# Consumption function estimate and consumption forecast[1]

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*In most countries, final household consumption accounts for more than half of GDP. The consumption function is thus one of the most frequently discussed topics in theoretical as well as empirical literature. From the point of view of the central bank, it is important to know the elasticities of disposable income or of other variables and to be able to forecast the future development of the consumption, because personal consumption expenditure affects the demand-pull inflation. This is particularly important for Slovakia, because inflation targeting under the ERM II exchange rate mechanism constitutes the framework for Slovakia's monetary policy.*

## Introduction

In the first part of the article, we are going to present the best-known works in the field of modern consumption theory.[2] In 1935, Keynes introduced his absolute income theory, in which he held that consumption was a function of disposable income. Later empirical research, however, came to the conclusion that this relationship does not provide a sufficient explanation for the behavior of aggregate data. The life cycle theory assumes that consumption makes up a constant part of the present value of lifetime income. Foundations of the theory were laid by Modigliani and Brumberg (1954). This theory says that the propensity to consume is lower with young households than with households of older persons who spend their savings. Aggregate demand thus depends not only on income and wealth, but also on demographic changes. An extension of the Keynes theory has been presented by Friedman (1957). His permanent income hypothesis divides consumption and income into a permanent and a transitory element and includes future income expectations. If an individual considers a change of his income transitory, he has no reason to change his consumption habits. On the other hand, if he finds out that the income change is of permanent nature, he simultaneously adjusts his consumption. According to Friedman's theory, the key determinant of consumption is the real wealth of the consumer, not his current real disposable income. The credibility of the permanent income theory with rational expectations is weakened by the presence of obstacles for borrowing – the "liquidity constraints". The existence of such constraints causes consumption to be determined more by present than future income and the interest rate not to play a major role in consumption decisions (e.g. Hall and Mishkin (1982)).

The said theoretical works are taken up by empirical research, which has dealt with estimating the consumption function. Takala (1995) says that the inclusion of a variable representing wealth entails more stable consumption function estimates. Côté and Johnson (1998) have added the consumer attitudes index to the short-term variables. This step has increased the proportion of the explained variance of the dependent variable and has enhanced the accuracy of the consumption prediction. Bredin a Cuthbertson (2001) have modeled a consumption function for the Czech Republic for the years 1993 to 1995. The authors have found a long-run equilibrium between consumption, real wages and inflation. They have also found out that the size of the income effect depended significantly on the decision to include the variable unemployment rate in the estimated model. Selected aspects of consumption in the Czech Republic have been also treated by Artl et al. (2002). In their work, they describe the co-integration between seasonally adjusted time series of real consumption and of real disposable income. The vector error correction model for household consumption in Spain was designed by Marínez-Carrascal and del Rio (2004), who have analyzed the impact of loans granted to households on the consumption of the households. The effect of financial and housing wealth has been analyzed e.g. by Bover (2006) and Sierminska and Takhtamanova (2007).

## Methodology

The selection of the methodology used to estimate the consumption function has been influenced by the presence of non-stationarity in the used time series. The Johansen approach based on the vector autoregression methodology (VAR) is used to estimate the consumption function. This methodology is used, similarly as the Engel-Granger approach, when working with non-stationary time series. It is also suitable for predictions at a short-term horizon (Pindyck and Rubinfeld, 1991). Gujarati (2003) says that in many cases forecasts obtained using this method are better than those obtained from complex simultaneous models. We will first briefly introduce the VAR models and then show how to convert the VAR model to a VEC model.

As an illustration, we will introduce a simple

1 *This article is a summary of the NBS working paper 1/2007 „Consumption function estimate for Slovakia and consumption forecast". The full version of the study is available at the address: http://www.nbs.sk/PUBLIK/07_SEN 1.PDF*

2 *The work Fernandez-Corugedo (2004) provides a detailed overview of the consumption theory.*

VAR model, consisting of the two endogenous variables $y_1$ a $y_2$ (both are non-stationary, type I(1)). For the sake of simplicity, we will assume two lags:

$$y_{1,t} = \mu_1 + a_{1,1}y_{1,t-1} + a_{1,2}y_{2,t-1} + b_{1,1}y_{1,t-2} + b_{1,2}y_{2,t-2} + \varepsilon_{1,t}$$
$$y_{2,t} = \mu_2 + a_{2,1}y_{1,t-1} + a_{2,2}y_{2,t-1} + b_{2,1}y_{1,t-2} + b_{2,2}y_{2,t-2} + \varepsilon_{2,t},$$

which corresponds to the following in vector notation:

$$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \varepsilon_t.$$

The equation (2) contains a vector of endogenous variables ($y_t$), a vector of constants ($\mu$), matrices of the coefficients of lagged variables ($A_1$ and $A_2$) and a vector of deviations ($\varepsilon_t$).

The VAR model notation can be transcribed to an error correction form. The resulting model is called vector error correction (VEC):

$$\Delta y_t = \mu + \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \varepsilon_t.$$

Based on the rank of the estimated matrix $\Pi$, we can decide whether the variables $y_1$ a $y_2$ are co-integrated as well as decide on the number of co-integration vectors. The number of co-integration vectors is always lower than the number of endogenous variables.

## DATA

We have used quarterly data for 1996 to 2005 to model the consumption function. We have not included the last up-to-date data for 2006 in the estimates, which allows us to compare out-of-sample consumption forecasts with the actual values. All time series have been converted to real values using the consumer price index and they have been seasonally adjusted. We realize that in terms of the general conception it would be better to use the consumption deflator, but we are not convinced about the reliability of the deflator data. After adjustments for the consumer price index, the estimated models had better statistical properties than under the use of the consumption deflator. In addition, the said deflator can be changed during data revision.

The modeled variable in this material is c, representing the final consumption of households. The national accounts set up by the Statistical Office of the Slovak Republic (in m. SKK) are the data source.

Like Côté and Johnson (1998) and Singh (2004), we use variables reflecting both income elasticity and the wealth effect.

Household income is most frequently represented by gross disposable income ($y$). This time series, just like consumption, comes from the national accounts and it is expressed in millions of SKK. We expect the disposable income to have a positive impact on consumption with an elasticity between 0 and 1.

The selection of the variable for reflecting the financial wealth effect is somewhat more complicated. Financial wealth is usually approximated by the monetary aggregate (M2) in the literature (Artl et al., 2001, Filáček, 1999). Possibly, bank loans are subtracted from the M2 aggregate, if applicable[3] (Berdin and Cuthberson, 2001). One of the proxies used is quasi money (Singh, 2004). In the circumstances of Slovakia, the best solution would be to use data regarding the financial assets of households, which are also included in the national accounts. A drawback of this solution is the fact that only annual data is available, which renders the use of the data impossible in this analysis. Hence, we have tested four variables as financial wealth proxies:[4] The first two variables are the monetary aggregate M0, i.e. currency in circulation, and the monetary aggregate M2, including cash savings. We later extended the monetary aggregate M2 to include household assets in mutual funds (PF)[5], which have become an increasingly important part of population savings. As the last proxy, we have tested the sum of quasi money, i.e. the difference between the aggregates M2 and M1, and assets in mutual funds. The source of this type of data is National bank of Slovakia.[6] We expect the wealth elasticity of consumption to be positive and smaller than one.

An important part of the non-financial wealth of households, especially in recent time, is housing wealth. For the sake of completeness, the value of real property should be added to the model, but this time series is not available for Slovakia. We can, however, assume that the impact of real property on consumption is not high in Slovakia, mainly due to its lower liquidity. On the other hand, some empirical works (e.g. Sierminska and Takhtamanova, 2007) hold that the value of housing wealth has a higher impact on consumption than financial wealth in developed countries. This implies for us that it is important to start monitoring this indicator also in Slovakia.

According to published empirical works and the data available for Slovakia, we have identified several variables that can affect consumption. One of them is the level of interest rates. We have used the BRIBOR interbank rates with a maturity of 1, 3 and 6 months, as well as rates on loans to households. Higher interest rates make saving more attractive and are likely to reduce also the demand for loans and this can subsequently be reflected in a drop of final consumption. Viewed from this standpoint, the interest rates have a negative impact on household consumption. On the other hand, higher interest rates cause an increase in the financial wealth of households, and if the wealth effect is positive, the impact of interest rates on consumption is positive, as well.

The growth of the employment (zam) has a positive impact on consumption, because it holds that the higher the number of employees, the higher the income of households. However, this effect is questionable, because the impact of the growth of the employment rate has been already included in the higher disposable income of the households. On the other hand, an employed person has better expectations regarding future income than an unemployed person, which, according to the life cycle theory, increases current consumption.

3 *Subtracting the loans entailed no significant estimates in the circumstances of Slovakia.*
4 *The use of the part of the M2 aggregate that contains population savings, yielded no reasonable results. We justify this by the fact that firms, too, are owned by particular individuals, so that an increase in savings has to be perceived as an increase in the wealth of the population.*
5 *Mutual fund data has been included in the statements of the NBS only since 2004. We got older data by an interpolation of annual data obtained from the Slovak Association of Asset Management Companies.*
6 *Monetary aggregates according to national methodology.*

Following Côté and Johnson (1998), we can include the consumer confidence indicator (ISD) in the estimated equations.

## CONSUMPTION FUNCTION ESTIMATE

We expect the variables we use to be non-stationary, and the formal tests conducted have confirmed the validity of this hypothesis. We have used two tests for stationarity testing: the Augmented Dickey-Fuller test (ADF) and Kwitakowski-Philips-Schmidt-Shin test (KPSS). The difference between them is that the null hypothesis of the ADF test assumes the presence of a unit root, while the null hypothesis of the KPSS test assumes stationarity of the examined time series. Identical results of both tests therefore considerably decrease the possibility of rejection of a true hypothesis. The results of both tests are unambiguous for all variables except quasi money[7] and tell us that the time series are not stationary. Their differences however are stationary, therefore we consider them integrated, which we denote as I(1).

Since we are modeling relationships between non-stationary variables, their mutual cointegration must be tested. Hence, we have applied the Johansen co-integration test to all four presented long-term equations. The test has confirmed the existence of a stationary combination of the variables. We can thus say that consumption, disposable income and wealth are cointegrated. In addition, only one cointegration vector has been found in all cases when three lags have been used. This means that current consumption is affected by the values from the four preceding quarters.

By using the vector error correction model, we have modeled the relationship between three variables. Long-term coefficients obtained from this estimate represent an estimate of the parameters of the consumption function, in particular elasticity on income ($\alpha$) and on financial wealth ($\beta$).

$$v_t = (c_{t-1} - const - \alpha y_{t-1} - \beta a_{t-1})\rho + \gamma_0 + \sum_{i=1}^{p} \gamma_i^T v_{t-i} + u_t,$$

where $v_t$ is the vector of the first differences of endogenous variables, $\rho$ is the vector of adjustment coefficients, $\gamma_i$ are vectors of estimated coefficients under lags of endogenous variables, $\gamma_0$ and const are constants and $\mu_t$ is the vector of deviations. The number of lags is limited by the values $p$ in this expression. As mentioned above, $p$ equals three in our estimates. For the sake of completeness, let us express the said relationships also by means of a formal notation:

$$v_t = \begin{pmatrix} \Delta c_t \\ \Delta y_t \\ \Delta a_t \end{pmatrix}, \quad \rho = \begin{pmatrix} \rho_1 \\ \rho_2 \\ \rho_3 \end{pmatrix}, \quad u_t = \begin{pmatrix} u_{1,t} \\ u_{2,t} \\ u_{3,t} \end{pmatrix}.$$

Estimates of the long-term equilibrium between consumption, disposable income and wealth are presented in table 1. We have considered 4 alternatives with various definitions of wealth. In the first model, wealth is approximated by currency in circulation M0 and in the second model by the monetary aggregate M2. In the third model, we have extended M2 to include household assets in mutual funds and in the last model the sum of quasi money and assets in mutual funds is used.

Based on the size of the estimated coefficients, we can exclude the second model, because income elasticity cannot be higher than 1. For the same reason, we can exclude model 4. In addition, if we use the sum of quasi money (QM) and assets in mutual funds as a proxy for wealth, the estimated coefficient for a variable defined this way is non-significant. The reason can be the fact that the population holds a part of its savings in the form of currency in circulation. In the Czech Republic, one third of the respondents say that they save in the form of currency in circulation (Artl et al., 2001) and we can assume that there is a comparable situation in Slovakia.

According to the statistical properties and economic interpretation, we prefer to select a model featuring the M2 monetary aggregate and mutual funds.[9] This long-term equilibrium quantifies the income elasticity at 0.93 and the financial wealth elasticity is 0.34. The signs of both coefficients are in line with our expectations. We assume that the relatively high values of the coefficient in the case of disposable income are primarily due to two factors: the high average propensity to consume (defined as the consumption to disposable income ratio), as well as the low volume of loans granted to Slovak households. This means that the main determinant of household consumption is their disposable income. The financial wealth elasticity is lower.

The estimate of long-term elasticities for Slovakia is comparable to estimates for some other developed world economies. For example, in Canada an income effect and wealth effect of

*7 Quasi money is second-order-integrated according to the KPSS test, but the ADF test rejects the hypothesis of the presence of a unit root both for the first difference and for the level.*
*8 Under the Johansen co-integration test*
*9 Application of the so-called net wealth, i.e. subtrating the loan volume from the selected proxy, did not yield reasonable results.*

*Tab. 1 Estimates of consumption function coefficients*

| Dependent variable: $c_{t-1}$ | | | | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| *const* | -1.19 | -5.15 | -3.75 | -2.03 |
| $\alpha$ | 0.95 (-12.97) | 1.20 (-17.26) | 0.93 (-13.23) | 1.17 (-17.31) |
| $\beta$ $m0_{t-1}$ | 0.16 (-4.85) | | | |
| $\beta$ $m2_{t-1}$ | | 0.21 (-2.78) | | |
| $\beta$ $m2_{t-1} + pf_{t-1}$ | | | 0.34 (-5.46) | |
| $\beta$ $qm_{t-1} + pf_{t-1}$ | | | | $1.1*10^{-6}$ ($2.6*10^{-5}$) |
| Number of lags | 3 | 3 | 3 | 3 |
| Number of cointegration vectors[8] | 1 | 1 | 1 | 1 |

*Source: Own calculations.*
*Note: Values of t-statistics are given in brackets.*

0.98 and 0.36 (Côté and Johnson, 1998) and in the USA 0.59 and 0.31 (Lettau and Ludvigson, 2001) has been recorded, respectively. For Finland, these values have been estimated at 0.71 and 0.23 (Takala, 1995).

Due to the shortness of the time series of the consumer confidence indicator (it has been recorded only since 1999), we have not included this variable in exogenous variables. However, estimates for a shorter time interval have confirmed that, unlike for Canada (Côté and Johnson, 1998), it does not have a significant impact on the explanation of the short-term deviation of consumption from its equilibrium value in the case of Slovakia. Similarly, adding interest rates has not improved the properties of the estimated models.[10] The insignificance of the interest rate coefficient is probably due to the fact that the interest rate effect on consumption is included in the variable representing wealth both in the long-term and in the short-term relationship. Not even the application of real interest rates has brought about significance of their coefficients.

## CONSUMPTION FORECASTIG

In this part, we present a forecast of final household consumption using the VEC model. The advantage of this way of consumption forecasting is that all three variables are considered endogenous, implying that they affect each other. We have tested several ways of forecasting consumption; and we have obtained the most exact forecasts by using the VEC model extended to include exogenous variables.[11]

The VEC model includes three variables, household consumption, disposable income and a proxy for wealth, expressed by the M2 aggregate extended to include assets in mutual funds. We have added the exogenous variable level of employment, as well as two dummy variables to the short-term specification, one of the dummy variables taking value one in the first quarter of 2003, the other one in the first quarter of 2004. This model extension has significantly improved the indicators under observation and hence also the ability to forecast the future development of final household consumption.

Table 2 contains indicators, based on which we can assess the accuracy of a dynamic ex-post forecast in the 2003 to 2005 period.

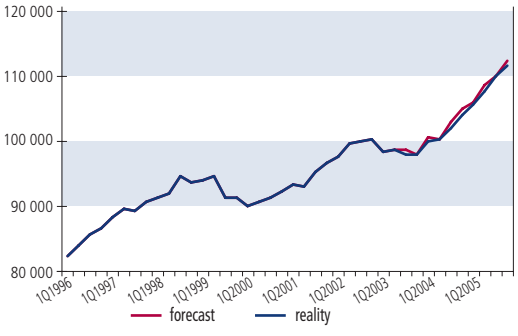
*Table 2 Indicators of consumption forecast accuracy*

| | | |
|---|---|---|
| Proxy for wealth | | M2+PF |
| Exogenous variables | | Yes |
| Adjusted $R^2$ | c | 0.730 |
| | y | 0.547 |
| | a | 0.086 |
| RMSP index[12] | c | 0.58 % |
| | y | 0.47 % |
| | a | 1.68 % |

*Source: Own calculations.*

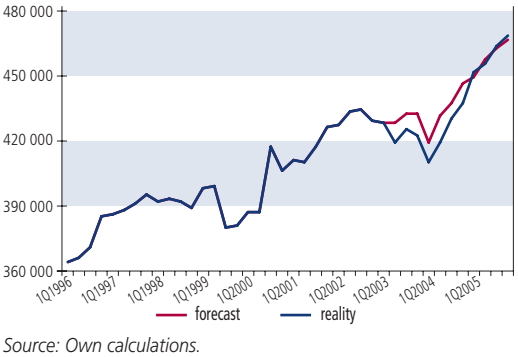
Charts 1 through 3 show forecasts for the individual variables.

*Chart 1 Final household consumption*



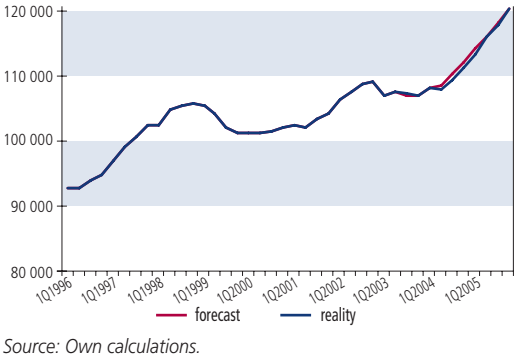

*Source: Own calculations.*
*Note: Dynamic forecast (period 2003:1, 2005:4)*

*Chart 2 Proxy for wealth (M2+pf)*



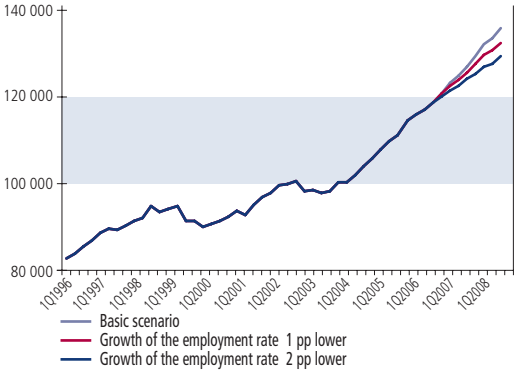

*Source: Own calculations.*
*Note: Dynamic forecast (period 2003:1, 2005:4)*

*Chart 3 Gross disposable income*




*Source: Own calculations.*
*Note: Dynamic forecast (period 2003:1, 2005:4)*

*Chart 4 Sensitivity analysis of the forecast*




*Source: Own calculations.*
*Note: At 1995 prices. Seasonally adjusted data.*

10 *Goh and Downing (2000), too, have not found a significant relationship between the interest rates and household consumption in a short-term specification.*
11 *Testing of other ways of household consumption forecasting in Slovakia can be found in the paper Senaj (2007).*
12 *Root mean square percentage error.*

We have created a forecast for the years 2007 and 2008 using the selected model. We have taken the expected values of the exogenous variable employment from the medium-term prediction of the NBS. The selected model predicts a continuation of the growth in household consumption at the level of 6.5 through 7 %. We have also conducted a sensitivity analysis by looking at the development of the forecast after a reduction in the expected growth of the employment rate by 1 or 2 pp (chart 4). We have found out that a reduction in the expected growth of the employment rate by 1 pp will manifest itself in a decrease in the growth of final household consumption by 1 to 1.5 pp. This means that even under a pessimistic scenario, where the employment rate will grow 2 pp more slowly than expected, real household consumption will grow at an average rate of 4.5 %.

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