An Econometric Analysis Of Air Travel Demand: The Moroccan Case

Elmostafa Erraitab, PhD Student
University Hassan II, Faculty of Low, Economic and Social Sciences
/ Laboratory of Research in Economic Performance and Logistics,
Mohammedia /Morocco

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Abstract

Given the importance of the air traffic analysis both for airlines and civil aviation authorities, the main aim of this paper is to develop an econometric model to analyze, assess and forecast the air travel demand in Morocco. To select the relevant variables, the all possible regression procedure was conducted. The model containing price index consumer, the gross national product, household final consumption per capita and international tourist's arrivals is the most appropriate model to represent the demand for air travel in Morocco.

Keywords: Air travel demand; Modeling air travel demand; all possible regression procedure; Morocco

Introduction

Air travel demand modeling is a major determinant of airport planning. In fact, forecasting errors of air travel demand can be very expansive. Underestimate the air traffic demand can cause airport facilities congestion, increasing wait time and inadequate airport facilities. In the same time, overestimate the air traffic demand can induce serious financial problems for airport authorities. Air travel market analysis allows airlines to rationalize its human and financial resources and estimate future needs for recruitment and training manpower. Moreover, air travel market analysis allows airlines to assess objectively the current and future air travel demand by destinations and routes.

Over the period 1970-2000, air traffic has been trending regular evolution. However, once Moroccan government conducted a voluntary policy of air service liberalization, air passenger traffic recorded an average annual growth rate of 9% over the period 2005-2012. Indeed of air traffic increase, the policy of air service liberalization has reconfigured the

Moroccan air travel market, there was a massive affluence of low cost carriers (LCC) and diversification of flight supply, as a consequence, the number of low cost European companies' weekly frequencies in the Moroccan market, rose from 600 in 2003 to 960 frequencies in 2009. This increased supply flights require a similar increase in airport facilities. Such a rapidly increase on aviation demand requires significantly accurate tools for short-term and long-term analyzing and forecasting. Thus, the main purpose of this paper is to develop an econometric model that not only predict traffic but also determine the impact of changes within the economic environment on traffic.

This paper is organized as follows. Section 2 provide the literature review and section 3 presents data source used to analyze and develop an econometric model for air travel demand in morocco. Section 4 describes the chronology of the air traffic development in Morocco. Section 5 presents the determinants of air travel demand in Morocco while the sixth section display a descriptive analysis based on matrix correlation. Section 7 section describes the base model development. Base model run results is provided and commented in section 8. Finally in section 9, conclude the paper.

Literature review

The rapid growth of global air traffic has attracted the attention of many researchers and academics in the period 1970-2012, global air passenger traffic achieved an average annual growth rate of 5.4% (The World Bank IBRD-IDA). Studies that explore the air traffic demand has emerged strongly over the past four decades, and an abundant literature dealing determinants of air traffic demand has emerged.

There are several methods to model the air travel demand, ranging from methods based on time series, which can be summarized in two approaches, Box&Jenkins (1976) univariate approach and multivariate approach based on VAR and VECM, until approach based on econometric modelling. Time series certainly has a strong predictive power, especially in short term, but are limited by their inability to determine the causes of changes in the explanatory variables. They cannot, for example, quantify the impact of rising income on the air travel demand. This question requires the specification and development of an econometric model that links changes in traffic demand with other relevant variables.

The study conducted by (Jung & Fujii, 1976) is considered one of the pioneering works in terms of estimating the price elasticity of air travel demand. Nevertheless, the authors did not consider the differences from one trip to another; the price elasticity of demand for air travel for a passenger who wants to spend his weekend in another city is not the same as if he has to travel for business. This is confirmed by a recent study by (Callaghan & Tol, 2013) where business trips are price inelastic but highly time elastic.

The quality[15] of air service is an important factor for modeling the air travel demand; this factor was still ignored at several studies that aim to model the air travel demand. (Spence, 1975, cited by ((Ippolito, 1981)), considers that this variable is the key element of product differentiation. Despite the theoretical interest of the variables that represent the level of air traffic services, empirical models for modeling the demand for air passenger traffic have generally assumed that demand is insensitive to the air level service quality (example (De Vany, 1974). (Jung & Fujii, 1976). In 1975 (De Vany, 1975) caught the omission of air service quality in his model (1975), he integrated flight frequency as an indicator which can reflect the quality of service, although the empirical results for the variable frequency of flights were unsatisfactory, but this study has the merit of including the variable quality of service as a determinant of air travel demand. To take into account the variable quality of service, (Ippolito, 1981) has specified the following model:

Equation 1 : Model taking into account the quality of service variables, (Ippolito, 1981)

$$Q = A\exp(bF^2)N^{\beta}\left[(Q+Y)/S\right]^{\alpha}$$

Where Q represents the origin/destination demand, Y passengers in transit, N flight frequencies, (Q + Y) / S is load factor and S is the average size of aircraft (the number of seats). The estimation results of Équation 1 are compatible with the assumptions given by (Ippolito, 1981) ; the empirical results show that the demand for air travel is positively related to frequency of flights and negatively to load factor. However, the study results (Ippolito, 1981) come from a relatively small sample and carefully chosen to eliminate the theoretical and empirical problems. Hence, the study results are related to these study assumptions.

In order to detect the determinants of domestic air traffic in the case of Saudi Arabia, (Abdullah O, Seraj, & Sajjad, 2000) used the technique of stepwise regression to find the best econometric model of the air traffic demand. The authors split the income into several categories; oil-GDP, Private Non-oil GDP, Government Non-oil GDP and total Non-oil GDP. They found that the model containing the explanatory variables as population size and total spending, is the appropriate model to explain the demand for domestic air traffic in Saudi Arabia. Neither aggregate income nor any of its

[15] Quality can be defined as: 'To what extent service fulfills or exceeds the needs and expectations of consumers (Lewis and Mitchell, 1990).

components were significantly explanatory of demand for international air travel in Saudi Arabia.

(Alperovich & Machnes, 1994) used permanent rather than current income as relevant variable which determines the demand for international air travel demand, the authors have shown that the main source of misspecification for last studies is the omission of variables representing the wealth of the consumer. The authors fond that demand for air travel out of Israel is price-inelastic and income-elastic, the results of their study support the fundamental assumption that the wealth of consumers is the key determinant of demand for air travel. The authors divided the consumers' wealth in two categories; financial and non financial assets. They argue that an aggregate income variable which combines income from different sources may be inadequate, since propensity to travel may be different according to the source of income. The main innovation of this paper is that (Alperovich & Machnes, 1994) found that wealth variables display the anticipated positive signs and highly significant. Thus, the demand for air travel depends on consumer wealth and not only the current income.

In order to evaluate the economic impacts of permitting charter flights on tourism in Israel, (Haitovsky, Salomon, & Silman, 1987) have specified a two-equation model, one for overall tourism demand and the other for tourism demand addressed to scheduled flights. The resulting model has shown that regular flights demand is price-elastic in the presence of charter flights, that being said, the permitting of charter flights induces a fall in air fares of regular flights as a result of competition, and this indirectly promotes tourism in the countries that liberalize charter flights.

Data source

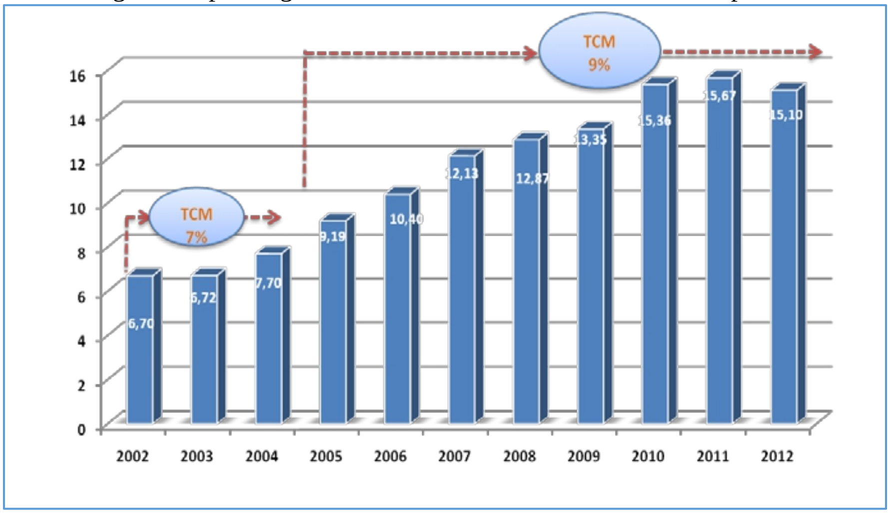
The data used to estimate the model have been taken from different sources. Data on Moroccan air travel are from Moroccan civil aviation authority database. The data on Moroccan social and economic characteristics that could affect demand for air traffic were taken from World Bank collection of development indicators (The World Bank IBRD-IDA).

Moroccan air travel developments

The geographical location and socio-political stability in Morocco, are considered as a significant factors to an important air traffic growth. Morocco is the first North African and seventh African country, with whom the United States signed an open skies agreement since 2002, in addition, indeed, in 2006, Morocco has signed with the European Union an open sky agreement, it was the first of its kind among the agreements between the European Union countries and non-EU countries.

Following the voluntary policy of air service liberalization conducted by the Moroccan government, the volume of air traffic passenger has increased from 6.7 million passengers in 2002 to 7.7 million passengers in 2006 and 15.2 million in 2012, realizing an average annual growth rate of 9% over the 2004-2012 period.

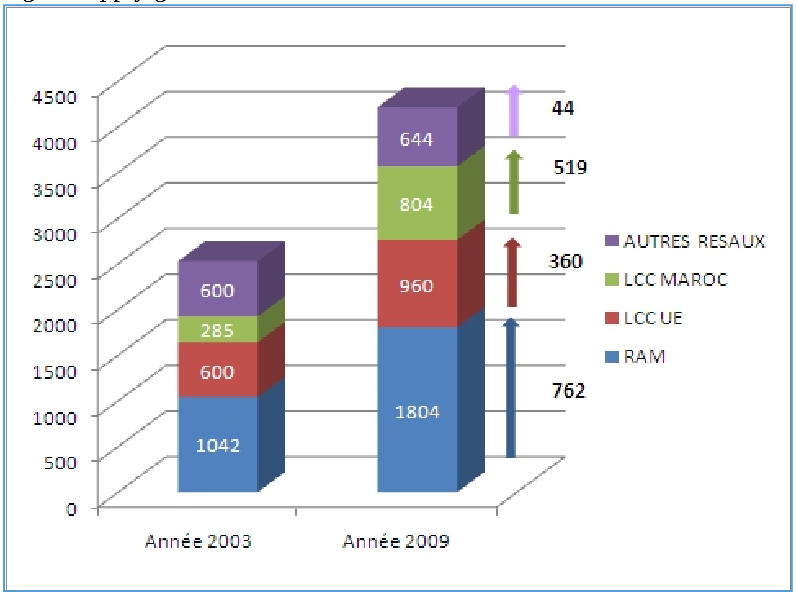
Fig 1 : Air passenger traffic evolution over the 2002 à 2012 period



Source: Author's calculations based on Moroccan Civil Aviation Authority data.

Airlines have strongly increased their supply since 2003, all types of airlines together, they have increased the seat supply over the period 2003-2009 by 1.685 additional monthly frequencies.

Fig 2 : supply growth of the Airlines that serve moroccan air travel market



Source : Author's calculations based on OAG data, may 2003-2009.

Taking advantage of the open sky agreement signed between Morocco and the EU in 2006, several low-cost airlines have begun to serve the Moroccan destination. Thus, the europeen low cost carriers alone have increased their monthly frequencies of 360 additional frequencies between 2003 and 2006, in turn, followed the trend, the Moroccan LCC increased their monthly frequencies of 519 frequencies over same period.

The determinants of air travel demand in Morocco

The literature review allowed us to identify several factors that impact the demand for air travel, these factors can be summarized into two categories; The first affecting air transport supply and second affect demand side.

The factors that affect the air transport supply sides include regulatory framework, airline strategy in terms of number and frequency distribution over the day and over the week, the level of service quality in terminal and during the flight, infrastructure capability and competition from the other transportation modes.

Factors that impact the demand sides of air travel include household wealth (Alperovich & Machnes, 1994), the population size and total expenditure (Abdullah O, Seraj, & Sajjad, 2000) and the purpose of travel (De Vany, 1974).

The examination of literature review allowed us to select a list of air travel demand explanatory variables.

Modeling air travel demand in morocco will enable us to decide on the significance of each variable. Before starting the conception and estimating the econometric model, we begin with a correlation analysis of the used variables list.

Correlation matrix analysis

Table 1 : Correlation matrix of the variables considered to explain air travel demand in Morocco

	PAX	GDPC	CPI	EGS	FCE	FDI	FF	GNI	HFCEPC	ITEP	ITET	ITNA	ITR
PAX	1	0,96	0,97	0,92	0,88	0,68	0,94	0,92	0,97	0,94	0,98	0,98	0,95
GDPC		1	0,99	0,95	0,85	0,77	0,96	0,97	0,99	0,96	0,96	0,99	0,97
CPI			1	0,96	0,88	0,76	0,97	0,97	0,99	0,97	0,97	0,99	0,97
EGS				1	0,85	0,81	0,95	0,95	0,93	0,95	0,89	0,95	0,98
FCE					1	0,65	0,87	0,90	0,84	0,87	0,87	0,90	0,87
FDI						1	0,70	0,77	0,76	0,77	0,69	0,73	0,84
FF							1	0,94	0,95	0,94	0,93	0,96	0,95
GNI								1	0,95	0,94	0,92	0,97	0,95
HFCEPC									1	0,96	0,98	0,98	0,96
ITEP										1	0,96	0,95	0,96
ITET											1	0,97	0,93
ITNA												1	0,96
ITR													1

Where GDPC : GDP per capita (constant 2005 US$), CPI: Consumer price index (2005 = 100), EGS: Exports of goods and services (constant 2005 US$), FCE: Final consumption expenditure (constant LCU), FDI : Foreign direct investment, net inflows (BoP, current US$), FF : Flight Frequency, GNI : HFCEPC : Household final consumption expenditure per capita (constant 2005 US$), ITEP : International tourism, expenditures for passenger transport items (current US$), ITET : International tourism, expenditures for travel items (current US$), ITNA : International tourism, number of arrivals, ITR : International tourism, receipts (current US$).

The correlation matrix shows that there is a high correlation between on the one hand, the consumer price index Household final consumption expenditure per capita, tourist spending, the number of international tourist arrivals and air traffic on the other.

One can observe that there is a strong correlation between the regressors variables and the dependent variable, it is a sign of collinearity presumption between independent variables. The presence of collinearity between the independent variables induces an increase of some estimated coefficients variance, instability of least squares coefficients estimator, and in case of perfect collinearity, the X'X matrix of regressors is singular, therefore it would be impossible to estimate the coefficients. Considering the problems that can cause the presence of collinearity phenomenon between the regressor variables, we must first check its presence and provide a procedure to treat it.

Farrar and Glauber test allows detecting the presence of collinearity. Appendix 1 gives program details for calculating the Farrar and Glauber test in Eviews.

According to the test results, it was found that the calculated chi-square is greater than the theoretical chi-square, $\chi_c^2 > \chi_{th}^2$,in this case we reject the null hypothesis H_0 of no collinearity and alternative hypothesis H_1 is accepted, there is a collinearity presumption among explanatory variables for air travel demand in Morocco.

As mentioned above, when there is an exact linear relationship between two or more explanatory variables, the linear regression equation becomes insoluble, that being said, one should keep only one of the explanatory variables among those that are perfectly correlated. This kind of collinearity treatment is especially true in cases where the correlated variables represent the same reality, when deleting one or several collinear variables, the remaining variable capture the effect of other removed variables.

Base model development

To find the right mix of explanatory variables, the all possible regression procedure for selecting independent variables was conducted (the detailed procedure program in Eviews is in Appendix 2. The procedure is to calculate all possible regressions or (2^k-1) regressions. In our case, we have to estimate 4095 models. Among 4095 models, we have to choose the appropriate model. The criteria for selecting the right model are the following:

a) All of the model coefficients must be significantly different to 0 and ;

b) The appropriate model must have the highest R^2

The procedure of selecting the relevant variables shows that the best model is as follows:

Equation 2 : Estimating the appropriate model on the basis of mix selection procedure

$$Y_t' = 11818357.89 - 168393.3848 * x_{2t} - 1.975783646e-005 * x_{7t} + 7502.938943 * x_{8t} + 2.624283968 * x_{11t}$$

(-2,30) (-4,66) (2,94) (8,02)

Adjested $R^2 = 0.990964$

NB. The values in parentheses represent the t-statistics of estimated parameters.

The R-squared (R^2), which can be interpreted as the fraction of the variance of the dependent variable explained by the independent variables, shows that there is a high linear relationship between air passenger demand in Morocco and the relevant variables chosen by the procedure (appendix 2), indeed, the F-statistic p-value, which is the marginal significance level of the F-test, is less than the significance level ($\alpha = 5\%$), so we reject the null hypothesis that all of the regression coefficients are zero.

Generally, when the time series are used, there is always a risk of falling into the error serial correlation phenomena when model is estimated by the OLS estimator. Therefore, before using the estimated model for statistic inference (eg, statistical hypothesis tests and projections), we should generally examine the residuals for evidence of serial correlation. Generally, according to ((Johnston & DiNardo, 1997), with 50 observations or more, and only a few independent variables, a DW statistic below about 1.5 is a strong indication of serial correlation of positive first order serial correlation.

Table 2 : Correlogram of residual squared

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. *| . |	. *| . |	1	-0.111	-0.111	0.2469	0.619
. *| . |	. *| . |	2	-0.153	-0.167	0.7515	0.687
. **| . |	. **| . |	3	-0.191	-0.239	1.5954	0.660
. *| . |	. **| . |	4	-0.107	-0.217	1.8816	0.758
. |***. |	. |** . |	5	0.343	0.240	5.0517	0.410
. *| . |	. *| . |	6	-0.122	-0.152	5.4901	0.483
. | . |	. *| . |	7	-0.052	-0.059	5.5784	0.590
. | . |	. | . |	8	-0.029	0.021	5.6089	0.691
. | . |	. | . |	9	0.000	0.011	5.6089	0.778
. | . |	. *| . |	10	0.000	-0.175	5.6089	0.847

Source: Author's calculations based on OAG data, world bank indicators database and Moroccan civil aviation authority database

The residual correlogram for the first 10 lags generated from equation (2) does not show a significant serial correlation in the residuals. This result is confirmed by the Breusch-Godfrey LM test for serial correlation of residuals.

Fig 3 : Test Breusch-Godfrey Serial correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.088754	Probability	0.915784
Obs*R-squared	0.296499	Probability	0.862216

Source : Author's calculations based on OAG data, world bank indicators database and Moroccan civil aviation authority database

The test does not reject the hypothesis of no serial correlation up to order two, The p-value of F-statistic and Obs * R-squared is well above the threshold of significance α 5%.

Results comment

By looking into the results of regression analysis of equation (2), it's found that variable X_2, which represents the effect of Consumer price index in Morocco, - holding other thing the same-, has a negative and significant effect on air travel demand in Morocco. As such, the Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. The consumer price index is usually calculated based on periodic surveys of price basket consumer. As shown in the regression results of equation (2), as consumer price index goes up by one percentage point, on the average, demand for air travel down by 16.8 million passengers. This result is consistent with those found by (Alperovich & Machnes, 1994), which showed that the air travel demand depends on the consumer total wealth. The inflation increase, as measured by consumer price index, increases artificially the basket price of goods and services purchased by a standard consumer, as a result, the consumer wealth, especially the current income, is modified.

Gross National Income (GNI), represented by the variable X_7, GNP under the old appelation, which represents the sum of value added produced by all residents plus any taxe product (less subsidies) not included in the production valorization, plus net receipts of primary incomes (compensation of employees and property income) from abroad. In other words, this variable is the sum of value added produced by national, whether in the country or abroad. According to the Moroccan tourism observatory, almost 95% of the air passengers are foreign tourists or the Moroccan living abroad. Therefore, it seems that the air travel demand in Morocco is influenced much more by macroeconomic aggregates emitting countries tourists than by economic fundamentals of the national economy. Although the GNP variable is significantly different from 0, his impact is very small, its coefficient does not exceed the value of 0.0000198.

Household final consumption expenditure per capita, represented by the variable X_8, have a positive and significant coefficient, the t-Student statistic value of his coefficient is 2.94, meaning that true X_8 coefficient is different from 0. This variable captures the effect of Household final consumption expenditure per capita, represented by the market value of all goods and services, including durable products (cars, washing machines, and home computers), purchased by households. In other words, the evolution of this variable reflects the standard of living of households, an increase in final consumption expenditure of households indicates an increase in household wealth. The X_8 coefficient sign is consistent with those found by (Schafer & David G, 2000), indicating that as far as personal income tends to increase, the people mobility increases accordingly by turning to other faster and more expensive modes of transportation. Thus, our results are consistent with what we found in the literature review on the air travel demand, the travelers mobility depends strongly on the passenger wealth. Nevertheless, the impact of this variable is a handle with care, its impact is very small, as X_8 goes up by one percentage point, - holding other thing the same, demand for air travel increased only by 0,7 million passengers. This confirms what we have said above, the air travel demand in Morocco largely come from international tourists and Moroccan living abroad.

The X_{11} variable, represents the international tourism, number of arrivals. This variable include international inbound tourists visiting

Morocco, ie, the number of tourists who travel to Morocco for a period not exceeding 12 months and whose main purpose in visiting is other than an activity remunerated from within the country visited. Under this definition, the Moroccan living abroad are also considered as foreign tourists.

The X_{11} variable has positive and strongly significant coefficient, this result is in line with those found by (Haitovsky, Salomon, & Silman, 1987), which concluded that the liberalization of charter flights in Israel, due to generation effect, forces scheduled air fares down and encourages improvement in the level of service; thus it indirectly favours tourism to countries permitting charter flights. Passengers on business trips or for other non-tourism purposes are price insensitive, but leisure purpose passengers are highly price sensitive.

The Moroccan government has adopted a deliberate policy of air service liberalization, it creates more competition between airlines, and such competition is played primarily on air fares. The introduction of low cost carriers in Moroccan air travel market induced lower air fares, increasing flight supply and diversification of destinations.

Conclusion

In this paper, an attempt is made to develop and estimate an econometric model explaining the air travel demand in morocco. The econometric model will be used as a tool to analyze and forecast the air travel demand, through establishing statistical relationship between selected demand-influencing factors and the corresponding level of traffic in morocco. In order to selecting the relevant variables, initially, we used correlation analysis, and then, we used a procedure that estimates all possible variables combinations and then choose between them the best model that satisfies the constraints required by the procedure.

We find that the model containing price index consumer, the gross national product, household final consumption per capita and international tourists arrivals is the best model. Thus, it seems that air travel demand in Morocco is dependent of socio-economic characteristics of transmitter States tourists.

The Moroccan civil aviation authorities and airlines, who want to deserve the Moroccan air travel market, can be based on this model to assess and predict the air travel demand in Morocco.

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Annexes

Annexe 1 : Farrar and Glauber test program in Eviews

```
equation eq2.ls  y c x1 x2 x3  x4 x5 x6 x7 x8 x9 x10 x11 x12
group mygroup1  x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12
mygroup1.cor
matrix mat=@cor(mygroup1)
scalar dt = @det(mat)
scalar khi = -(@regobs-1-(2*@ncoef+5)/6)*log(dt)
scalar ndf = 0.5*@ncoef*(@ncoef-1)
if @chisq(khi,ndf) < 0.05 then scalar test2 = 0
else scalar test2 = 1
endif
```

Annexe 2 : Based model selection with all possible regression in Eviews

```
!a = 1
FOR !I =1 TO 7
equation eq!a.ls Y C X!i
!a = !a + 1
next
```

```
'Equation à deux variables'
FOR !I = 1 TO 6
FOR !J = !I+1 TO 7
equation eq!a.ls Y C X!I X!J 'equation à deux variables
!a = !a + 1
next
next

'Equation à trois variables'
for !i=1 to 5
for !j=!i+1 to 6
for !k=!j+1 to 7
equation eq!a.ls y c x!i x!j x!k
!a=!a+1
next
next
next

'Equation à quatre variables'
for !i=1 to 4
for !j=!i+1 to 5
for !k=!j+1 to 6
for !l=!k+1 to 7
equation eq!a.ls y c x!i x!j x!k x!l
!a=!a+1
next
next
next
next

'Equation à cinq variables'
for !i=1 to 3
for !j=!i+1 to 4
for !k=!j+1 to 5
for !l=!k+1 to 6
for !m=!l+1 to 7
equation eq!a.ls y c x!i x!j x!k x!l x!m
!a=!a+1
next
next
next
next
next
'Equation à six variables'
for !i=1 to 2
for !j=!i+1 to 3
for !k=!j+1 to 4
for !l=!k+1 to 5
for !m=!l+1 to 6
for !n=!m+1 to 7
```

```
equation eq!a.ls y c x!i x!j x!k x!l x!m x!n
!a=!a+1
next
next
next
next
next
next

'Equation à sept variables'
for !i=1 to 1
for !j=!i+1 to 2
for !k=!j+1 to 3
for !l=!k+1 to 4
for !m=!l+1 to 5
for !n=!m+1 to 6
for !o=!n+1 to 7
equation eq!a.ls y c x!i x!j x!k x!l x!m x!n x!o
!a=!a+1
next
next
next
next
next
next
next

'Selection du meilleur modèle'
Scalar BEST = 0
FOR !I = 1 TO 127
scalar IND = 0
scalar NV = eq!I.@ncoef
for !J = 2 TO NV
scalar te =@abs( eq!I.C(!J)/sqr(eq!I.@covariance(!J,!J)))
scalar ddl = eq!I.@regobs-eq!I.@ncoef
IF @tdist(te,ddl)> 0.05 then ind = 1
endif
NEXT !J
IF IND = 0 then
 IF eq!I.@R2 > BEST then scalar neq= !I
 BEST = eq!I.@R2

ENDIF
ENDIF
NEXT
```

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