Public Debt Management in Transition Countries The Case of Armenia

Luciano Greco* Svitlana Moskalyuk†

Preliminary Draft
May 2009

Abstract

Based on a simplified set of public securities (i.e. T-bills, nominal and real-indexed long-term bonds denominated in domestic currency, and dollar denominated loans), and on a simple structural model of Armenian economy, we develop an analysis of the optimal composition of Armenian public debt aiming at reducing the risk of fiscal instability while controlling the cost of public debt. Considering four sources of macroeconomic shocks (demand, supply, exchange rate and international interest rates), we find that optimal public debt in Armenia requires a reduction of foreign-currency denominated debt as well wider shares of fixed-rate bonds, and the introduction of real-indexed bonds.

Keywords: Public debt management, transition economies, fiscal risk, Armenia

JEL classification: H63, P3, F3, G1

*Dipartimento di Scienze economiche, Università degli Studi di Padova, via del Santo 33 - 35123 Padova (Italy), luciano.greco@unipd.it.

†Corresponding author, Dipartimento di Scienze economiche, Università degli Studi di Padova, via del Santo 33 - 35123 Padova (Italy), svitlana.moskalyuk@unipd.it.

1 Introduction

Public debt management is both complex and crucial in transition and other emerging economies as compared to developed ones. The choice of the financial structure of public debt is key to warrant fiscal stability because of higher volatility of macroeconomic conditions. Moreover, public debt dynamics adds the fiscal risk to other sources of macroeconomic instability. While some contributions have investigated optimal public debt management in developed and developing countries, a systematic analysis of these issues in transitional countries is still poor.

Transition from centrally planned to market economy for Former Soviet Union (FSU) countries followed a delayed and differentiated path with respect to other transitional countries. From the collapse of the centrally directed economy in 1991, when all fifteen FSU countries went through deep macroeconomic and financial crises, different transition patterns can be acknowledged.[1] We focus on Armenia, which belongs to the Caucasian region, while companion papers will focus on countries belonging to different regions of the FSU. The choice of Armenia is based on several theoretical and practical issues: Armenia is one of the few transition countries that has never practiced a fixed exchange rate regime after gaining the independence (Poghosyan and Koenda , 2006), which makes relevant the exchange

[1]We follow the FSU classification of the European Bank for Reconstruction and Development (see http://www.ebrd.com/): Baltic states, Russia and Western CIS (Commonwealth of Independent States), Caucasian states, Central Asian states. Baltic states (Estonia, Latvia, Lithuania) performed a successful macro- and microeconomic path, joining the WTO and the EU; Russia and Western CIS (Belarus, Moldova, Ukraine) performed relatively poorly in terms of industrial transition, with the quite good economic position of Russia (in the last decade) being explained mainly by huge trade surplus related to raw commodities export; Central Asian states (Kazakhstan, Kyrgystan, Tajikistan, Turkmenistan, Uzbekistan) are featured by poor economic conditions (mainly due to 1998 Asian-Russian shock), and - in some cases - bad fiscal conditions; Caucasian countries (Armenia, Azerbaijan, and Georgia) economic performance has been quite good in Azerbaijan though Armenia and Georgia remain negatively affected by political instability of the region.

rate risk for the analysis of optimal debt management; no administrative restriction has been imposed on deposit rates, thus short-term interest rate is driven by market conditions. Moreover, availability of high frequency data on foreign and domestic debt of the Republic of Armenia makes the analysis viable.

The Republic of Armenia has experienced a rapid economic transformation since mid-1990s, though different shocks affected its macroeconomic situation: adjustment of energy prices to world levels; loss of transfers from Soviet Union budget; collapse of the payments system; the 1998 Russian crisis. As a consequence and common to other FSU countries, poverty grew sharply and fiscal needs were initially covered by peculiar public liabilities such as expenditure arrears. Though macroeconomic situation is still affected by political instability[2] and trade imbalance, partially offset by international aid and grants[3] and huge foreign remittances[4]. Armenia succeeded in implementing crucial economic reforms, such as introducing the Armenian Dram (ADM) as national currency in 1993 and joining the WTO in 2003. Macroeconomic policy also was successful: inflation was curbed by the half of 90s, thanks to inflation targeting; real GDP growth became positive by 1995; the trend of public debt to GDP ratio became downward sloping by 2003 (see Figure 1).

Relying on the model developed by Giavazzi and Missale (2004), the main contribution of this paper is to investigate the optimal composition of public debt of

[2]Political and economic relations with Russia remain close, but the conflict for the Nagorno-Karabakh region continues to damage relations with Azerbaijan and Turkey disadvantaging the investment climate.

[3]According to Central Bank of Armenia (CBA) annual report, in 2007, Armenian government received 0,9% of GDP (16,7% of public revenues) in grants. For 2008, these figures are projected as 1,1% of GDP, and 16,3% of public revenues (see http://www.cba.am).

[4]Only 3 million of Armenians are resident in the Republic, another 6 to 8 million live and work abroad (for further details: http://www.armeniadiaspora.com/followup/population.html). According to the CBA Statistical Bulletin (for details: http://www.cba.am) Armenians transferred (mainly from Russia and including seasonal workers) USD 1635 million in 2008, or 14% of GDP.

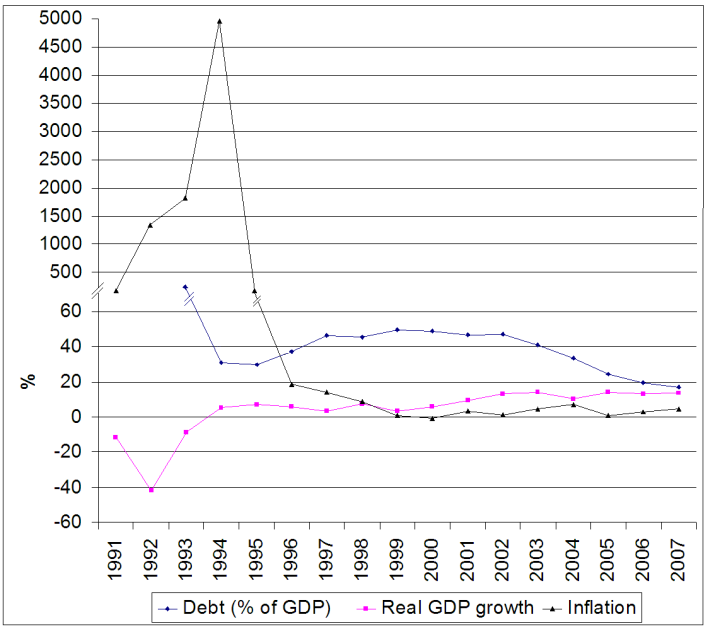

Figure 1: Macroeconomic conditions of Armenia 1991-2007

the Republic of Armenia, in terms of public securities (maturity, currency denomination, and indexation), as driven by the task to minimize the probability of fiscal instability (namely, of undesired growth of debt-to-GDP ratio), trading off risk and cost minimization tasks. As suggested by Giavazzi and Missale (2004), the optimal structure of public debt is a function of the expected return differentials between debt instruments[5], of the conditional variance of debt returns and of their covariances with output growth, inflation, exchange-rate depreciation and interest rates. To estimate the macroeconomic and financial risks associated to different public securities, we rely on a simple structural model of the Armenian economy estimated with quarterly data for the period between the first quarter of 2000 to the last

[5]As discussed in Section 1.1, we will consider four types of securities: T-bills, T-bonds, real-indexed bonds, and US dollar-denominated loans.

quarter of 2007[6].

Our main results are that debt obligations in foreign currency have to be reduced, giving priority to fixed-rate and real-indexed long term securities, thus increasing the borrowing volume in the domestic market. This implies that the Republic of Armenia should focus on development the domestic market of government securities as a mean of lessening dependence on external sources of financing.

The paper is organized as follows. In the remaining sections of Introduction, we provide an overview of the structure and evolution of Armenian public debt and a review of the related literature on public debt management. The second section discusses the application of the Giavazzi and Missale (2004) model of optimal liability portfolio to the Armenian case. The third section presents and discusses the main results of the paper, namely the effects of demand, supply, exchange rate and international interest rate shock on the optimal structure of public debt. The forth section concludes. In the appendixes, we present the structural model estimation (Appendix I), the simulation of variances and covariances (Appendix II), and the data set sources (Appendix III).

1.1 Armenian public debt composition

After the collapse of the USSR in 1991, Russia took over all assets and liabilities of the Soviet Federation[7]. Therefore, most of the FSU countries (and Armenia among them) started their transition path with almost no public debt. While in early transition years, these countries faced high financial cost in issuing securities, the

[6]Covariances and variances of relevant variables are estimated as the one-year cumulated impulse responses to shocks to inflation, output gap, exchange rate and LIBOR rate.

[7]The "Zero agreement" relieved Armenia of any obligations related to the former USSR's public debt, in exchange for Armenia forgoing claims on any USSR foreign assets.

situation quickly chanced. For most of the FSU some adverse initial conditions of the transition path (basically related to the break down of former central planning and the cutoff of transfers from Moscow) and subsequent difficult economic and political conditions (the 1998 Russian crisis, internal and regional political instability, growth of energy prices, and so on) caused rapid debt accumulation, e.g. Helbling et al. (2004). FSU countries then benefitted of relatively easy international credit lines (both from multilateral financial institutions, and commercial banks) that compensated large current account deficits, despite an increase in export, substantial foreign direct investment inflows, decline in interest rates, and real exchange rate appreciation. After almost two decades of transition, most of FSU countries tend to have low debt-to-GDP ratios (except for Russia and some Central Asian countries).

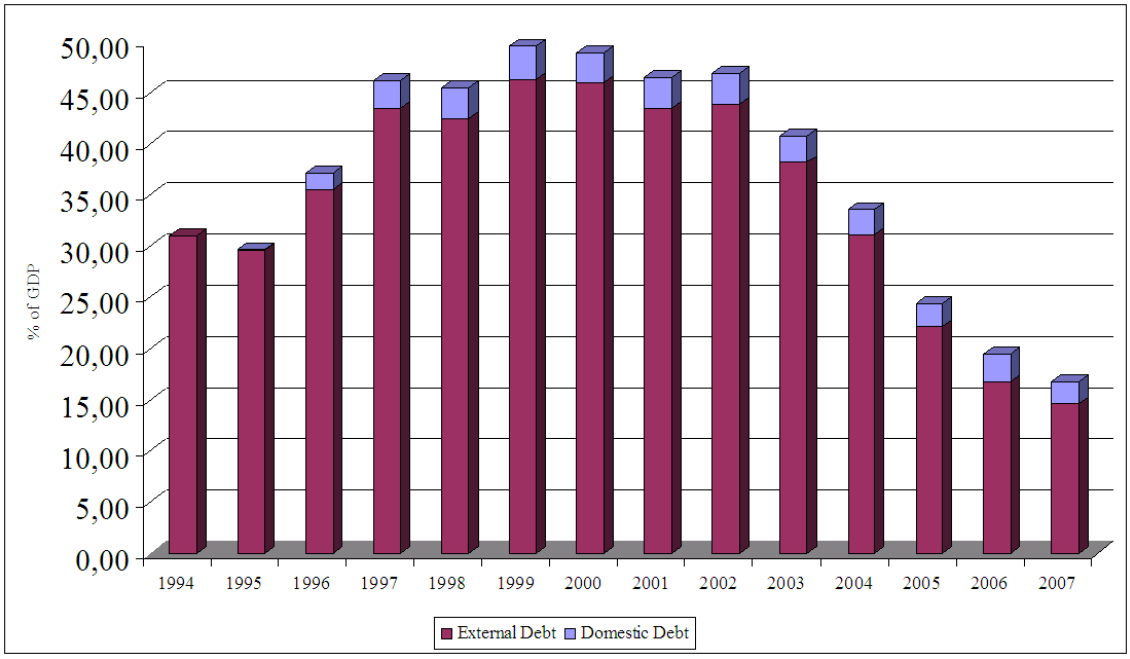

Figure 2: Total Armenian debt shared in Domestic and External public debt 1994-2007

Most of the public debt of the Republic of Armenia is denominated in foreign currencies. However, the domestic-currency denominated share is growing relatively fast (see Figure 2). Public debt management is assigned to the Central Treasury[8], subordinated to the Ministry of Finance.

1.1.1 Domestic-currency denominated debt

All ADM-denominated debt securities are currently non-indexed with various maturities. Figure 3 shows the composition of the domestic public debt, which includes debt of the Central Bank of Armenia (CBA). The Republic of Armenia started to issue government securities on the domestic financial market in September 1995. The first securities auctioned on the primary market were one-month T-bills[9]. In May 1996, the government began auctioning 3- and 6-months T-bills; in 1997, the maturity range was further expanded to 9- and 12-months with the share of longer maturities increasing steadily.

Till 2000 only short-term T-bills were issued. Accordingly, the debt maturity was very short (ranging from seven days to a year) and the interest-rate cost was relatively high. The widened security market has attracted an increasing number of nonresidents causing the dual effect of lowering the average yield on T-bills (since April 1997), and raising the share of T-bills held by nonresidents to over half of the total by September 1997.

Building on growing confidence in the securities issued by Republic of Armenia,

[8]Within the Central Treasury, debt management is carried out by the Government Debt Management Department, including the External Debt Management Division, the Domestic Debt Management Division and the Treasury Direct Division. Treasury Direct, that is responsible for T-bills management, used to be supervised by the Central Bank of Armenia at the outset of its mission in 1999 and passed under the Ministry control in 2001.

[9]Treasury bills (T-bills) or Short-term T-bills are discount securities, issued in non-paper (electronic) form and accounted at the CBA.

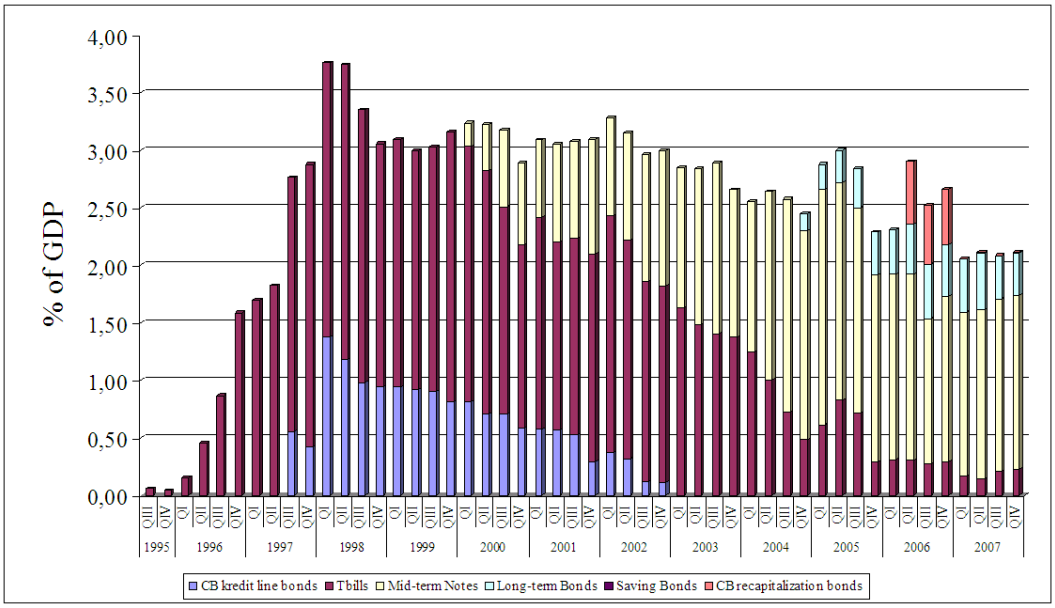

Figure 3: Structure of the Domestic Debt of Armenia 1995-2007

the government has implemented, since 2000, a strategy for debt-maturity extension, reduction in interest-rate cost, and ensuring market transparency. Part of this strategy relied on issuing new types of securities: Medium-term coupon notes (MTCN)[10]; Long-term coupon bonds (LTCB)[11], with coupon based on a fixed interest rate and paid semi-annually; Saving coupon bonds (SCB)[12]. Upon the considered evolution

[10]MTCN have been issued for the first time since March 2000. They are issued in a non-paper form, and may be sold at a price which is higher, or lower than the nominal, depending on auction conditions.

[11]MTCN from 15 months to 5 years and LTCB with a maturity period from 6 to 30 years were introduced in September 2004. In 2008, benchmark bonds of this type were issued with starting maturity of 3, 5, 10 and 20 years.

[12]SCB are non marketable securities issued since 2007 with maturity period from 3 months to 25 years, allocated only through Treasury Direct System and sold exceptionally to individuals. The coupon income will be paid quarterly, semiannually or annually and certain redemption days are envisaged for these bonds. Issuance of saving-type coupon bonds is done for stimulating the population to accumulate savings and to invest them in the public bond market. These bonds contribute to the development of treasury saving system and increasing the bonds turnover volumes in the system.

of the primary market of government securities, a secondary market has recently started its operation.

In our analysis, we simplify the structure of existing government securities denominated in domestic currency as follows: T-bills (short-term and floating interest rate), including all T-bills; T-bonds (long-term and fixed interest rate), including all MTCN and LTCB. We will also consider R-bonds (long-term and real-indexed interest rate) that are currently not issued on the domestic market of government securities.

1.1.2 Foreign-currency denominated debt

Since independence in 1991, the public external debt of the Republic of Armenia[13] (i.e. denominated in foreign currencies and owned by foreign institutions, namely multilateral organizations, foreign governments, and commercial banks) has increased rapidly, often in the form of structural reforms credits provided to the government and the CBA by international financial organizations (multilateral loans) and public and private institutions of foreign countries (bilateral loans), as well as of credits provided against guarantee of the government and the CBA.

Most of Armenian external debt was issued on concessional terms (Figure 4), basically by multilateral institutions. The bulk of this concessional debt has the following main features: 7 to 10 years grace period (say, period in which no repay-

[13]Helbling et al. (2004) noted that the external debt structure of Armenia is similar to that of other low-income countries: high share of debt issued or guaranteed by the public sector (private sector has less admittance to international financial capital markets); official external financing on concessional terms dominates that on commercial terms (primarily of energy import-related debt to Russia and Turkmenistan); the maturity is long term (from 25 to 40 years); the average interest rate of new debt commitments on concessional terms has decreased to less than 1%, at present the World Bank and the IMF are the largest shareholders of Armenia's external debt leaving small share for bilateral official creditors and private creditors.

ment is owed by the Republic of Armenia); 25 to 40 years repayment period; very low interest rate (usually, 0.75%). Though concessional terms are very convenient as regards cost of public debt, also this form of external debt involves exchange-rate risk, given foreign-currency denomination (namely, SDR for loans granted by the IMF and the World Bank; EURO, USD, Ruble, and Yen for bilateral loans). As of 2007 the portion of concessional loans on total external public debt was 99,1%. In particular, loans provided by the World Bank and Germany increased. The World Bank is currently the largest lender to the Republic of Armenia.

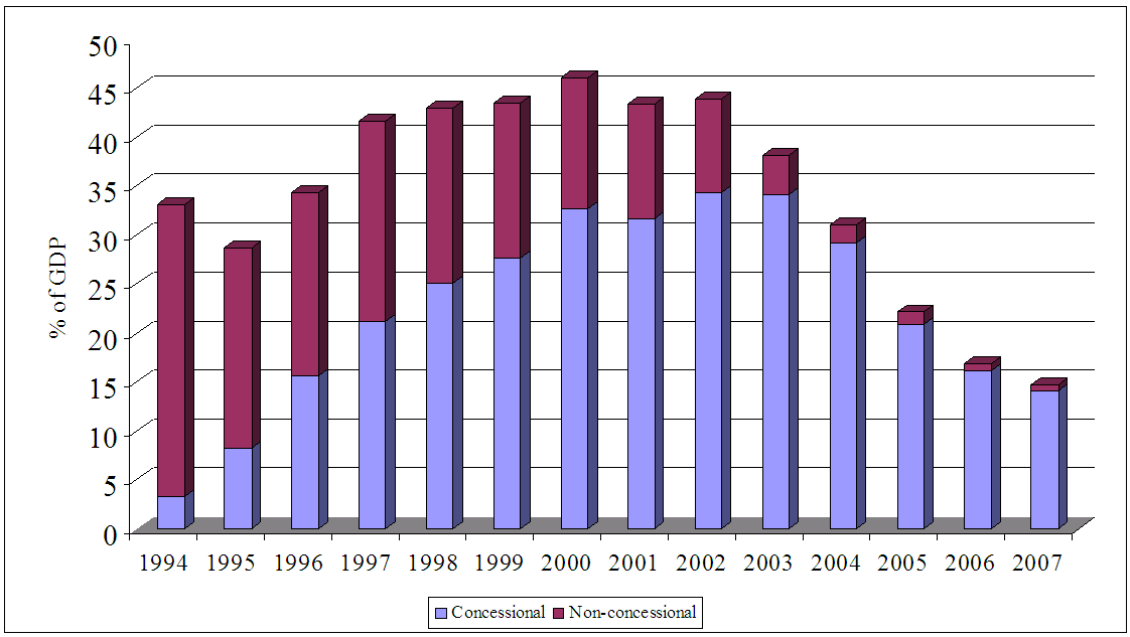

Figure 4: Structure of the External Debt of Armenia 1994-2007

The remaining (shrinking) share of Armenian external debt is bilateral and lent on non-concessional terms, mainly provided in USD through the restructuring of credits. Loans provided by IBRD, EBRD, EU, Russian Federation (last two were Armenia's first creditors) and Turkmenistan were provided on non-concessional

terms. In 1999-2003 period, the Armenian government negotiated the restructuring of the non-concessional loans owned by Turkmenistan and Russia: the term of payment of the Turkmen loan was prolonged, with partial repayments in the form of goods[14], while the Russian loans of USD 94 million were repaid in 2002 by passing certain enterprises to the property of the Russian Federation. In 2007, 83% of the external loans were provided by international organizations and the rest 17% by foreign states. Taking into consideration that the external obligations consist of loans provided in different currencies, exchange-rate risk associated to this external debt is potentially relevant, though its absolute dimension and trend suggest that this issue is negligible.

Finally, to complete the structure of government securities, we consider both concessional and non-concessional debt like US dollar denominated debt (on non-concessional terms based on LIBOR+1 interest rate). Even if concessional debt has very low interest rate it does not mean that it does not induce any costs for the Armenian government. External debt of Armenia basically is aid from multilateral institution, therefore the government cannot decide the currency denomination and etc., and is forced to receive loans in dollars.

1.2 Related Literature

Theories on optimal public debt management[15]. have emphasized a variety of goals over time, including macroeconomic stabilization, supporting monetary policy, mini-

[14] All external arrears to Turkmenistan were cleared through cash payments, the export of goods or deferrals by the creditors.

[15] "Public Debt Management is the process of establishing and executing a strategy for managing the government's debt in order to raise the required amount of funding, pursue its cost and risk objectives, and to meet any other public debt management goals the government may have set, such as developing and maintaining an efficient and liquid market for government securities"IMF and World Bank (2002)

mizing costs and risks. In many countries, the debt managements' primary objective of securing funds to finance the government deficit is complemented by objectives of minimizing the costs and risks of the debt portfolio, and promoting financial development and efficient country's securities markets (Missale, 1999, ch. 2 and 3).

In the traditional view of public debt management: the primary objective is to support monetary and fiscal policies as a tool of macroeconomic stabilization, with minimization of interest costs coming secondary, and risk minimizing playing no role at all; in particular, in small open economies, high substitutability of securities denominated in domestic and foreign currencies leaves cost minimization as the primary objective of debt management (Tobin, 1963). The literature has also emphasized the role of tax-smoothing as guideline for a welfare-improving public debt management. Though tax-smoothing can be approximated by issuing securities indexed to the tax base (or GDP level) (Barro, 1999), in real world this quasi-optimal policy has to be replicated (though imperfectly) by other instruments. Along this research line, Faraglia et al. (2007) analyze public debt management in OECD countries to assess its capacity to trade off tax-smoothing and hedging against fiscal risk (i.e. shocks to the public budget). They find that apparently public debt management provides limited support to fiscal policy [16].

Additional objectives for public sector debt management include promoting well-functioning securities markets and providing instruments for monetary and fiscal policy. This is crucial for the integration of emerging countries into the global economy and thus their access to external financing have increased their exposure to volatility in international asset prices, thus reducing vulnerability of developing

[16]Faraglia et al. (2008) extend the standard debt management model by introducing the constraint to buyback of outstanding public debt - new analysis in the literature of optimal policy

countries to external shocks (Cassard and Folkerts-Landau, 1997)[17].

The composition of the outstanding public debt is much more complex in emerging countries (including transition economies), because volatility in the macro environment is much higher. As far as emerging countries are considered, minimizing public-debt service costs may prove inefficient because potential increase of fiscal risk related to the volatility and dynamics of outstanding debt, and ultimately a growth of default risk (Dooley, 2000). In this context, optimal public debt management in the FSU countries remains relatively less explored in the literature. Several articles focus on the issues arising by growing external public debt. Gray and Woo (2000) point out that the external borrowing for emerging markets make sense if a government wishes to increase resources available to the economy, non accessible for private sector, but if a government is accessing international capital markets because it appears to be cheaper, make sure that all costs and risks have been taken into account. Government should allow the domestic market to be accessed more cheaply than international capital market borrowings. De Mello and Hussein (2001) based on a simple model of foreign debt portfolio test for the existence of a stable long run relationship between the currency composition of a country's foreign debt portfolio and exchange rate movements and provide evidence that the currency composition of the debt in a number of emerging market countries is not optimal because adverse exchange rate movements have not been offset by a reduction of debt denominated

[17]Most treasuries sell their securities at auctions either directly or indirectly through an agent. Although they can control both the rules and the timing of the auction, they may not be able to control the information and valuations of bidders. Rossi (1998) argues that the public debt management costs can be minimized by avoiding government securities auctions at times when information about certain important macroeconomic variables is to be released. Announcement is likely to have a significant impact on government securities prices and, hence, on bidders' behavior. Bangura, Kitabire, and Powell (2000) give practical advice for improving public debt management capacity in low-income countries, including how to establish an appropriate institutional framework that supports effective implementation and improve data collection.

in the appreciating currency. Jeanne (2003) presents a model, supported by cross-country data, where the currency composition of public debt is chosen to minimize the probability of default. The less credible monetary policy is, the more foreign currency-denominated debt will be issued.

As regards transition economies, the literature on public debt management integrates theories of debt management into models of optimal fiscal and monetary policies. Montiel (2005) provides an overview of important factors in determining the optimal debt composition and, based on this analysis, attempts to establish general guidelines for public debt management in emerging economies. This analysis suggests that in order to retain market access and promote domestic financial market development, governments should finance themselves at market rates using a wide variety of financial securities. The optimal composition of the public debt involves a tradeoff between raising the government's anti-inflationary credibility and reducing the vulnerability of its budget to different macroeconomic shocks. A key insight of Matalik and Slavik (2004) in their research on debt management in the Czech Republic is that debt management represents one of the central areas of the fiscal and monetary policies, has the crucial impact not only on the financial market development, but also on the most important macroeconomic variables. In economies with less developed financial markets or in an earlier stage of transformation, a relatively consistent coordination of the monetary and fiscal policies targets with public debt management targets is required. Izák (2003) argues the dominating opinion that the debt service cost depends on the variables that determine the debt dynamics: primary balance, outstanding debt level, economic growth and inflation. Therefore the relationship between the government debt costs and some explanatory variables has been studied in a panel of four transition economies: Czech Republic, Hungary,

Poland and Slovakia. The results show that the impact of inflation and real growth rate of GDP is robust and have a statistically significant effect on borrowing costs, whereas the impact of fiscal variables primary fiscal balance is weak and insignificant and that of outstanding debt exhibits even a bad sign. Country-specific factors have played a very important role especially at the beginning of transition and influenced the dynamics of the debt costs.

In recent years, the debt management literature has focused on the optimal debt portfolio and macroeconomic stabilization in indebted countries, particularly in Latin America, Central and Eastern Europe. In the literature exist many different aspects on the targets of public debt management[18] but in the case of Brazil, as shown by Giavazzi and Missale (2004), the prevailing debt management objective is to reduce the country's fiscal vulnerability. Giavazzi and Missale (2004) relying on Brazilian data over 1999-2003, derive the optimal debt composition by looking at the relative impact of the risk and cost of alternative debt instruments on the probability of missing the stabilization target. Given that GDP-indexed securities are unavailable, the optimal debt portfolio was estimated (based on four types of securities) as a function of the expected return differentials between debt instruments, of the conditional variance of debt returns and of their covariances with output growth, inflation, exchange-rate depreciation and the domestic debt interest rate.

This risk management approach to debt sustainability goes therefore beyond the existing traditional debt sustainability literature that focuses simply on determining the primary deficit (surplus) and/or growth rate of GDP that would keep the public debt level at a certain level. The traditional approach analyses in essence public debt

[18]See Missale (1999) for an outstanding survey of the literature on the objectives of public debt management

sustainability in the absence of risk. The risk management approach, in contrast, shows that risk is minimised if a chosen debt instrument provides insurance against fluctuations in the primary budget, in the interest payments and the debt ratio due to uncertainty about output and inflation Blommestein (2005).

2 Optimal Debt Management Model

As argued, our focus in the assessment of optimal structure of public debt in Armenia. We rely on the technique developed by Giavazzi and Missale (2004) for Brazil, which is based on the minimization of the risk that shocks hitting the Armenian economy may determine a fiscal risk, say an increase (or lower reduction) of the public debt-to-GDP ratio above government projected level.

The optimal debt structure is estimated by evaluating the relative impact of the costs and risks of the different public debt instruments on the debt-to-GDP ratio.

We assume that the prevail debt management objective is reducing the variability in the primary surplus/deficit by stabilizing the debt ratio. Given our focus on the assessment of the optimal structure of public debt in Armenia we will rely on technique developed by Giavazzi and Missale (2004) to illustrate that the choice of different debt instruments trades off the risk and expected costs of debt service.

In order to stabilise the debt ratio, B_t, the government decides to implement a fiscal adjustment, taking into account the realization of debt returns, output, inflation and the exchange rate. Consequence of a stabilisation program is uncertain. As a result, a debt crisis cannot be prevented with certainty. When a debt crisis

arises, the debt ratio increases rapidly:

$$B_{t+1}^T - A_{t+1} + X > B_t \tag{1}$$

where B_{t+1}^T is the trend debt ratio[19], A_{t+1} is the expected fiscal adjustment, and X is the uncertain component of the fiscal adjustment (or external or internal shocks to the budget).

Debt accumulation $\Delta B_{t+1}^T = B_{t+1}^T - B_t$ is driven by:

$$\Delta B_{t+1}^T = I_{t+1}B_t + \Delta e_{t+1}B_t - S_{t+1}^T - (\Delta y_{t+1} + \pi_{t+1})B_t \tag{2}$$

where $I_{t+1}B_t$ are the nominal interest payments on outstanding amount of debt, e_{t+1} is the log of the nominal exchange rate, q is the share of foreign currency-denominated debt, S_{t+1}^T is the trend primary surplus, y_{t+1} is the log output and π_{t+1} is the rate of inflation.

Total interest payments $I_{t+1}B_t$ are equal to:

$$I_{t+1}B_t = i_{t+1}sB_t + (R_t^{US} + RP_t)qB_t + (R_t^I + \pi_{t+1})hB_t + R_t(1 - s - q - h)B_t \tag{3}$$

where s is the share of debt indexed to the (average) domestic interest rate i_t, R_t^{US} is the world (US dollar) interest rate, RP_t the risk premium[20] q is the share of foreign currency-denominated (US dollars) bonds, R_t^I is the real interest rate, h is the share of price-indexed debt and R_t is the nominal rate of return on nominal fixed-rate bonds.

[19] this is the debt ratio that would persist in the period t+1 in the absence of the fiscal adjustments

[20] the return on dollar denominated bonds $(R_t^{US} + RP_t)(1 + \Delta e_{t+1})$ has been approximated by $(R_t^{US} + RP_t)$

The ratio of the trend surplus-to-GDP, S^T_{t+1}, depends on cyclical conditions and unanticipated rate of inflation:

$$S^T_{t+1} = E_t S^T_{t+1} + \eta_y(y_{t+1} - E_t y_{t+1}) + \eta_\pi(\pi_{t+1} - E_t \pi_{t+1}) \tag{4}$$

where E_t denotes expectation conditional on the available information at time t, η_y is the semi-elasticity of the government budget (relative to GDP or output), η_π is the semi-elasticity with respect to the price level, and $y = lnY_{t+1}$.

Hence, expression (4) captures the notion that S^T_{t+1} can be higher than expected because of output surprises and/or inflation surprises.

We consider a model which aims to determine shares of different debt instruments to minimize the probability that debt stabilization fails because of uncertainty in the fiscal adjustment (in terms of GDP) which we denote as X. The optimal debt portfolio (that is, the choice of debt denomination and indexation) is based on the minimisation of the probability that the expected fiscal adjustment program fails:

$$Min\{E_t Prob[X > A_{t+1} - \Delta B^T_{t+1}]\} \tag{5}$$

subject to (2), (3) and (4).

The probability Pr of debt crisis is the integral of the probability density function $\phi(X)$ over the possible realizations of fiscal adjustment.

In order to identify the optimal debt structure, minimizing Pr, we derive the probability of debt instability with respect to the shares of debt instrument that we assume the government can issue, obtaining the first order conditions which are functions of $\phi(X)$ parameters.

Since $\phi(X)$ cannot be estimated, following Giavazzi and Missale (2004), we apply a linear approximation[21]. Under this assumption, $\phi(X)$ is completely identified by introducing the worst possible realization $\bar{X}$. The model could work having an estimate of $\bar{X}$. Otherwise we prefer to transform $\bar{X}$ in the probability Pr of a debt crisis as it is perceived by the government.

Thanks to these hypothesis the optimal values of debt-instrument shares can be calculated solving (5) with respect to s, q and h. These first-order conditions show also the trade-off between the risk and expected cost of debt service related to the choice of debt instruments.

The next step is to use a structural macroeconomic model to investigate how the optimal debt portfolio depends on the type of shocks hitting the economy (demand, supply, exchange rate, international interest rate, etc.).

Following the analytical derivation of Giavazzi and Missale (2004), and the types of debt securities we considered (as discussed in Section 1.1), the optimal shares of T-bills, $s*$, US dollar-denominated LIBOR-indexed loans, $q*$, and Real-bonds, $h*$, are:

[21]The reason for this choice is that the triangular density function means that the higher value of X (worse cases realization) have less probability to happen.

$$s* = \frac{\eta_y + B_t}{B_t}\frac{Cov(y_{t+1}i_{t+1})}{Var(i_{t+1})} + \frac{\eta_\pi + B_t}{B_t}\frac{Cov(\pi_{t+1}i_{t+1})}{Var(i_{t+1})} - q * \frac{Cov(e_{t+1}i_{t+1})}{Var(i_{t+1})} \quad (6)$$
$$-h * \frac{Cov(\pi_{t+1}i_{t+1})}{Var(i_{t+1})} + TP_t\frac{\sqrt{2P_r}}{1-\sqrt{2P_r}}\frac{E_t(A_{t+1} - \Delta B^T_{t+1})}{B_t Var(i_{t+1})}$$

$$q* = \frac{\eta_y + B_t}{B_t}\frac{Cov(y_{t+1}e_{t+1})}{Var(e_{t+1})} + \frac{\eta_\pi + B_t}{B_t}\frac{Cov(\pi_{t+1}e_{t+1})}{Var(e_{t+1})} - s * \frac{Cov(e_{t+1}i_{t+1})}{Var(e_{t+1})} \quad (7)$$
$$-h * \frac{Cov(\pi_{t+1}e_{t+1})}{Var(e_{t+1})} + FP_t\frac{\sqrt{2P_r}}{1-\sqrt{2P_r}}\frac{E_t(A_{t+1} - \Delta B^T_{t+1})}{B_t Var(e_{t+1})}$$

$$h* = \frac{\eta_y + B_t}{B_t}\frac{Cov(y_{t+1}\pi_{t+1})}{Var(\pi_{t+1})} + \frac{\eta_\pi + B_t}{B_t} - q * \frac{Cov(e_{t+1}\pi_{t+1})}{Var(\pi_{t+1})} \quad (8)$$
$$-s * \frac{Cov(\pi_{t+1}i_{t+1})}{Var(\pi_{t+1})} + IP_t\frac{\sqrt{2P_r}}{1-\sqrt{2P_r}}\frac{E_t(A_{t+1} - \Delta B^T_{t+1})}{B_t Var(\pi_{t+1})}$$

where $Var(.)$ and $Cov(.)$ - variances and covariances conditional on the information available at time t; $Cov(y,i)/Var(i), Cov(y,e)/Var(e), Cov(y,\pi)/Var(\pi)$ - covariances of output growth with all types of debt; $Cov(e,i)/Var(i), Cov(i,e)/Var(e)$, $Cov(e,\pi)/Var(\pi), Cov(i,\pi)/Var(\pi)$, $Cov(\pi,i)/Var(i), Cov(\pi,e)/Var(e)$ - the conditional covariances between the returns on the various debt instruments (positive covariance between the returns on two types of debt makes them substitutes in the government portfolio); Pr - the probability of a debt crisis as perceived by the government (from 0 to 1); $E_t(A_{t+1} - \Delta B^T_{t+1})$ - function of the expected reduction in the debt-to-GDP ratio; B_t - the debt-to-GDP ratio; η_y - the semi-elasticity of the government budget (relative to GDP) with respect to output; η_π - the semi-elasticity of the budget with respect to the price level; TP_t, FP_t, IP_t - risk premia (the excess return of fixed-rate bonds relative to the instrument considered).

The optimal debt shares depend on risk and cost conditions.

- The first two terms of each equation provide insurance against the risk of

variations in the primary budget and the debt ratio due to output and inflation uncertainty.

(first column risk no hedge in the debt composition table)

- Then the government chooses the debt composition which provides the best insurance against the risk of deflation and low growth. Risk minimization also depends on the conditional covariances between the returns on the various debt instruments.

  (second column risk in the debt composition table)

- Cost minimization is considered in the last term. Debt stabilization thus implies a trade off between risk and cost minimization.

  (third column risk plus cost in the debt composition table):

  - increases with the risk premia, the impact of the excess return on the optimal share depends on the marginal increase in Pr. The latter has been written as $E_t(A_{t+1} - \Delta B^T_{t+1})$ and Pr. Pr depends on the expected debt reduction.

  - decreases with a greater variance of the return on a given debt instrument $Var(i), Var(e), Var(\pi)$ reducing the importance and the impact of interest cost differentials on its optimal share as much as it reduces the relevance of its hedging characteristics.

2.1 Fiscal stabilization and fiscal risk

The optimal debt structure depends on the sensitivity of the primary surplus to unexpected variations in output and inflation, η_y and η_π, on the reduction in the debt ratio B_t, and on the probability of debt stabilization as perceived by the government

$Pr.$

2.1.1 Fiscal adjustment

The reduction in quasi-fiscal deficits[22] has been a main source of fiscal adjustment in Armenia in the second part of the 90-s. These declines also explain significant improvements in macroeconomic stability in Armenia (since 1997) and positive changes in its debt profile (since 2000)Freinkman et al. (2003).

Similar to the majority of Eastern European and FSU countries, one of the characteristics of the State Budget of Armenia is its certain dependency on external borrowings, in particular deficit financing, essentially depends on external loans and grants. Domestic savings in Armenia are forecast to grow over the next few years, which will enable to increase the share of the deficit financed from internal sources, while reducing the interest rates. The share of internal sources within the total volume of sources for financing of the budget deficit over 2008-2010 is forecast to vary within 20,1-69,2%, against 39,3% in 2007.

In the coming years, expenditure will still exceed revenues of the State Budget. In 2008 the share of State Budget expenditure in GDP is within the 23,3-23,9% compared to 20,1% in 2007 (growth of 3,2%).

There has been a tendency for growth in revenues from 17,2% in 2007 to 21,2 - 21,8% in 2008 (4% growth). This level of annual revenues will largely be driven by anticipated budget tax revenues, which constitute 90% of annual revenues over 2008-2010.

[22]Largest component of quasi-fiscal deficits in Armenia was the subsidization of economy through non-payments, complemented by poor financial management in the sector, resulted in losses financed by borrowing and other debts to the private sector and accumulated by public companies in utilities and infrastructure.

At the end of 2007 the debt ratio was 18,4% of GDP and the debt ratio should stabilize next year and in 2008 is forecasted to be around 18,1% of GDP. Therefore the expected debt reduction is assumed to be 0,3% of GDP.

In order to stabilize the debt ratio the government applies a fiscal correction A_{t+1} of the State Budget (reduces the expenditures or increases the revenues). In 2008 an expected revenue-based fiscal adjustment of Armenia is 0,8%,[23] thus the expected debt reduction yields 1,1% of GDP.[24]

2.1.2 Probability of debt crisis

The probability density function, used to derive the optimal debt shares, cannot be estimated. Giavazzi-Missale takes a linear approximation of density function decreasing with X for $X > 0$; it implies that bad realizations of the fiscal adjustment are less likely to occur the greater is their size. The difference between the worst possible realization of the fiscal adjustment $\bar{X}$ and the expected change in the debt ratio after the fiscal correction, $A_{t+1} - E_t(\Delta B^T_{t+1})$ [25] is transformed in terms of the probability of a debt crisis as perceived by the government (the probability that the shock X exceeds the expected debt reduction). Then an assumed triangular probability density function could be rewritten as follows,

$$Pr[X > Z = A_{t+1} - E_t \Delta B^T_{t+1}] = \int_Z^{\bar{X}} \frac{\bar{X} - X}{\bar{X}^2} dX = \frac{(\bar{X} - Z)^2}{2\bar{X}^2} \tag{9}$$

[23] calculated as the proportion of the adjustment obtained from expenditure growth in comparison with the proportion gained from tax increases

[24] Function of the expected debt reduction $E_t(A_{t+1} - \Delta B^T_{t+1})$ is the difference between the expected fiscal adjustment and the debt accumulation. $\Delta B^T_{t+1} = (B^T_{t+1} - B_t)$ where B^T_{t+1} denotes the trend debt ratio, that is, the debt ratio in period t+1 in the absence of the fiscal correction

[25] $E_t(A_{t+1} - \Delta B^T_{t+1})$ is equal to $A_{t+1} - E_t(\Delta B^T_{t+1})$.

where, $X > 0$ is the uncertain component of the fiscal adjustment, a shock to the budget after the fiscal adjustment or a debt increase ($B^T_{t+1} - A_{t+1} + X > B_t$) and $\bar{X}$ is the worst possible realization of the fiscal correction ($\bar{X} > A_{t+1} - \Delta B^T_{t+1}$).

Replacing $A_{t+1} - E_t(\Delta B^T_{t+1})$ for Z in the density function yields:

$$Pr = \frac{(\bar{X} - A_{t+1} - E_t \Delta B^T_{t+1})^2}{2\bar{X}^2} \tag{10}$$

From this equation follows that:

$$\bar{X} = \frac{A_{t+1} - E_t(\Delta B^T_{t+1})}{1 - \sqrt{2} Pr^2} \tag{11}$$

In 2008 in Armenia the expected debt reduction yields 1,1% of GDP, then maximum negative shock to the budget, $\bar{X}$, equal to 1,2% of GDP. It follows that the probability Pr that the stabilization plan by government fails is set at 2% of GDP (see Figure 5).

2.1.3 Semi-elasticity of the primary surplus

Many components of government budget are affected by the macroeconomic situation of the country (external shocks), thus the public debt ratio increases.

Particularly, in recent years many important financial international institutions have demonstrated an increasing interest towards primary budget balance sensitivity to the output and the inflation rate fluctuations. The empirical literature on this issue has been evolved by different authors[26]. As consequence, different approaches have been developed over time to disentangle cyclical and structural components of

[26]For earlier attempts to estimate the response of the primary surplus to macroeconomic variables (GDP and inflation rate) see Bevilaqua and Werneck (1997), Persson at al. (1998), Van Den Noord (2000), Blanco and Herrera (2002), Ginebri et al. (2005), Braz (2006)

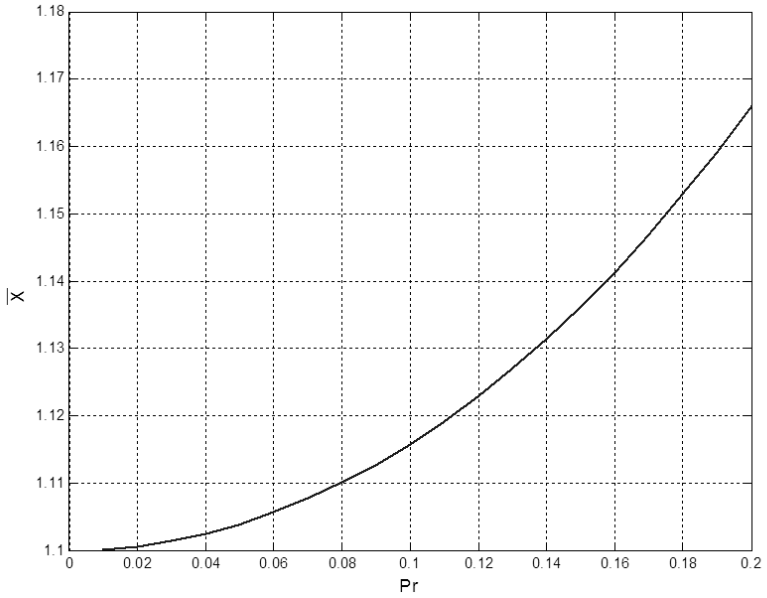

Figure 5: Relationship between the probability of a debt crisis as perceived by the government and maximum negative shock to the budget

government expenditure, (tax) revenues and balance[27].

The difficulties in explaining this indicator to the general public, the diversity of available methodologies, the ex-post revision of cyclically adjusted budget balances are among the principal factors that have hampered its widespread use.

In order to investigate the semi-elasticity[28] of the budget balance with respect to GDP and inflation rate, there can be distinguish two methods of calculation Braz (2006):

(1) The approach of the European Commission: the Commission uses a simple methodology, fiscal elasticities are estimated directly with respect to GDP and

[27]The cyclical component of the government budget balance corresponds to the cyclical component of tax revenues and current primary expenditure

[28]Note that an elasticity compares a percentage change of one variable x with the percentage change of the other variable y, i.e., [dln(y)/dln(x)]. A semi-elasticity compares a level change in one variable with a percentage change of the second variable, i.e., [dln(y)/dx]

inflation, neglecting the intermediate effect on tax bases (European Commission, 1995).

(2) The OECD approach: the OECD estimates revenues elasticities taking the output transmission mechanism into account[29]. Then the effect of the expansion of the tax base on revenue is estimated. The elasticities can be separated into two components, an elasticity of tax proceeds with respect to the relevant tax base and an elasticity of the tax base relative to a cyclical indicator. On the expenditure side, like the European Commission does, the OECD considers that unemployment benefits are considered the only category automatically related to the cycle.

There are some aspects related to the selection of the fiscal variables and the respective macroeconomic bases Braz (2006):

- non-tax revenue and the different expenditure components, other than unemployment benefits, are not affected by economic activity[30]

- the macroeconomic bases are defined in real terms, which means that the effect of actual inflation on public accounts is not taken into consideration. Although in terms of tax and social contributions revenue it would be more appropriate to consider nominal macroeconomic bases in the cyclical adjustment.

- the institutional structure relevant for budgetary decisions, the type of government, the starting point of the fiscal position are factors determining the response of public expenditure to the macroeconomic circumstance.

- the main difficulties in the quantification of the impact of the price changes on the budget balance emerge on the expenditure side, given its dependance on

[29]linking different taxes to different tax bases, and not directly to GDP

[30]This characteristic, common to the cyclical adjustment methodologies implemented by the European Commission, the OECD and the IMF, results from the difficulty in measuring, in a standardized manner in different countries and even in one country in different years, the impact of the economic cycle on most public expenditure items and non-tax revenue.

the budgetary authorities behavior in response to inflation deviations from initial forecasts.

Nevertheless, although estimates used in the European Union framework are those of the European Commission, other international institutions, such as the OECD and the IMF, have been regularly publishing values for cyclically adjusted budget balances.

This paper gives an estimate of measure of sensitivity of the Armenian primary budget balance in response to macroeconomic variables base on the European Commission approach. Due to the difficulty of defining the base and limited data base, tax levies and expenditures were regressed directly on nominal GDP.

The next procedure was applied: first, the macroeconomic variables driving the automatic component were chosen: in our case, nominal Gross Domestic Product (GDP) and the Consumer Price Index (CPI).

Then, the revenue side of the Armenian government budget[31] has been decomposed into the following revenue category for consideration - tax income and duties.

On the expenditure side[32] the current primary government expenditures is only government expenditure category that is assumed to react automatically to cyclical fluctuations, other benefits were not considered, as they are unrelated to the economic cycle.

Finally, each government budget item that was supposed to include an automatic component (tax income and duties (revenues) and current expenditures (expenditures)) was regressed directly on the GDP and the inflation rate[33] affecting the

[31]State budget revenues consists of budget revenues (tax income and duties, non-tax and capital incomes) and grants

[32]State budget expenditures consists of current expenditures, capital expenditures and net lending, repayment of previous debts

[33]There was applied a joint estimation of elasticities with respect to both the inflation rate and

automatic components.

The overall elasticity of the primary budget balance with respect to (cyclical) economic activity is calculated as a difference between revenues and expenditures elasticities.

OLS regression was run with the following specification:

$$lnA_t = \alpha + \eta_y lnY_t + \eta_\pi ln\Pi_t + \varepsilon_t \tag{12}$$

where A_t represents the specific category of the government budget deficit (in nominal terms, mln of Drams)[34], Π_t is the inflation rate (Consumer Price Index), Y_t stands for nominal GDP (mln of Drams), η_y semi-elasticity of the government budget relative to the output (GDP), η_π semi-elasticity of the government budget relative to the price level (inflation), ε_t is an error term.

The series were available and thus estimated with one-year frequency data covering the period of time from 1994 to 2008. The regression coefficients are significant at 5% level of confidence for the revenue part and 10% level of confidence for expenditure part.

Estimation results for the explanatory variables as the inflation rate and the GDP are presented in table below:

the GDP, estimated by Ginebri et al. (2005) through regression analysis and thus providing new insights in such a research field.

[34]As our concern refers mainly to the central government borrowing requirement, the object of our estimation is the primary budget balance on a cash basis.

	Coeff.	Std.Err.	t-ratio	$P > \|t\|$	$Adj.R^2$	DW
GDP semi-elasticity						
Tax incomes	1,04	0,055	18,81	0,000	0,99	1,66
Current expenses	-0,89	0,392	-2,27	0,053		
Inflation rate semi-elasticity						
Tax incomes	0,81	0,065	12,51	0,000	0,96	1,47
Current expenses	-1,09	0,651	-1,68	0,131		
Total balance η_y	0,23					
Total balance η_π	0,20					

Note: The total balance is the semi-elasticity which measures the change of the government budget balance, as a per cent of GDP, for a 1% change in GDP and the inflation rate respectively.

Revenues and expenditures prove sensitive to changes in the inflation rate and to variations in the activity level.

Increase in the GDP results in a greater increase in revenues. The findings show that a one percent growth in the output is associated with the increase of the primary surplus balance of 0,2% (as a percentage of GDP).

The effect of the unexpected inflation on the government budget (as a percentage of GDP) estimates a budget improvement of 0,2% of GDP on a yearly basis for a one percent increase in the inflation rate.

2.1.4 Expected return differentials

Optimal public debt composition also depends on expected return differentials (or risk premia), TP_t, FP_t and IP_t, more precisely, on the excess return perceived by

the government of fixed-rate bonds relative to the debt instrument considered.

Term risk premium:

$$TP_t = R_t - E_t i_{t+1} \tag{13}$$

The expected return differential between fixed-rate bonds and T-bills, TP_t, is the difference between the yield at auction of fixed-rate bonds, R_t and the expected average return on T-bills between time t and $t+1$, $E_t i_{t+1}$. At the end of December 2007 the average auction yield on fixed-rate bonds was 6,9%, the short-term interest rate expected for the end of December 2008 is 2,07%. The expected return differential, TP_t, can thus be set at 4,8%. Issuing T-bills is optimal until the uncertainty of the short-term interest rate raises the probability of failure as much as paying the term premium on fixed-rate bonds.

Foreign currency exchange-rate risk premium:

$$FP_t = R_t - R_t^{US} - E_t e_{t+1} \tag{14}$$

To estimate the expected return differential between fixed-rate bonds and dollar denominated bonds, FP_t, the yield on fixed-rate bonds, R_t of 6,9% must be compared to the interest rate for US federal funds rate, R_t^{US} of 4,5% (see the British Bankers' Association December 2007) and in the same period, the expected depreciation of exchange rate, $E_t e_{t+1}$ was 0,6%. The expected return differential, FP_t, can thus be estimated at around 1,8%. Foreign exchange-rate risk premium depends on the realization of the exchange rate.

Inflation rate risk premium:

$$IP_t = R_t - R_t^I - E_t\pi_{t+1} \tag{15}$$

The premium on price-linked bonds over fixed-rate bonds, IP_t, can be estimated as the difference between the interest rate on fixed-rate bonds and the (real) yield at issue of price-linked bonds augmented by the expected by the market between time t and t+1 inflation. With an interest rate of 6,9% on fixed-rate bonds, real interest rate for possible issued price-indexed bonds R_t^I estimated of 1,3% [35] while the expected average rate of inflation for 2007 $E_t\pi_{t+1}$ was settled around 4%. This implies an inflation risk premium of 1,5%.

3 The model of Armenian economy

The structural backward-looking model of the Armenian economy used to estimate the optimal debt composition is made of following five equations for: (i) the LIBOR; (ii) the exchange rate; (iii) the output gap; (iv) the inflation rate and; (v) the short-term interest rate. The model, which is presented in Appendix I, is consistent with that proposed by Favero and Giavazzi (2003) under the hypothesis of "Ricardian fiscal policy"[36].

The model is estimated on quarterly data for the period 2000:01-2007:04. Then, the impulse response function was used in order to describe the dynamic behaviors of

[35] this was calculated as the difference between the interest rate on T-bills at time t (5,7% in 2007) and the average rate of inflation in the same period of time (4,4% in 2007)

[36] A simple model of the Brazilian economy was estimated in order to obtain the threshold beyond which the economy might fall into a bad equilibrium, analyze the dynamics of the main variables in the bad equilibrium and investigate the effectiveness of monetary policy in controlling inflation in three different fiscal environments: a mildly Ricardian one, a strong Ricardian one, and exogenous

the whole system with respect to unit shocks in the residuals of the time series. There are considered four types of shocks: a supply shock (in the inflation equation), a demand shock (in the output gap equation), an exchange rate shock (in the exchange rate equation) and a shock to the LIBOR.

We compute impulse responses of the interest rate, LIBOR, the exchange rate, inflation and output gap from the distribution of each type of shock. The cumulated responses are then used to estimate the ratios of conditional covariances relative to conditional variances which are presented in Tables 2,4,6 and 8 for the LIBOR, supply, demand and exchange rate shock, respectively. The optimal debt composition is reported in Tables 3, 5, 7 and 9 for each type of shock.

3.1 LIBOR shocks

Tables 3 shows the debt composition that stabilizes the debt ratio against shocks to the LIBOR.

Column 1 reports the debt composition that stabilizes the debt ratio against variations in output and inflation, in the case we abstract from hedging against variations in debt returns. The share of T-bills is very small, reflecting the negative covariances of their returns with output growth. LIBOR shocks does not lead to neither unexpected inflation nor exchange rate depreciation, the positive covariances of T-bills and the exchange rate with inflation dominate their negative covariances with output. It follows that real-indexed bonds should be issued so as to isolate the budget from unexpected output contractions.

Column 2 shows that issuing fixed-rate debt is optimal for risk minimization in the case we consider the role of each instrument in hedging against the returns of

the other instruments. The government should issue both real-indexed debt and fixed-rate bonds and hold T-bills. When in Column 3 the debt instruments are constrained to be non-negative, still the optimal solution is to issue fixed-rate bonds and real-indexed bonds.

Finally, when cost consideration is presented in the analysis, as in Column 4 an 5, the optimal debt composition clearly moves towards price indexation.

3.2 Supply shocks

Table 5 shows the optimal debt composition that stabilizes the debt ratio against shocks to the inflation equation.

Column 1 shows that real-indexed bonds provide the best hedge against variations in the primary surplus and in the debt ratio due to lower than expected inflation and output growth. Though, T-bills are good hedges against lower than expected inflation, they provide limited insurance against budget risk, since their returns are negatively correlated with output. As supply shocks lead to a negative covariance of output with the short-term interest rate, dollar denominated debt helps in the debt stabilization.

Column 2 shows that, when we consider the risk of variations in debt returns along with budget risk and debt-ratio uncertainty, the optimal composition for risk minimization consists a small share of dollar denominated bonds, a big share of price-indexed bonds and a negative share of fixed-rate bonds. The share of T-bills becomes negative since they offer a limited insurance against inflation uncertainty.

Columns 3 shows that when cost considerations are taken into account, the debt composition that maximizes the probability of stabilizing the debt ratio comprises

the share of real-index bonds. It would be optimal to hold fixed-rate assets and fund this position with the price-index bonds. Column 4 shows that, when the optimal shares are constrained to be non-negative, there is again a strong case for price indexation.

Last Column 5 shows that real-indexed debt is optimal if we abstract from the insurance provided by fixed-rate debt against the returns of the other instruments.

3.3 Demand shocks

Table 7 shows the debt composition that stabilizes the debt ratio against shocks to the output gap equation.

The first Column of Table reports the share of real-indexed bonds is positive and exceed the total amount of debt several times; such bonds are optimal for minimizing the risk of fluctuation in the primary surplus and the debt-to-GDP ratio, abstracting from insurance against variations in the returns of other debt instruments. T-bills presents a worse alternative living little and decreasing role for dollar denominated bonds.

Column 2 shows that the risk minimizing debt structure calls for issuing large amounts of fixed rate bonds and real-indexed bonds considering, along with budget and debt-ratio uncertainty, the role of each debt instrument in hedging against variations in the returns of other debt instruments. In Column 3 if we restrict the shares of T-bills and dollar denominated debt to be non-negative the risk minimization clearly favors fixed rate bonds and real-indexed bonds.

The optimal debt structure changes when cost minimization is considered along with risk hedging. Column 4 shows that only real-indexed bonds should be issued

while large holdings of fixed rate bonds and some dollar denominated assets were feasible. Column 5 shows indexation to the price level as the optimal choice when the debt shares are constrained to be non-negative.

3.4 Exchange rate shocks

In addition we have assumed that the exchange rate shock hits the Armenian economy and in the Table 8 there is presented the public debt composition that stabilizes the debt ratio against exchange rate shock (shock to the exchange rate equation).

The first Column reports the shares of each type of public debt, except fixed-rate debt, are optimal for minimizing the risk of variations in the primary surplus and the debt ratio abstracting from insurance against variations in the returns of the other debt instruments. Therefore the shares of T-bills and dollar denominated bonds are positive, the share of real-indexed bonds exceeds several times the total amount of the debt offering a valuable insurance against variations in the primary surplus and the debt ratio.

Column 2 presents the risk minimizing debt structure when the role of each debt instrument in hedging against the returns of the other instruments is considered along with budget and debt-ratio uncertainty. Large amounts of indexed instruments: T-bills and especially real-indexed bonds are hedged by dollar denominated bonds in order to fund foreign assets holdings.

As the debt composition is computed assuming that debt shares cannot be negative, we restrict the shares of dollar denominated debt and fixed rate debt to be non-negative. In this case, see Column 3, risk minimization clearly favors price indexation over short-term indexation.

The optimal composition of the public debt does not change when cost minimization is considered along with risk hedging. Column 4 shows that both T-bills and big amount of real-indexed bonds should be issued.

However, when the debt shares are constrained to be non-negative price indexation again clearly emerges as the optimal choice. Column 5 shows that all the debt should be indexed to the price level.

3.5 Concessional external debt

In our research we have made an assumption that all external debt both concessional and non-concessional is US dollar denominated debt on non-concessional terms based on LIBOR + 1% interest rate. This is based mainly on the consideration that even if concessional debt has very low interest rate it does not mean that it does not induce any costs for the Armenian government.

Further in this section, we present the public debt structure under the consideration that all external public debt of the Republic of Armenia is US dollar denominated debt on concessional terms based on 1% interest rate. As of 2007 the portion of concessional loans in total external public debt was 99,1%. Though concessional terms are very convenient as regards cost of public debt, also this form of external debt involves exchange-rate risk, given foreign-currency denomination (mainly SDR[37] for concessional debt).

In this case foreign currency exchange-rate risk premium is:

[37]Special Drawing Rights (SDRs)- are defined in terms of a basket of major currencies used in international trade and finance. In 2006-2010, the currencies in the basket are the US dollar, the euro, the Japanese yen, and the pound sterling. The exact amounts of each currency in the basket, and their approximate contributions to the value of SDR are USD - 0.6320(44%), Euro - 0.4100(34%), Yen - 18.4(11%), Sterling - 0.0903(11%). Based on this composition we consider all concessional debt like US dollar denominated debt

$FP_t = R_t$ - 1% - $E_t e_{t+1}$

To estimate the expected return differential between fixed-rate bonds and dollar denominated bonds the yield on fixed-rate bonds of 6,9% must be compared to the interest rate for concessional debt of 1%, and in the same period, the expected depreciation of ADM per US dollar exchange rate of 0,6%. The expected return differential can thus be estimated at around 5,3%.

The results are shown in the last two columns of the tables. In the case all Armenian external debt is concessional and under all types of shocks, the empirical evidence suggest that foreign currency denominated debt should be further reduced and substituted by the issuance of the debt indexed to the price level.

4 Conclusions

In this paper we construct a model of optimal debt management of the Republic of Armenia, in terms of public securities (maturity, currency denomination, and indexation), as driven by the task to minimize the probability of fiscal instability (namely, of undesired growth of debt-to-GDP ratio), trading off risk and cost minimization tasks. Results, obtained from the analysis of structural model of Armenian economy whether and how the optimal public debt composition depends on shocks hitting the economy, suggest four solutions relative to four types of shocks.

While fixed-rate bonds play no role in the case of supply and exchange rate shocks, they are a worse alternative to price-indexed bonds in the case of demand and LIBOR shock.

Issuance of debt indexed to the short-term interest rate should be avoided if LIBOR shock prevail while T-bills are a worse alternative to price-indexed bonds

in the case of demand shocks (the conditional variance of the short-term interest rate is low and short-term interest rate is positively correlated with unanticipated output and inflation). Although their role is limited in the case of exchange rate shocks and supply shocks.[38]

Considering foreign currency denominated debt, there comes out to be a small role, a worse alternative to price-indexed bonds, for dollar denominated bonds in case of supply shocks, (note that even if the conditional variance of the exchange rate is not very low the exchange rate is positively correlated with unanticipated output and inflation which means that variations in the primary budget could be hedged by dollar denominated debt). Exposure to exchange rate risk should be avoided in case of LIBOR, demand and specially exchange rate shocks.[39]

Whether price-indexed bonds should be issued depends on the type of shocks hitting the economy of Armenia. The best hedge against exchange rate and supply shocks consistently provide real-indexed bonds (the conditional variance of the inflation rate is low and inflation rate is positively correlated with unanticipated output), they play an important role in insurance against LIBOR shock although their role is limited in the case of demand shock[40].

We suggest to substitute the foreign currency denominated debt by the real-

[38]Floating-rate debt is optimal when $Cov(y,i)/Var(i)$ and $Cov(i,\pi)/Var(i)$ is positive. This allows the government to pay less interests when output and inflation are unexpectedly low. Lower output growth tends to increase the debt ratio, instruments with returns correlated to nominal output growth help to stabilize the debt ratio. The case for indexation weakens as $Var(i)$ increases, thus producing unnecessary fluctuations in interest payments.

[39]Dollar denominated debt is optimal when $Cov(y,e)/Var(e)$ and $Cov(e,\pi)/Var(e)$ is positive. If the exchange rate appreciated at times of unexpectedly low output (an unlikely event) cyclical variations in the government budget could be hedged by dollar denominated debt. To the extent that exchange rate depreciation is associated with inflation, foreign currency debt helps to stabilize the debt ratio. Exposure to exchange-rate risk becomes less attractive as $Var(e)$ increases.

[40]Price-indexed debt is optimal when $Cov(y,\pi)/Var(\pi)$ is positive or even zero, lower interest payments on price-indexed debt provide an insurance against the cyclical deficit due to unexpected slowdowns in economic activity.

indexed debt in case all Armenian external debt is concessional.

Figure 12, 13, 14 and 15 show what happens with the optimal public debt composition under four types of shocks LIBOR, supply, demand and exchange rate respectively under an assumption that the probability of a debt crisis perceived by the Armenian government Pr might increase from 0 to 10%.

References

Bangura, S., D. Kitabire, and R. Powell. 2000. "External Debt Management in Low-Income Countries", IMF Working Paper No. 00/196.

Barro, R.J. 1999. "Notes on optimal debt management", *Journal of Applied Economics*, 2(2), 281-289

Bevilaqua, A.S. and R.L.F.Werneck. 1997. "Fiscal Impulse in the Brazilian Economy, 1989- 1996," Working Paper No.379

Blanco, C.F.A. and S. Herrera. 2002. "The Quality of Fiscal Adjustment and Procyclical Policies in Brazil." Background Paper for World Bank Country Economic Memorandum. Washington, D.C.

Blommestein, H.J. 2005. "Overview of Advances in Risk Management of Government Debt." Financial Market Trends, No. 88, March 2005.

Braz, C.R. 2006. The calculation of cyclically adjusted balances at banco de Portugal. Economic Bulletin. Banco de Portugal. 75-93

Cassard, M., and D. Folkerts-Landau. 1997. "Risk Management of Sovereign Assets and Liabilities", IMF Working Paper No. 97/166

Dooley, M.P. 2000. "Debt management and crisis in developing countries", *Journal of Development Economics*, 63, 45-58

De Mello, L., and K. Hussein. 2001. "Is Foreign Debt Portfolio Management Efficient in Emerging Economies?" *Journal of Development Economics*, 66(1), 317-35

Faraglia E., A. Marcet and A.Scott. 2007."Fiscal Insurance and Debt Management in OECD Economies".

Faraglia E., A. Marcet and A.Scott. 2008."In search of a theory of debt management".

Favero, C. and F. Giavazzi. 2003. "Targeting inflation when debt and risk premia are high: lessons from Brazil", this volume

Giavazzi, F., and A. Missale. 2004. "Public Deb Management in Brazil", NBER Working Paper Series No. 10394

Ginebri, S., B. Maggi and M. Turco. 2005. "The automatic reaction of the Italian government budget to fundamentals: an economic analysis" *Applied Economics*, 37, 67-81

Gray, S., and D. Woo. 2000. "Reconsidering External Financing of Domestic Budget Deficits: Debunking Some Received Wisdom", IMF Policy Discussion Paper No. 00/8.

Helbling, T., A. Mody, and R. Sahay. 2004. "Debt Accumulation in the CIS-7 Countries: Bad Luck, Bad Policies, or Bad Advice?", IMF Working Paper No. WP/04/93.

Guidelines for Fiscal Adjustment. Pamphlet Series No. 49. IMF, Fiscal Affairs Department, Washington, D.C. 1995.

Guidelines for Public Debt Management: Accompanying Document. IMF and the WB. Approved by V.Sundararajan and K.G. Lay. 2002.

Izak, V. 2003. "Public debt service, interest rates and fiscal variables in transition countries", paper presented at the 59th Congress of the International Institute of Public Finance, Prague

Jeanne, O. 2003."Why Do Emerging Market Economies Borrow in Foreign Curerncy", IMF Working Paper No. WP/03/177.

Freinkman, L., G. Gyulumyan, and A. Kyurumyan. 2003. "Quasi-Fiscal Activities, Hidden Government Subsidies, and Fiscal Adjustment in Armenia" World Bank Washington, D.C

Matalik, I., and M. Slavik. 2004. "Debt Management in the Czech Republic: formation in the nineties and the current state", Prague Economic Papers, Praha 1 S. 33-50 graph. Darst., Lit. S. 50

Missale, A. 1999. *Public Debt Management*, Oxford University Press, Oxford

Mitchell, J. 2000. "The importance of long run structure for impulse response analysis in VAR models" National Institute of Economic and Social Research, Mimeo

Montiel, P.J. 2005. "Public Debt Management and Macroeconomic Stability", Oxford University Press, Oxford.

Persson, M., T. Persson and L.E.O. Svensson. 1998. "Debt, Cash Flows and Inflation Incentives: A Swedish Example", in G. Calvo and M. King, eds., The Debt Burden and its Consequences for Monetary Policy: 28-62. IEA Conference Volume No.118, MacMillan Press

Poghosyan T., and E. Koenda. 2006. "Foreign Exchange Risk Premium Determinants: Case of Armenia", Working Paper No. 06/16.

Roberts, B.W. and K. Banaian. 2005. "Remittances in Armenia: size, impacts, and measures to enhance their contribution to development", Armenian International Policy Research Group Working Paper No. 05/01.

Rossi, M. 1998. "Economic Announcements and the Timing of Public Debt Auctions", IMF Working Paper No. 98/44.

Tobin, J. 1963. "An essay on principles of debt management", in *Fiscal and Debt Management Policies*

Van Den Noord, P. 2000. "The Size and the Role of Automatic Fiscal Stabilisers in the 1990s and Beyond", OECD Economic Department Working Paper No.230

5 Appendix I: Structural model estimation

The structural model applied in the simulation exercises in order to obtain the impulse responses to different shocks (LIBOR shock, Supply shock, Demand shock and Exchange rate shock) hitting the economy of the Republic of Armenia is composed by the following five equations for: (1) the LIBOR; (2) the exchange rate; (3) the output gap; (4) the inflation rate; (5) the interest rate for T-bills:

$$LIBOR_t = \mu_0 + \mu_1 LIBOR_{t-1} + \nu_{LIBOR_t} \tag{16}$$

$$e_t = \delta_0 + \delta_1 e_{t-1} + \delta_2 (i_{t-4} - {i_{t-4}}^{US}) + \nu_{e_t} \tag{17}$$

$$y_t = \gamma_0 + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \gamma_3 i_{t-2} + \gamma_4 LIBOR_{t-4} + \nu_{y_t} \tag{18}$$

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 y_{t-1} + \alpha_3 (e_{t-3} - e_{t-5}) + \alpha_4 \Delta LIBOR_{t-1} + \nu_{\pi_t} \tag{19}$$

$$i_t = \rho i_{t-1} + (1-\rho)[\beta_0 + \beta_1 (\pi_{t-3} - \pi^T) + \beta_2 i_t^{US} + \beta_3 \Delta e_{t-2}] + \nu_{i_t} \tag{20}$$

where, $LIBOR_t$ is the London Inter-Bank Offered Rate, e_t – the change of the exchange rate, i_t – interest rate for T-bills, i_t^{US} – US federal funds rate, y_t – output gap, π_t – inflation rate, π^T - the CBA inflation target.

This seven-variable model includes the five domestic variables together with the two world variables: GDP, CPI, CPI target, IR, ER, and wLIBOR rate, wIR.

Each equation of the model was estimated considering the largest available sample: 2000:01 - 2007:04 of the financial variables. Because of short period of time 2000:01 - 2007:04 the use of quarterly data is necessary to obtain reasonably precise estimates of the covariances.

All the equations have been estimated by OLS.

5.1 LIBOR equation

$$LIBOR_t = \mu_0 + \mu_1 LIBOR_{t-1} + \nu_{LIBOR_t} \tag{21}$$

where, $LIBOR_t$ is the London Inter-Bank Offered Rate

Results for the LIBOR equation:

$\mu 0$	$\mu 1$
$0,007$	$0,758$
$(0,004)$	$(0,102)$

We have thus assumed that LIBOR only depends positively on growth. The empirical evidence shows that one of the main determinants of LIBOR is international factor, specifically US Federal Funds Rate (see Figure 6). Note, that foreign interest rates are allowed to affect domestic interest rates, but not viceversa.

LIBOR is just one of the elements determining the cost of the Armenian public debt. In 2001 the LIBOR decreased, and it has had a positive effect on the service of external debt of the Republic of Armenia.

5.2 Exchange rate equation

$$e_t = \delta_0 + \delta_1 e_{t-1} + \delta_2 (i_{t-4} - {i_{t-4}}^{US}) + \nu_{e_t} \tag{22}$$

where, e_t – the change of the exchange rate, i_t – interest rate for T-bills, i_t^{US} – US federal funds rate

Results for the Exchange rate equation:

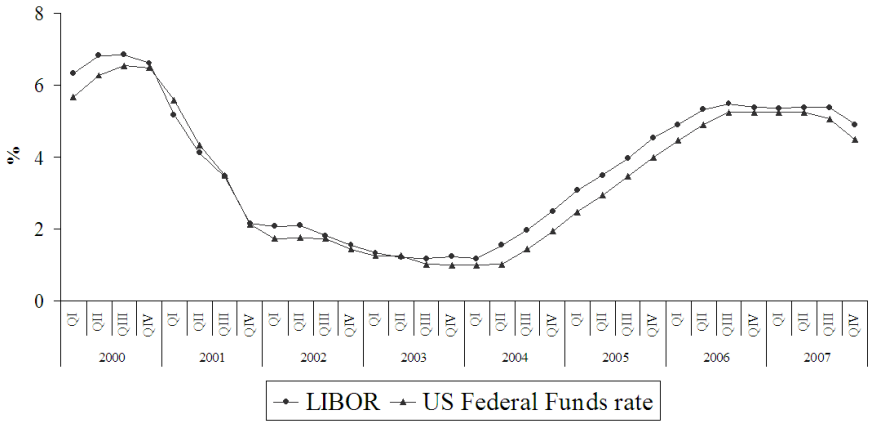

Figure 6: LIBOR and US Federal Funds Rate

$\delta 0$	$\delta 1$	$\delta 2$
$-1,149$	$1,187$	$-0,023$
$(0,328)$	$(0,055)$	$(0,012)$

The change in the exchange rate depends on the interest rate differential (domestic interest rate minus US Federal Funds rate). The coefficient is negative: a 1% increase in the domestic interest rate appreciates the exchange rate by 0,023%.

The external debt of the Republic of Armenia consist of loans provided in different currencies, changes of shares of currencies and exchange rate fluctuations (see Figure 7) have their direct effect on the level of external debt of Armenia.

5.3 Output Gap equation

$$y_t = \gamma_0 + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \gamma_3 i_{t-2} + \gamma_4 LIBOR_{t-4} + \nu_{y_t} \tag{23}$$

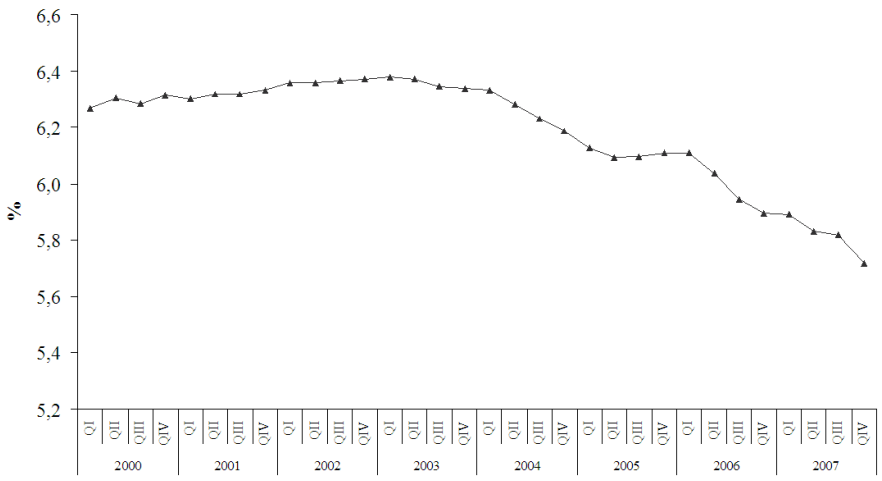

Figure 7: US dollar exchange rate

where y_t – output gap, i_t – interest rate for T-bills, $LIBOR_t$ – London Inter-Bank Offered Rate

Results for the Output Gap equation:

$\gamma 0$	$\gamma 1$	$\gamma 2$	$\gamma 3$	$\gamma 4$
$-0,004$	$0,643$	$-0,381$	$-0,014$	$0,779$
$(0,012)$	$(0,227)$	$(0,176)$	$(0,005)$	$(0,202)$

The percentage GDP or output gap is the difference between potential and actual GDP divided by the actual GDP. The potential GDP for Armenia was estimated using a Hodrick-Prescott filter. The calculation gives us also a negative number which is known as a expansionary gap and indicates an economy in recession (positive number or recessionary gap indicates an economy in expansion) (see Figure 8).

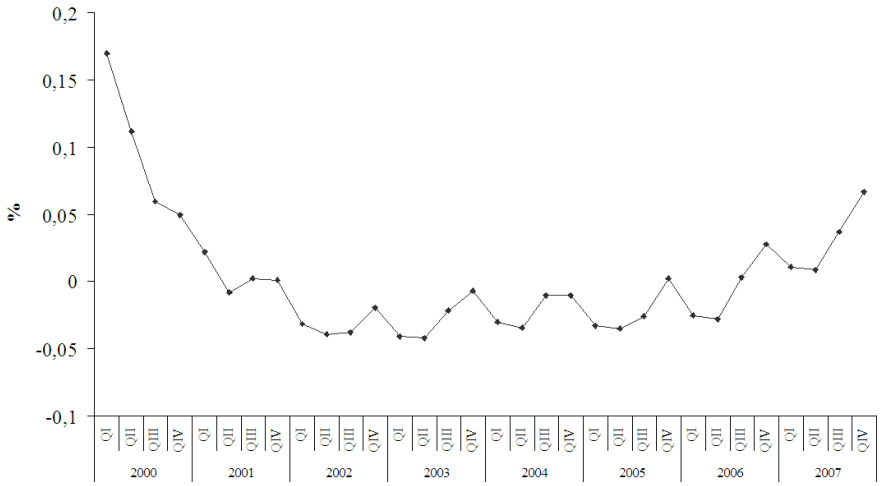

Figure 8: Output Gap

5.4 Inflation equation

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 y_{t-1} + \alpha_3 (e_{t-3} - e_{t-5}) + \alpha_4 \Delta LIBOR_{t-1} + \nu_{\pi_t} \qquad (24)$$

where, y_t – output gap, e_t – exchange rate, π_t – inflation rate, $LIBOR_t$ – London Inter-Bank Offered Rate

Results for Inflation equation:

$\alpha 0$	$\alpha 1$	$\alpha 2$	$\alpha 3$	$\alpha 4$
$0,019$	$0,830$	$0,407$	$0,212$	$1,379$
$(0,006)$	$(0,122)$	$(0,162)$	$(0,069)$	$(0,721)$

Inflation depends positively on growth (the effect of activity on prices), positively on exchange rate depreciation and positively on LIBOR.

Armenia has reached a low inflation rate thanks to inflation targeting regime,

relatively little exchange rate intervention, increase in interest rates, tight fiscal policy (see Figure 9). Main inflationary risks in 2009 are large foreign exchange inflows (remittances, foreign direct investments and aid, real estate).

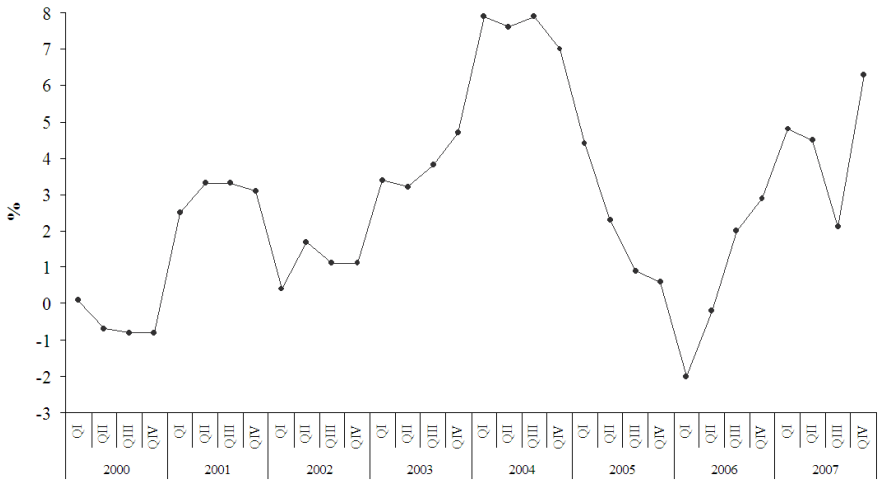

Figure 9: Inflation rate

5.5 Interest rate for T-bills equation

$$i_t = \rho i_{t-1} + (1-\rho)[\beta_0 + \beta_1(\pi_{t-3} - \pi^T) + \beta_2 i_t^{US} + \beta_3 \Delta e_{t-2}] + \nu_{i_t} \tag{25}$$

where, i_t - interest rate for T-bills, e_t - exchange rate (there is added to the Taylor Rule one more argument, such as the realized change in the exchange rate), π_t - inflation rate, π^T - the CBA inflation target,i_t^{US} - US federal funds rate

Results for the Interest rate for T-bills equation:

ρ	β_0	β_1	β_2	β_3
$0,916$	$0,125$	$1,833$	$6,619$	$2,143$
$(0,055)$	$(0,010)$	$(0,106)$	$(0,230)$	$(0,123)$

β_1 and β_2 - should be positive and measure how the central bank of Armenia reacts to deviations of the expected inflation from the target and to deviations in the exchange rate. The exchange rate depreciation affects inflation expectations and the inflation rate itself. This induces the central bank to increase in the interest rate for T-bills (see Figure 10) further, which further raises the public debt service costs.

In 2006 the Central Bank shifted its main policy objective from monetary targeting to inflation targeting. Initial phase of inflation targeting was introduced in Armenia in 2005 and appears to be successful in stabilizing inflation and GDP growth. The target band was settled at 3% level.

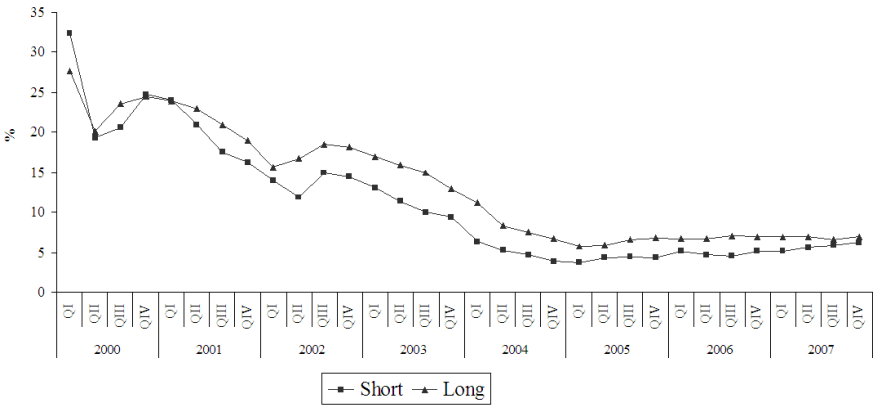

Figure 10: The interest rates on T-bills and long-term bonds

5.6 Estimation results

Table 1. The estimated quarterly model, sample $2000:01-2007:04$

	Coeff.	Std.Err.	t-ratio	$P>\|t\|$	$Adj.R^2$	DW
LIBOR equation						
μ_0	0,007	0,004	1,53	0,137	0,65	1,96
μ_1	0,758	0,102	7,39	0,000		
Exchange rate equation						
δ_0	-1,149	0,328	-3,50	0,002	0,98	1,57
δ_1	1,187	0,055	21,63	0,000		
δ_2	-0,023	0,012	-1,90	0,069		
Output gap equation						
γ_0	-0,004	0,012	-0,35	0,729	0,66	1,55
γ_1	0,643	0,227	2,83	0,009		
γ_2	-0,381	0,176	-2,17	0,041		
γ_3	-0,014	0,005	-2,69	0,013		
γ_4	0,779	0,202	3,86	0,001		
Inflation equation						
α_0	0,019	0,006	3,26	0,004	0,65	1,86
α_1	0,830	0,122	6,82	0,000		
α_2	0,407	0,162	2,51	0,020		
α_3	0,212	0,069	3,09	0,005		
α_4	1,379	0,721	1,91	0,069		

Interest rate for T-bills equation						
ρ	0,916	0,055	16,71	0,000	0,96	1,46
β_0	0,125	0,010	-1,10	0,283		
β_1	1,833	0,106	1,46	0,157		
β_2	6,619	0,230	2,41	0,024		
β_3	2,143	0,123	1,47	0,155		

6 Appendix II: Simulation of variances and covariances

A MATLAB program has been used in order to compute the economy behavior under the following four types of shocks: a shock to LIBOR, a supply shock, a demand shock and an exchange rate shock.

6.1 Impulse responses

Impulse response analysis is widely used in the empirical literature to uncover the dynamic relationship between different macroeconomic variables within vector - autoregressive (VAR) models [41].

The shock amplitude was taken as one standard deviation of the variables LIBOR (for LIBOR shock), inflation (for supply shock), output gap (for demand shock) and exchange rate (for exchange rate shock). The variables π_t, i_t, e_t, y_t, $LIBOR_t$ depend on values in the past. External variables are not considered in the program (US federal funds rate). The maximum negative time is set at 9 time quarters. In order

[41] Impulse responses measure the time profile of the effect of a shock, or an impulse, on the (expected) future values of a variable. By imposing specific restrictions on the parameters of the VAR model the shocks can be attributed an economic meaning Mitchell (2000).

to let the program compute the variables values at time $t = 0$, all the variables are initialized at zero for 9 time quarters. The program in composed by four sections dedicated to a shock type. The sections differ in the initialization of the variable under shock at time t = 0 which contains one standard deviation of the variable under shock. At this point the program can compute the four impulse response values for from t=1 to a time value to be determined.

Figure 11 summarises the outputs generated by the different types of shocks.

We explore the behavior of LIBOR, exchange rate, output gap, inflation and short-term interest rate equations under LIBOR, supply, demand and exchange rate shocks.

As far as the LIBOR equation is concerned, LIBOR shock quickly tends to die out and to reabsorb completely.

If we look at the mean responses for exchange rate equation we can see that they present similar profiles under all types of shock. The effects of the shocks tend to increase quickly and there is not much difference in the size of their responses.

A different profile emerges for output gap equation. The effects of a demand shock tend to die out quickly and after five quarters they are almost completely reabsorbed. While the responses from other shocks have almost the same growing tendency and tend to be reabsorbed after ten quarters.

For the inflation rate equation we can draw a picture where the effects are very strong moving up and down at the beginning and finally following a tendency to increase.

When the shocks are introduced into the short-term interest rate equation, the responses move in the same direction tending to die out and to be reabsorb completely after some period of time.

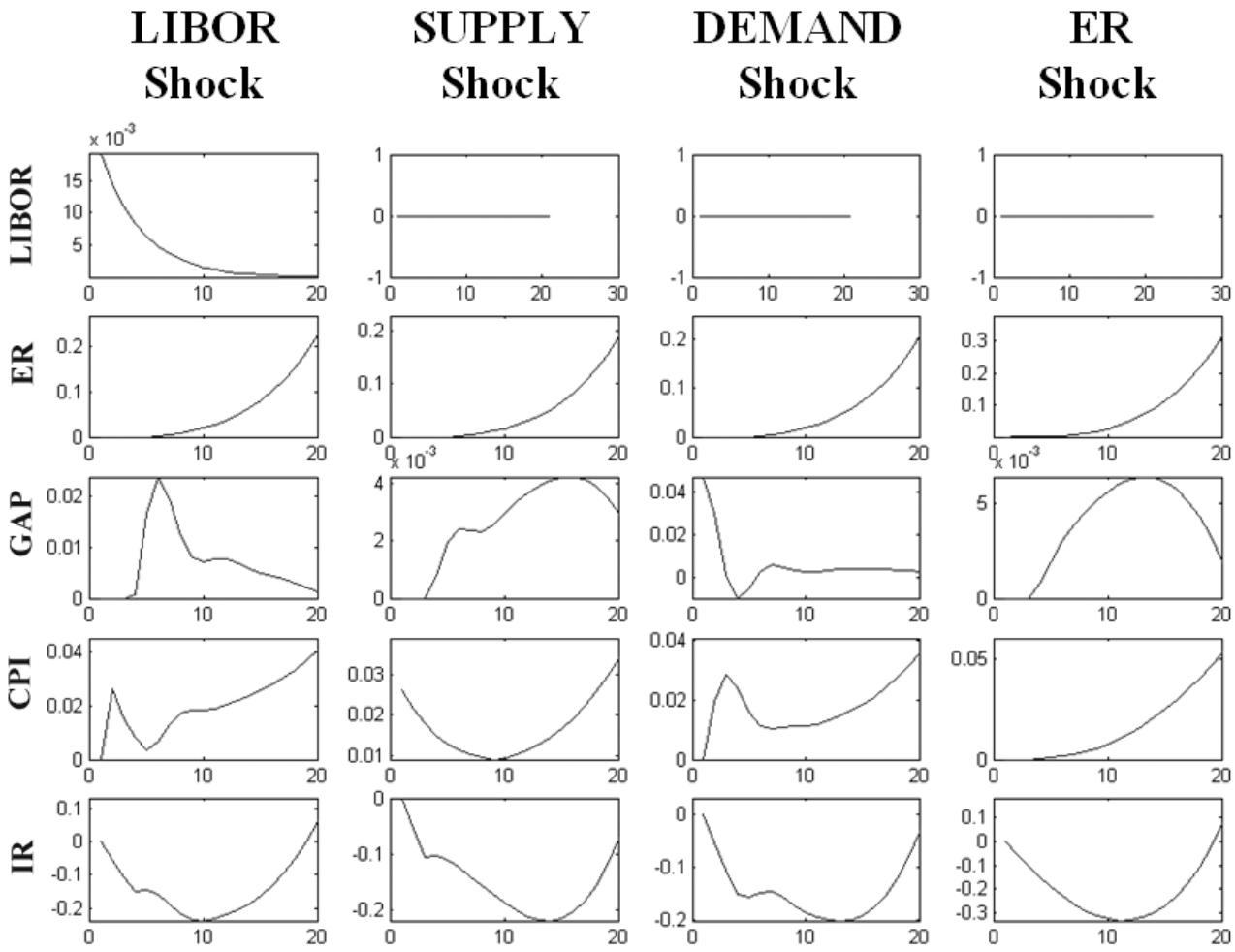

Figure 11: Impulse responses for a shock to LIBOR, output gap, inflation and exchange rate equation (Notes: Deviation Mean)

6.2 Variances and Covariances

We use an estimate of the variance - covariance matrix from one-period ahead forecast in order to identify the impact of structural shocks. The conditional covariance's are estimated running the model under four types of shocks considered in the economy. The conditional variances and covariance's are computed using the functions $var()$ and $cov()$ for time values from $t = 0$ to the 20th quarter.

The results of estimated conditional variances and covariances are shown in Table 2,4,6 and 8 for LIBOR shock, supply shock, demand shock and exchange rate respectively. Positive covariance between the returns on two types of debt makes them substitutes in the government portfolio.

6.2.1 LIBOR Shock

Table 2. Structural Model - Covariances and Variances

$Cov(y,i)/Var(i)$	$-0,032$	$Cov(i,\pi)/Var(i)$	$0,080$
$Cov(y,e)/Var(e)$	$-0,040$	$Cov(e,\pi)/Var(e)$	$0,123$
$Cov(y,\pi)/Var(\pi)$	$-0,391$	$Cov(e,\pi)/Var(\pi)$	$6,776$
$Var(i)$	$1,038$	$Cov(i,e)/Var(i)$	$0,664$
$Var(e)$	$0,678$	$Cov(i,e)/Var(e)$	$1,017$
$Var(\pi)$	$0,012$	$Cov(i,\pi)/Var(\pi)$	$6,788$

Notes: Variances are multiplied by 10^3.

Table 3. Results - Optimal Debt Composition

	Risk no hedge	Risk	Risk s=q=0	Risk+Cost	Risk+Cost q=f=0	Concess	Concess q=f=0
Short (s)	0,09	-0,05	0	0,14	-0,14	-0,04	-0,14
Foreign (q)	0,17	0,17	0	-1,16	0	-0,50	0
Inflation (h)	1,21	0,42	0,41	9,93	1,14	6,69	1,14
Fixed (f)	-0,47	0,46	0,59	-7,92	0	-5,15	0

Notes: The optimal debt composition is obtained from equations (6)-(8).

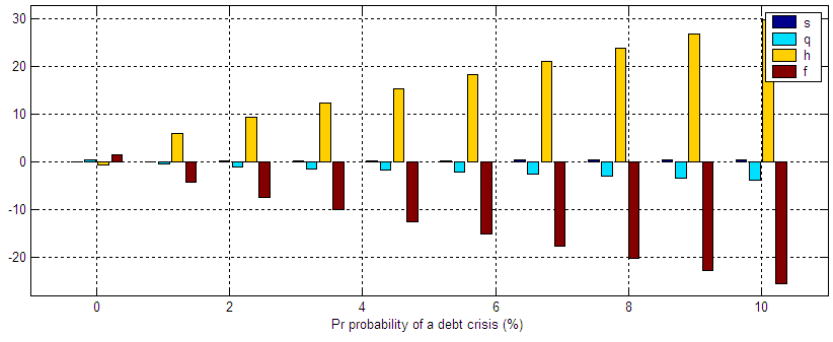

Figure 12: Optimal debt composition under different probability of a debt crisis

6.2.2 SUPPLY Shock (shock to inflation equation)

Table 4. Structural Model - Covariances and Variances

$Cov(y,i)/Var(i)$	$-0,015$	$Cov(i,\pi)/Var(i)$	$0,088$
$Cov(y,e)/Var(e)$	$0,007$	$Cov(e,\pi)/Var(e)$	$0,112$
$Cov(y,\pi)/Var(\pi)$	$0,003$	$Cov(e,\pi)/Var(\pi)$	$7,357$
$Var(i)$	$3,574$	$Cov(i,e)/Var(i)$	$0,389$
$Var(e)$	$4,835$	$Cov(i,e)/Var(e)$	$0,287$
$Var(\pi)$	$0,074$	$Cov(i,\pi)/Var(\pi)$	$4,278$

Notes: Variances are multiplied by 10^3.

Table 5. Results - Optimal Debt Composition

	Risk no hedge	Risk	Risk+Cost	Risk+Cost q=f=0	Risk+Cost no hedge	Concess	Concess q=f=0
Short (s)	0,15	-0,03	-0,17	-0,25	0,17	-0,13	-0,04
Foreign (q)	0,25	0,06	-0,26	0	0,26	-0,15	0
Inflation (h)	2,09	1,77	5,06	1,25	2,40	4,03	1,04
Fixed (f)	-1,49	-0,80	-3,63	0	-1,82	-2,75	0

Notes: The optimal debt composition is obtained from equations (6)-(8).

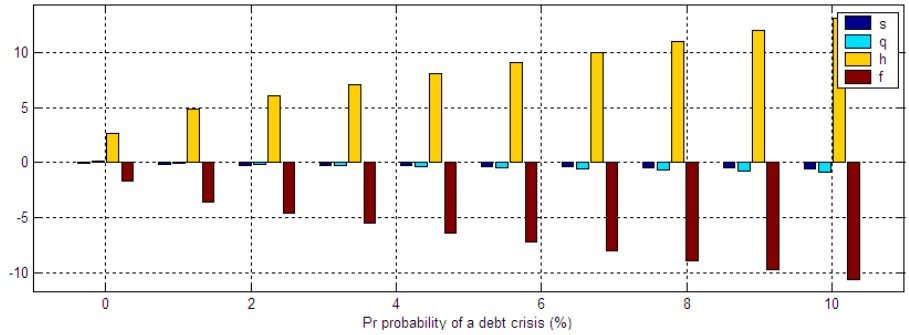

Figure 13: Optimal debt composition under different probability of a debt crisis

6.2.3 DEMAND Shock (shock to output gap equation)

Table 6. Structural Model - Covariances and Variances

$Cov(y,i)/Var(i)$	$0,027$	$Cov(i,\pi)/Var(i)$	$0,114$
$Cov(y,e)/Var(e)$	$-0,007$	$Cov(e,\pi)/Var(e)$	$0,098$
$Cov(y,\pi)/Var(\pi)$	$-0,085$	$Cov(e,\pi)/Var(\pi)$	$6,895$
$Var(i)$	$0,399$	$Cov(i,e)/Var(i)$	$0,753$
$Var(e)$	$0,569$	$Cov(i,e)/Var(e)$	$0,528$
$Var(\pi)$	$0,008$	$Cov(i,\pi)/Var(\pi)$	$5,621$

Notes: Variances are multiplied by 10^3.

Table 7. Results - Optimal Debt Composition

	Risk no hedge	Risk	Risk s=q=0	Risk + Cost	Risk + Cost q=f=0	Concess	Concess q=f=0
Short (s)	0,30	0,23	0	-0,21	-0,11	-0,19	-0,11
Foreign (q)	0,19	0,02	0	-0,70	0	-0,42	0
Inflation (h)	1,90	0,44	0,43	10,69	1,11	8,63	1,11
Fixed (f)	-1,38	0,30	0,57	-8,78	0	-7,02	0

Notes: The optimal debt composition is obtained from equations (6)-(8).

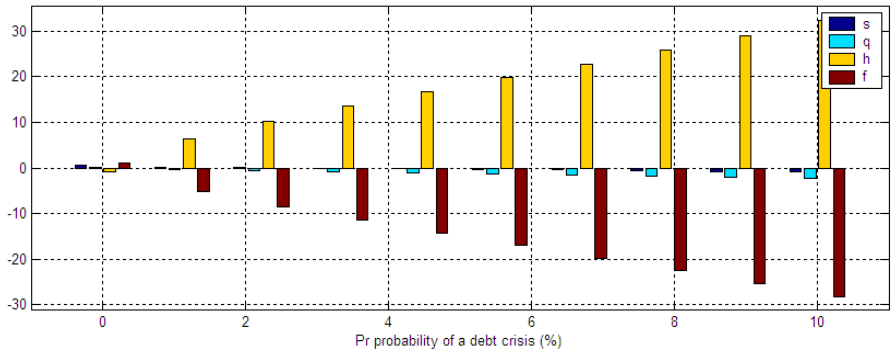

Figure 14: Optimal debt composition under different probability of a debt crisis

6.2.4 EXCHANGE RATE Shock (shock to exchange rate equation)

Table 8. Structural Model - Covariances and Variances

$Cov(y,i)/Var(i)$	$-0,012$	$Cov(i,\pi)/Var(i)$	$0,085$
$Cov(y,e)/Var(e)$	$-0,002$	$Cov(e,\pi)/Var(e)$	$0,167$
$Cov(y,\pi)/Var(\pi)$	$0,001$	$Cov(e,\pi)/Var(\pi)$	$5,895$
$Var(i)$	$2,094$	$Cov(i,e)/Var(i)$	$0,577$
$Var(e)$	$1,336$	$Cov(i,e)/Var(e)$	$0,905$
$Var(\pi)$	0,038	$Cov(i,\pi)/Var(\pi)$	$4,728$

Notes: Variances are multiplied by 100.

Table 9. Results - Optimal Debt Composition

	Risk no hedge	Risk	Risk q=f=0	Risk + Cost	Risk + Cost q=f=0	Concess	Concess q=f=0
Short (s)	0,15	0,08	-0,23	0,11	-0,22	0,05	-0,22
Foreign (q)	0,34	-1,00	0	-0,87	0	-0,43	0
Inflation (h)	2,09	7,62	1,23	4,65	1,22	2,30	1,22
Fixed (f)	-1,58	-5,70	0	-2,89	0	-0,92	0

Notes: The optimal debt composition is obtained from equations (6)-(8).

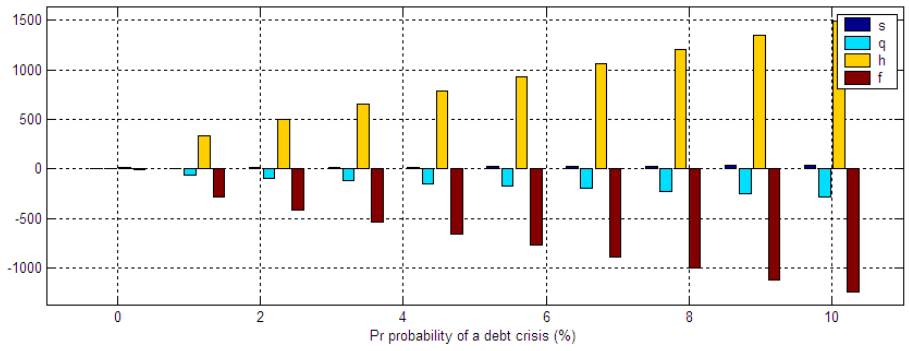

Figure 15: Optimal debt composition under different probability of a debt crisis

7 Appendix III: Data

All the financial variables series are constructed by using the last available observation, using quarterly frequency or were converted into quarterly terms from daily, weekly, monthly terms.

Main macroeconomic indicators: data for nominal and real Gross Domestic Product (GDP), growth rate of GDP (in current prices, cumulative, in million of USD and ADM); inflation rate (in percent change with respect to the same period of the previous year, cumulative) is growth rate of the Consumer Price Index (CPI is a price of a "basket" of 470 goods and services in Armenia); the exchange rate ADM per USD is the logarithm of the ADM/USD exchange rate (sale, end of period); budget balance, domestic interest rates are taken from the Central Bank of Armenia website: http://www.cba.am. The exchange rate, domestic interest rates, LIBOR for 6-month USD deposit rate (Source: The British Bankers' Association, website: http://www.bba.org.uk/), USD Federal Funds Rate (Source: Board of Governors of the Federal Reserve System, website: http://www.federalreserve.gov/), are converted into quarterly terms from monthly, The inflation rate, the interest rates and the output gap have not been multiplied by 100.

Public debt composition is not available and undeveloped financial market of most FSU countries causes extremely difficulties to collect high-frequency data. Data on the composition of the public debt: Domestic and External by debt instruments (in millions of ADM, USD and % of GDP), interest rate and maturity of securities are taken from the website: http://www.minfin.am/of the Ministry of Finance of the RA, and directly contacting Shushanik Mkrtchyan - Head of Domestic PDM Division and Heghine Karapetyan - Head of External Debt Division.