possibility that the capital evading the capital control flows in and out of the country through the items of the current account, for example by over- and undercharging (Prasad et al., 2005; Xie, 2006; Goldstein et al, 2008). Ma and McCauley (2008) pointed out, in addition to over- and undercharging, how both the foreign and the Chinese investors could evade the strict controls through the current incomes and current transfers in the past years.

significance level, the multiplier, the net export, the government expenditures, the USD yields and the cyclical GDP have a considerable effect in both cases (in addition, the required reserve rate in the 6th equation).

The increase of the multiplier and the price level bring about the negative movement of the result variables as we assumed. In the case of inflation, we used one-period delay in both equations. It was needed because both the foreign investors and the central bank can react effectively to the changed inflation environment after one period passed. In addition, the change of price level has a much more direct effect on the net foreign assets.[29] The coefficient of the required reserve ratio also met the expectations for the most part. The ΔRR has positive significant effect on the ΔNFA dependent variable – i.e. the increase of ΔRR causes ceteris paribus the increase of ΔNFA, which can be explained by the strengthening exchange rate expectations embodied through the rising yield levels. On the other side, however, the RR has a negligible effect on the central bank assets.

A significant effect can also be observed in the examination of the effect of the cyclical income and the USD interest rates on the dependent variables. The increase of the American money market yields reduces the amount of the incoming capital on the one hand, and it results in restriction measures on the part of the central bank.

In the case of the positive deviation of economic growth (y_{ct}) from the potential output, the booming import demand – and through it the deteriorating current account balance – generates decrease in foreign exchange reserves. The response of the economic policy to the increase of the output gap is also significant, since the overheating of the economy is followed by restriction measures. In both cases, the effect intensifies with the shift of a period. We consider that the cause of this "slip" in the latter case is that exact statistical data series which form the basis for economic planning and implementation are available for the decision makers only with a delay of some months.

A similar delayed response-reaction can be observed in connection with the increase in net export income. The coefficient of NEX induces the mild positive change of foreign exchange reserves in the case of a two-period delay, while it causes the significant negative change of central bank assets by a three-period delay. We assume that the cause of the above shifted temporal reaction is that while the data series published by the IMF IFS and used in the model provide the registered trade transactions, the financial compensation of transactions is settled only at a later date.

In the case of the increase in budget expenditures, we found that both the monetary policy and the investors respond with restriction and withdrawal of capital in the same period. This effect is significant in both cases, but it is considerably stronger regarding foreign exchange reserves.

The change of real effective exchange rate has a positive effect on net domestic assets, as it was expected. The monetary authority responds to the excessive strengthening of the yuan real exchange rate with easing. However, its effect on foreign exchange reserves is dual. While the strengthening real exchange rate causes the decrease in foreign exchange reserves in the first period through the deteriorating current account, in the case of one-period delay it results in the increase in central bank reserves. Our opinion is that it may explained by the foreign investors' slower reaction time and caution.

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[29] We must note, however, that the inflation does not have a significant effect on the result variables! The result must be handled with proper caution.

3.1. Sterilization on the level of broad monetary supply

The outlined methodology examined the effectiveness of sterilization in terms of the monetary base. Using a regression technique we established that the authorities neutralized nearly 94% of the liquidity increasing effect of foreign capital inflow on the level of the monetary base.

Figure 4: Sterilization on the level of monetary base: the change of the NFA and NDA assets and the monthly growth of the monetary based on year, billion yuan
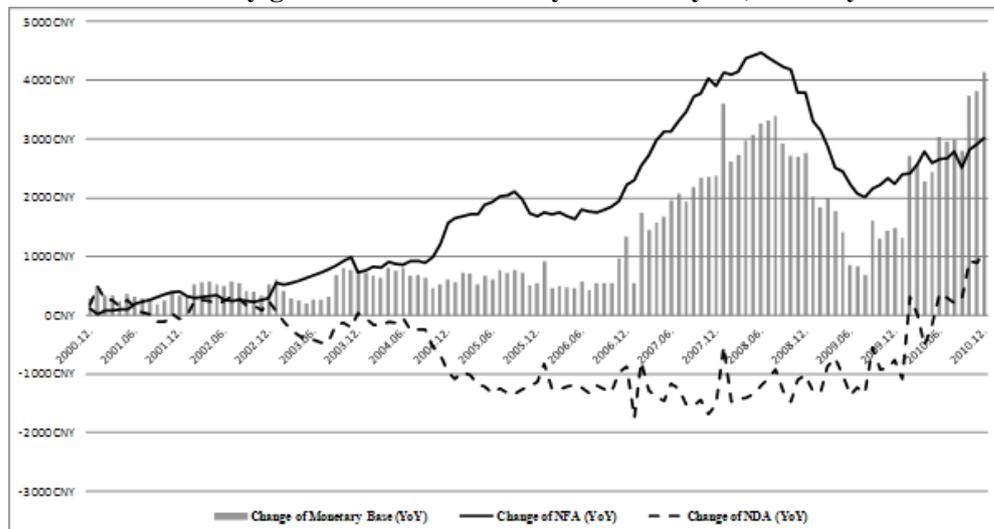
Source: People's Bank of China

Figure 4 demonstrates the change of the NFA and NDA assets and the monthly growth of the monetary based on year. It can be observed that the monetary base shows an accelerating growth in the two years preceding the global financial crisis and since the beginning of 2010. In our opinion, this dynamics can be explained by the following factors.

First of all, since the second half of 2006 the monetary authorities has put a greater emphasis on required reserve policy in order to stem the increase in monetary supply (M2). As a result, the required reserve ratio, standing on 7.5% for a long time, was doubled within less than two years. Since the rise of the reserve ratio entails the increase in the central bank deposits of commercial banks in certain cases, these changes may partly account for the growth of the monetary base.[30]

Secondly, it seems that the role of the sterilization bond auctions has diminished recently. The total stock of sterilization bonds reached its culmination of 4.800 billion yuan in October 2008, which then decreased by more than 20% in two years. Figure 2 illustrates this weight shift, and it can be observed that the ratio of bonds to the central bank reserves exceeding 40% has been reduced to 18% by today! It may be explained by the objectives of interest policy. If the central bank systematically increases the required reserves ratio, it results in the desiccation of the interbank market liquidity and in the increase

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[30] The rise of the reserve ratio increases the monetary base if the commercial banks produce the cover of additional capital demand by releasing central bank bonds or by selling foreign exchange. The rearrangement of the central bank's excess deposits does not entail the increase in the monetary base.

of market yields.[31] In order to avoid it, the PBC renews less expiring bonds parallel with raising the reserve ratio, thus the released sources produce the cover to fulfill the greater reserve expectations.[32]

The third reason is to be searched in the credit expansion. The new credit amount, swelling explosively since the second half of the decade, would have caused monetary base increase even without the increase in required reserves. Although the global financial crisis has not affected China to the same extent as it affected the developed countries due to its unique economic system, the "credit taps" of commercial banks have been turned on even more intensively in order to ease the recession concerns caused by narrowing export markets and the sudden stop of global lending and at the same time to stimulate internal demand. The bank system produced twice as much new credit in 2009 (9.600 billion yuan) and half as much again in 2010 (7.950 billion yuan) than in 2008.

The *fourth* factor accounting for the monetary base growth is the change in the other liabilities of the monetary authority balance sheet since the second quarter of 2009.[33] As the result of the sharply decreasing other liabilities, the net domestic assets (NDA) had increased by 1.100 billion yuan by December 2010 based on year (Figure 4). We think that the monetary base growth lasting since the end of 2010 can be mostly explained by this change. Since the PBC does not publish data regarding the composition of the other assets and liabilities, the causes underlying the fluctuation of the other liabilities cannot be established.

In the light of the bias of the sterilization policy, it is not practical to examine the effectiveness of the excess liquidity neutralization merely on the level of the monetary base. With required reserve ratio and window guidance policy, the central bank is also able to moderate currency oversupply caused by foreign exchange inflow in the broader dimensions of monetary aggregates. In the case of the former, it can do so by decreasing the money market multiplier and in the latter by defining the credit contingents. Taking all this into consideration, we examined the factors forming the M2 monetary aggregate on the basis of the above described variable set with the help of a simple OLS model. Although the received explanatory force (R2= 47.6%) is not specifically strong compared to the values received in the case of the previous regressions, its output is still can be suitable to draw some conclusions with certain reservations.

We involved the values of the estimated beta parameter in the M2 regression equation as well:

$$\Delta M2 = 0.180 *** + 0.584 ** \Delta NFA_t + 0.973 *** \Delta mm_t + 0.302 ** \Delta RR_t - 0.077\Delta CPI_{t-1} + 0.053\Delta G_{t-1} + 0.053\Delta SZSE_t + 0.529\Delta REER_{t-1} - 0.153 *** \Delta R_{\$t} + 0.008y_{ct}$$
(8)

The low explanatory force and the lower number of the significant variables can presumably be traced back to that the relationship between the M2 and the monetary base is not stable![34] The reason for this

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[31] The uncontrolled increase in yield is a delicate area for the PBC because it further intensifies the already quite considerable revaluation pressure.
[32] The bond auction was suspended two times in the first half of 2011 – in February and in June – by the PBC due to the excessive narrowing of the money supply caused by increasing required reserves ratio and to the rising yields. Source: Xinhua: China's central bank suspends bill issue, 23.06.2011.
[33] The value of the net other assets increased between January 2001 and April 2005, then it had reached the lowest point of -2.010 billion yuan by April 2009 as a result of the greater increase – 2.600 billion yuan – of the other liabilities. In the next 15 months, however, the balance of the net other assets became positive again as a consequence of the drastic decline of the other liabilities.
[34] The ratio of M2 and MB is considerably depends on the portfolio-allocation decisions of the real economic actors, on which central banks have only a limited influence.

can be partly that the central banks link their operative objectives to the development of monetary aggregates very rarely.[35]

The *M2-sterilization coefficient* of the *ΔNFA* takes on a value of 0,584 by a significance level of 5%. Accordingly, the increase of 1 unit of the international foreign exchange reserves resulted in the increase of M2 by 0,58 unit, i.e. the central bank has sterilized only 42% of the foreign capital inflow successfully during the last 15-year period on the level of M2 supply. The multiplier and the American yield level coefficient took on the expected significant direction. In the case of the required reserve ratio, we received a negative value only in the second differential. The higher reserve requirements through the narrowing of the lending latitude of banks cause the reduction of M2 one period later. The inflation, the government expenditures, the stock index, the real effective exchange rate change and the cyclical income do not have significant effect, but they took on the expected direction according to the above description.

As a summary, we found that the central bank has neutralized the rapid increase in the foreign exchange reserves which has been experienced in the past one and a half decades in nearly 94% in the case of the monetary base but only in 42% on the level of the M2.

4. The costs of monetary sterilization

The practice of economic policy outlined in the previous section and the maintenance of the strictly managed exchange rate regime entail serious costs. The increasing foreign exchange inflow in the past decade is responsible not only for the accumulation of foreign exchange reserves, but also for that of the central bank sources serving the sterilization. The interest burden of these steps can be reduced by the income on the foreign assets, mostly on the American government bonds.

The main components of the costs of monetary sterilization are the interest payments on outstanding bonds and on the central bank deposits deposited as required reserves. The short-term repo transaction has also appeared recently in the sterilization toolbox of the monetary policy, but we did not take its related costs into consideration due to its low proportion within open market operations.

In what follows, we try to provide an answer to the question on how much explicit cost the neutralization of the monetary oversupply involves for the monetary authorities by estimating the direct costs[36] of monetary sterilization and the yields earned on foreign exchange reserves.

4.1. The interest burden of sterilization

In the knowledge of the bond yields of different maturities and the composition of the stock, the interest payments on the sterilizations bonds can be calculated. The interbank market yields of the 3- and 6-month and the 1- and 3-year sterilization bonds (hereinafter referred to as CBB and *central bank bond*) have been available since September 2005 from the Bloomberg LP database. As we started the

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[35] The ultimate aim of the PBC – similarly to most central banks – is to maintain the purchasing power of currency.

[36] If we took account of the indirect costs which do not occur for the central bank as explicit expenditures, we would have to take account of the costs charged to the society by the banks due to the high reserve ratio, the exchange rate loss caused by revaluation and the cost of the higher inflation resulting from the exchange rate management.

time series analysis from April 2003, the first CBB bond auction, we calculated with the yields of the 1-year Chinese government bonds in the case of the period lasting until September 2005.[37]

It has been mentioned earlier that the PBC pays interest on both the required and the excess reserves. Since the level of interest payment was identical for both deposit types until 2003 and the yield gap between them did not grow to a considerable extent until the beginning of 2005, the reducing effect of the required reserve ratio policy on monetary oversupply remained ineffective in the first few years of the increase due to the rearrangement charged on the excess reserves. After recognizing it, the interest level of excess reserves was reduced, which led to reduction in the excess reserves.[38] Since November 2008, the central bank has paid an interest of 1.62% on required reserve deposits and 0.72% on excess reserves. Given that the central bank does not publish the breakdown of required and excess reserves, it is not possible to define the exact costs of the required reserve ratio policy. To deal with this problem, we determined a higher and a lower cost level, which presume the two extreme cases when the total central bank deposits consist of required or excess reserves. The interest paid on reserves is somewhere between the two values.[39] In the analysis on the cost of reserves, we relied on the data about the deposits of the deposit collecting financial institutions of the central bank balance sheet and the interest levels paid on required and excess reserves published by the PBC.

The assumed higher and lower level of the total sterilization costs of the monetary authority equal the sum of the interest payment received in the previous two methods (Figure 5).

4.2. The income of foreign investments

The cost of sterilization can be reduced by the income earned on foreign exchange investment. The quantification of this capital income is a great challenge, since the Chinese authorities does not publish the data regarding the composition of foreign exchange reserves. According to the literature, the foreign exchange reserves consist of mostly USD-, euro- and yen-based assets. The opinions agree unanimously that the decisive part of the reserves is denominated in USD. However, there is no consensus about the proportion of USD assets within the total assets. Scissors (2011) claims that this number is approximately between 58 % and 72%. With regard to China's decisively USD-based reserve policy, our analysis started out from that the entire foreign exchange assets are based on USD. The database of the U.S. Treasury helped us to choose the proper asset, where the data regarding the American government bonds kept by foreigners is updated on a monthly basis. It showed that China hold the 36.6% of the American government debt possessed by the overseas countries, numerically 1154 billion USD at the end of January 2011.[40] Taking account of the stock of 2847 billion USD of the Chinese foreign exchange reserves in December 2010, the proportion of the American government

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[37] In the first years of open market sterilization, the 1-year papers dominated in the CBB auctions, thus we used the yields of bonds of the same maturity to replace the CBB yields until September 2005.

[38] Due to the interest level paid on the excess reserves, the average 4.5% excess reserves ratio in 2003 decreased to 1.9% by 2010.

[39] It is assumed that the real interest burden converges towards the upper threshold of the sterilization costs because the ratio of the excess reserves to the required reserves has continuously decreased since the beginning of 2003.

[40] However, the monthly data published in the system of the U.S. Treasury TIC is hardly realistic. In reality, the value of the American government bonds owned by China is considerably higher than 1154 billion USD. These data series do not contain the stock of approximately 250 billion USD, obtained through other intermediary countries. Furthermore, a stock of approximately 300 billion USD is also left out from this research, which was owned by China in two federal institutions of the American mortgage finance, in the Fannie Mae and the Freddie Mac in December 2010. Finally, a short-term debt and stock investment of 126 billion USD has also been left out of consideration. These shortcomings are supplemented by the U.S. Treasury in the annual TIC report. Accordingly, the value of the American assets possessed by the Chinese is estimated at 1611 billion USD on 30 June 2010.

bonds within the total exchange rate reserves can be estimated to 40% at the end of 2010. If we also take account of the government bond purchase completed through other countries and the stock possessed by other American federal institutions, this ratio increases to approximately 60%.[41]

Within the total American investments of China, the proportion of the short-term investment has been only an average of 8% in the past 8 years. Taking this observation as a starting point, we assume that the maturity composition of the central bank's foreign portfolio shows a similar tendency as in the case of the total USD assets possessed by the Chinese. Therefore, our examination started out from the 5- and 10-year American government bond yields. The yields were converted to domestic currency on the average monthly yuan-USD exchange rate, thus the incomes became comparable with the costs of sterilization. In addition, we assumed that the PBC does not capitalize the interest incomes, but it spends them on covering the sterilization costs. Taking all this into consideration, the average annual yield earned on the foreign exchange reserves was 3.32% for the 5-year and 4% for the 10-year government bond between April 2003 and December 2010.

Figure 5 shows the estimated monthly income of the PBC foreign exchange reserves and the tendency of the monetary sterilization costs between April 2003 and June 2011. Thanks to the exponentially increasing reserves and the – until the autumn of 2008 – increasing USD yield levels, it can be seen that the incomes covered the upper threshold value of the sterilization cost during almost the entire period.

Figure 5: The tendency of sterilization costs and yield earned on foreign exchange reserves, 2003-2011, billion yuan
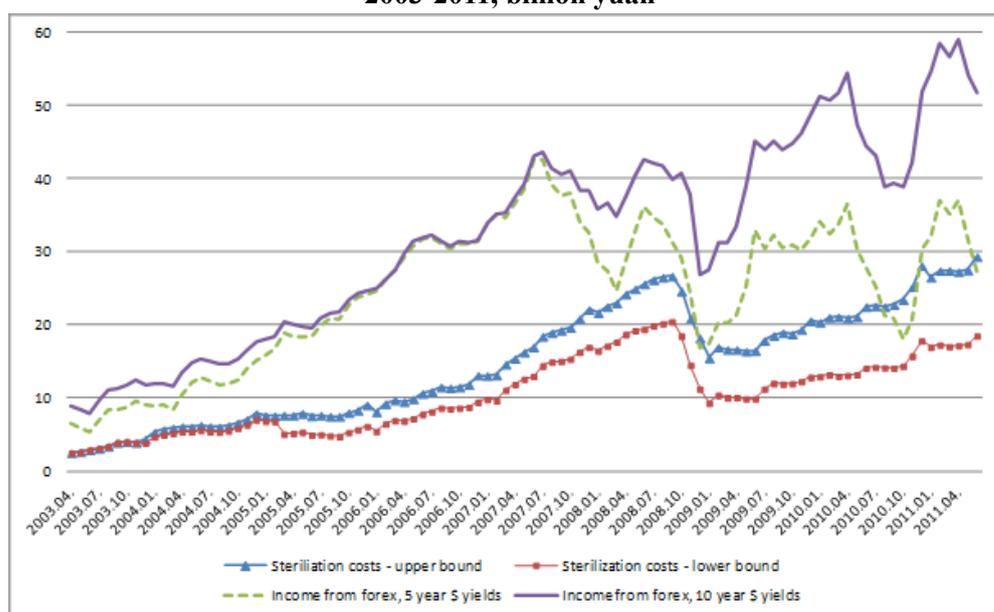
Source: CEIC (2011), US. Treasury, Bloomberg LP

Note: In the case of the sterilization costs, the data of the first six months of 2011 are estimated values. We assumed that through the increase of interests paid on CBB bonds the costs of sterilization bonds increases with 33% annually, to the same extent as the average of the increase of 2010. By the constancy of the interests paid on required and excess central bank deposits, we prognosticated an average annual increase of 29% for the central bank deposits, observed during the entire period.

Figure 5 shows the growth of the gap between incomes and costs until autumn 2007. After this, as a result of the money market tensions caused by the American sub-prime crisis, the FED started an

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[41] Source: US Treasury TIC, The People Bank's of China

aggressive monetary easing from the second half of 2007, which induced the decline in market yields. The effect of the globally decreasing yield levels spread in China in the last quarter of 2008, as a consequence of which the costs of sterilization reduced. With the escalation of the European sovereign debt problems, however, in the second half of 2010 and from June 2011 the profitability of foreign exchange-accumulation continues to decrease, which manifests itself in that the incomes estimated for the 5-year yields do not entirely cover the estimated upper threshold of the sterilization costs. It is further refined by the accelerating increase of the consumer price index experienced in the last year, in the light of which the further rise of the required reserve ratio is expected.[42]

According to our prognosis[43] developed on the tendency of the expected incomes and costs – until December 2014 – after June 2010 the upper bound of the sterilization costs exceeds the lower margin of the income earned on foreign assets to an increasing extent – by more than 40% by the end of 2014. However, the upper income level provides a proper amount of cover for the sterilization costs as time progresses.

We also examined a case when the majority of the Chinese foreign exchange reserves would be put in one- and two-year American government bonds. In such a scenario, the average yield ratio would be 2.4% and 2.6% during the entire period, as a result of which the incomes would not cover the lower bound of the sterilization costs already after March 2008.

In the analysis of costs, we cannot leave the fact out of consideration that China was compelled to book considerable losses on its American asset backed securities during the crisis, which certainly further increases the sterilization cost we outlined.

Assuming the exchange rate and the bond market yields at the end of 2010 to be constant in the future, the 41% decrease in foreign exchange reserves would be needed in order that the lower margin of the incomes touch the lower margin of the sterilization costs. Such a scenario, however, can hardly be imagined in the near future due to the current priorities of the exchange rate and trade policy.

In the analysis of monetary sterilization, we have so far quantified merely the direct costs of the measures narrowing the money supply. We have not taken account of the indirect costs which can be originated from the effects of sterilization policy that divert the money and real market balance. So for example the harmful effects of excess capacities caused by the undervalued yuan, the costs of high reserve ratio charged to the private sector, the extent of exchange rate loss due to revaluation[44], and the lower domestic demand caused by increasing foreign exchange reserves (Gábor, 2010c).

Apart from the indirect costs, we think the delusions that the monetary sterilization created unsustainable processes in the Chinese economy do not hold. At least it certainly does not hold according to the cost-benefit principle proper, since the capital income of the continually increasing foreign exchange assets has provided more than sufficient cover for covering the costs of monetary sterilization in the past decade.

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[42] The required reserve rate has been raised by the central bank twelve times, with 650 base points to 21.5% since 2010. According to market analysts, with a rise of 50 base points, a money supply of approximately 350-400 billion yuan can be withdrawn from the market.

[43] During the extrapolation of the incomes, we regarded the American government bond yields of June 2011 to be constant, assuming the annual 32% increase in the foreign exchange reserves. In the case of the sterilization costs, we prognosticated an annual increase of 33% for the CBB costs, while 29% for central bank deposits. We regarded the yields paid on the central bank's required and the excess deposits to be constant.

[44] Although the exchange rate loss is not an explicit expenditure for the central bank, its extent cannot be neglected. In the two revaluation periods (2005-2008 and 2010-), the central bank had to book an exchange rate loss of approximately 2935 billion yuan.

5. The sustainability of the process of the regular foreign exchange intervention

In our research, we aimed to find out how efficiently the sterilization measures for maintaining the managed exchange rate regime neutralized the liquidity increasing effect of the foreign exchange-inflow and how much costs this economic policy practice imposed on the monetary authority. As the result of the 2SLS regression we carried out, we could observe that the central bank was able to neutralize the increase of the money oversupply with an almost total success on the level of the monetary base, while with half success on the level of the M2 supply. In the knowledge of today's accelerating inflation and the limits of sterilization, however, it is questionable whether the monetary policy will be able to stem the increase of the price level, one of the most frequent causes of social tensions, in the long term while maintaining the current exchange rate regime.

In the light of this, the question raised by many people on how a country which has an increasingly open economy and strives for great power status and – perhaps – key currency position will be able to maintain its strictly managed exchange rate system in a way that it meanwhile leaves increasing room for foreign capital and it remains financially open. The current stabilization-sterilization practice does not seem to be an unsustainable process, if we take account of only the explicit costs of the sterilization policy. However, if we also take the direct, social political costs into consideration, we get a completely different picture. Consequently, there is a need for the types of research which set the aim of the quantification of implicit costs in order to provide a more exact answer to the question on the sustainability of the Chinese sterilization.

6. China as the new financer of the European Union

The economic crisis of the 21st century has caused sharp changes in the geopolitical filed of the world. The greatest "beneficiary" of these changes and, at the same time, the unequivocal winner of the crisis has been the People's Republic of China. It is an unquestionable fact that due to the increasing weight of China, Beijing is gaining an increasing momentum in developing the frameworks of the global order. With the growth in the world political, global security and world economic position of the first great power of the Asia-Pacific region, it has an increasing effect on the international order.

In addition to gaining position during the crisis, the increasing world market role of the economy that has a huge internal market and record high foreign exchange reserves has done an undeniably great service to attenuate the hard-landing of the world economy and to mitigate recession. China's import demand, which has a significant volume also in global context, and increasing foreign direct investments were considerably revalued during the crisis. Despite the fact that before the occurrence of the crisis China was the greatest trading partner of the United States and the United States was that of China, and the largest trade flow was transacted between China and the USA, considerable changes occurred in terms of both trade and capital flows in the course of the crisis. The European Union was perhaps one of the greatest "beneficiaries" of these changes.

The revaluation of the European economic region for the Chinese can also be explained by that China's relationship with the European Union has been much less characterized by tensions than what we could observe in the American-Chinese cooperation.[45]

The first official trade agreement of China and the European Community was signed in 1985. Although the economic and political relation system of the two countries has been far from cloudless for the past more than two and half decades, the Union has all the while tried to take a tone towards China which is "softer" and more ready for compromise compared to the overly one-sided and strict American tone. However, the acceleration of the trade relationships can also be explained by that different competencies have come under the powers of the member states and that of Brussels. While the responsibility of the formers is the development of trade and economic relationships, the latter is responsible for managing the problematic areas such as human rights or the protection of the intellectual property right. The economic cooperation of the two countries speeded up by China's accession to the WTO in 2001 and the creation of the strategic partnership in 2003. Although after this, and partly because of the EU accession of the new member states, the dynamics of the trade relations of the EU27 and China continuously increased, these processes accelerated even more significantly during the crisis.

China's interest is the stability of the economy of the Eurozone and the European Union. This must be examined in two aspects; in terms of trade on the one hand, and in terms of investments on the other. The literature uniformly considers that nearly one fourth of the Chinese foreign exchange reserves of 3200 billion USD – approximately 700-800 million USD – is invested in euro assets (Scissors, 2011). The unsuccessful management of the European sovereign debt problem projects the decline of the European single currency and – in the most pessimistic case – the potential future disintegration of the European Monetary Union. In such a case, as a consequence of the negative wealth effect China would have considerable losses due to its European investments.

According to European estimations, China owned more than 7 per cent of the Eurozone's total debts in 2011, which tendency has continuously increased in the past period as well. Many claim that Ireland may soon be the next after Greece, Portugal and Spain (Szunomár, 2011). In 2011, the Asian giant appeared as a purchaser also in the state debt market of our country – in the market of both the forint based and the foreign exchange based bonds – as a consequence of which China had possessed Hungarian government bonds in the order of about hundred million euros by the summer of 2011 based on the data of the Government Debt Management Agency (ÁKK) (Portfólió, 2011; Index, 2011). According to the latest news, Beijing also considers purchasing bonds issued by the European Financial Stabilization Facility (EFSF), which provides the Union's financial support of the member states having serious financial problems.

In addition to that China gives help to the European states that struggle with troubles and external financing difficulties, it gains significant extra yields compared to the American government bond investments. Let alone it can reduce to an extent the tension originating from the "dollar trap" through the diversification of the foreign exchange reserves.

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[45] Similarly to the EU, the United States continues to refuse China's market economic status, with the difference that the USA classifies China among the "non-market" state regulated economies – while the EU regards China as a transition economy. It means that the USA may adopt (and it does adopt) considerably stricter anti-dumping measures against the Chinese products than the EU – which is counted as very discriminative in the judgment of the Chinese. In addition, the States has kept Beijing under serious diplomatic pressure for almost a year due to the undervalued dollar exchange rate of the yuan.

However, it must not be forgotten that the European "spreading" of the Chinese foreign direct- and portfolio capital is not a good will and presumably not only business.

Increasing the European influence serves the growing great power interest of China. As the new financer and significant investor of Europe it thus moves in quite a good direction in these terms. Today European leaders queue up to China to share somehow in the gigantic foreign exchange reserves of the "Asian lion" – and they do it in a way that avoids the earlier conventional talks and instructs on human rights.

It seems that China gradually manages to soften the earlier solid opinion of Brussels in such delicate questions as the case of the "undervalued yuan", the concerns over human rights and the question of the weapons embargo to China effective since the Tiananmen massacre in 1989.

The cautious and "the small steps policy" type of attitude characterizing Beijing's foreign policy seems to come up to the expectations. The second part of the president of the republic Hu Jintao's reputed statement that "China's development is unimaginable without the world and the world's development also needs China" is becoming increasingly evident today.

Furthermore, the Chinese foreign exchange reserves which support several European states and finance European great investments (e.g. Polish motorway tender, construction of Italian and Greek sea- and Italian airport, etc.), in addition to increasing Beijing's European economic and political influence and returning considerable profit, they decrease the one-sided dependence of China on the USA, strengthen the euro and indirectly the multipolar world view in which the European Union is similarly interested as China.

Although the amount of the Chinese direct investment present in Europe – compared to other regions, e.g. the United States – can be regarded small today (in 2010 investment with a total value of altogether 6.7 billion euro), it has been growing increasingly dynamically in the past years – in 2010 by 17.5% compared to the previous year!)

Contrary to the foreign exchange movements related to capital flow, the intensification of the relationship of China and the EU27 is even more visible in the field of trade. China could raise its participation in terms of both the Union's export and import before and during the crisis as well. According to the Eurostat data, between 2008 and 2010 China's participation in the total Union export increased from 6 to 8.4 per cent, while it increased from 15.8 to 18.7 per cent in the case of import.

During the years of the crisis, due to the even more intensive trade relationship between the two economies, the EU became the largest trading partner of China in 2010 China, while China became the most significant trading partner of the Union by the summer of 2011 (in both cases pushing the USA back to the second place). While in 2010 they transacted a trade of record high 395 billion euros, more by 100 billion euros than the previous year, in the first three quarters of 2011 the extent of trade already exceeded the 80% of the year 2010! Furthermore, it can also be stated that despite the fact that the EU's Chinese import demand significantly dropped back (by ~40 billion euros) in 2009[46], a trade balance deficit emerged again between the two countries in 2010 that reached the extent of the 2007-

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[46] The decline can be explained by a dual cause. On the one hand, in the year mainly involved in the crisis and the real economic shrinkage, in 2009, the Union's internal demand extremely dropped back, which apparently has a significant effect on the EU's foreign trade, particularly on the import (Figure 1). *On the other hand*, the considerable decline of the euro compared to the USD, sometimes reaching 20% (compared to 2008), also caused the decrease in import. The euro thus considerably declined compared also to the Chinese currency fixed to de facto dollar, which made the Chinese import products more expensive through the exchange rate effect.

2008 (Figure 1) – which to some degree shadows the EU-China economic relations (similarly to the case of the USA and China).

Figure 6: EU's Trade Balance with China and the year-on-year change of its export and import, million euro
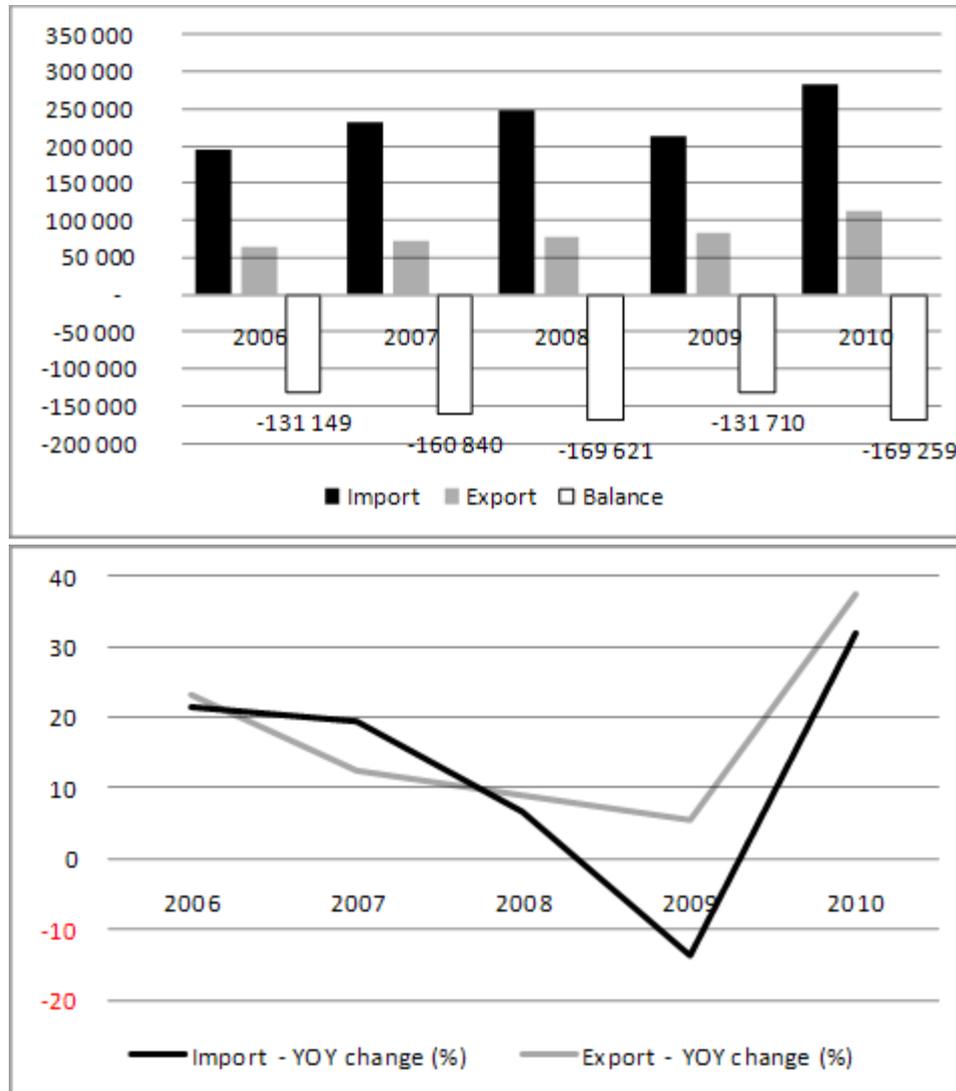
Source: EUROSTAT

Despite the exchange rate of the yuan that is considered undervalued, Europe's export towards China has been able to dynamically increase in the past two years, which has significantly facilitated the mitigation of recession of the European countries arranged to export. In the most serious year of the crisis, in 2009, Belgium, Portugal, Poland, Slovakia, Romania and Cyprus (and also our country by 17%) could increase its export towards China by more than 20% compared to the previous year (Inotai, 2011).[47] It must be emphasized because these countries that are relatively small and have quite an open economy – and they are exposed to the changes of the international demand – were unable (more exactly were not allowed) to stimulate the national demand with such gigantic Keynes-type government spending (fiscal expansion) as for example Germany or France did in 2009-2010 given the rising government debt path. Therefore, the declining domestic consumption could be to some extent compensated with the increase in export in addition to the moderate increase of fiscal

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[47] And decrease exceeding 10% was registered in the case of only three countries (Slovenia, Luxemburg and France)!

expenditure. It was further helped by the devaluation of the euro and of the national currencies of the non-eurozone member states to the USD (and quasi the yuan).

The economic interdependence and trade symbiosis of China and America ("Chinamerica") by today has become a cooperation full of tensions that has made necessary for China to open towards other regions. The "Asian lion" gaining headway and influence, in addition to being a prospering business for China, decreases dollar-dependency, fosters building a multipolar world order, in which the European Union is also interested, and softens the opinion of Brussels in the issues that earlier caused tensions.

In the light of the economic relationships of the past years, it can be expected that the trade and investment relationships between the EU and China continues to flourish. Given that China's 12th five-year plan puts a great emphasis on intensifying internal consumption and decreasing export dependency, it can be expected that the trade disproportion developed between the two countries will be reduced and the European export will increase exceeding the import in the middle term.

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