Accumulation of Foreign Exchange Reserves and Long Term Growth

Polterovich, Victor and Popov, Vladimir

New Economic School

2003

Victor Polterovich and Vladimir Popov[1]

ACCUMULATION OF FOREIGN EXCHANGE RESERVES AND LONG TERM GROWTH

ABSRACT

Cross-country regressions, reported in this paper for 1960-99 period, seem to suggest that the accumulation of foreign exchange reserves (FER) contributes to economic growth of a developing economy by increasing both the investment/GDP ratio and capital productivity. We offer the following interpretation of these stylized facts: (1) FER accumulation causes real exchange rate (RER) undervaluation that is expansionary in the short run and may have long term effects, if such devaluations are carried out periodically and unexpectedly; (2) RER undervaluation allows to take full advantages of export externality and triggers export-led growth; (3) FER build up attracts foreign direct investment because it increases the credibility of the government of a recipient country and lowers the dollar price of real assets. A three-sector model of endogenous economic growth (including a consumer good sector, investment good sector and an export trade sector) is suggested to demonstrate how undervaluation may improve social welfare. Concepts of FER accumulation trajectories and equilibrium trajectories are introduced. It is demonstrated that small udervaluation of the equilibrium exchange rate may be wealth improving.

[1] New Economic School, Moscow.

V. Polterovich, V. Popov

ACCUMULATION OF FOREIGN EXCHANGE RESERVES AND LONG TERM GROWTH

1. Introduction

Whereas it is widely recognized that devaluation can increase output in the short run, bringing actual output above the potential level, it is generally assumed that in the long term growth rates of output do not depend on the exchange rate. On the contrary, the exchange rate itself in the long run is considered as an endogenous variable determined by the growth rates of prices and outputs in two countries. Nevertheless, there is a strong empirical evidence (provided below) that the accumulation of foreign exchange reserves (FER) leads to lower exchange rate, which in turn stimulates export-led growth. Countries with rapidly growing FER/GDP ratios, other things being equal, exhibit higher investment/GDP ratios, higher trade GDP/ratios, higher capital productivity and higher rates of economic growth.

The FER build up should be financed - either through a government budget surplus or via money printing, or through the accumulation of debt. In either case, there is a net loss in the current consumption because a part of potentially available resources is not used. Besides, accumulation leads to a gap between the money supply and the goods sold at the domestic market. This gap may results in inflation or should be financed by additional regular taxes, expenditure cuts, or debts that should be finally paid. So if FER accumulation not only stimulates economic growth, but results in the increase of total welfare, it should be considered as a puzzle: by limiting consumption today it becomes possible to increase the integral discounted consumption. The analogy may be with the Keynesian policy of fiscal expansion that takes the country out of the recession. In words of Joan Robinson, when the government of a country in a recession hires the unemployed to do any kind of work, even totally senseless (digging the pits and filling them with soil again), the actual GDP approaches the potential GDP. In a similar way, it appears that under certain conditions (externalities associated with international trade and/or various kinds of traps in which developing countries often find themselves due to market failures) the authorities/central bank can boost economic growth by under-pricing their exchange rates via FER accumulation. The important

difference with the standard Keynesian effect, of course, is that here we are talking about long-term growth rates of GDP, not about the deviation of actual from potential income.

In this paper we have in mind the following explanation why the exchange rate under-valuation can promote long-term economic growth. *First*, accumulation of foreign exchange reserves has the conventional short term expansionary effect - relative prices of tradables increase with respect to prices of non-tradables and to wages. In the long run this effect disappears as increased profits are invested and lead to increased demand for non-tradables and labor. But if there are subsequent unexpected rounds of FER build up, the long term growth rates may increase. *Second*, undervaluation of the currency stimulates the increase in exports. This increase in exports raises accumulated knowledge due to the learning by doing externality and therefore economic productivity as well. The rate of growth rises and this more than compensates the potential gain from spending reserves for current needs. *Third*, undervaluation lowers foreign currency prices of domestic real assets and thus attracts foreign direct investment. Besides, continuing FER build up (especially in periods of terms of trade deterioration) gives a powerful signal to investors that the government is in full control of the situation and can afford costs for the sake of pursuing a consistent policy. Technologically backward countries on obvious reasons have much more to gain from export externality and from the inflow of foreign direct investment. That is why benefits of reserve accumulation should be especially promising for developing countries.

The paper is organized as follows. In the next section we briefly review the literature and the basic stylized facts on the dynamics of foreign exchange reserves, exchange rates, relative prices, investment/GDP ratios and economic growth. Section 3 contains the results of cross-country regressions for the period 1960-99 that examine the relationship between reserve accumulation and economic growth and deals with the endogeneity problem. In section 4 we suggest a three-sector model of endogenous economic growth with a possibility for the exchange rate to deviate from equilibrium level; this model demonstrates the theoretical plausibility of the discussed effects. Section 5 concludes.

2. Review of the literature and stylized facts

Undervaluation of domestic currency is a common feature for most developing and transition countries. Unlike in mature market economies, in most poorer countries the exchange rates of national currencies are low as compared to PPP (table 1).

Table 1. Ratio of actual exchange rate of national currencies in $US to PPP for selected countries in 1993, % (figures in brackets - for 1996)

Countries/regions	Ratio, %	Countries/regions	Ratio, %
OECD*	116	Transition economies*	81
- Germany	126 (133)	-Central Europe*	54
- Japan	165 (158)	- Bulgaria	30 (25)
- U.S.	100 (100)	- Croatia	65 (94)
- Portugal	73 (77)	- Czech Republic	36 (48)
Developing countries*	44	- Hungary	62 (63)
-Asia*	36	- Poland	48 (59)
- India	24 (23)	- Romania	31 (34)
- Indonesia	30 (33)	- Slovak Republic	37 (47)
- Korea	72 (81)	- Slovenia	69 (78)
- Malaysia	(44)	-USSR*	91
- Philippines	35 (34)	-Armenia	(20)
- Thailand	43 (45)	- Azerbaijan	(32)
- Turkey	54 (48)	- Belarus	8 (30)
-Latin America*	46	- Estonia	29 (64)
- Argentina	(90)	- Georgia	(29)**
- Brazil	(70)	- Kazakhstan	(39)
- Chile	(43)	- Kyrghyzstan	(19)
- Mexico	58 (45)	- Latvia	27 (50)
- Peru	(56)	- Lithuania	19 (47)
- Venezuela	(36)	- Moldova	14 (28)
-Middle East*	83	- RUSSIA	26 (70)
- Kuwait	(67)	- Tajikistan	(3)
-Saudi Arabia	(68)	- Turkmenistan	(45)
- United Arab Emirates	(100)	- Ukraine	19 (39)
-Africa*	37	- Uzbekistan	(22)
- Ethiopia	(20)	China	22 (20)
- Mozambique	(17)	Mongolia	(21)
- Nigeria	36 (90)	Vietnam	(20)

* 1990. ** 1995.

Source: UN International Comparison Program (Russian Statistical Yearbook 1997. Moscow, Goskomstat, 1997, p. 698; Finansoviye Izvestiya, November 10, 1995); World Bank, 1998; Transition Report, 1997.

For resource rich countries, however, there is a danger of "Dutch disease", which arises because resource export is so profitable that it allows to earn a trade surplus even under the overpriced exchange rate. Thus, Middle East countries (mostly oil exporters) are the only major group of states in developing world with the exchange rate close to PPP (table 1).

There is a number of explanations why equilibrium exchange rate in poorer countries is well below PPP rate (Froot, Rogoff, 1995). On a theoretical level, references are usually to the Balassa-Samuelson effect (smaller productivity gap between developing and developed countries in non-tradable goods sector than in tradables, but equal wages in both sectors) and to Bhagwati -Kravis-Lipsey effect (non-taradables, which are mostly services, are more labor intensive, so if labor is cheap in developing countries, prices for services should be lower)[2].

The Balassa-Samuelson effect states that, if productivity grows faster in sectors producing tradable output (mainly goods) than in sectors producing non-tradable output (mainly services) and if wage rates are equalized across sectors - with the result that economy-wide real wage increases lag behind productivity growth - then the real exchange rate (RER) can appreciate without undermining business profits.

A similar explanation was recently developed for transition economies to which the Ballasa-Samuelson effect can hardly be applied directly, since the services sector in such economies was generally underdeveloped before transition and was expected to show *stronger* productivity gains than the traded goods sector. Grafe and Wyplosz (1997) argue that even if the appreciation of the exchange rate in transition economies undermines business profits (in the export sector and in industries that compete with imports), this should not necessarily lead to a deterioration of the current account, since the need for capital accumulation in transition economies declines - that is, they can operate with lower savings ratios than they could before the transition. Indeed, the evidence shows that the ratio of investment to GDP was abnormally high in most centrally planned economies because of the need to compensate for low capital productivity (Shmelev and Popov 1989) and that, in virtually all cases, when these economies move into the transition phase, investment ratios initially fall. Even after a country's recovery, its investment ratio usually does not return to the levels that existed prior to the reforms (Popov 1998a). Even though the decline in investment-to-GDP ratios has now ended in most transition economies, Halpern and Wyplosz (1997) argue that real appreciation in transition economies will continue until the transition is over, which may be "decades away."

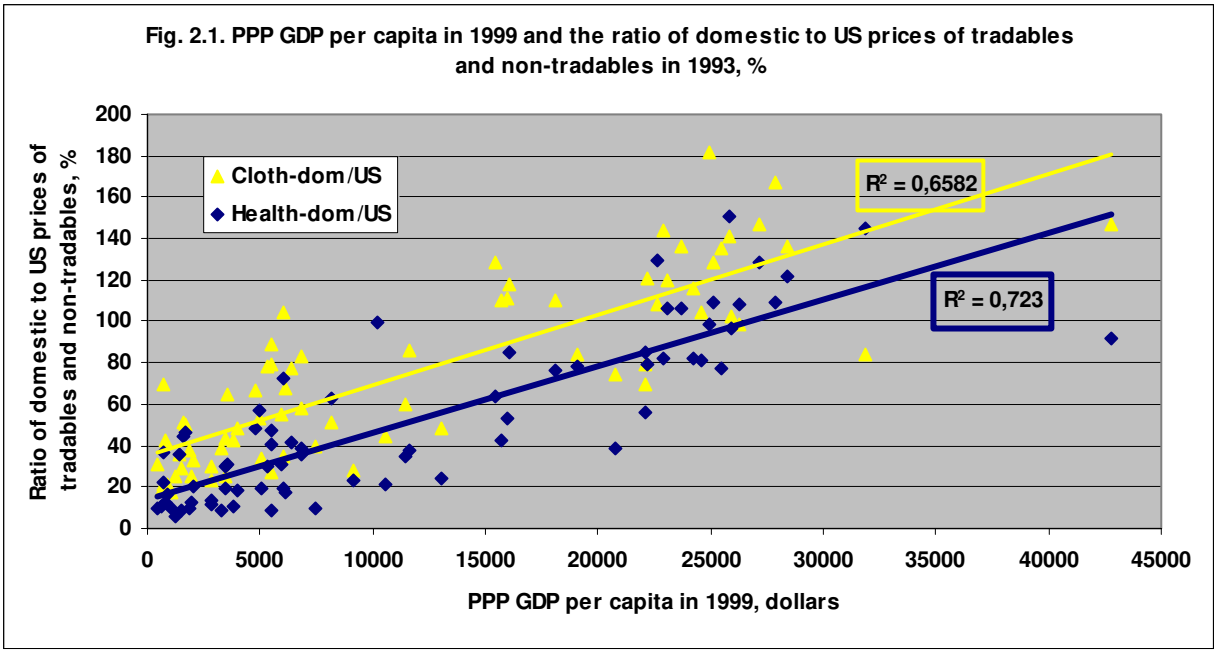
Another study (ESE, 2001) found evidence of Balassa-Samuelson effect in transition economies of Eastern Europe and former Soviet Union in the 1990s. The period is too short, however, and the

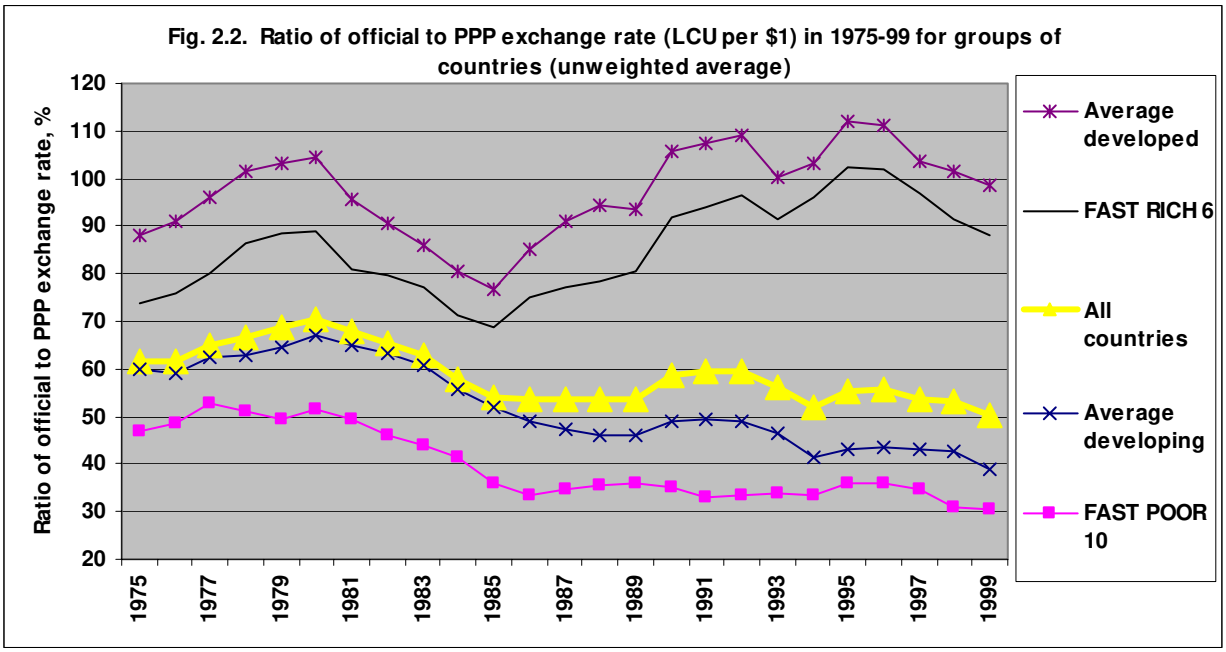
[2] For the general description and references see: (Krugman, Obstfeld, 1994, Ch. 16).

increases in RER that actually took place in most transition economies may be the reaction to the overshooting initial devaluations that occurred in the beginning of the 1990s, when convertibility was introduced. The increases of the relative prices of services that occurred in many countries were most probably caused by previous "distortions" in relative prices (housing, health care, education were virtually free) rather than by faster growth of productivity in manufacturing than in services.

As fig. 2.1 below suggests, there is an obvious relationship between GDP per capita and the level of national prices to the US prices (RER) - this correlation exists not only for non-tradables, but also (although a bit weaker) for tradable goods. But it is difficult to detect the effect of RER appreciation for particular countries even for the period of 25 years - as fig. 2.2 illustrates, even in fast growing developing countries RER was generally declining, driven more by the deterioration of terms of trade than by Balassa-Samuelson effect.

There are other, more prosaic considerations explaining the low level of RER, such as price controls, exercised by many developing countries for non-tradables (housing rents, education, health care, transportation, etc.); capital flight and debt service payments that increase the demand for foreign currency and create a downward pressure on the exchange rate of the national currency; externalities, such as higher crime rates and greater risk in developing countries that limit the demand for non-tradables.





On the other hand, many other developing countries (including those rich in resources) pursue the conscious policy of low exchange rate as part of their general export orientation strategy. By creating a downward pressure on their currencies through building up foreign exchange reserves, they are able to limit consumption and imports and to stimulate exports, investment, and growth. To put it differently, there are generally two major reasons for relatively low exchange rates - (1) the generally lower level of development, leading to lower prices of non-tradable and perhaps even tradable goods and imposing the burden on the balance of payments in the form of the capital flight and debt service payments (non-policy factor) and (2) the governments/central banks conscious policy to underprice the exchange rate in order to use it as a instrument of export-oriented growth (policy factor).

At an intuitive level udervaluation of the exchange rate seems to be a way to encourage exports, restructuring, and growth, while fighting inflation through tight fiscal and monetary policy (sterilization of increases in money supply caused by the growth of foreign exchange reserves), not through highly priced national currency. Undervalued currency - the necessary component of export led growth. It used to be the strategy of Japan, Korea, Taiwan and Singapore some time ago, when those countries were still poor and were catching up with high income states. This is currently the strategy of many new emerging market economies, especially that of China, which continues to keep the exchange rate at an extremely low level (20-25% of the PPP rate) by accumulating foreign exchange reserves at a record pace. It is by no means an accident that all very fast growing

economies are also famous for high and rapidly growing international reserves: China and Japan accounted in 2005 for over 1/3 of total world FER, East Asia - for over half; reserves to GDP ratio for these countries is normally above 20% as compared to below 10% for the world as a whole.

Similar arguments were made with respect to transition economies. Hölscher (1997) believes that EE countries can gain from underpricing their national currencies drawing on the West German experience with undervalued mark in the 1950s. Pomfret (1997) argues that undervalued exchange rate in China during the reform period (since 1978) was the powerful factor of stimulating economic growth. Some scholars concluded that the overvaluation of the Russian ruble in 1996-98 was the major reason of the Russian 1998 currency crisis (Illarionov, 1999; Montes and Popov, 1999; Popov, 1998a; Shmelev, 1999). Indeed, unlike in East Asian countries, where economic recession followed devaluation, the reduction of output in Russia started nearly a year before the devaluation of the ruble in August 1998; one month after devaluation output started to grow.

Rodrik (1986) developed a model demonstrating how disequilibrium exchange rate in the presence of foreign trade externalities could lead to the acceleration of growth[3]. It was shown for developing countries that overvaluation of the exchange rate is detrimental for economic growth by including the variable that characterizes the undervaluation of the exchange rate into standard growth regressions (Dollar, 1992; Easterly, 1999).

Aghion, Bacchetta, Ranciere, Rogoff (2006) examine mainly the impact of volatility of the real exchange rate on productivity growth, but also look at the impact on growth of under/overvaluation of the exchange rate (the measure of overvaluation is basically the residual from the regression of RER on the GDP per capita – to control for the Balassa-Samuelson effect – and a couple of regional dummies. They find that overvaluation of RER negatively affects economic growth, especially in poorer countries.

Overall, there were only 5 poor countries, all of them in East Asia, that succeeded in catching up with the "rich club" in recent half-century (Japan and four Asian tigers - Hong Kong, Singapore, South Korea, Taiwan) - all of them were rapidly accumulating reserves. Only 7 countries in the world increased their GDP per capita in 1960-99 at a rate higher than 4% a year (table 2) and all

[3] In this early paper Rodrik assumes the import externality, which is used via the overvaluation of the exchange rate that stimulates imports of machinery and equipment. There is no doubt this import externality exists, especially at the early industrialization stages, but there are only limited opportunities to reap this externality through overvalued exchange rate because such an overvaluation would lead to the trade deficit and the depletion of reserves. Rather, the appropriate way to use this externality is to set

these countries, except Japan, increased FER at a high pace, had relatively low domestic prices and prices for non-tradables due to the undervaluation of their currencies, and experienced rapid increases in export/GDP and investment/GDP ratios. Japan that was not growing in the 1990s, but accumulated reserves until 1994, may be an exception that proves the rule. Similarly, the ratio of domestic to US prices that was high in Japan, Hong Kong and Singapore in the last quarter of the 20-th century, was much lower in the preceding 25 years.

Out of 17 countries that demonstrated growth rates of GDP per capita of 3% and higher (table 2) there are more exceptions - in addition to Japan these are Ireland, Luxembourg, Portugal and Spain. These are developed countries, which obviously - due to better investment climate and EU membership - had ways to increase capital productivity that were beyond the reach of poor countries. Mauritius and Indonesia also managed to achieve high growth rates with relatively low investment/GDP ratios, which requires explanation. Otherwise, however, the data are very meaningful.

Table 2. Some macroeconomic indicators for rapidly growing countries in 1960-99

Countries	Annual average GDP pe capita growth rate, %	Increase in FER/GDP ratio, p.p., 1960-99	Average FER/GDP ratio, %	Highest FER/ GDP ratio in 1960-99, %	Average FER in months of import, 1975-99	Ratio of PPP to official exchange rate in 1975-99, %	Ratio of prices of health care and clothing, 1993, %	Ave-Rage Export /GDP ratio, %	Increase export/ GDP ratio, p.p.	Average Invest-ment/ GDP ratio, %
Countries with average annual growth rate of GDP per capita of over 4%										
Botswana	6,13	86,93 (1976-99)	68,89 (1976-99)	121,82 (1998)	13,64	53,86	66,9	41,83	3,88	27,61
China	4,94	13,72 (1977-99)	8,68 (1977-99)	16,31 (1999)	7,36	38,26		11,76	20,77 (1970-9	31,31
Hong Kong,	5,12	27,59 (1990-99)	42,74 (1990-99)	60,56 (1999)	3,61	83,03	80,8	103,37	48,8	27,33
Japan	4,18	2,37	3,42	6,76 (1999)	3,54	115,98	54	11,20	-0,34*	32,01
Korea, Rep.	5,82	14,17	5,89	18,21 (1999)	2,11	58,23	38,9	25,08	38,9	27,93
Singapore	5,87	72,76	60,55	90,52 (1998)	4,76	93,93	52,3	163,66	41,96 (1965-9	34,57
Thailand	4,51	14,44	14,75	27,97	4,47	41,69	25,3	41,63	26	27,98

different tariffs for final products (high) and intermediate products (low) or to subsidize imports of machinery directly.

				(1997)						
Countries with average annual growth rate of GDP per capita of 3 to 4%%										
Hungary	3,11	27,59 (199	14,18 (1983-99)	22,67 (1999)	3,52	36,05	57,5	38,06	22,44 (1970-99)	28,79
Greece	3,36	9,90	6,83	15,64 (1994)	3,86	69,99	49,69	14,42	10,76	27,02
Indonesia	3,43	19,09 (196	6,65 (1967-99)	23,89 (1998)	3,36	42,54	38,4	22,04	19,9	22,34
Ireland	3,89	-11,22	14,61	22,51 (1977)	2,46	93,99	94,3	49,20	57,9	18,71
Luxembourg	3,06	-3,61 (19	2,10 (1984-99)	4,29 (1985)	0,03	123,23	62,5	103,76	14,4	18,43
Malaysia	3,91	24,55	21,26	42,13 (1993)	4,19	59,12		58,80	71,1	27,83
Mauritius	3,30	6,94	14,53	32,32 (1991)	2,74	42,99	81,9	50,29	36,9	22,83
Norway	3,03	6,94	10,57	22,56 (1985)	3,91	125,96	89,8	38,19	2,22	22,83
Portugal	3,83	-9,31	26,77	51,40 (1979)	2,86	56,78	72,2	24,98	15,28 (1960-98)	24,66
Spain	3,31	1,80	8,18	13,06 (1997)	5,25	80,05	69,2	15,56	19,2	23,13

*In 1960-84 the ratio increased by 4,09 p.p.

Source: WDI.

Whatever the reasons for the equilibrium dynamics of the RER in poorer countries, and whatever are the equilibrium patterns of this dynamics, it is clear that the monetary authorities can influence these patterns through the accumulation of FER. If Balassa-Samuelson effect really holds, countries accumulating reserves, other conditions being equal, will experience smaller increases in RER since the policy of the central bank in this case would be to prevent the appreciation of the national currency. It is important to realize that the accumulation of FER is an indicator of the deviation of the actual exchange rate from its equilibrium level (defined as a level, which ensures the balance of payment equilibrium without the change in reserves), although this equilibrium level itself for developing countries is lower than the PPP rate and also may change in time, approaching the PPP rate.

The argument against a policy of low exchange rate is that the accumulation of reserves leads to monetary expansion and hence - to inflation. Calvo, Reinhart and Vegh (1995) argue that undervaluation of the exchange rate is inflationary in theory and was inflationary in practice for Latin American countries in the 1980s. Sterilization is often viewed as a self defeating policy, since

it is achieved only at a cost of higher domestic interest rates, which in turn leads to the greater inflow of capital, the need for the new sterilization and thus even higher interest rates, etc. However, in practice sterilization is usually carried out by countries exercising some kind of capital control, either administrative or in the form of the Tobin tax, which makes sterilization policy efficient. It appears also that countries that accumulated FER faster than others usually financed such accumulation with a government budget surplus and thus managed to escape high inflationary pressure. Data for all countries (see below) do not show any link between the accumulation of FER and inflation.

3. A closer look at stylized facts - cross-country regressions

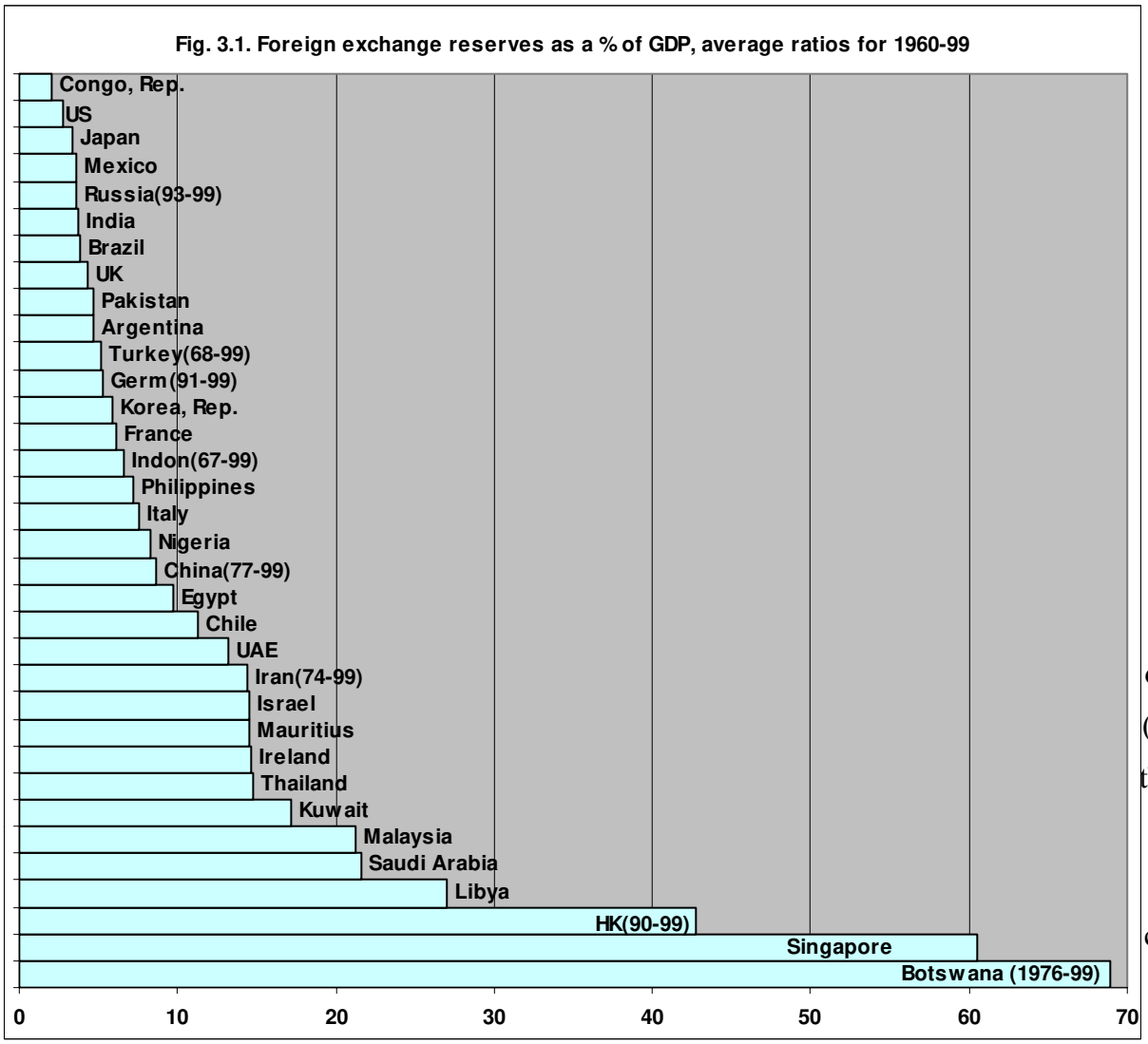
All data are taken from the World Bank tables (WDI, 2001). We have observation for about 100 countries for the period of 1960-99, but for some countries the values of particular indicators for particular years are missing. We kept the country on the list, if the number of missing observations for the 40-year period was less than 20.

(1) Explaining the level and change of FER. To begin with, foreign exchange reserves as a % of GDP (whether converted at official or PPP exchange rates) vary dramatically (fig. 3.1). The average ratio of FER to GDP for 1960-99 ranged from several percent of GDP to several dozen percent (Hong Kong - over 40%, Singapore - over 60%; Botswana - 69%; by the end of 1999 Botswana had reserves over 100% of GDP). In East Asian countries the ratio of reserves to GDP in general increased in the course of recent four decades, whereas in African and Latin American countries foreign exchange reserves grew less rapidly than GDP.

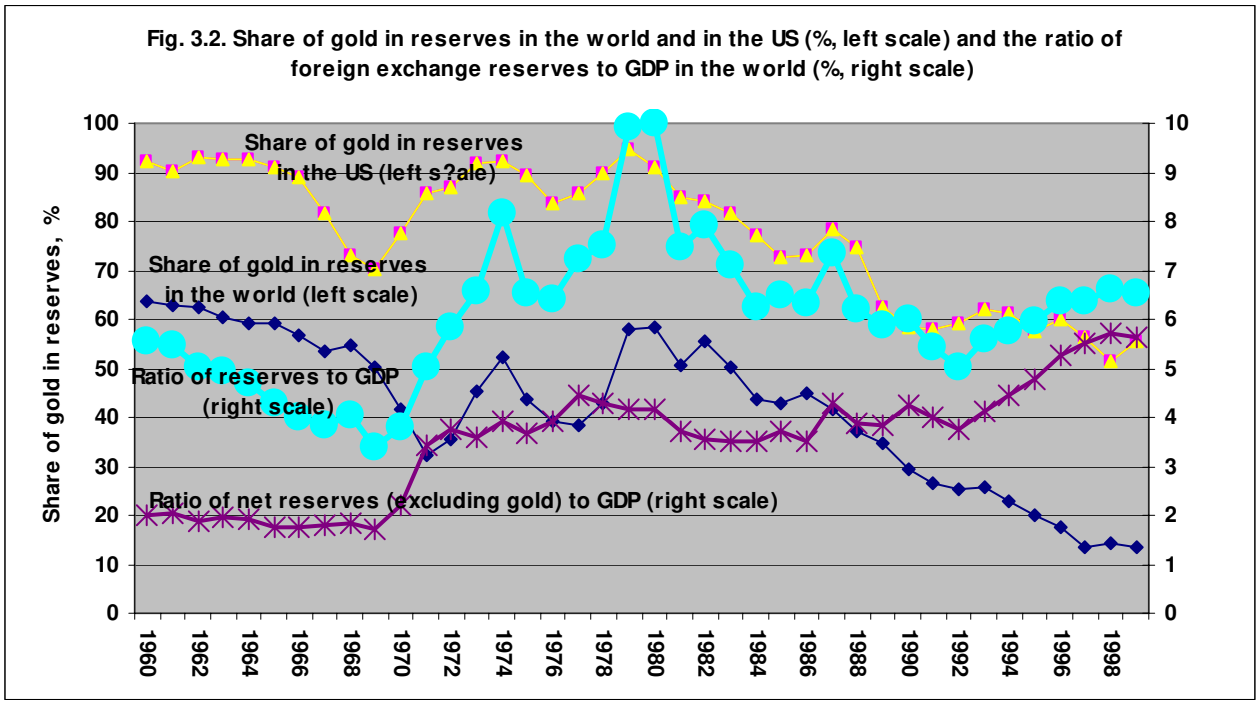
If reserves are needed to ensure smooth foreign exchange operations, as the theory suggests, it might be expected that smaller countries with higher foreign trade would have relatively (as a % of GDP) higher reserves[4]. In practice, however, this is not the case: there is practically no relationship between FER/GDP ratios and the GDP itself, no matter whether it is measured at PPP or official exchange rates. Similarly, the FER adjusted for the size of international trade of the country

[4] The standard formula for explaining FER is $FER = Y^{\alpha} * O^{\beta} * \sigma O^{\gamma} * i^{\delta}$, where Y is income, O is the measure of openness of the economy (external trade to GDP ratio), σO is the volatility of openness, and i is the opportunity costs of holding foreign exchange reserves (difference between the interest rate earned on FER invested into short-term low risk securities and interest rate on alternative investment), and $\alpha, \beta, \gamma, \delta$ are respective elasticities. It is interesting to note that collapse of the Bretton-Woods fixed exchange rates system in 1971 did not have a large impact on the demand for FER (Grennes, 1984, Ch. 22).

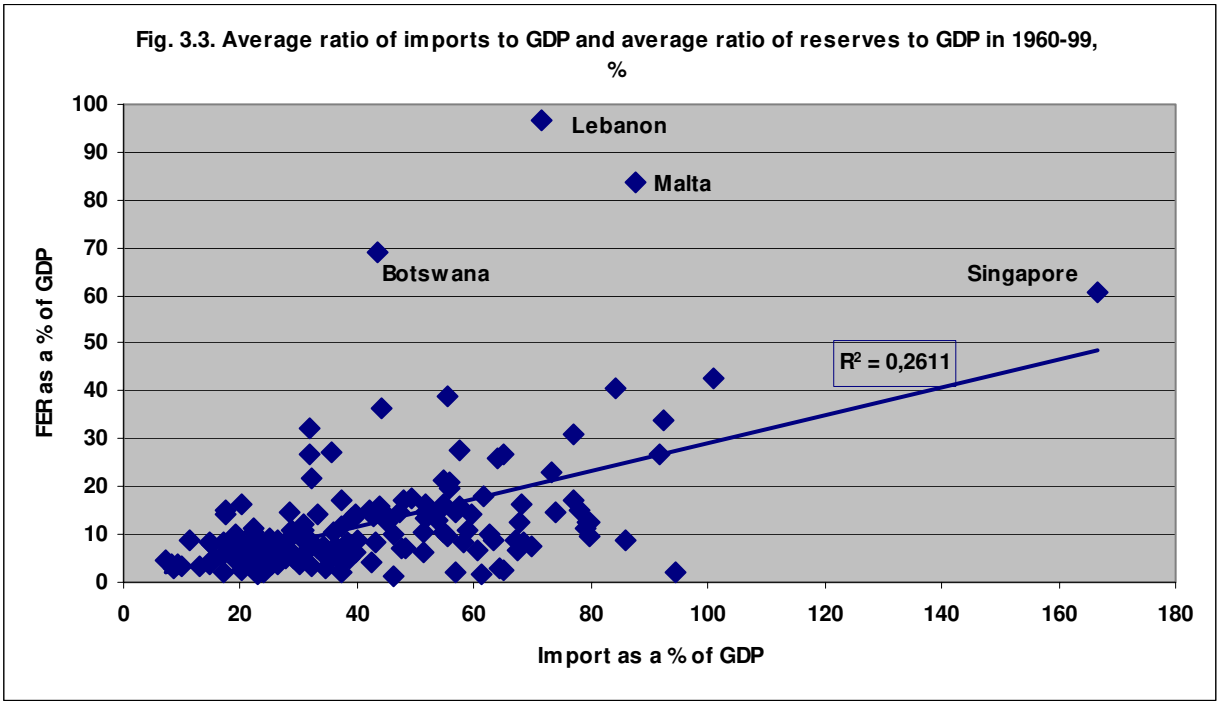
(measured in month of imports) differ considerably - from less than one month to over 1 year. Botswana, for instance, in the late 1990s kept enough reserves to support import for 24 months, whereas Jamaica with similar magnitude of international trade (40-50% of GDP) was unable to finance its import even for 2 months.



due to the US (fig. 3. in the in the capital



Is there a rationale, except for the goal of ensuring the stability of the external transactions, for differing magnitude of foreign exchange reserves? FER are correlated with imports (with exports - as well, but the correlation is much weaker, adjusted R^2 is 26% and 13% respectively - fig. 3.3), but are not correlated with many other variables that are supposed to explain the level of reserves (table 3). We tried the volatility of external trade, terms of trade, net fuel imports, the current account, private capital flows, total debt and short-term debt, debt service payments, international and domestic interest rates - neither of the indicators was statistically significant (not shown in the table). GDP per capita and the indicator of investment climate acquire the negative sign - the worse is the investment climate, and the poorer is the country, the more rapid is the growth of reserves. To put it differently, other things being equal, poor countries with poor investment climate should increase FER faster (probably using them as a collateral) than others. The average *level* of FER to GDP ratio for the long term period (1960-99) has a negative impact on the *change* of FER in 1975-99, which is in line with the intuition – countries with high level of FER did not need to increase it.



For the 1975-99 period, for which more data are available, the best equation explaining changes in FER is shown below:

$$\Delta R = 39 - 0.4(R/Y_{60-99}) - 6.2\lg Y - 0.3ICI_{84-90} + 0.2(T/Y) + 0.3(\Delta[T/Y]), \qquad (1)$$

R^2=50%, N=72, all coefficients significant at 3% level or less, where:

ΔR -- the increase in the reserves/GDP ratio in 1975-99, p.p.,

Y - initial (1975) GDP per capita,

T/Y - average ratio of foreign trade to GDP over the period,

$\Delta[T/Y]$ - the increase in the same ratio over the period,

R/Y_{60-99} - average ratio of FER to GDP in 1960-99,

ICI_{84-90} - average investment climate index in 1984-90 (ranges from 0 to 100, the higher, the better).

Then we consider the residual from this equation, ΔRpol, as the *policy induced change in foreign exchange reserves.* The logic behind such an approach is to net out changes in reserve/GDP ratio caused by objective circumstances, such as the level of development and investment climate, the accumulated level of FER and the level and dynamics of foreign trade. Afterwards we used the *policy induced change in foreign exchange reserves* as one of the explanatory variables in growth regressions. In this way we deal with the possible endogeneity problem: policy-induced change in reserve to GDP ratio in 1975-99 could be regarded as an exogenous policy variable.

It remains to be said that the accumulation of FER is financed in practice[5] through government budget surplus and debt accumulation, but not through money printing, since inflation is not significant as an explanatory variable (table 3). That is to say, most countries that accumulated reserves rapidly exhibited low inflation, and low budget deficit (or budget surplus), but growing government debt.

Table 3. Factors explaining the level of FER in 1960-99 and the sources of FER accumulation - cross country OLS regression results

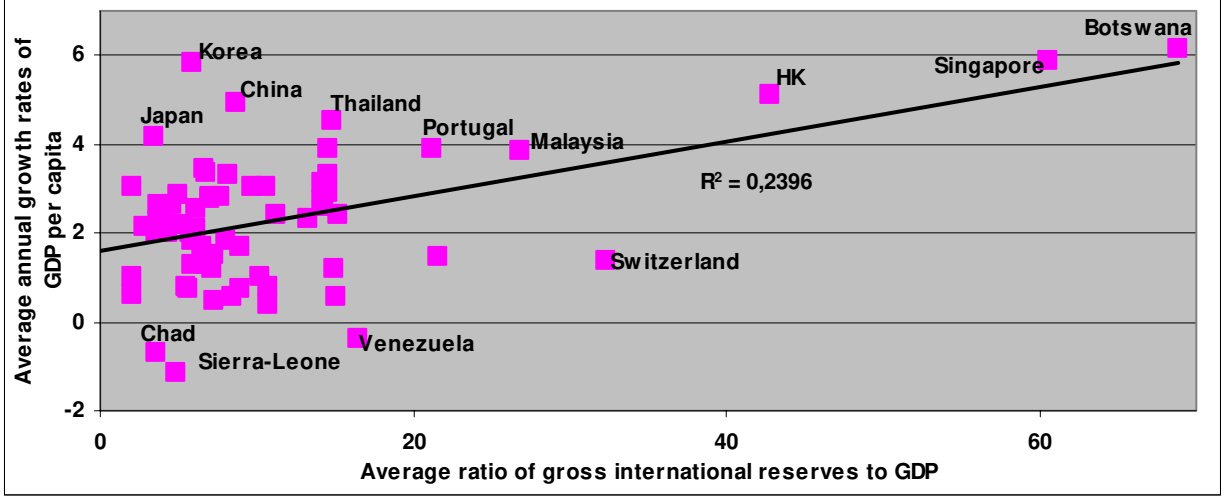
Dependent variable	Average ratio of FER to GDP in 1960-99, %	Average ratio of FER to GDP in 1960-99, %	Increase in the ratio of FER to GDP from 1960 to 1999, p.p.	Increase in the ratio of FER to GDP from 1960 to 1999, p.p	Increase in the ratio of FER to GDP from 1960 to 1999, p.p.
Number of observations	172	122	62	58	
Average budget surplus in 1960-99, % of GDP			0.55*	1.0***	1.07***
Average government debt in 1960-99, % of GDP				0.08*	0.09**
Average annual inflation (GDP deflator), 1960-99, %			0.05		0.07
Average import of goods and services, % of GDP	0.29***	0.32***			
2000 investment climate index, ICRG, %		0.18**			
Constant	0.09	-13.1**	7.1***	5.6**	4.5*
Adjusted R^2	26	32	2	8	7

*, **, *** - Significant at 10%, 5% and 1% level respectively.

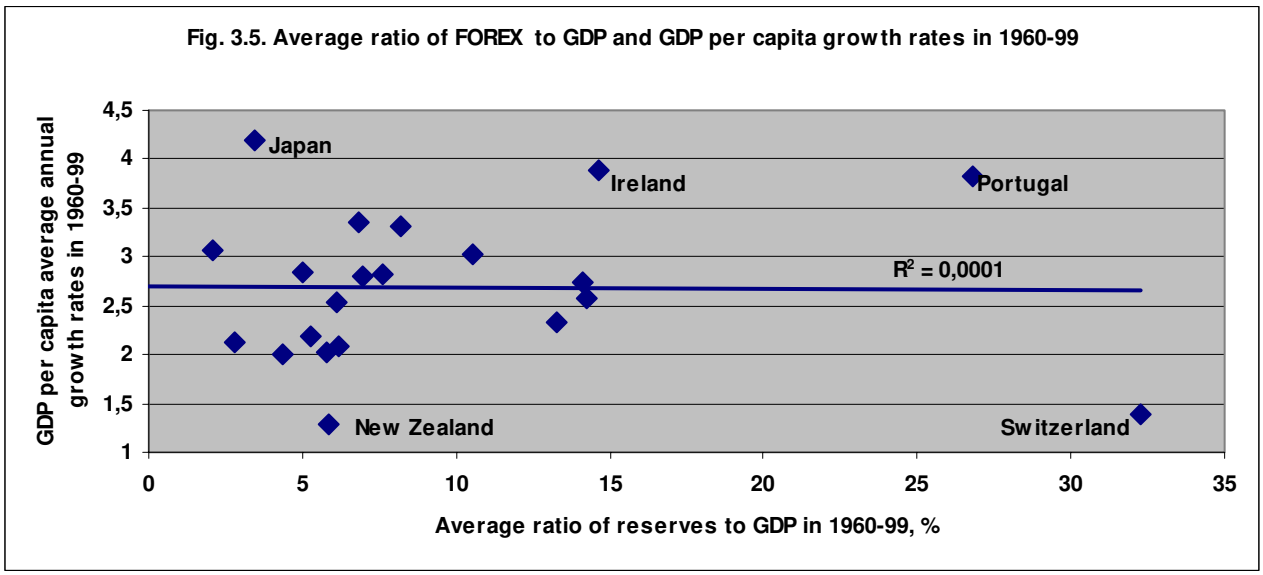
[5] Formally, the following identities hold:
$\Delta M=\Delta FOREX+\Delta B_{CB}$
$BD = \Delta B_{CB} + \Delta B_P$
$\Delta FOREX = \Delta M + BS + \Delta B_P$,
where $\Delta FOREX$ – increase in foreign exchange reserves, ΔM – increase in money supply, BS – budget surplus (BD – budget deficit), ΔB_P – increase in bonds held by the public, ΔB_{CB} - increase in bonds held by the central bank. The last identity implies that the increase in foreign exchange reserves can be financed by the increase in money supply, i.e. inflation tax on everyone (ΔM), budget surplus (BS), accumulation of debt held by the public (ΔB_P).

(2) Accumulation of FER and economic growth. Overall there seems to be a positive relationship between the accumulation of foreign exchange reserves by the monetary authorities and the rates of long term economic growth. It is observed for different periods, and for different measures of FER - average for the period, as well as the increment for the period, as a proportion of GDP and in months of import (fig. 3.4). It is not observed however for developed countries (fig. 3.5). But fast growing developing countries more often than not appear to have high and rapidly growing reserves. Which way the causation runs?

Fig. 3.4. Average ratio of gross international reserves to GDP and average annual growth rates of GDP per capita in 1960-99, %,



It is difficult to argue that the successful growth leads to rapid accumulation of reserves because the accumulation of reserves is a policy variable. Monetary authorities theoretically can accumulate as much reserves as they like over the long run through buying foreign currency with domestic currency. Sterilization of the increases in money supply resulting from the reserve accumulation may be a difficult task in the presence of open capital account, but the facts are that countries with high reserves had better record of macroeconomic stability than the others. In any case, if successful growth is somehow accompanied by the rapid accumulation of FER, the appropriate question to ask is whether this reserve build up is a necessary pre-condition for growth, or whether this growth could continue without the reserve build up.



We used standard growth regressions to show that the accumulation of reserves and policy-induced accumulation of FER matters for economic growth even after other factors are taken into account. We control for initial level of development and for investment climate index (ranging from 0 to 100; the higher it is, the better the climate), for investment/GDP ratios and population growth rates[6]. Regression results (table 4 - for 1960-99 period and 4a - for 1975-99 period) show the link between investment/GDP ratios and growth, but also suggest that the accumulation of reserves creates stimuli for growth through greater involvement into foreign trade. Even after controlling for investment/GDP ratios, investment climate and population growth, it turns out that the goodness of fit improves once the level of reserves (or change in this level) or increase in export/trade or the underpricing of the exchange rate is added on the right hand side. This is to suggest that the accumulation of FER is associated with greater involvement into the international trade that in turn produces externalities - higher capital productivity. With equal investment/GDP ratios and population growth rates countries that accumulate FER at a faster pace exhibit higher growth rates of international trade as compared to GDP and higher growth of GDP itself. The results for developing countries only are very similar.

[6] Although it obviously does not go automatically that higher investment result in the higher growth rate of output, although traditional Solow-type growth models predict that in the long term output growth rates cannot be influenced by higher investment, and although critics of the investment - growth nexus were recently quite vocal (see, for instance, Easterly, 2001), the positive link between investment and growth appears to be one of the most robust relationships that was established by the empirical research of economic growth (Kenny, Williams, 2000). In all growth regressions investment or the share of investment in GDP turn out to be highly statistically significant.

Table 4. Factors explaining the average growth rate of GDP per capita in 1960-99 - cross country OLS regression results

Dependent variable	Average growth rate of GDP per capita in 1960-99					
Number of observations	59	75	75	75	75	56
Average investment/GDP ratio in 1960-99		0.14 ***	0.12 ***	0.13***		0.08 ***
Log PPP GDP per capita in 1975	1.25 ***	-1.2 ***	-1.1 ***	-1.2 ***	-1.13 **	-.0002 ***
2000 investment climate index, ICRG, %		0.08 ***	0.06 ***	0.06 ***	0.09 ***	0.06 ***
Average population growth rate in 1960-99		-0.2,Tst = -1.2	-0.33*	-0.3*	-0.33 *	-0.47 **
Increase in the ratio of FER to GDP 1960 to 1999, p.p.	0.032**					
Average growth rates of FER in 1960-99						0.08*
Average level of FER to GDP in 1960-99, %			0.034 ***			
Policy-determined average level of FER to GDP in 1960-99, % (calculated as the residual from the equation linking reserves to import)				0.042 ***	0.05 ***	
Constant	-2.31	-2.4	-1.2	-1.1	0.05	-3.29 **
Adjusted R^2	14	54	58	58	43	49

*, **, *** - Significant at 10%, 5% and 1% level respectively.

In table 4, we use the indicator of policy determined *level* of reserves (calculated as the residual from the equation linking average FER/GDP ratio to import)[7]. It has stronger impact on growth than the actual level of reserves (coefficients are 0.042 and 0.034 respectively). Overall the growth promoting effect of FER accumulation is quite powerful: a country that keeps the FER to GDP ratio at a level 20 p.p. higher than the required level of reserves gains about 1 p.p. extra average annual growth of GDP per capita over the 40 year period. Or else, a country that raises it's FER/GDP ratio by 1 p.p. a year over the course of 40 years may hope to increase the annual average growth rate of GDP per capita by 1.3 p.p. (40*0.032 = 1.3) The effect of reserve accumulation is noticeable allowing for cross-country differences in investment/GDP ratios and it becomes even stronger, if investment/GDP ratios are not included on the right hand side. This is to suggest that the

[7] Later, for the 1975-79 period, we use the indicator of policy induced *change* in FER/GDP ratio, computed as a residual from (1). For the 1960-99 period, however, we use the policy-induced *level* of FER/GDP ratio because there is not enough points for the *change* indicator.

impact of reserve accumulation on growth is multidimensional - it raises investment/GDP ratios, and it also contributes to the increase in the productivity of this investment.

Table 4a. Factors explaining the average growth rate of GDP per capita in 1975-99 - cross country OLS regression results, robust estimates

Dependent variable	Average growth rate of GDP per capita in 1975-99						
Number of observations	92	77	90	90	90	70	70
Average population growth rate in 1975-99, %	-0.88 ***	-0.68 **	-0.77 ***	-.086 ***	-0.76 ***	-1.22 ***	-0.93 ***
Log PPP GDP per capita in 1975, $US		-1.16*	-1.44**			-1.15***	
1984-90 investment climate index, ICRG, %		0.06 ***					
Average investment/GDP ratio in 1975-99			0.12 ***		0.11 ***		
Annual average inflation in 1975-99, %			-0.01*	-0.01 **	-0.01 **	-0.01**	-0.01**
Total population in 1999, million				$3*10^{-09}$ ***	$3*10^{-09}$ ***	$2*10^{-09}$ **	$3*10^{-09}$ **
Population density in 1999, people per 1 sq. km				.0005 ***	.0003*	.0007 ***	.0004 ***
Increase in the ratio of FER to GDP from 1975 to 1999, p.p.	0.037 *	0.05 **	0.040 ***	0.040 **	0.032 *		
Increase in the ratio of FER to GDP, determined by objective factors – according to equation (1)							0.068**
Policy-determined increase in the ratio of FER to GDP in 1975-99 - ΔR pol						0.10**	0.059*
Interaction term = (Policy-determined in the ratio of FER to GDP in 1975-99)* (Per capita PPP GDP in 1975, % of US level)						-0.0015 **	
Constant	2.8***	2.9	0.11	2.65***	0.2	7.3***	3.0***
Adjusted R^2	27	38	50	46	55	56	56

*, **, *** - Significant at 10%, 5% and 1% level respectively.

In table 4a we consider the 1975-99 period and use the indicators of actual accumulation of FER (as a % of GDP) and policy determined *increase* in the FER/GDP ratio over the period - as a residual from (1). We also control for inflation because the policy of FER accumulation influences growth positively only if it does not lead to inflation, i.e. accumulation of reserves is accompanied by sterilization and does not lead to expansionary monetary policy. It turns out that the actual accumulation of reserves has a positive and significant impact on growth and that this relationship

is quite robust to the inclusion of common sense control variables – population growth rates, total population and population density, initial level of GDP per capita and (sometimes) investment/GDP ratio.

Interestingly enough, both indicators of reserve accumulation – the one determined by objective circumstances according to (1), and the one determined by policy considerations (computed as a difference between actual increase in FER/GDP ratio and objectively determined increase) have a positive and significant impact on growth (table 4a, 6th column). The interpretation is quite transparent: high and low growth is usually associated with greater trade/GDP ratios and hence – greater FER/GDP ratios; but if accumulation of reserves proceeds at an even higher pace – in excess of objective needs, leading to the undervaluation of RER, this has a positive impact on growth.

The best equation explaining growth in 1975-99 without the investment variable (only with non-policy variables, such as population, population density, initial level of GDP per capita in 1975, and population growth rates) and only with two policy variables – policy determined increase in FOREX/GDP ratio and inflation for the period is as follows (table 4a, 7th column):

$$\text{GROWTH} = \text{CONST.} + \text{CONTR. VAR.} + \Delta R_{pol}\,(0.10 - 0.0015\,Ycap75us) \qquad (2)$$

$R^2 = 56$, N=70, all variables are significant at 10% level or less,
where Ycap75us – PPP GDP per capita in 1975 as a % of the US level.

It turns out that there is a threshold level of GDP per capita in 1975 – about 67% of the US level: countries below this level could stimulate growth via accumulation of FER in excess of objective needs, whereas for richer countries the impact of FER accumulation was negative. This is exactly in line with our explanation (see the section on theoretical model) – one of the most important effects of the accumulation of reserves is the undervaluation of the RER that encourages export and international trade in general and allows the country to reap the benefits of export externality. This externality, however, is the strongest for developing countries: developed countries have already achieved the optimal share of foreign trade in GDP, whereas in developing countries the share of foreign trade stays at sub-optimal level. If returns to the economy from exports are greater than the returns to particular firms, export would stay below the optimal level. One way to reach the optimal level of international trade and to reap the benefits of trade externalities is to accumulate foreign exchange reserves, which would lead to the underpricing of the exchange rate and greater exports

and later – imports[8]. Below we try to show that countries with high reserve accumulation have lower real exchange rate, and that the latter is correlated with the increase in the share of external trade in GDP.

The following stylized facts point into the direction of the existence of the mechanism which can transform the accumulation of FER into higher economic growth.

(3) Accumulation of FER and exchange rate undervaluation. The PPP exchange rate of the US$ in local currency, e_{PPP}, is defined as the ratio of domestic prices, P, to US prices, P^*:

$$e_{PPP} = \frac{P}{P^*},$$

so the ratio of the PPP exchange rate to official exchange rate, e_{of}, is equal to the ratio of domestic prices to the US prices converted into domestic currency at official exchange rate:

$$\frac{e_{PPP}}{e_{of}} = \frac{P}{P^* * e_{of}}$$

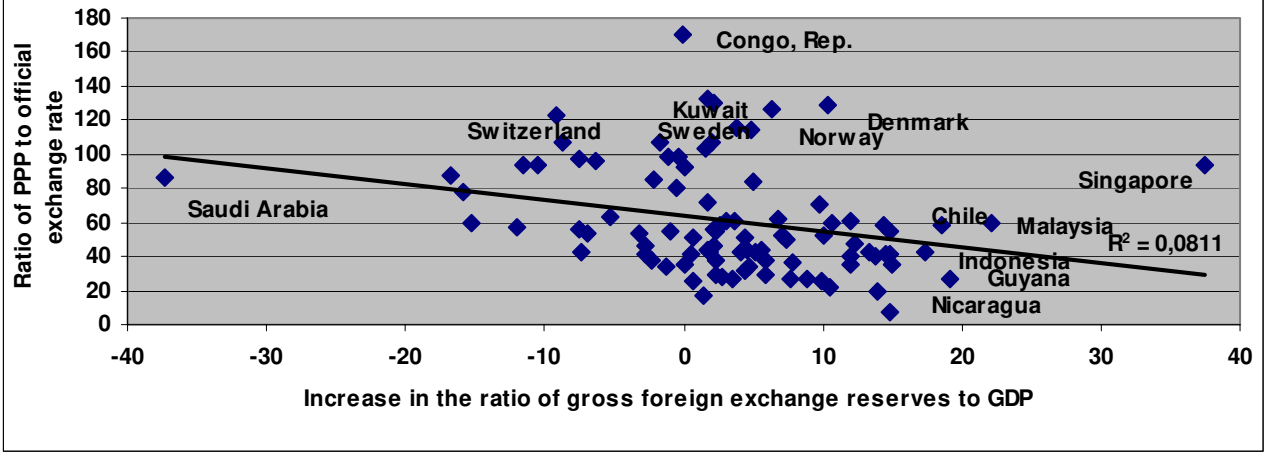
As was previously argued, there are a number of reasons why the actual (official) exchange rates in less developed countries are usually below the PPP levels. One of the reasons is associated with the policy of monetary authorities in accumulating the foreign exchange reserves. The faster the accumulation of reserves, the more undervalued is the exchange rate as compared to PPP, the lower are domestic prices as compared to prices of other countries (US prices in our case, since the exchange rate of the local currency is measured against $US). How important is this particular policy factor in comparison with other factors beyond the immediate control of the policymakers?

The data suggest that the impact of policies of monetary authorities on the exchange rate is by no means negligible: there is a negative relationship between the increase in FER and the exchange rate undervaluation as measured by the ratio of PPP exchange rate of local currency in US$ to the official exchange rate (fig. 3.6). On the other hand, the policy of reserve accumulation and undervaluation of domestic currency has its obvious costs – countries that pursue this kind of policy

[8] In another paper (Polterovich, Popov, 2004) we apply this principle to other policies – tariff protectionism, regulation of FDI, migration, etc. The argument is that "good" policies vary depending on the level of technological development (GDP per capita) and the quality of institutions. At a low stage of development the country can stimulate growth by accumulating FER, by using protectionist instruments, and by controlling the inflow of FDI, whereas at a higher stage

appear to experience some appreciation of real exchange rate, although even with this appreciation it remains lower than in countries with no reserve build up. Increase in the ratio of FER to GDP in 1975-99 period is statistically significant in regression equations explaining the average ratio of domestic to foreign prices in this period (table 5). The goodness of fit improves if net external balance is taken into account – not every accumulation of reserves, but only the accumulation that occurs under the positive external balance (i.e. is not financed by foreign borrowing) can lead to the undervaluation of the exchange rate.

Fig. 3.6. Increase in the ratio of gross foreign exchange reserves to GDP and the ratio of PPP to official exchange rate in 1975-99, %



In 1975-99 the ratio of domestic to the US prices (i.e. the real exchange rate against the US$) for all developing countries, as a group, declined, whereas for rich countries it increased (fig. 2.2). It has to do more with the terms of trade effect and the long cycle in resource prices (after peaking in 1980 the resource prices mostly declined or were low until 1999) than with Balassa-Samuelson effect, which is not observable also because developing countries as a group were not catching up with rich countries in productivity levels in this period. It is noteworthy, however, that for the fastest growing developing countries (Botsawna, Chile, China, Egypt, India, Indonesia, Malaysia, Mauritius, Sri Lanka, Thailand), in which the Balassa-Samuelson effect should have been the strongest, the decrease in real exchange rate versus the US$ was no less pronounced than for all developing countries. This probably means that the accumulation of FER in the fastest growing

---

of development the growth conducive policies are exactly the opposite – liberalization of trade and capital flows, no

developing countries completely outweighed the productivity growth effect, so the real exchange rate was declining as fast as in slowly growing economies.

Table 5. Factors explaining the average ratio of domestic to US prices in 1975-99 – cross country OLS regression results

Dependent variable = average ratio of domestic to US prices in 1975-99

Number of observations	89	78	78	72 (dev. only)
PPP GDP per capita in 1975	.006***			
2000 investment climate index, ICRG, %		1.00***	1.37***	
Increase in the ratio of FER to GDP from 1975 to 1999, p.p.	**-0.53****	**-.88*****	**-0.54***	**-.57*****
Average ratio of trade to PPP GDP in 1980-99	.35***	.39***		.41***
Average external balance in 1975-99, % of GDP			1.37***	
Net fuel imports, % of total imports				-.27***
Constant	33.8***	-17.3	162.7***	39.7
Adjusted R^2	64	53	45	62

*, **, *** - Significant at 10%, 5% and 1% level respectively.

(4) Relative prices and exchange rate undervaluation. It is usually assumed that prices for tradable goods do not differ much across countries and that the ratio of prices of non-tradables to tradables is one of the measures of real exchange rate. Theoretically, the FER accumulation should affect relative prices for non-tradables, whereas prices for tradables should more or less the same across countries (the difference is due to trade barriers and transportation costs). To put it differently, international differences in price levels should be mostly determined by differences in prices for non-tradables. We tried to verify that by looking at relative prices of health care and education (non-tradables) as compared to prices of clothing and footwear (taken as a proxy for the tradable goods prices)

The problem is that health care and education are often non-tradables not only internationally, but within the country as well and are poor proxies for prices of all non-tradables, which include other important services, such as transportation, communications, housing and public utilities, trade and financial services for which comparable data are not available. Prices for health care and education are usually to a large extent controlled by the government and hence may not respond immediately to the change in relative prices caused by the accumulation of FER and undervaluation of the

accumulation of FER, etc.

exchange rate. It is noteworthy nevertheless that countries with low relative prices for health care, education and energy exhibit higher investment/GDP ratios. Overall, it seems that some relative prices of intermediate goods may react to the accumulation of foreign exchange reserves (build up of reserves – devaluation – increase in prices for tradables – decline of relative prices of non-tradables) and that lower prices for some these goods, even when not caused directly by the reserve accumulation, contribute to higher investment/GDP ratios and higher growth rates of output.

The correlation of prices for tradables with prices for non-tradables is very high and prices for these goods are strongly correlated with the level of development – GDP per capita (table 6, fig. 2.1), which creates the false impression that there is no difference in the levels of prices for tradables and non-tradables (the lower is the GDP per capita, the lower are prices for tradables and non-tradables). In fact, it is easy to show that low price levels in developing countries are associated first and foremost with low prices for non-tradables (table 6). The accumulation of FER suppresses relative prices for non-tradables more than it lowers prices for tradables – in table 7 the coefficient of the FER increase variable in the equation explaining relative health care prices in not significant and the R^2 in this equation is less than in the equation explaining relative prices for clothing and footwear.

Table 6. Correlation coefficients between prices of tradadbles and non- tradables (55 observations)

	All domestic to US prices, 1980-99	Domestic prices of clothing to US prices	Domestic prices of healthcare to US prices	1975 PPP capita
All domestic to US prices, 1980-99	1			
Domestic prices of clothing to US prices	0.6681	1		
Domestic prices of healthcare to US prices	0.7061	0.8392	1	
1975 PPP GDP per capita	0.7009	0.8365	0.8946	1

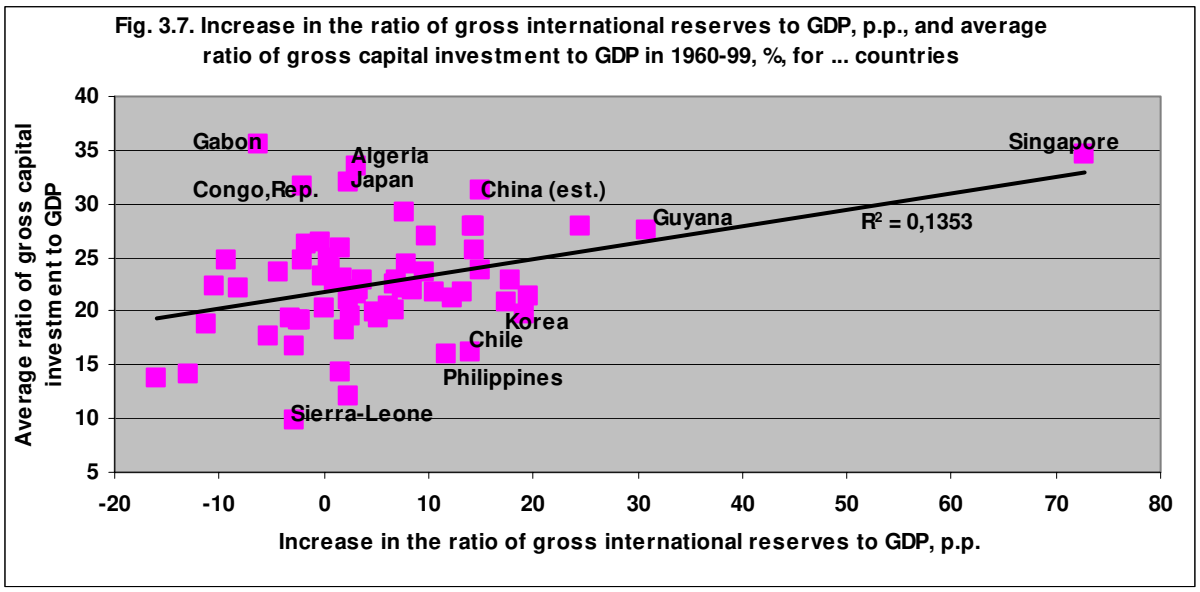
Table 7. Factors explaining 1993 price levels of health care and education, clothing and footwear

Dependent variable	Ratio of pr health care to clothing	Ratio of pr education to clothing	Ratio of health care pric prices	Ratio of clothing and prices to the U
Number of observations	77	77	58	58
PPP GDP per capita in 1999	.000647*	.0008086*	0.0033***	0.0032***
Average ratio of domestic to US prices in 1975-99	0.26**	0.28**		

Increase FER/GDP ratio in 1980-99			-0.33**	-0.32 (T stat=-
Constant	38.93***	34.57***	17.95***	41.52***
Adjusted R^2	23	23	78	64

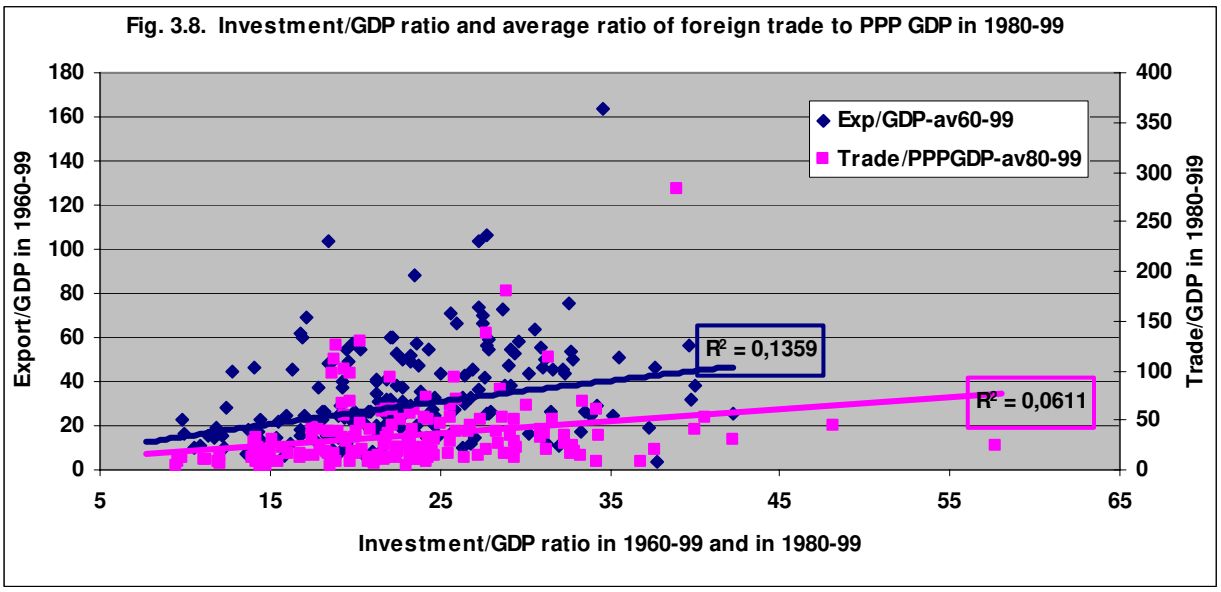
*, **, *** - Significant at 10%, 5% and 1% level respectively.

(5) Accumulation of FER and investment/GDP ratios. If accumulation of reserves leads to devaluation and results in higher relative prices of tradables (as compared to wages and prices of non-tradables) and higher profits, it is reasonable to expect that this would result in higher savings and investment/GDP ratios. But on the other hand, not every devaluation of national currency should be expected to produce higher investment, but only devaluation caused by the active policy of reserve accumulation: if the exchange rate of the national currency is low (falling) due to the outflow of capital caused by, say, poor investment climate as a result of political uncertainty (war), it would only cause the transformation of limited domestic savings into the capital flight at the expense of investment. Hence, the link between investment and accumulation of FER should be stronger than the link between investment and the undevaluation of currency, which actually seems to be the case. The link between the FER accumulation and the share of investment in GDP appears to be quite strong even without controlling for other factors (fig. 3.7).



The results of regression of the average share of investment in GDP on the ICRG index of investment climate, and the increase in foreign exchange reserves for the periods of 1960-99 and 1975-99 are reported in table 8 and 8a. Investment climate index (ranging from 0 to 100; the higher

it is, the better the climate) is strongly correlated with GDP per capita, so in many cases they act as substitutes, GDP per capita being just another proxy for investment climate. Both – FER required *level* and FER policy-induced *level* have a significant impact on the ratio of investment to GDP. The same goes for the impact of required *change* in FER and policy-induced *change* in FER for the period 1975-99. The link for required level and change in FER and investment/GDP ratio could be explained by the fact that required reserves depend on imports, whereas investment/GDP ratios are strongly correlated with trade/GDP ratios (fig. 3.8), and hence greater FER go hand in hand with larger international trade and higher investment (the causation probably runs both ways).



To take into account all factors that suppress prices for non-tradables as compared to prices in developed countries (US), we control for the ratio of healthcare prices to clothing prices (as compared to the US. This variable has a predictable negative sign – the lower are prices for non-tradables, the higher are profits, exports and investment of the tradable goods sector. To put it differently, accumulation of FER is not the only way of underpricing non-tradables and driving the country into export-oriented growth; similar results could be reached by taxation, price controls, and other policy instruments, but these latter policy instruments are more selective and hence corruption-prone.

Table 8. Factors explaining the average share of investment in GDP in 1960-99 – cross country OLS regression results

Dependent variable = average share of investment in GDP in 1960-99

Number of observations	59	58	109	34	34	57	57	58	57	40 (dev only)	39 (dev only)
Log PPP GDP per capita in 1975	4.61**		3.71**	4.97**		5.24 ***	4.15**				
Increase in the ratio of FER to GDP from 1960 to 1999, p.p.	0.15**	0.13 ***		0.14**	0.10*			0.11 **	0.09*	0.11 *	0.10(Ts =1.6)
Required average level of FER in 1960-99,%			0.33**								
Policy-determined average level of FER in 1960-99, %			0.09*								
Investment climate index, ICRG, %		0.14 ***			0.19 **			0.22 ***	0.22 ***	0.19 **	0.18*
Ratio of prices for healthcare to prices for clothing in 1993				-0.03	-0.05 ***	-0.05 **					
Ratio of prices for education to prices for clothing in 1993							-0.05				
Average external balance in 1960-99, % of GDP								-0.24 *	-0.23 *	-0.27 *	-0.26 *
Net fuel imports in 1960-99, % of total imports								-0.09 ***	-0.09 ***	-0.10 ***	-0.11 ***
Interaction term = (increase in reserves)x(foreign/domestic prices)x (external balance)									0.01, T		0.02 (Tst. =0.9)
Constant	5.02	11.7**	6.7*	8.73	13.0**	9.2**	9.8 **	29.4	5.6	7.2	7.8
Adjusted R^2	21	21	25	21	25	18	11	35	30	39	35

*, **, *** - Significant at 10%, 5% and 1% level respectively.

We also control for foreign financing of investment - positive external balance means that the net foreign financing of domestic investment is negative and consequently investment/GDP ratios are lower. This effect of negative foreign financing on investment appears to be stronger than the effect of positive current account leading to the accumulation of reserves and to the undervaluation of domestic currency (the impact of reserve accumulation on the ratio of domestic to foreign prices is the strongest, when reserve accumulation is not financed by the inflow of foreign capital – see table 5). The latter effect, however, is captured by the interaction term in table 6: the increase in reserves together with the current account surplus and higher ratio of foreign to domestic prices leads to higher investment/GDP ratios, although the T-statistics of this interaction term is low, when its

components are included into regression equation as separate variables. The results for developing countries only (excluding 24 countries that were first members of OECD) are very similar and coefficients of FER accumulation variable are even a bit higher. The results for the 1975-99 period (table 8a) are very similar as well.

Table 8a. Factors explaining the average share of investment in GDP in 1975-99 – cross country OLS regression results

Dependent variable = average share of investment in GDP in 1975-99

Number of observations	79	79	79	72	59 (dev. only)	85	46	46	48	42
Log PPP GDP per capita In 1975					-.0008 **					
2000 investment climate index, ICRG, %	0.17 ***	0.17 ***	0.21 ***		0.27 ***	0.15 ***	0.23 ***	0.26 ***	0.24 ***	
1984-90 investment climate index, ICRG, %				0.14 ***						0.14 ***
Increase in the ratio of FER to GDP from 1975 To 1999, p.p.	0.15 ***	0.24 ***	0.22 ***		0.23 ***		0.19 ***	0.26 ***		
Policy-determined in-Crease in the ratio of FER to GDP from 1975 To 1999, p.p.				0.28 ***						0.22 ***
Ratio of prices for health-Care to prices for clothing In 1993							-0.06 ***	-0.07 ***	-0.08 ***	-0.08 ***
Average external balance In 1960-99, % of GDP			-0.21 ***	-0.20 **						
Net fuel imports in 1960-99, % of total imports		-0.09 ***	-0.12 ***	-0.09 ***	-0.12 ***	-0.06 ***		-0.15 ***	-0.13 ***	-0.11 ***
Interaction term = (increase in reserves) x (foreign/domestic prices)x (external balance)						0.03*			0.03 *	
Constant	10.3 ***	9.5 ***	6.3 **	33.8 ***	4.63	11.3 ***	10.7 ***	9.6 ***	11.5 ***	20.2 ***
Adjusted R^2	17	34	39	37	42	16	37	63	44	55

*, **, *** - Significant at 10%, 5% and 1% level respectively.

It is worth noting that savings rate increases with the accumulation of reserves as well, but the correlation is weaker than that with investment. The interpretation could be as follows. The FER build up leads to the undervaluation of the exchange rate, increase in prices of tradadbles in local

currency and increase in profits (business savings) because wages and prices for non-tradables lag behind the growth of prices of tradable goods. However, the increase in business savings may be offset by the drop in personal savings since real incomes fall (increases in personal income lag behind the increases in prices) and the households in difficult times try to maintain their consumption at the expense of savings. If total private savings remain unchanged (the increase in business savings is exactly matched by the decline in personal savings), there may be an increase in investment due to the inflow of foreign capital (attracted by higher profitability) and due to the decline in government budget deficit resulting from increased revenues (due to price increases) and lagging increases in expenditure (for transfers, wages and salaries and purchases of non-tradables).

The good control variable is population density, it improves the goodness of fit in virtually all equations. For instance, if included into 4th equation in table 8a, it increases R^2 to 46%, whereas in the last regression in table 8a, it increases R^2 to 64%.

(6) Accumulation of FER, undervaluation of currency, trade and investment. Accumulation of reserves boosts not only investment/GDP ratios, but also the share of exports and trade in GDP. Trade/GDP ratios are positively related to the accumulation of reserves and negatively to the ratio of domestic to US prices.

Fig. 3.8 suggests that increases in investment and foreign trade go hand in hand. To put it differently, increases in investment and output are linked to the growth of exports and output in the tradable goods sector This is probably the major advantage of the strategy of reserve accumulation: it ensures not only rapid increases in investment, but also high returns to investment, high capital productivity due to increasing involvement into international trade. During export-led growth benefits emerge partly because investment projects are for the expansion of exports and hence their competitiveness is constantly tested by the world market, partly from greater specialization and externalities from international trade.

External trade/GDP ratios depend on the level of development (GDP per capita) and on a country size –smaller countries are more engaged in the international trade and the share of trade in GDP of these countries grows faster. As table 3.9 suggests, the ratio of trade to GDP and the increase in this ratio, after controlling for the size of the country (GDP), the level of development (GDP per capita) and the abundance of resources (share of net fuel imports in total imports or terms of trade change) is correlated with the increase in FER, with the undervaluation of the exchange rate

(the ratio of domestic to foreign prices) and with lower levels of prices of non-tradadbles as compared to tradables.

Table 3.9. Factors explaining the share of export and foreign trade in GDP in 1960-99 – cross country OLS regression results

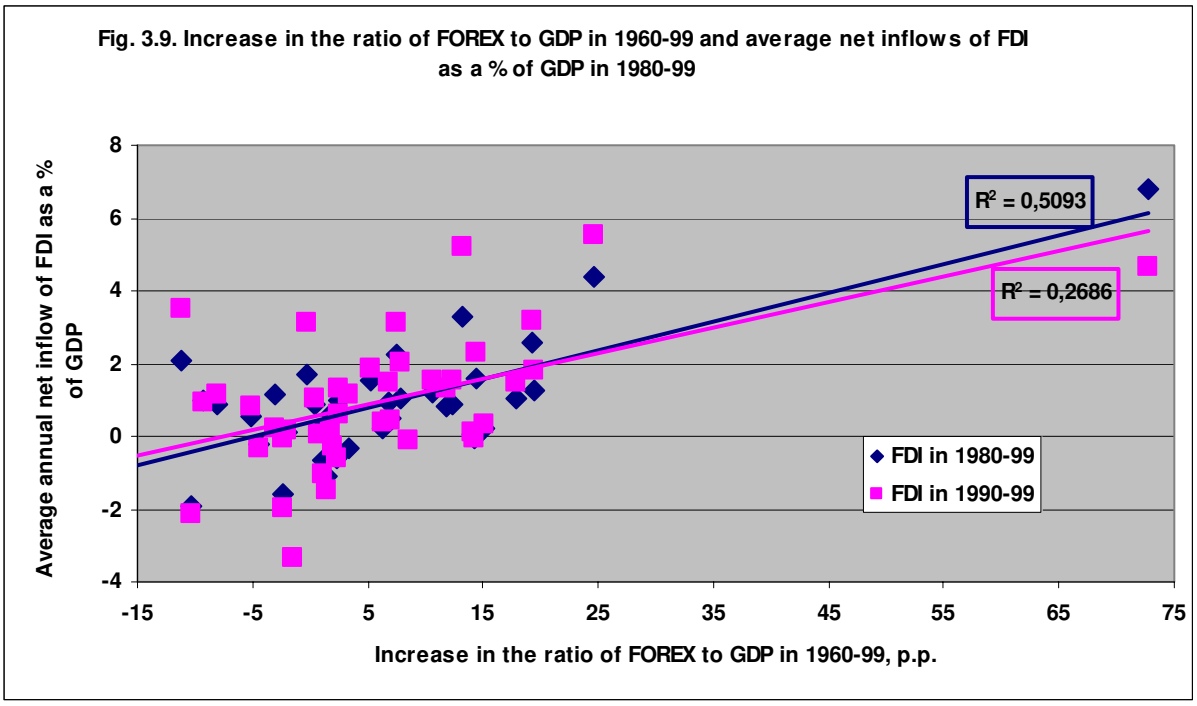
Dependent variable	Increase in the ratio of export to GDP in 1960-99			**Average ratio of trade to PPP GDP in 1980-99**		Increase in the ratio to PPP GDP in 1980-99, p.p.		
Number of observations	59	47	30	94	**62**	86	93	81
Log PPP GDP per capita in 1975	15.59 ***							26.7 ***
PPP GDP per capita in 1975				0.0085 ***			0.007 ***	
PPP GDP per capita in 1999					**.003 *****			
2000 investment climate index, ICRG			0.76 *					
Average ratio of export to GDP in 1960-99		0.77 ***	0.71 ***					
Average ratio of trade to PPP GDP in 1960-99,%								-0.19 ***
Terms of trade improve-ment index, 1960-99		-0.23 ***						
Net fuel imports in 1960-99, % of total imports			0.39 ***		**-.31****	0.53 ***		0.40 ***
Increase in the ratio of FER to GDP from 1960 to 1999, p.p.	1.06 ***	0.37 (Tst= 1.6)	0.56 *					
Average ratio of domestic to US prices in 1980-99, %							-0.49 ***	-0.18 **
Increase in the ratio of FER to GDP from 1960 to 1980 , p.p.					**1.79 *****			
Increase in the ratio of FER to GDP from 1980 to 1999, p.p.				0.7 8***	**1.44 *****	0.58 ***		0.74 ***
PPP GDP in 1999, bill.$	-.004*			-0.009 ***	**-.009 ****			
Average annual FDI net inflow in 1980-99, % of GDP			4.9 **					
Constant	-25.57	12.3	-67.9	-15.40	**.87**	8.9	3.82	-80

			**	***		***		***
Adjusted R^2	41	38	61	21	**49**	29	19	57

*, **, *** - Significant at 10%, 5% and 1% level respectively.

(7) Foreign direct investment and FER accumulation. It appears that the inflow of foreign direct investment (FDI) depends on the accumulation of FER in the preceding period and in the current period. Fig. 3.9 tells the story – there is a surprisingly strong correlation between the increase in FER in 1960-99 and the net inflow of FDI in the 1980s and the1990s. The FER build up underprices the exchange rate and thus makes domestic assets look cheap in foreign currencies. Even more important is probably the demonstration effect – the ability of authorities to accumulate reserves for a considerable period of time is taken as a sign of the government credibility and consistency of its policy. China in recent 25 years may be a case in point – the inflow of FDI was miniscule for the whole period of the 1980s, although the openness policy was enacted from the very start of reforms (1979) and although the growth rates in the 1980s were close to 10% a year. Only in the 1990s foreign direct investment poured into China.

Fig. 3.9. Increase in the ratio of FOREX to GDP in 1960-99 and average net inflows of FDI as a % of GDP in 1980-99



As regressions reported in table 10 show, the inflow of FDI in 1980-99 is not correlated with the investment climate index, but is strongly correlated with build up of FER in the preceding period

(1960-80) and current period (1980-99). As a matter of fact, the impact of the preceding period is stronger than that of the current period – the coefficients are higher and the T-statistics is better.

Table 10. Factors explaining the net inflow of foreign direct investment (FDI) in 1980-99 – cross country OLS regression results

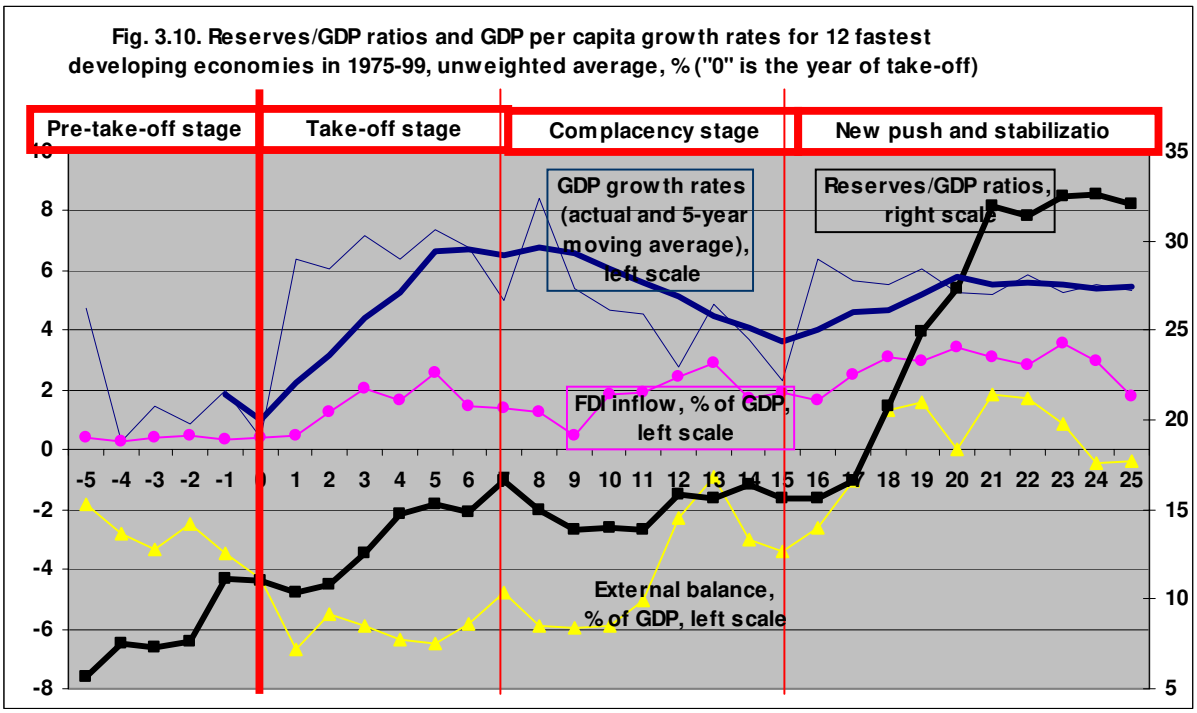
Dependent variable	Average annual net inflow of FDI in 1980-99, % o						
Number of observations	59	40	47	40	39	37	36
PPP GDP per capita in 1975					-.0001 *		-.0004 ***
2000 investment climate index, ICRG			-0.1			-0.02	0.05*
Average ratio of FER to GDP in1960-99, %	0.05 ***						
Increase in the ratio of FER to GDP from 1960 to 1999, p.p.		0.08 ***				0.08 ***	
Increase in the ratio of FER to GDP from 1960 to 1980, p.p.				0.1 ***	0.09 ***		0.09 ***
Increase in the ratio of FER to GDP from 1980 to 1999, p.p.				0.07 ***	0.06 ***		
Increase in the ratio of FER to import from 1980 to 1999, p.p.							0.1, Tst.= 1.6
Constant	0.4	0.4*	1.7	0.26	0.8**	1.7	
Adjusted R^2	18	50	-2	50	53	51	52

*, **, *** - Significant at 10%, 5% and 1% level respectively.

(8) FER accumulation and stages of economic growth. The analysis of the effect of FER accumulation on growth is complicated by the fact that that there are three (and possibly more) mechanisms that we identified so far, and that these mechanism may operate in different countries at different periods, so cross-country regressions should be supplemented with the analysis of panel data and time series for particular, especially rapidly growing, countries. We were able to make only initials steps in distinguishing stages of growth and mechanisms that operate at each stage. The results are very preliminary.

We identified all countries that were increasing GDP per capita by more than 3% annually in 1975-99 and the year of "take off" for every country defined as the year when these countries increased their long term growth rate (measured by the 5-year moving average of GDP per capita

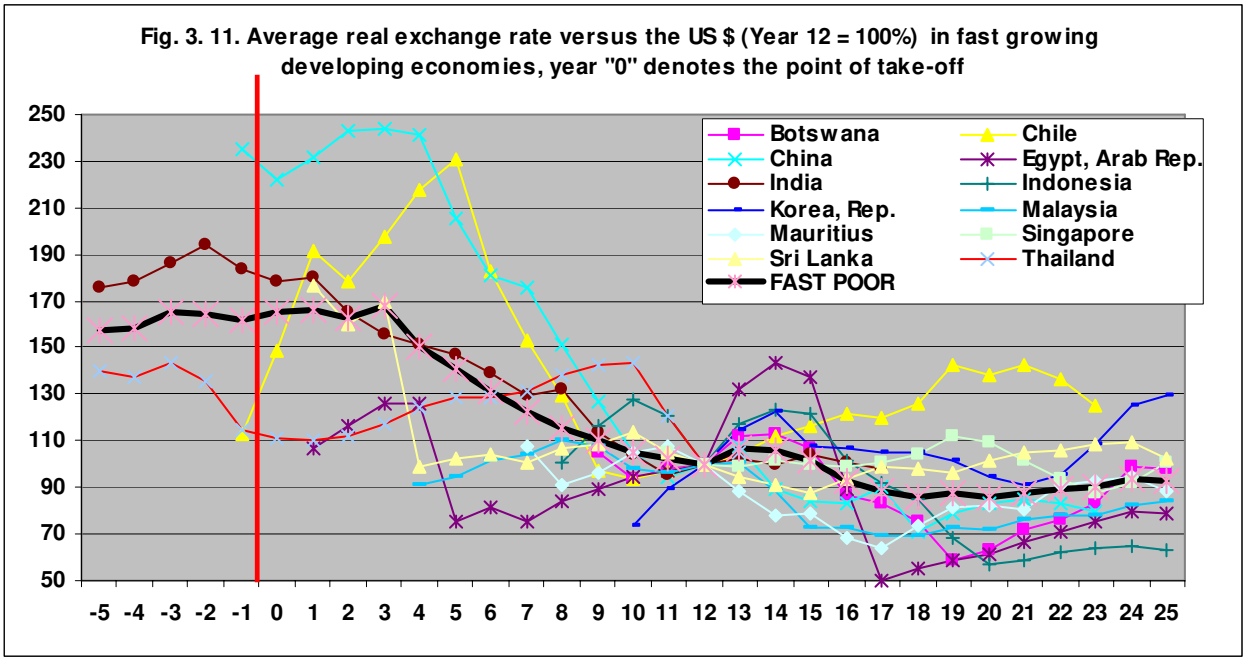
growth) by at least 2 p.p. After excluding Cyprus, Ireland and Luxembourg as developed countries and Hong Kong – because its take-off point was in the 1950s (no comparable statistics) there remained 12 countries on the list: Botswana that "took off" in 1966, Chile (1976), China (1976), Egypt (1974), India (1982), Indonesia (1967), Korea (1965), Malaysia (1971), Mauritius (1968), Singapore (1964), Sri Lanka (1974) and Thailand (1986). The trajectories of FER/GDP ratios, growth rates of GDP per capita, external balance and net FDI inflows as a % of GDP are presented at fig. 3.10.



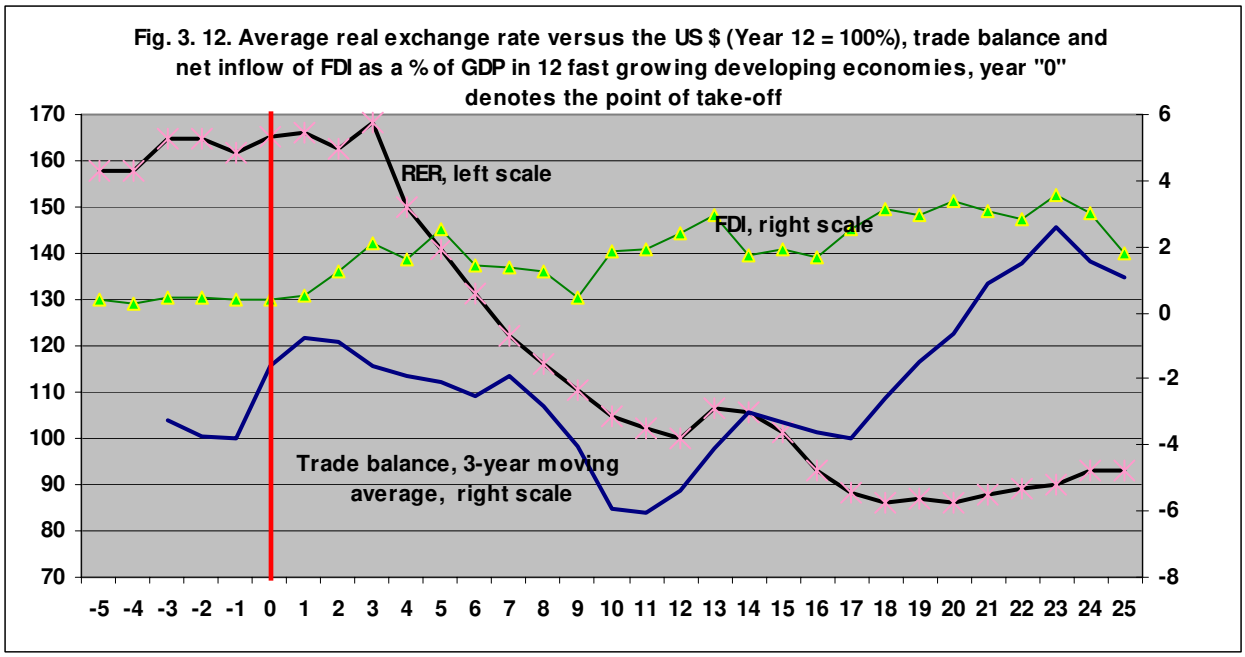
It appears that reserve accumulation preceded the period of take-off at least by 5 years and continued during the take-off stage. After 10 years of rapid reserve accumulation, when the FER/GDP ratio increased from 5 to 15%, there was a pause of about 10 years long (which probably resulted in the slow down of economic growth from the year 7 to the year 15), whereas after that the FER accumulation accelerated again.

The real exchange rate for these countries depreciated slightly before the take off and more substantially – after the take off, but after 10 years showed signs of stabilization (fig. 3.11). Trade balance improved around the take-off date, but deteriorated afterwards, as the net inflow of FDI and other capital increased (fig. 3.12). The external balance (export minus import of non-factor services)

was strongly negative and did not show signs of improvement until 10 years after the take-off. The inflow of FDI increased shortly after the take-off and continued to increase afterwards.



The crucial question is whether the net inflow of FDI was larger than the increase in FER. For the period of 1980-99 it actually was larger for Chile, Egypt, India, Malaysia, Mauritius, Singapore, Sri Lanka, but was smaller than the FDI inflow for Botswana and Korea. If it is assumed that all FDI inflows were associated with the build up of FER (which is clearly an exaggeration), then it turns out that for the first group of countries the accumulation of FER resulted in a completely counterweighing inflow of FDI, which on balance pushed the exchange rate upwards, not down.



Whereas the story is different for various countries and various periods, it appears that in at least some countries in the second decade after the take off, the inflow of FDI outweighed totally the downward pressure on the exchange rate due to the FER accumulation. In this period the export externality mechanism associated with the undervaluation of the exchange rate was turned off completely and replaced by another one – by the investment inflow mechanism associated with the overvaluation of the exchange rate. The model in the next section examines these two mechanisms formally.

4. Accumulation of foreign exchange reserves: a model

Why do countries accumulate foreign exchange reserves (FER)? It is a surprise that only a few researches are devoted to this question and that a related theory does not seem to be well developed. One may argue that FER are necessary to pay debt, to support a chosen exchange rate regime, to smoothen foreign exchange operation, and to prevent an attack against domestic currency. Another possible explanation refers to the portfolio argument: FER are a part of a country portfolio investment that earns world market interest rate. Our statistical analysis seems to reveal that these explanations are incomplete since the speed of FER accumulation is a policy variable that may be used to accelerate economic growth. In this section we suggest a combination of a Sidrauski-type model and an AK-type model of endogenous economic growth to study FER accumulation policies.

It will be shown that, under reasonable conditions, FER accumulation may influence real exchange rate. Two hypotheses on mechanisms of this influence are considered. The first one assumes that the accumulation policy forces a country to follow an unbalanced regime keeping positive current account at a steady state.

At the first glance, there is no any sense to choose this regime since it results in pure losses. Why do not spend the reserves to increase consumption? We show, however, that the FER accumulation brings real exchange rate down**.** Therefore, this policy facilitates export development and helps to defend domestic producers. If the export sector dominates in the knowledge accumulation, then, in accordance to the logic of AK-models, the FER accumulation accelerates growth. Moreover, under some more restrictive conditions, it may also increase discounted utility value even if the accumulated reserves do not earn any interest and can not be used in the future. The essence of this effect is, of course, strong positive export externality.

There are several objections against this hypothesis. One can think that reserve accumulation leads to inflation. This is not necessarily the case, however, if the rate of reserve accumulation does not exceed the rate of economic growth. Moreover, small inflation is not necessarily harmful, particularly for a developing economy[9]. In what follows we disregard its influence assuming money superneutrality.

The unbalanced regime is associated with direct losses of resources[10]. Clearly, waste of resources is not a first best solution. If the government is strong enough it can tax consumers and subsidize exporters to extract the potential gain from the externality. However, subsidizing activity may be costly since it entails rent seeking. The costs are rather large for developing country where inclination to rent seeking is particularly strong.

Therefore reserves accumulation may be considered as a second best policy. However, if a government pursues a direct export promoting policy then the stimulating role of the FER accumulation turns out to be questionable.

Another objection might stress the fact that import may have strong externality as well. In this case exchange rate undervaluation would not be reasonable. Some studies seem to show that export oriented policy is growth promoting. This may be interpreted as evidence that export externalities is

[9] This is a conclusion of a number of empirical works (Lucas ( ), Bruno and Easterly (1995)). It is also a conclusion of the authors who consider the optimal taxation problem including inflation tax (Felps (1993), Braun (1994), Movshovich (1998)).

stronger in the most developing countries than import ones. It is quite plausible however that the undervaluation policy is not efficient for import dependent countries.

If domestic production substantially influences knowledge accumulation then the mechanism described above does not work. For this case FER accumulation can play a different role: it serves as a signal for foreign investors that the economy is in a good state.

In accordance with our second hypothesis, the speed of foreign investment is proportional to the speed of the FER accumulation. We assume also that the foreigners use domestic intermediators and earn world market interest rate that is smaller than domestic one. Under these conditions, FER accumulation results in pure capital inflow and brings real exchange rate up. This accelerates growth if domestic production externality is strong enough so that export sector has no knowledge accumulation advantage.

The first hypothesis seems to be more plausible for earlier stages of fast development, and the second one fits better the later stages when a country is better integrated into the world market. Note that for the third stage, when an economy is open, and domestic capital market is well developed, FER loose their role as an instrument of the economic growth acceleration.

The model has some specific features that seem to be reasonable to postulate for a developing economy. The economy is small and is open for good flows. Concerning capital flows, we consider two versions of the model. In the first one foreign capital is not permitted at all. In the second version, foreigners may purchase assets through domestic intermediators. The intermediators pay them world market interest rate that is less than domestic one. These are foreigners who take the decisions on the investment volumes dependently on the speed of reserve accumulation. Indebtedness issues are ignored, and, in both versions, the domestic forces form the domestic interest rate. Under such conditions the learning-by-doing capital externality can influence economic growth as it does in Romer-type models (Romer(1996)).

We assume also that export sale requires much greater capital expenditure than import purchase. This asymmetry seems to be plausible for a developing country where producers and traders have so much to learn about how to sell the domestic product. Thus export trade sector is introduced. This sector uses capital to convert a quantity of “nontradable” consumption good into the same

[10] The losses may be not so large if one takes into account that the reserves earn world market interest rate and may be used in the future.

quantity of the good marketed abroad.[11] There are two interpretations of the trade sector activity. First, it may be considered as building marketing infrastructure: creating brands, making connections, and building capacities for selling goods abroad. Under this interpretation, one could count the consumption good as tradable one; the model reflects the fact that domestic and world prices of tradables are very different for many developing countries. Second, the activity may be considered as re-shaping of nontradables into tradables. Additional quantities require increasing increments of capital so that one could talk about a spectrum of goods with different degrees of tradability.

The import trade is costless, so that the price of the imported good coincides with the world price. The model includes also a representative consumer and two production sectors (fig. 4.1).
The first sector produces a consumption good, and the second one produces an investment good that can be also imported. Its dollar price is taken for 1.

The representative consumer maximizes overall utility function

$$\Phi = \max \int_o^\infty (u(c) + v(m))e^{-\rho t} dt \qquad (1)$$

subject to the budget constraint

$$da/dt + pdm/dt + \pi pm = ra - pc + \Pi + (r - r_1)b + pT, \qquad (2)$$

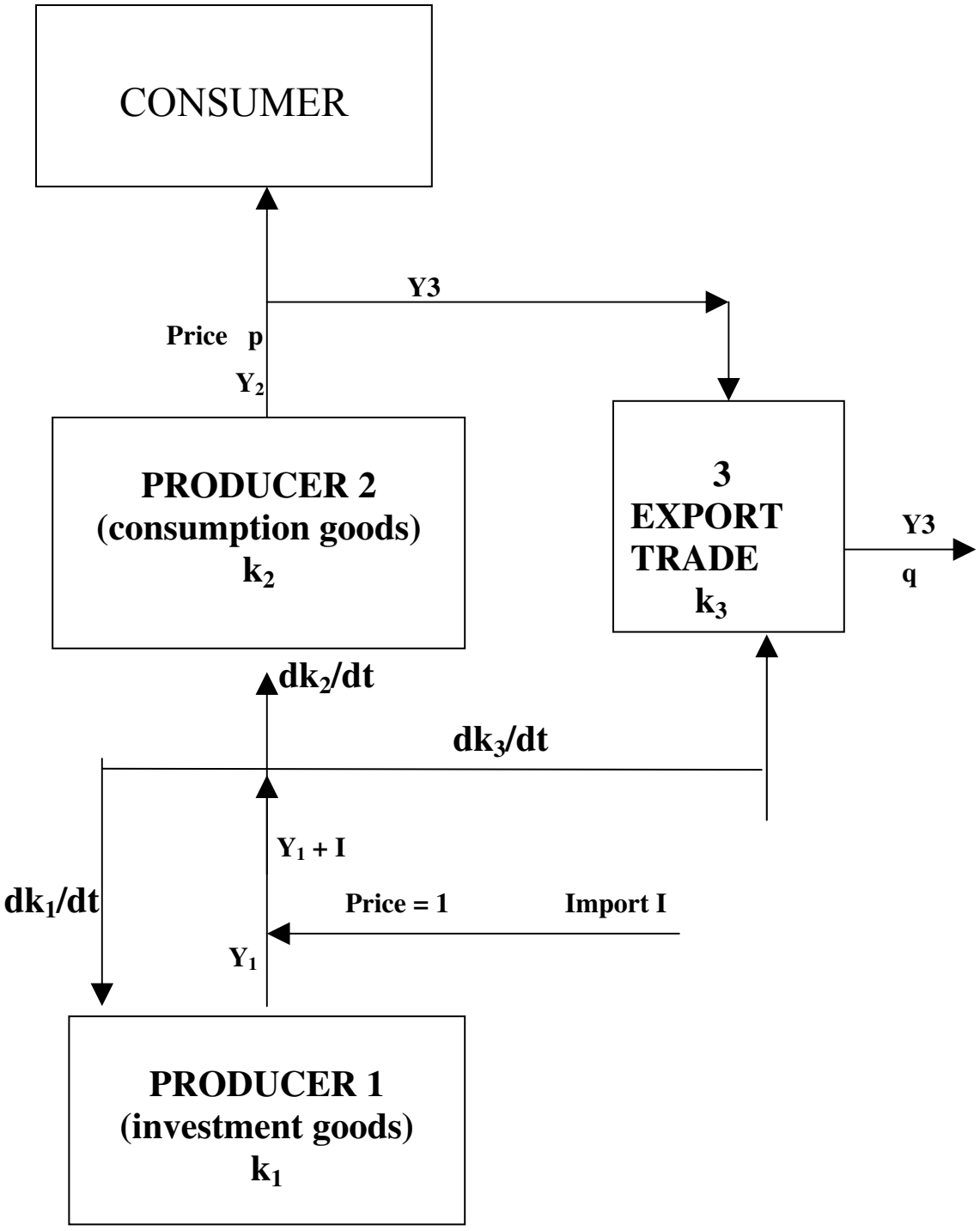
where $u(c) + v(m)$ is an additive momentary utility function, c is consumption, m is real money holding, $\rho > 0$ is a constant rate of time preference, a is the quantity of real assets, Π is the production profit, p is a price of the consumption good, π is inflation rate, b is a volume of assets held by foreigners, T is a money transfer, r, r_1 are, relatively, domestic and world market interest rates. The term $(r - r_1)b$ is intermediators' profit[12]. All prices and real money are calculated in dollars. Real money and money transfers are measured in units of consumption. Note that the choice of p is equivalent to the choice of real exchange rate.

---

[11] Probably one can use a more standard model with composition of tradable and non-tradable goods (see , for example, Obstfeld and Rogoff (1996)). The model should be modified properly to allow for endogenous growth. This approach does not seem to be simpler. Our model contains three sectors instead of two and one consumption good instead of two in the standard models with nontradables.

[12] The average real interest rate in all countries in 1975-99 was 4.7%, in the 13 fastest developing economies – 5.4, in the United States – 5.1%, in the UK –2.2%, in Japan – 3.5%. For 1960-99: US – 4.0%, UK – 2.5%, Japan – 1.6%.

Fig 4. 1. THE ECONOMY



For simplicity and following a tradition, we take labor force in each sector as a constant[13], and assume that the "consumption part" of the momentary utility function is given by

$$u(c) = c^{1-\theta}/(1-\theta), \qquad (3)$$

where $\theta>0$, $\theta \neq 1$. As usual, the No-Ponzi-Game –Condition is supposed to be valid.

The profit Π is a sum of three terms

$$\Pi = \Pi_1 + \Pi_2 + \Pi_3, \qquad (4)$$

where Π_i - is the profit of the Sector i. For simplicity we assume that all sectors have Cobb-Douglas production functions that differs only by productivity multipliers,

$$Y_i = A_i F(k_i, K), \quad F(k,K) = k^{\alpha} K^{1-\alpha}. \quad (5)$$

Here k_i is capital accumulated in the sector i, and K is the knowledge accumulated in the process of learning by doing. It is assumed that

$$K = \Sigma \beta_i k_i \ . \quad (6)$$

The profit of Producer i is derived from maximization of the profit

$$\Pi_i = \max \ (b_i F(k_i, K) - r k_i), \quad (7)$$

where $b_1 = A_1, b_2 = pA_2, b_3 = (q-p)A_3$, q is a fixed price of the exported good.

The following balance conditions are supposed to be valid.

$$I = \sum_{i=1}^{3} dk_i / dt - Y_1. \qquad (8)$$

$$c = Y_2 - Y_3 . \qquad (9)$$

$$I = qY_3 + db/dt - r_1 b - dR/dt + r_1 R. \qquad (10)$$

[13] The model may be developed to include labor allocation among sectors. It does not change our conclusions.

Here R are accumulated reserves. The quantities b, db/dt, and R, dR/dt are supposed to be chosen by foreigners and the Central Bank, respectively.

Asset market has to be balanced as well:

$$a + b = k = \sum_{i=1}^{3} k_i, \qquad (11)$$

where k denotes total capital in the economy. Let k_0 be total initial capital. The following initial condition is postulated.

$$k_0 = k(0). \qquad (12)$$

It seems to be more natural to suppose that initial capital is fixed for each sector. In this setting, however, the study of the model would be much more complicated.

An equilibrium trajectory is defined as a set of functions, $c, a, Y_i, k_i, k, K, I, p, r, \lambda, m, \pi$, that meets maximization and balance requirements (1)-(11) and initial condition (12).

It follows from the equilibrium conditions above and the budget constraint (2) that the money inflow in real terms is determined by the equation

$$pdm/dt + \pi pm = dR/dt - r_1 R + pT. \qquad (13)$$

Since the momentary utility is additive, the first order conditions for the real part of our economy and, therefore, the real trajectory itself are independent on the monetary variables, m and π [14]. It drastically simplifies our analysis.

Keep in mind that, in the described setting, the price of consumption p represents real exchange rate.

The described three-sector model inherits a very useful property of a standard one sector AK model: it has no transitional dynamics.

To show this, suppose that the price of consumption p is constant over time. Then maximum principle for the consumer problem (1)- (3) leads to a well known expression for the rate of economic growth, λ,

$$\theta\lambda = r - \rho. \qquad (14)$$

[14] This is well known property of superneutrality. It looks not very restrictive for the long term analysis.

It is convenient to introduce the notations

$$d_1 = A_1^{\sigma}, d_2 = p^{\sigma} A_2^{\sigma}, \sigma = 1/1-\alpha . \quad (15)$$

$$d_3 = (q-p)^{\sigma} A_3^{\sigma} \text{ if } p \le q, \; d_3 = 0 \text{ if } p > q . \quad (15a)$$

$$h = h(p) = \Sigma \beta_i d_i . \quad (16)$$

$$D = D(p) = (\Sigma d_i)^{-1} . \quad (17)$$

The following equalities are straightforward consequences of the relations (6), (16), (17) and first order conditions.

$$K = h(p) D(p) k , \quad (17)$$

$$r = r(p) = \alpha h^{1-\alpha}, \quad (18)$$

$$k_i = d_i K h \quad (19)$$

$$Y_i = A_i d_i^{\alpha} h^{1-\alpha} D k . \quad (20)$$

If p is constant then rate of return, r, is constant as well. In view of (14), the economy develops with a constant rate of growth. From the balance equality (8) one gets

$$I = \lambda k - Y_1 . \quad (21)$$

Using (10) one has an equation

$$\lambda k - Y_1 = q Y_3 + db/dt - r_1 b - dR/dt + r_1 R . \quad (22)$$

Assume that b, R grow with the rate λ. Since $k = k_0 e^{\lambda t}$, one has from (20) and (22):

$$\lambda k_0 - A_1 d_1^{\alpha} h^{1-\alpha} D k_0 = q A_3 d_3^{\alpha} h^{1-\alpha} D k_0 + (b_0 - R_0)(\lambda - r_1) . \quad (23)$$

This is an equation with respect to p. We assume that it has an appropriate solution, and will demonstrate that under some conditions, this is really the case.[15] If p is a root of (23), then all real variables are defined by formulas (14)-(21), (9). Rate of return, r, and rate of growth, λ, are constants, initial values of capital variables, K, k_i, and outputs, Y_i, are calculated from (17), (19), and (20). Initial values of import, I, and consumption, c, are defined by (21) and (9). All the quantities grow with the same rate, λ.

Note, that money transfer T may be chosen by such a way that real money, m, grow with the rate λ as well, whereas inflation rate, π, is equal to zero (see (13)).

We say that the economy follows a FER accumulation or unbalanced trajectory if $dR/dt \neq 0$. In this case trade balance $qY_3 - I$ may be positive or negative. If $qY_3 = I$ the trajectory is called balanced one.

The integral (1) exists if the inequality

$$\lambda < r \qquad (24)$$

holds[16], or equivalently,

$$\rho > (1-\theta)r \qquad (25)$$

In what follows we compare balanced and unbalanced trajectories by the value

$$\Phi = \int_o^\infty u(c)e^{-\rho t}dt$$

along the trajectory considered.

Denote by c_0 an initial consumption that is defined by (9). Then the integral utility (24) is equal to

$$\Phi = c_0^{1-\theta}/(1-\theta)(r-\lambda) \qquad (26)$$

for both FER accumulation and balanced trajectories. It is simple to check that

$$c_0 = Y_2 - Y_3 = Dh^{1-\alpha}[A_2 d_2^{\alpha} - A_3 d_3^{\alpha}]\ . \quad (27)$$

---

[15] We postulate that the investment good is imported and the consumption good is exported. This can not be the case under arbitrary parameters of the model.

[16] The average annual growth rate of GDP per capita in 13 fastest developing economies in 1975-99 was 4.6%, whereas the real interest rate – 5.4%. The "world" real interest rate in this period was probably 3-4% (US – 5.1, UK – 2.2, Japan – 3.5%), so the inequality $r > \lambda > r_1$ most probably holds in reality.

Obviously, c_0 has to be positive, and, in view of our assumptions, import, I, has to be positive as well. Thus a solution, p, of the equation (23) defines an equilibrium trajectory if and only if it meets (25) and the following additional requirement

$$A_2 d_2^{\alpha} \geq A_3 d_3^{\alpha}. \quad (28)$$

It is equivalent to the inequality

$$q\zeta < p, \quad (29)$$

where $1/\zeta = 1 + (A_2 / A_3)^{1/\alpha}$.

Let introduce a concept of an autarkic trajectory. It is a trajectory of the economic system where export trade sector does not exist. Formally, one has to substitute zero for Y_3 in the formulas above to have an autarkic trajectory. A balanced trajectory may be autarkic if the term of trade, q, is not favorable enough so that foreign trade does not occur.

It follows from the above consideration that reserve accumulation may influence real exchange rate and, therefore, long run growth. Below, we consider two hypotheses on the influence mechanism. The consideration uses the fact that, if real exchange rate, r, increases then the rate of growth, λ, may go up or down dependently on the knowledge accumulation coefficients β_i. Indeed, from (14) one has

$$h'(p) = \sigma[\beta_2 A_2 d_2^{\alpha} - \beta_3 A_3 d_3^{\alpha}]. \quad (30)$$

Therefore the following statement is a straightforward consequence of (16), (18), and (29).

Proposition 1. The function $h(p)$ as well as $r(p)$ and $\lambda(p)$ reach their minimum at

$$p = q\zeta^*, \text{ where } 1/\zeta^* = 1 + (\beta_2 / \beta_3)^{-1+1/\alpha} (A_2 / A_3)^{1/\alpha}. \quad (31)$$

If $\beta_2 = 0$ then rate of growth and rate of return both are decreasing functions of the real exchange rate. If $\beta_2 \geq \beta_3$ then $r(p)$ and $\lambda(p)$ increase with respect to p in the feasible aria.

The basic equation (23) may be written as

$$h^{1-\alpha}[\alpha - \theta q A_3 d_3^{\alpha} D - \theta A_1 d_1^{\alpha} D] = \rho + \Delta, \quad (32)$$

where $\Delta = (b_0 - R_0)(\lambda - r_1) k_0^{-1} \theta$. A trajectory is balanced if $\Delta = 0$. A balanced trajectory is autarkic if $d_3 = 0$. Denote by $\Psi(p)$ the left hand side of (32).

The function $D(p)$ is decreasing since

$$D'(p) = -D^2\sigma(A_2 d_2{}^{\alpha} - A_3 d_3{}^{\alpha}) \quad (33)$$

and in view of (28).

4a. Positive trade balance hypothesis

Assume that foreign investments are absent. For simplicity, we assume also $r_1 = 0$. Then $\Delta = -k_0{}^{-1}\theta dR/dt = -R_0\lambda k_0{}^{-1}\theta$. For a balanced trajectory Δ=0 and trade balance is zero. At a FER accumulation trajectory, positive trade balance $qY_3 - I$ are accumulated by the Central Bank and never used. The model generates an unbalanced trajectory if a real exchange rate, p, meets the inequality

$$qY_3 > \lambda k - Y_1.$$

Usually a continuum of unbalanced trajectories exists. It was shown above that the real exchange rate is directly connected with the speed of FER accumulation $dR/dt = qY_3 - I$. In framework of our model, FER grow with the rate λ, and the speed dR/dt is defined by initial value R_0.

Assume also that $\beta_2 = 0$ so that the production of the consumption good, Sector 2, does not contribute to the exchange rate. Then autarkic real exchange rate, p_a, has to be found from the equation

$$\beta_1 A_1{}^{\alpha}[\alpha - \theta A_1{}^{\sigma}(A_1{}^{\sigma} + p^{\sigma} A_2{}^{\sigma})^{-1}] = \rho \ , \qquad (34)$$

(see(32)) .The following proposition immediately follows from (34) and (25).

Proposition 2. Let $\beta_2 = 0$. An autarkic trajectory exists if and only if the following inequalities are valid:

$$\alpha\theta > \alpha - \rho \ \Big/ \ \beta_1{}^{1-\alpha} A_1 > 0 . \quad (35)$$

An autarkic trajectory is unique under these conditions.

If $\beta_2 = 0$, then $h(p)$ decreases with respect to p, and therefore r, λ are decreasing functions of p (see ((18),(14)). Thus, one gets the following important conclusion.

Proposition 3. Let p_a be an autarkic price, and the influence of consumption good sector, β_2, on the knowledge stock, K, be small enough. There exists $\bar{q}$ such that for each q from the interval $p_a < q < \bar{q}$ a small FER accumulation increases rate of economic growth. This is reached by a small real exchange rate undervaluation.

To prove the proposition, consider $\Psi(p)$, the left hand side of the basic equation (32), under β_2=0 and $q = p_a$. In view of (15a), (30), and (33), the derivative $\Psi'(p_a)$ is strictly positive. The same is true under β_2 small enough and for q closed enough to p_a. Thus $\bar{q}$ exists.

Let $p_a < q < \bar{q}$, and consider the equation (32), $\Psi(p) = \rho + \Delta$, where Δ is a small quantity. Since $\Psi(p)$ is increasing, the solution, $p(\Delta)$, is an increasing function of Δ. FER accumulation means that $\Delta < 0$. Hence, FER accumulation decreases $p(\Delta)$ in comparison to the balanced trajectory, and, in view of Proposition 1, increases rate of growth.

An increase of the growth rate may be accompanied by a decrease of initial consumption, c_0, so that the effect of undervaluation on the overall utility, Φ, is not clear a priory. The following proposition points out some conditions that guarantee a positive affect of the undervaluation policy.

Proposition 4. Let p_a be an autarkic price, and the following inequalities hold:

$$\alpha > 1/2, \qquad (36)$$

$$\alpha < p_a{}^{\sigma} A_2{}^{\sigma} / (A_1{}^{\sigma} + p_a{}^{\sigma} A_2{}^{\sigma}), \qquad (37)$$

where $\sigma = 1/(1-\alpha)$. If β_2 is small, and $p_a < q < \bar{q}$ then a small undervaluation brings initial consumption up as well as overall utility, Φ.

Proof. Taking into account that $\theta(r-\lambda) = \rho - r(1-\theta)$, one has from (25)

$$\Phi'(p) = c_0{}^{-\theta}\theta[c_0{}'(r-\lambda) + c_0 r'] / (r-\lambda)^2.$$

Thus the sign of Φ' coincides with the sign of the function

$$F(p) = c_0{}'(r-\lambda) + c_0 r'.$$

In view of (30) and (33), one has from (27)

$$c_0' = -\sigma D^2 h^{1-\alpha}[A_2 d_2{}^{\alpha} - A_3 d_3{}^{\alpha}]^2 + Dh^{-\alpha}[\beta_2 A_2 d_2{}^{\alpha} - \beta_3 A_3 d_3{}^{\alpha}][A_2 d_2{}^{\alpha} - A_3 d_3{}^{\alpha}] +$$

$$+ \alpha\sigma D h^{1-\alpha}[A_2{}^2 d_2{}^{2\alpha-1} + A_3{}^2 d_3{}^{2\alpha-1}] \qquad (38)$$

Assume $p = p_a, d_3 = 0$. Since $\alpha > 1/2$, one has $c_0' = D\sigma A_2{}^2 h^{\alpha-1} d_2{}^{2\alpha-1}(\alpha - Dd_2)k_0$,

where $d_2 = A_2{}^{\sigma} p_a{}^{\sigma}, D^{-1} = A_1{}^{\sigma} + p_a{}^{\sigma} A_2{}^{\sigma}$. Therefore $c_0' = D\sigma A_2{}^2 h^{\alpha-1} d_2{}^{2\alpha-1}(\alpha - Dd_2)k_0 < 0$ in view of (28).

This proves Proposition 4.

Note that the condition (27), (28) seem to be restrictive.

One can prove also that if β_2 is small and a balanced rate of return r is close enough to λ then there exists a small efficient deviation from the balanced trajectory, so that reserves accumulation results in an increase of overall utility. Whereas the first condition seems to be reasonable (increase of domestic production of consumption goods does not increase knowledge too much), the second requirement looks like very restrictive again.

In our model accumulated reserves are considered as completely useless. Under this condition, the detected possibility of a gain is a paradoxical result. Allowing the use of reserves in distant future would make advantages of the reserve accumulation policy much more evident. Net gains of FER accumulation could then be demonstrated under much less restrictive conditions.

The undervaluation policy may be beneficial even if the conditions formulated above are not fulfilled. Our numerical calculations reveal that there is a significant set of parameters under which small undervaluation raises overall utility. Fig. 4.2-4.4 demonstrate an example.

4b. Negative trade balance hypothesis

In the previous section we considered the initial stage of building an export trade sector when export externality is comparatively strong. Assume now that $\beta_2 \geq \beta_3$, and that

$\Delta = (b_0 - R_0)(\lambda - r_1)k_0{}^{-1}\theta > 0$ since foreign investment are effectively attracted due to FER accumulation. Thus the trade balance turns out to be positive.

In view of the Proposition 1, the function h and the growth rate, λ, are increasing with respect to the real exchange rate. Consider again the basic equation (32)

$$h^{1-\alpha}[\alpha - \theta q A_3 d_3^{\alpha} D - \theta A_1 d_1^{\alpha} D] = \rho + \Delta .$$

It's left hand side, $\Psi(p)$, is an increasing functions in the feasible area.

A balanced solution exists and is unique if the following sufficient conditions are fulfilled

$$\psi(\zeta q) < \rho < \psi(q), \alpha > (q^{\sigma} A_3^{\sigma} (1-\varsigma)^{\sigma-1} + A_1^{\sigma}) D(\zeta q)$$

The last inequality ensures $\rho > (1-\theta) r$ (or, equivalently, $\lambda > r$).

Indeed, for a balanced trajectory the equation (32) entails

$$r - \rho = h^{1-\alpha}(\theta q A_3 d_3^{\alpha} D + \theta A_1 d_1^{\alpha} D) < r\theta$$

if $q A_3 d_3^{\alpha} D + A_1 d_1^{\alpha} D < \alpha$. The left hand side is decreasing and has to be taken at $p = \xi q$.

Proposition 5. Assume $\beta_2 \geq \beta_3, \beta_2 \geq \beta_1$. Then a small FER accumulation increases rate of economic growth as well as initial consumption and, therefore, overall utility. This is reached by a small real exchange rate overvaluation.

Proof. Using relation (38) and the theorem condition, one gets

$$c_0' \geq D h^{-\alpha} (\beta_2 - \sigma D h)[A_2 d_2^{\alpha} - A_3 d_3^{\alpha}]^2 + \alpha \sigma D h^{1-\alpha} A_2^2 d_2^{2\alpha-1}$$

If $\beta_2 < \sigma D h$, then

$$c_0' \geq D h^{-\alpha} A_2^2 d_2^{2\alpha} [\beta_2 - \sigma D h + \alpha \sigma h d_2^{-1}]$$

Since $\beta_2 \geq \beta_1, \beta_3$, the following inequalities are valid

$$\alpha + \frac{\beta_2 d_2 (1-\alpha)}{\Sigma \beta_i d_i} - \frac{d_2}{\Sigma d_i} \geq \alpha + \frac{d_2 (1-\alpha) - d_2}{\Sigma d_i} > 0$$

Thus, $c_0' > 0$. Since $\Psi(p)$ is increasing, an increase in the right hand side of (32) brings the real exchange rate up and accelerates growth.

Fig. 4. 2. Imbalance is better: an example

Parameters:

$A_1 := 0.15$ $A_2 := 0.1$ $A_3 := 0.1$

$\beta_1 := 1$ $\beta_2 := 0.1$ $\beta_3 := 1$ $\rho := 0.05$ $\alpha := 0.45$ $\theta := 0.6$ $q := 6$ $Z := 2$

BALANCED TRAJECTORY VARIABLES

P= $\xi = 4.8777$ $I(\xi) = 0.1527$ $q \cdot Y(\xi)_3 = 0.1528$

$c(\xi) = 0.0593$ $h(\xi) = 12.8827$ $r(\xi) = 0.1103$ $\lambda(\xi) = 0.1006$ $\Phi(\xi) = 82.5765$

$$Y(\xi) = \begin{pmatrix} 0.0484 \\ 0.0847 \\ 0.0255 \end{pmatrix} \quad k(\xi) = \begin{pmatrix} 0.1976 \\ 1.6859 \\ 0.1166 \end{pmatrix}$$

IMBALANCE IS BETTER:

$\Phi(\xi) = 82.5765 < \Phi(0.99 \cdot \xi) = 86.9624$

Fig. 4. 3. IMPORT (solid line) AND EXPORT (dotted line) EXPENDITURES

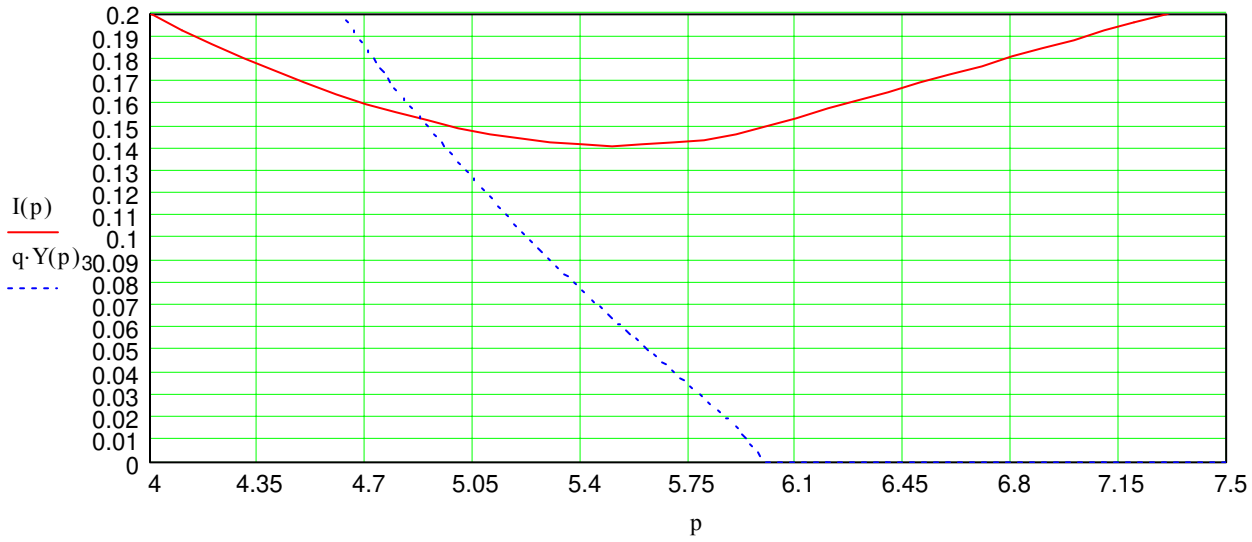
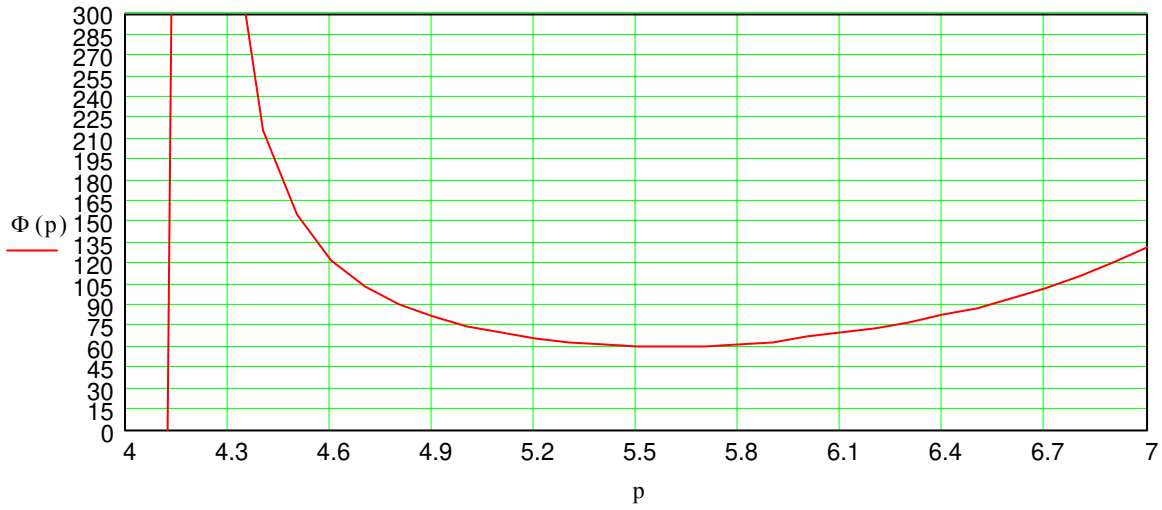


Fig. 4. 4. UNDERVALUATION INCREASES THE UTILTY FUNCTION



5. Conclusions

The accumulation of foreign exchange reserves is neither a necessary nor a sufficient condition of economic growth. It may well be that countries that do not accumulate reserves grow faster than the others because of better investment climate, better institutions, greater involvement into international trade achieved through greater openness of their economies even though their exchange rate is at equilibrium level, etc. It can also be the case that countries accumulating reserves are not able to increase their investment/GDP ratios due to high capital flight resulting from poor investment climate. Moreover, even if accumulation of FER yields increases in investment/GDP ratios the growth of output may still be low due to poor marginal capital productivity. This happened, for instance in former centrally planned economies, or, more generally, in countries that promoted import substitution, although the example is of limited value, since in most of these countries the accumulation of reserves did not occur on any significant scale, whereas high investment/GDP ratios resulted from more direct government measures, not from the intensive accumulation of reserves and underpricing of the exchange rate.

However, the accumulation of FER, as we tried to show in this paper, is a powerful macroeconomic mechanism of raising long term growth rates. It is simple, if not to say primitive, but this is exactly where it's major strength lies. It is available to all countries in all periods, even when other measures to boost economic growth are not feasible due to political economy reasons or

require long time for the first dividends to be reaped. If there is nothing else to do in a country with numerous government failures, poverty trap and institutional traps, there is at least a chance to provide an efficient "big push" to economic development via accumulation of reserves by a central bank. Even the most inefficient and corrupt governments can use the reserve accumulation as the last resort device to promote growth.

The accumulation of FER brings about the undervalued exchange rate, the increase in revenues and profits of the export sector at the expense of consumption, and boosts investment and export-led growth. The resulting greater involvement into the international trade ensures that new investment would not be used to create industrial dinosaurs enterprises of the sort of "white elephants" or "Egyptian pyramids" that were often created under the import substitution policy. On the contrary, capital productivity and TFP increases due to externalities associated with greater participation in the international trade. Besides, FER accumulation that continues for a decade or so appears to attract foreign direct investment because low exchange rate makes domestic assets look cheap and because foreign investors are impressed by the consistency of the government policy.

The main difficulty in the analysis of the FER accumulation policy is the tradeoff between the rate of growth and current consumption. A weak government may be prone to pressure to spend reserves immediately for current consumption, even this could undermine long-term growth. However, there is a very strong argument in favor of FER accumulation policy, if it raises overall consumption. The question about the conditions that guarantee this outcome is not a trivial one.

In this paper we were able to make only an initial step in analyzing these conditions. We believe we formulated the problem properly, introduced a new concept of real exchange rate undervaluation, and demonstrated the possibility of efficient FER accumulation policy. More efforts are needed to develop a general theory of FER accumulation.

REFERENCES

Aghion, Ph., Ph. Bacchetta, R. Ranciere, K. Rogoff (2006). Exchange Rate Volatility and Productivity Growth: The Role of Financial Development. Manuscript.

Barro, R. (1997). Determinants of Economic Growth. A Cross Country Empirical Study. The MIT Press. Cambridge, Mass.

Beine, M., Benassy-Quere, A., Lecourt, C. (2002). Central Bank Intervention and Foreign Exchange Rates: New Evidence from the FIGARCH Estimations. – *Journal of International Money and Finance*, Vol. 21 (2002), pp. 115-144.

Braun, A.(1994) How large is the optimal inflation tax? *Journal of Monetary Economics*, 34, 201-204.

Bruno, Michael, and Easterly, William (1995), Inflation Crises and Long-Run Growth. Unpublished. World Bank.

Bruno, Michael (1995), Does Inflation Really Lower Growth? - *Finance & Development,* September 1995.

Buffie, E. (1986) Devaluation, investment and growth in LDCs. *Journal of Development Economics*, 20: 361-380.

Calvo, G., Reinhart, C., and Vegh, C. (1995). *Journal of Development Economics*, Vol. 47, 1995, pp. 97-133.

Dollar, David (1992), Outward-oriented developing economies really do grow more rapidly: evidence from 95 LDCs, 1976-1985. – *Economic Development and Cultural Change*, Vol. 40, No. 3, April 1992, pp.523-44.

Dynnikova, O., Sosunov, K., Tsyganova, N. (2002). Empirical Model of Joint Determination of Real GDP and Real Exchange Rate in Russia. Mimeo.

Easterly, William (1999). The Lost Decades: Explaining Developing Countries Stagnation 1980-1998. World Bank, 1999

Easterly, William (2001). The Elusive Quest for Growth. Economists' Adventures and Misadventures in the Tropics. MIT Press, Cambridge, Mass.

Economic Survey of Europe, 2001, No.1

Edwards, S. (1989) Real exchange rates, devaluation and adjustment. MIT Press, Cambridge, Massachusetts.

Engel, Ch. (2001). Optimal Exchange rate Policy: The Influence of Price Setting and Asset Markets. – *Journal of Money, Credit and Banking*, Vol. 33, No.2, (May 2001, Part 2), pp. 518-41.

Ethier (1991b) The economics

Froot, K.and Rogoff, K. (1995). Perspectives on PPP and Long-Run Real exchange Rates. – In: Handbook of International economics, Vol. III, Ed. By G. Grossman and K. Rogoff. Elsevier Science B.V., 1995

Godek (1989)

Grafe, C., Wyplosz, C. (1997), "The Real Exchange Rate in Transition Economies". Paper presented at the Third Dubrovnik Conference On Transition Economies in Dubrovnik, Croatia, June 25-28, 1997.

Grennes, T. International economics. Prentice-Hall Inc., NJ, 1984.

Halpern L. and Wyplosz, C. (1997), Equilibrium Exchange Rates in Transition Economies. *IMF Staff Papers,* Vol. 44, No. 4 (December), pp. 430-61.

Hölscher, J. (1997). "Economic Dynamism in Transition Economies: Lessons from Germany." *Communist Economies and Economic Transformation* 9 (2): 173–181.

Illarionov, A. (1998). "How the Russian Financial Crisis Was Organized." *Voprosy Ekonomiky* 11–12. In Russian.

Kamin, S., Rogers, J. (2000). Output and Real Exchange Rate in Developing Countries: An Application to Mexico. – *Journal of Development Economics*, Vol. 61 (2000), pp. 85-109.

Kenny, Ch., Williams, D. (2000), What Do We Know About Economic Growth? Or, Why Don't We Know Very much? – *World Development*, Vol. 29, No.1, pp. 1-22.

Krugman, P., Obstfeld, M. International Economics. Theory and Policy. Third edition, Harper Collins College Publishers, NY, 1994.

Krugman P., L.Taylor (1978). Contractionary effects of devaluation. *Journal of International Economics*, 8: 445-456.

Lucas, R.E. (1996). Nobel Lecture: Monetary Neutrality. *Journal of Political Economy*, 104, N.4, 669-682.

Magee S. P. (1994). The political Economy of Trade Policy. In : Greenway

Montes, M., Popov, V. (1999), *The Asian Crisis Turns Global.* Institute of Southeast Asian Studies, Singapore, 1999.

Morley, S. (1992) On the effect of devaluation during stabilization programs in LDCs. *Review of Economics and Statistics*, LXXIV.P21-7.

Obstfeld, M. (1982) Aggregate spending and the terms of trade: is there a Laursen-Metzler Effect? *Quarterly Journal of Economics*, 97(2): 251-270.

Obstfeld, M. and Rogoff, K. (1996) Foundations of International Macroeconomics. The MIT Press, Cambridge, Massachusetts

Phelps, E.S. (1973) Inflation in the Theory of Public Finance. *Swedish Journal of Economics*, 75, 37-54.

Polterovich, Victor (1998), Institutional Traps and Economic Reforms. Working Paper # 98/004. New Economic School, Moscow, 1998.

Polterovich, V., V. Popov (2004). APPROPRIATE ECONOMIC POLICIES AT DIFFERENT STAGES OF DEVELOPMENT. NES, 2004. (http://www.nes.ru/%7Evpopov/documents/STAGES-MAY-2005-English.pdf).

Pomfret, R. (1997), Growth and Transition: Why has China's Performance Been So Different?, *Journal of Comparative Economics*, Vol. 25, No 3, December 1997. Pp. 422-440.

Popov, V. (1998a). "Investment in Transition Economies: Factors of Change and Implications for Performance." *Journal of East-West Business* 4: 1–2.

Popov, Vladimir (1998b). Will Russia Achieve Fast Economic Growth? By - *Communist Economies and Economic Transformation,* Vol. 10, No. 4, 1998a, pp.421-49.

Rodrik, Dani (1986). Disequilibrium Exchange Rates as Industrialization Policy. – *Journal of Development Economics*, 23, 1986, pp. 86-106.

Rodrick, D. (1996), Institutions and Economic Performance in East and South East Asia. In *Round Table Conference: The Institutional Foundations of Economic Development in East Asia.* Tokyo, December 1996, pp. 391-429.

Rodrik, Dani (2003). Growth Strategies. Working draft for eventual publication in the *Handbook of Economic Growth*. April 2003 (http://ksghome.harvard.edu/~.drodrik.academic.ksg/growthstrat10.pdf)

Romer

Sachs, J. and Warner, A. (1996), Achieving Rapid Growth in the Transition Economies of Central Europe. Harvard Institute for International Development, January 1996.

Shmelev, N. (1998). "The Crisis Inside the Crisis." *Voprosy Ekonomiky*, No. 10. In Russian.

Shmelev, N., and V. Popov. (1989). *The Turning Point: Revitalizing the Soviet Economy*. New York: Doubleday.

Turnovsky S. (2000)

WDI – World Development Indicators (1998-2001). World Bank.

Van Wijnbergen, S. (1986) Exchange rate management and stabilization policies in developing countries. *Journal of Development Economics*, 23: 227-248.

Дынникова (2001). Макроэкономические перспективы укрепления рубля и валютная политика. В сб. «Инструменты макроэкономической политики для России», 108-132.

Мовшович С.М. (2000). Общественные потери от налогов и инфляции. ЭММ, т.36, вып.4.