Keynesianism and Modern Economy

Ilona V. Tregub[*]

The Financial University under the Government of the Russian Federation

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Abstract

In this paper, attempt was made to analyze the basic laws of Keynes's theory by constructing a linear regression model. France was analyzed using data for the period from 2001 to 2010 to test the applicability of the constructed models for the prediction of economic variables. It was shown that despite the Keynes's claims that it is impossible to use the linear relationships between the factors for predicting macro-economic indicators because macroeconomic environment is intricate, some models have been constructed with the results that are adequate and suitable for forecasting.

JEL: B22; C20; E12; E17

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[*] Sc.D, Professor. Department: Mathematical Modeling of Economic Processes,
Email: itregub@fa.ru

1. Introduction

One of the most famous and recognized schools of economics, which offered their recipes regulation of the economy, are linked with the name of John Maynard Keynes (1883-1946). Keynes's ideas came to prominence after his work The General Theory of Employment, Interest and Money [1].

Keynes's theory has been widely used in practice by governments of developed countries after World War II as a tool to avoid economic crises. However, by 1970, this approach has led to inflation and the strong growth in debt and a rise in unemployment at the same time, which led to a decrease in interest in the work of Keynes.

Return of interest in Keynesian macroeconomics took place during the global financial crisis of 2007 [2]

During the financial crisis monetary policy is no longer adequate. Banks have reduced lending, the interest rate was lowered. Other words, Governments have begun put into practice the ideas of Keynes.

It is known that Keynes was opposed interpretations of the economy as an exact science. That his position was reflected in the famous debate with Tinbergen [3]. Keynes believed that economics should not claim to be accurate, and that his opponent underestimates the interdependence of factors. Referred to Tinbergen investment income, interest rates, consumption and costs at the macro level may depend on each other in a large variety of connections are typically nonlinear. Without denying the importance of econometrics in principle [4], Keynes believed that lack of understanding of the interdependence between the factors in a complex, changing world can be fraught with negative consequences in terms of adequacy of the model to the real world [5].

2. Description of econometric system

This is a time-series analysis aimed primarily to test different macroeconomic models of consumption, or more specifically to test the consumers' non-durable expenditure in ***France***. It aims to examine the extent to which household consumption (the exogenous variable) is directly related to present income (the endogenous variable) but also to investigate the influence of past income levels.

The study involves Ordinary Least Squares (OLS) regression of aggregate France consumption data to econometric functions, although focus is on the ***Keynesian and DHSY models***. The period that is covered in this paper is between 2001, when the country entered the new century, century of high tech and rapid progress and the current year of 2011.

There are many potential issues in modeling the aggregate French consumptions using time series data. One example is the existence of uncontrolled - i.e. beyond the scope of what the model can capture based on theory - economic factors that affect annual consumption of non-durable goods leading to autocorrelation, heteroskedasticity, model misspecification and so forth. Thus, the economic reason for pursuing this study is to investigate how the components of the model relate to each other and to analyze the causes of the consequently biased models.

The broad hypothesis being tested is that consumption is closely related to the level of current income and to the levels of past income (i.e. the lagged effect of income). The hypothesis rests on the idea that consumption is made possible depending on the amount of money available for spending. Also I'm going to include GDP indicator to the analysis, and determine which influences the most on the aggregate consumption: GDP or net income.

Keynesian theory (1936), what is also known as the Absolute Income Hypothesis (AIH), postulates that average and marginal propensities to consume decline with income. It was also said that consumption expenditures play a large role in determining aggregate income levels. However, Duesenberry (1949) with his Relative Income Hypothesis (RIH) suggested that consumption demonstrates only a laggardly response to income and reacts only passively.

Both the income and consumption time series that is considered in the models have been said to be non-stationary, an assertion rigorously tested. Furthermore, this paper is expected that they show linear upward trends. There are also other parameters which are included that are expected to further explain the relationship between income and consumption.

This paper seeks to explain consumption with one econometric model, but with comparison of the influences of two variables – Gross Domestic Product and Disposable income, to contest their credibility through the thorough testing of data, and to forecast the trends.

3. Data related to the model

The purpose of this study is to estimate a ***consumption function for France*** using time series data from ***the World Bank Statistics*** (2011)[1]. The consumption function has been a topic of much debate in the field of econometric modeling and has stimulated innovations in methodology.

The data used for the Keynesian model for consumption is the sum of household final consumption expenditure (private consumption) and general government final consumption

[1] http://data.worldbank.org/

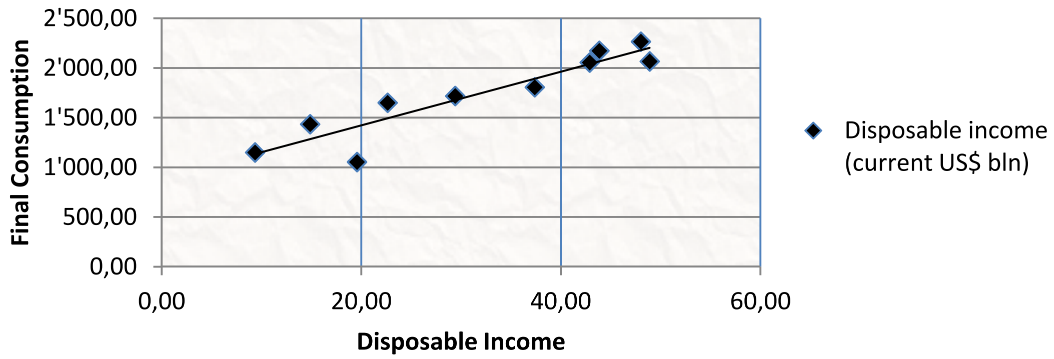
expenditure (general government consumption). This estimate includes any statistical discrepancy in the use of resources relative to the supply of resources. Data is provided in current U.S. dollars for ten-year period of 2001-2011. In this model the chosen data for the consumption parameter is estimated using the consumers' non-durable expenditure in the France at current USD prices (billion $).

Autonomous consumption represents consumption when income is zero. In estimation, this is usually assumed to be positive. The marginal propensity to consume (MPC), on the other hand measures the rate at which consumption is changing when income is changing. In a geometric fashion, the MPC is actually the slope of the consumption function.

The MPC is assumed to be positive. Thus, as income increases, consumption increases. However, Keynes mentioned that the increases (for income and consumption) are not equal.

Gross domestic product (GDP) refers to the market value of all final goods and services produced within a country in a given period. I've taken this value to compare its influence on consumption expenditure, in contrast to disposable income, because it's a common knowledge that in times of prosperity GDP rises and provides people with opportunity to consume more.

Disposable income is the amount of money that households have available for spending and saving after income taxes have been accounted for.



The chart above shows how disposable incomes and consumer spending have grown in the recent decade. This increase in incomes has been a factor behind the yearly growth of consumer demand in each of the last decades.

4. Model estimation. Construction of the econometric model:

According to the definition linear regression is an approach to modeling the relationship between a scalar variable *y* and one or more explanatory variables denoted *X*. Since Keynes Consumption

Function represents a linear model, we are going to use OLS (ordinary least squares). Two reasons occur when the issue comes to the use of linear regression:

- Prediction or forecasting, that is linear regression can be used to fit a predictive model to an observed data set of Y and X values. After developing such a model, if an additional value of X is then given without its accompanying value of Y, the fitted model can be used to make a prediction of the value of Y.
- Given a variable Y and a number of variables $X_1,..,X_p$ that may be related to Y, linear regression analysis can be applied to quantify the strength of the relationship between Y and the X_t, to assess which X_t may have no relationship with Y at all, and to identify which subsets of the X_t contain redundant information about Y.

4.1. Model Specification.

To specify the model, we need to convert a theory into a regression model. Keynes began with a very simple proposition: when income goes up, consumption increases, but not by as much as income. So: $0 < \frac{\Delta C}{\Delta D} < 1$.

$\frac{\Delta C}{\Delta D}$ is called the MPC (marginal propensity to consume). MPC is an additional consumption from an additional dollar of disposable income. So we can think of present consumption as a function of disposable income:

$C = MPC \times Yd$, where Yd is disposable income;

But is present income is not the only determinant of present consumption. So are accumulated past savings, access to credit, expectations of future income, social standards, etc. All these and other determinants of present consumption other than present disposable income we will call $ß_1$, or autonomous consumption so:

$$Y_t = \beta_1 + \beta_2 X_t + \varepsilon_t$$

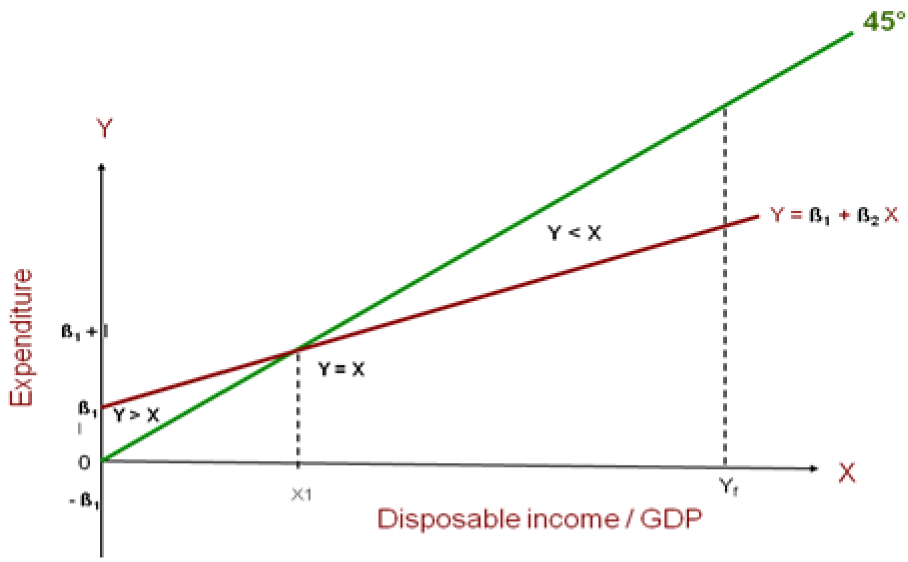
Since I've renamed the variables for a better understanding of the function, the interpretations are:

- $\mathbf{Y_t}$ is an aggregate consumption for the fiscal period 2001-2011; is a variable;
- $\mathbf{X_t}$ is both: 1) Gross Domestic Product; 2) Disposable Income;

- β_1 is "autonomous consumption", i.e. consumption does not depend on current income and past income; is constant;
- β_2 is Marginal Propensity to Consume
- ε_t is an error term measuring the extent to which the model cannot fully explain consumption

Consequently, "β_1" and "β_2" (MPC) are parameters to be estimated. Keynes' theory is satisfied if β_1 >0 and if β_2 lies between 0 and 1.

As you can notice the function takes form $Y_t = \beta_1 + \beta_2 X_t$ is linear function; β_2 is slope and β_1 is y-intercept. Consequently the consumption model can be plotted in expenditure/output (income) space:



Thus, the specified consumption model appears to be in form of:

$$\begin{cases} Y_t = \beta_1 + \beta_2 X_t + \varepsilon_t; \\ \beta_1 > 0; \\ 0 < \beta_2 < 1. \end{cases}$$

4.2. Coefficients' estimation.

In order to analyze the consumption function in Keynesian closed economy, with respect to Gross Domestic Product and Disposable Income relatively, it is necessary to use Microsoft Excel with all its variety of functions. At this point I'm going to describe all my calculations step by step. The full version of data available and the estimations on both functions you may find in Appendix.

Linear regression models generate the following statistics that describe the model as a whole.

Actually it's much easier to use Excel for calculating these estimators, because there's a "Data analysis" function, which provides us with all the needed estimators. When analysis the data we don't have to take the last values; they are needed to be left for checking the correctness of intervals.

To calculate other estimators, which are not given by this function, we need to know some formulas.

1) Thus, for example, to calculate *F critical*, one should enter a function "FРАСПОБР(probability;v1;v2)", or

Appendix 2: Table 5	Function	Result
F critical =	FРАСПОБР(0.05;1;7)	5.59

Appendix 1: Table 5	Function	Result
F critical =	FРАСПОБР(0.05;1;8)	5.31

2) Next estimator – *t-critical* also has a function in Excel, which is "СТЬЮДРАСПОБР(probability;v2)" or

Appendix 1: Table 5	Function	Result
t-critical =	СТЬЮДРАСПОБР(0.05;7)	2.36

Appendix 2: Table 5	Function	Result
t-critical =	СТЬЮДРАСПОБР(0.05;8)	1.33

3) Then, in order to *check the credibility*, we need to pass through next steps: denote Residuals as ε_i, and find ε_{i-1}, $(\varepsilon_i - \varepsilon_{i-1})$ and $(\varepsilon_i - \varepsilon_{i-1})^2$. Calculate the sum of squares $\sum_{n=9}^{1}(\varepsilon_i - \varepsilon_{i-1})^2$.

Appendix 1: TABLE 2	**ВЫВОД ОСТАТКА**				
		ei	***ei-1***	***ei - ei-1***	***(ei - ei-1)2***
Наблюдение	*Предсказанное Y*	*Остатки*			
1	*1408,57*	*-354,57*			
2	*1115,85*	*34,75*	*-354,57*	*389,32*	*151573,56*
3	*1274,06*	*161,04*	*34,75*	*126,29*	*15948,54*
…	*…*	*…*	*…*	*…*	*…*

9	*2104,74*	*68,86*	*41,87*	*26,98*	*728,05*
10	*2249,36*			*SUM OF SQUARES*	*216247,26*

Appendix 2: TABLE 2	**ВЫВОД ОСТАТКА**				
		ei	***ei-1***	***ei - ei-1***	***(ei - ei-1)^2***
Наблюдение	*Предсказанное Y*	*Остатки*			
1	1057,55	-3,55			
2	1151,34	-0,74	***-3,55***	***2,81***	***7,90***
3	1431,97	3,13	***-0,74***	***3,87***	***14,99***
…	…	…	**…**	**…**	**…**
10	2065,32	1,68	***55,08***	***-53,39***	***2850,97***
11	***2309,98***			*SUM OF SQUARES*	***9598,51***

4) Estimate the confidence interval for 95% when we take Disposable Income as a variable, and 78% confidence interval, when GDP is taken as a variable. Confidence interval has two boundaries: lower and upper. Lower level is calculated as: $Y_{10} - t_{crit} \times \sigma \quad or\ 2249.36 - 2.36 \times 167.73 = 1852.73$; and upper level is: $Y_{10} + t_{crit} \times \sigma \ \ or\ 2249.36 + 2.36 \times 167.73$ = 2645.99 .

Appendix 1: TABLE 3	***lower level***	***upper level***
Confidence interval (covers in 95%) =	***1852,73***	***2645,99***

Appendix 2: TABLE 3	***lower level***	***upper level***
Confidence interval (covers in 78%) =	***2278,5***	***2341,4179***

5) DW (Darbin-Watson) statistic equals $DW = \frac{\sum_{n=9}^{1}(\varepsilon_i - \varepsilon_{i-1})^2}{\sum_{n=9}^{1} \varepsilon i^2} = \frac{216247.26}{196943.91} = 1.098.$

6) Mistake of forecasting also contains an Excel function and is calculated as follows $\frac{ABS\,(Y_{10,11,forecasted} - Y_{10,11})}{Y_{10,11,forecasted}} = \frac{ABS(2249.36-2067)}{2249.36} = 0.08$.

Appendix 1: Table 3	*Function*	*Result*
Mistake of forecasting =	$\frac{ABS(2249.36 - 2067)}{2249.36}$	***0,08107***

Appendix 2: Table 3	Function	Result
Mistake of forecasting =	$\frac{ABS(2309.98 - 2293.60)}{2309.98}$	***0,0071***

7) And the last estimator to be calculated is GQ (and 1/GQ). It may be done, using the formula:

$$GQ = \frac{RSS_1}{RSS_2} = 3.98.$$

Appendix 1: Table 16	Function	Result
GQ =	176669.79/44370.09	3,981731549
1/GQ =	44370.09/176669.79	0,251147017
Fcrit =	FРАСПОБР(0,05;3;3)	9,276628154

Appendix 2: Table 16	Function	Result
GQ =	87.598/4032.04	0,021725626
1/GQ =	4032.04/87.598	46,02859252
Fcrit	FРАСПОБР(0,05;4;4)	9,117182253

4.3 Results interpretation.

The first step is to define what is known as a residual for each observation. This is the difference between the actual value of "Y" in any observation and the fitted given by the regression line that is the vertical distance between P_i and R_i in observation i. It will be denoted ε_i. it is known that $\varepsilon i = y_i - \beta_1 - \beta_2 x_i$. And hence the residual in each observation depends on our choice of β_1 and β_2. We choose β_1 and β_2 such that the residual becomes as small as possible. One way of overcoming the problem is to minimize the sum of the squares of the residuals – RSS. $RSS = \varepsilon_1^2 + \varepsilon_2^2 + \varepsilon_3^2 + \varepsilon_4^2 + \varepsilon_5^2 + \varepsilon_6^2 + \varepsilon_7^2 + \varepsilon_8^2 + \varepsilon_9^2 + \varepsilon_{10}^2$; RSS = 196943.9.

4.4 Estimated model specification.

Since the values for β_1 and β_2 were calculated previously and the results you may find in the Appendix, it is possible to construct an estimated econometric model for Keynes consumption function of France, which will depend on GDP:

$$\begin{cases} Y_t = \underset{(347,83)}{-46.4} + \underset{(0,13)}{0.82X_t} + \underset{(23,63)}{\epsilon_t} \\ R^2 = 0.997\ ;\ F = 2849.65\ ;\ Fcrit = 5.32 \end{cases}$$

The next estimated econometric model for Keynes consumption function of French economy depends on Disposable income:

$$\begin{cases} Y_t = \underset{(585{,}43)}{847.86} + \underset{(13{,}19)}{28.67} \cdot X_t + \underset{(167{,}73)}{\varepsilon_t} \\ R^2 = 0.87\,;F = 45.42\,;Fcrit = 5.59 \end{cases}$$

As far as the conditions were set as

$$\begin{cases} \beta_1 > 0 \\ 0 < \beta_2 < 1 \end{cases};$$

the first model, where we've used GDP as X-variable, is inappropriate, since its β_1 is less than zero. So the model I'm going to concern further will be only the model №2. In France the autonomous consumption is $847.86 bln, that is the French population spends this amount when their income level is zero. Such consumption is considered *autonomous* of income only when expenditure on these consumables does not vary with changes in income. If income levels are actually zero, this consumption counts as dissaving, because it is financed by borrowing or using up savings. Moreover, autonomous consumption is more than the average disposable income that means in France borrowings exceed incomes.

Of course there are standard deviations from actual values of parameters:

$$Y_t = \underset{(138.42)}{847.86} + \underset{(4.25)}{28.67X_t} + \underset{(167.73)}{\varepsilon_t}$$

4.5 Tests

At this point I'm going to test several indicators. The following estimators are also taken from the table in Appendix:

1) The coefficient of determination R^2 is used in the context of statistical models whose main purpose is the prediction of future outcomes on the basis of other related information. It is the proportion of variability in a data set that is accounted for by the statistical model. It provides a measure of how well future outcomes are likely to be predicted by the model. In such cases, the coefficient of determination ranges from 0 to 1. In our case $R^2 = 0.866$ indicates that the regression line fits the data well.

1) Though the coefficient of correlation is good, it could be obtained randomly. In order to check it out, it's necessary to pass F-test: calculate F and compare it to $F_{critical}$.

$$\text{if;} \quad \begin{cases} F > Fcrit\,, & R^2 is\, not\, random \\ F < Fcrit\,, & R^2 is\, random \end{cases};$$

In my consumption model F = 45.42, and $F_{critical}$ = 5.59. Proved that R^2 is not obtained randomly, and the coefficients β_1 and β_2 are very close to the actual values. The model is proved to be good.

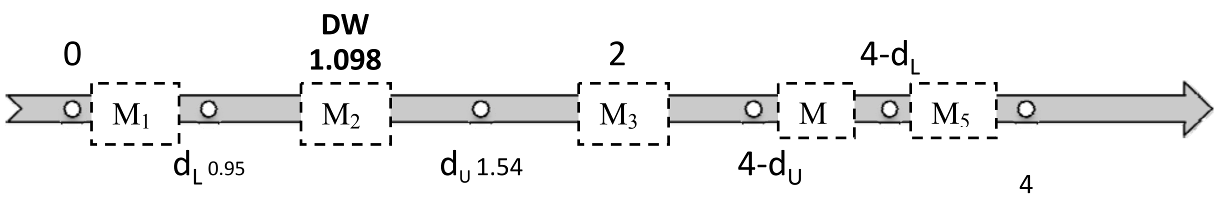
2) The next test is t-test: a statistical hypothesis test in which the test statistic follows a Student's *t* distribution if the null hypothesis is supported. Firstly it is used to check whether the coefficients we obtained previously are significant enough, and what is the percentage probability of getting those values by chance. In case of French economy:

$$t_{stat\,\beta 1} = 6.1;\ t_{stat\beta 2} = 6.7 \text{ and } t_{crit} = 2.36.$$

$$\begin{matrix} t_{\beta_1} > tcrit \\ t_{\beta_2} > tcrit \end{matrix};$$

The coefficients are significant with probability of 95%.

3) The last two tests are DW and GQ: the Durbin–Watson statistic is a test statistic used to detect the presence of autocorrelation (a relationship between values separated from each other by a given time lag) in the residuals (prediction errors) from a regression analysis.



DW appears to be between lower and upper boundaries, thus it's impossible to detect the presence or absence of autocorrelation in the residuals, and becomes inconclusive.

5) In the Appendix you may find estimated GQ = 3.98; GQ^{-1} = 0.25; Fcrit = 9.28. To estimate GQ, we need to divide the table into two arrays, k=5 (number of variables in the first array) and n-k=5 (the second array). Estimate regression equation for both arrays and find RSS_1 and RSS_2.

$$GQ = \frac{RSS_1}{RSS_2} = \frac{176669.8}{44370.1} = 3.98\,;$$

$$If \quad \begin{cases} GQ \leq Fcrit \\ GQ^{-1} \leq Fcrit \end{cases}.$$

Then homoscedasticity in regression analysis is considered to be credible. The estimators meet both conditions, GQ-test is passed. Consequently, Keynes consumption function model can be used for forecasting the French economy.

4.6 Checking reliability

I've mentioned the confidence interval, which is true for the forecasted values with the confidence of 95%. To check the credibility we need to calculate the forecasted value of Y_{10} (you may find it in the Appendix). $Y_{10} = \beta_1 + \beta_2 X_{10} = 847.86 + 28.67 \times 48.89 = 2249.4$. Then what is confidence interval? It is a particular kind of interval estimate of a population parameter and is used to indicate the reliability of an estimate. It is an observed interval in principle different from sample to sample, that frequently includes the parameter of interest, if the experiment is repeated. How frequently the observed interval contains the parameter is determined by the confidence level or confidence coefficient. Let's calculate the interval: $the\ upper\ level = Y_{10} + t_{crit} \times \sigma = 2067.00 + 2.36 \times 167.7 = 2645.99$, and $the\ lower\ level = Y_{10} - t_{crit} \times \sigma = 2067.00 - 2.36 \times 167.7 = 2645.99$. Thus you may notice that our observation lies between the confidence intervals, so our model is adequate on the level of σ=95%.

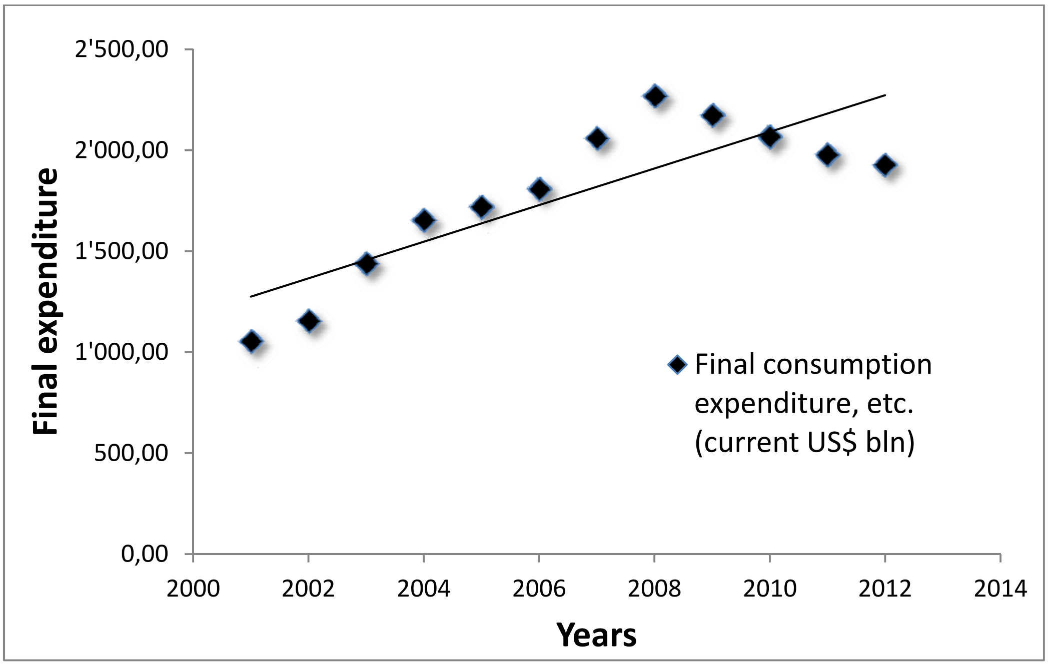
4.7 Model forecasting

According to the regression analysis we can conclude that to forecast the final consumption we may use probability approach, since the values don't contain time trend, and fluctuate around some variable.

Year	***Final consumption expenditure, etc. (current US$ bln)*** **(Y)**	***Disposable income (current US$ bln)*** **(X)**
2001	1 054,00	19,56
2002	1 150,60	9,35
2003	1 435,10	14,87
2004	1 650,30	22,63

2005	1 718,80	29,40
2006	1 806,50	37,37
2007	2 055,80	42,88
2008	2 266,00	48,01
2009	2 173,60	43,85
2010	2 067,00	48,89
2011	1 974,00	40,83
2012	1 926,96	39,23

The figures which are grayed out are predicted data. And the graph below shows the linearly approximated trend of the final consumption and includes the predicted figures for further 10 years 2011-2012.



5. Conclusions.

Throughout this paper I have explored the problem of explaining consumption using French data. I have applied many commonly used econometric tests and examined a few significant models to which the study was focused.

The aim was to determine which variable is more efficient to use: Gross Domestic Product or Disposable Income. According to 4.2 disposable income is more appropriate variable, because it resulted in an adequate model, since it meets all the conditions. Moreover, this paper demonstrated that consumption does depend on current income and past income. The lagged effect of income on consumption implies that consumers do not spend all their income but rather smooth out their consumption by saving and borrowing over the long run. F-test showed that the regression fits the line well. R^2 is not obtained randomly, and the coefficients β_1 and β_2 are very close to the actual values. T-test shows that both coefficients are significant. DW-test indicates that it's impossible to detect the presence or absence of autocorrelation in the residuals, and the model is inconclusive. GQ-test resulted as homoscedasticity in regression analysis is considered to be credible. The estimators meet both conditions, GQ-test is passed. Consequently, Keynes consumption function model can be used for forecasting the French economy. The confidence interval was detected and is correct with probability of 95%. Thus you may notice that our observation lies between the confidence intervals, so our model is adequate.

There is room to improve these existing models or even establish new ones based on the results of this study. As with many models, a definitive answer will never be found as to what exactly and how it describes consumption in the United Kingdom but I have achieved my aim of examining well known models with interesting econometric techniques.

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