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METHODOLOGICAL PROPOSALS FOR A QUALITATIVE EVALUATION OF ITALIAN DURUM WHEAT VARIETIES

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Abstract:
In the complex frame of the EU agriculture politics, a particular relevant aspect is given by the new regulation on durum wheat production and diffusion incentives. These subsidies are assigned according to a particular indicator (Quality Global Index - QGI), built up through a weighted mean of four qualitative parameters. However, as we are going to show, the actual method used to evaluate QGI could not be statistically correct. In this work we propose, both from a theoretical and an empirical point of view, a comparison between the actual method and a series of alternative ones. A particular emphasis is given to a normalisation criterion, modified in order to properly take into account the asymmetry level observed on the four parameters empiric distributions.

Keywords: agricultural incentives; asymmetry; durum wheat quality; normalisation, statistical index.

JEL Classification: C43; H23; Q18.

1. Introduction

In the field of durum wheat production and diffusion in the European area, the late EU agriculture politics allow significant monetary incentives to farmers who use specific seeds, among the numerous varieties (*cultivars*) present in the market. In particular, the EU Regulation (Reg. 2237/2003 and 1973/2004) specifies parameters (x) and their weight (w) for the calculation of the *Quality Global Index* (QGI): hectolitric weight - HW (10%); protein level - PL (40%); gluten index - GI (30%); yellow index - YI (20%).

However, there is not a general agreement on the statistical procedure to be adopted for the calculation of QGIs. The policy maker defines the minimum limit - below which the admission to the EU incentive is not allowed - setting it at *98*, compared with *100* represented by the average of the *witness-cultivars*. The *witness-cultivars* are selected among the most diffused cultivars at national level. In Italy, 3 witness-cultivars have been originally identified: Creso, Duilio and Simeto.

According to these premises, from a statistical point of view the problem consists in identifying the right methodology to be used to synthesize the collected data for the quantification of the QGI [24], [12], [14]. The presence of the witness-cultivars, basis of reference for the calculation of the quality indicator, indirectly suggests the building of a series of weighted *index numbers*. However, in the recent past a serious mistake derived from the not appropriate use, for each variety, of a weighted arithmetic mean applied to the 4 original parameters quantified with non homogeneous measurement units [5], [15].

A successive improvement has been recently developed [7], on the basis of the above mentioned *indicisation criterion* (or *Ind*)*:* each parameter is divided by its mean and the final QGI is given by a weighted arithmetic mean applied to these 4 new transformed parameters. It must be pointed out that such a choice is explained by the necessity of eliminating differences

in the measurement scales of the V = 4 variables. However, indicisation eliminates measurement unit differences, but is still dependent on differences among variation ranges [12], [13] , e.g. differences between the highest and the lowest observed values: as referred by Pasqui [25], according to a data collection built up along five years (1994-1999), HW varies between 60 and 88 (*Max* - *Min* = variation range is equal to 28), PL from 11 and 16.5 (*Max* - *Min* = 5,5), GI from 0 and 100 (*Max* - *Min* = 100), YI from 17 and 32 (*Max* - *Min* = 15).

In this situation, *Ind* reduces, but does not eliminate diversity between parameters in terms of variation range. Recently it has been pointed out that *normalisation* (or *Norm)* should fit better with the problem concerned [28], [30], [14], [13].

More generally, herein one wants to link the specific aspect concerned with evaluation of durum wheat quality with the not new problem due to the need of a more careful use of ordering criteria for multivariate data [2], [4], [20], [26], [29].

After additional empirical and theoretical remarks (paragraph 2), in paragraph 3 we resume main features of linear transformations, while in paragraph 4 and 5 a new family of not linear transformation that can improve *Norm* is introduced. A series of methods, resumed and commented in paragraph 6, is applied to real durum wheat data in paragraph 7, while some perspective conclusions have been drawn in paragraph 8.

2. Empirical and theoretical remarks

If we consider a variable *h* measured on unit *i*, the *Ind* method simply consists in referring original data to their mean as x_{hi} / μ_h, obtaining new figures not dependent from measure unit used and the average magnitude of variables. However, since this criterion does not take into account the effective variation, range of the original variable, one can also use transformation $((x_{hi} - m_h)/(M_h - m_h)$ - where m_h and M_h are, respectively, the lowest and the highest value of the *h-th* variable - which can be defined as *Norm* method [6] [31]. Recourse to indicisation can be dangerous and lead to an under-evaluation of variables characterised by small variation ranges when m_h and M_h are quite different among variables. In [13] the authors present a Theorem showing that, in order to have parameters with the same weight, it is necessary to apply the procedure of normalization otherwise variables with a large range of variation (*rv*) are "overweighted" with respect to variables with a small one.

In the following example (see Table 1) final scores were got by simple arithmetic mean of the 4 transformed variables (indicised or normalised), while its relative weight on final score (that has not to be confused with weights w defined above) is the mean (over n units) of ratios between the transformed variable and final score. We have *n* = 7 units and 2 variables characterised by the same mean (8.7), the same minimum (1.0) but a different maximum (18.0 for variable A and 13.0 for B). *Ind* leads to a synthetic score on which, on the average, the relative weight of the 2 original variables is approximately the same (respectively, 0.49 and 0.51); on the other hand, *Norm* emphasises the highest relevance of variable B (0.57) respect to A (0.43). That is because, given the mean, using *Norm* a whatever *x* value is more influent respect to the variable having the lowest variation range (B in this case).

For instance, units 2 and 5 have the same original *x* values for A and B (respectively, 5.0 and 10.0): while using *Ind* both variables assume the same weight (0.50) on the final score of these units, using Norm the relative weight of variable B is quite higher (0.59 for both units). Moreover, an increase of one point for A produces, on unit 2, an increase of final score equal to 9.03% with *Ind* and to 10.34% with *Norm* (so, the relative effects are quite similar), while an increase by one point for B leads to an increase of final score still equal to 9.03% with *Ind*, but quite higher with Norm (14.66%). Generally speaking, a transformation based on *Ind* seems to be more suitable when the purpose consists in building up a series of independent

index numbers, without the need to synthesise them into a unique overall performance indicator.

Table 1 - Comparison between *Ind* and *Norm*

	Variables		*Indicisation*			*Normalisation*		
Unit	A	B	Score	Weight A	Weight B	Score	Weight A	Weight B
1	1,0	9,0	1,15	0,10	0,90	0,67	0,00	1,00
2	5,0	5,0	1,15	0,50	0,50	0,57	0,41	0,59
3	6,0	11,0	1,95	0,35	0,65	1,13	0,26	0,74
4	7,0	1,0	0,92	0,88	0,13	0,35	1,00	0,00
5	10,0	10,0	2,30	0,50	0,50	1,28	0,41	0,59
6	14,0	13,0	3,10	0,52	0,48	1,76	0,43	0,57
7	18,0	12,0	3,44	0,60	0,40	1,92	0,52	0,48
Mean	8,7	8,7	2,00	0,49	0,51	1,10	0,43	0,57
$Max - Min$	17,0	12,0	2,52			1,57		

However, also *Norm* results could be heavily affected by potential outlier values for minimum and/or maximum [1]. Moreover the effects of *Norm* are less immediately clear when original variables are characterised at the same time by different mean, minimum and maximum. In the following table 2, seven varieties of durum wheat are compared according to the same 4 variables used in the application of paragraph 7: HW, PL, GI and YI. Variation ranges are quite different and vary from 1.6 (PL) up to 37.5 (GI). The main results concern variety 1, since its score is lower than the mean using IND, but higher with Norm; that is mainly because *IND* does not assign enough relevance to the first place occupied by this variety in the ranking, characterised by the lowest variation range. However, on the average, using *Norm* PL is not the most influent variable on final scores: while its relative weight is 0.22 - as for HW - the highest weights concern YI (0.29) and GI (0.27).

This potential problem can be reduced using as minimum and maximum *ad hoc* theoretical values instead of empirical ones; however, this choice could not completely eliminate the problem if at least one of them is not representative because quite far respect the mass of data of the observed distribution.

Generally speaking a useful preliminary step is given by an explorative analysis of data and their density distributions [17] [18].

Table 2 – Comparison between *Ind* and *Norm* for some *cultivar*

Cultivar	*Variables*				*Final score*	
	HW	PL	GI	YI	*Ind*	*Norm*
1	98,5	13,7	60,5	19,8	3,93	**2,18**
2	98,8	12,1	75,0	23,1	**4,19**	2,12
3	100,0	12,6	40,0	23,6	3,72	1,77
4	98,4	13,6	75,5	22,7	**4,29**	**2,95**
5	103,5	12,3	44,0	17,1	3,49	1,23
6	99,4	12,5	73,0	20,9	**4,09**	2,07
7	97,1	13,5	77,5	22,3	**4,29**	**2,68**
Mean	99,4	12,9	63,6	21,4	4,00	2,14
Min	97,1	12,1	40,0	17,1		
Max	103,5	13,7	77,5	23,6		
Max − *Min*	6,4	1,6	37,5	6,5		
Avgw *Ind*	0,25	0,25	0,25	0,25		
Avgw *Norm*	0,22	0,22	0,27	0,29		

Avgw = Average weight; in bold, units with scores not lower than the mean

3. Variables transformation and choice of the mean

If x_{hi} is the value that the variable h = 1, 2,..., k assumes on unit i =1, 2,..., n, one can define a general linear transformation of original data, given by:

$$y_{hi} = a_h + b_h x_{hi} \qquad (1)$$

The most important feature of a linear transformation is *proportionality* [1]: it allows keeping the same ratio between observations with a different origin $a_h \neq 0$ and scale $b_h \neq 0$. In addition, transformed variables (1) keep the same linear correlation each other characterising the original x -variables; this property is not guaranteed using not linear transformations (as that proposed in paragraph 4).

Many of the most used transformations of original data can be reconnected to (1) for particular choices of a_h and b_h. In particular, when $a_h = 0$ and $b_h = 1/\mu_h$ one gets *IND* method: $y_{hi} = x_{hi}\mu_h^{-1}$; when $a_h = -m_h/(M_h - m_h)$ and $b_h = 1/(M_h - m_h)$ one gets *Norm* method: $y_{hi} = (x_{hi} - m_h)/(M_h - m_h)^{-1}$.

Given (1), a first consideration concerns the kind of mean used for synthesizing values y_{hi}. If w_h represents a series of given weights summing up to one, the use of a weighted arithmetic mean (*A*) or a weighted geometric mean (*G*) leads, respectively, to the global scores:

$$s_{(A)i} = \sum_{h=1}^{k} (a_h + b_h x_{hi}) w_h; \qquad (2)$$

$$s_{(G)i} = \prod_{h=1}^{k} (a_h + b_h x_{hi})^{w_h}; \qquad (3)$$

One can suppose that for the *i-th* unit one variable - say, variable r - increases of one point. As a consequence, according to (2) the *gain* of the global score will be given by $b_r w_r$ and the ratio between the increased score s^{+1} and the old score s will be:

$$\frac{s^{+1}_{(A)i}}{s_{(A)i}} = \frac{\sum_{h=1}^{k}(a_h + b_h x_{hi})w_h + b_r w_r}{\sum_{h=1}^{k}(a_h + b_h x_{hi})w_h} = 1 + \frac{b_r w_r}{s_{(A)i}} \tag{4}$$

The main consequence of (4) is that the choice of the variable *r* that, when increased by one point, produces the highest gain in global score for the *i-th* unit *does not depend* from the level assumed by this unit for any particular variable. On the other hand, the choice should be in favour of the variable with the highest weight and/or the highest coefficient b_r: with *Ind* and *Norm* the highest gains are got, respectively, increasing the variable with the lowest mean and the lowest variation range. According to (3) it is easy to get the relation:

$$\frac{s^{+1}_{(G)i}}{s_{(G)i}} = \frac{(a_r + b_r x_{ri} + b_r)^{w_r}}{(a_r + b_r x_{ri})^{w_r}} = \left(1 + \frac{1}{(a_r/b_r) + x_{ri}}\right)^{w_r} \tag{5}$$

In this case, the main consequence of (5) is that the choice of the variable *r depends* from the single *x*-values and, given all the ratios *a/b*, it should be chosen the variable with the lowest level x_{ri}, meaning that it is more convenient to increase by one point the variable for which the *i-th* unit has the worst performance. Lets note that $a_h/b_h = 0$ with *Ind* and $a_h/b_h = -m_h$ with *Norm*, so that the highest gain is got increasing the variable with the lowest difference $(x_{ri} - m_r)$, that is the lowest *x*-value if $m = 0$.

Since one would appreciate an equilibrated behaviour of each unit for the single indicators - instead of a very good performance for one variable and low performance for the others { one could prefer a mean as (3), that awards more performance improvements for variables which assume the lowest values [12] [15]. A further point in favour of geometric mean is that it is more sensitive respect to low values (respect to the mean) than large values, and it can be helpful when some outlier values could cause an under-evaluation of the other units' performance. On the other hand, the main limit of geometric mean is that it cannot be used in presence of null or negative values.

Score *sensitiveness* respect to an increase of a variable can be obtained considering the elasticity of the global score that expresses the percent increase of score respect to an increase of one percent of the variable considered. This tool eliminates the problem due to different magnitudes and variation ranges of the single variables. As well known, if $y = f(x)$ elasticity is given by $e = (\partial y/\partial x) \cdot (x/y)$. It follows that, supposing that a_h and b_h are given (as it happens when witness durum varieties are used as benchmarks) and independent respect to any x_h, the elasticities respect to x_r for the *i-th* unit using
(2) and (3) are given by:

$$e_{(A)i} = \left(\frac{\partial s_{(A)i}}{\partial x_{ri}}\right)\left(\frac{x_{ri}}{s_{(A)i}}\right) = \ldots = \left(\frac{w_r b_r x_{ri}}{s_{(A)i}}\right) \tag{6}$$

$$e_{(G)i} = \left(\frac{\partial s_{(G)i}}{\partial x_{ri}}\right)\left(\frac{x_{ri}}{s_{(G)i}}\right) = \ldots = \left(\frac{w_r b_r x_{ri}}{a_r + b_r x_{ri}}\right) \tag{7}$$

From (4) and (6) it follows that $s^{+1}_{(A)i}/s_{(A)i} = 1 + e_{(A)i}/x_{ri}$. While elasticity cannot ever be constant when using an arithmetic mean - because of (6) - using a geometric mean elasticity will always be constant (so, independent from any particular level x_{ri}) for any transformation[1]

[1] It is well known that the only transformation characterised by a constant elasticity of *y* respect to *x* has the form: $y = (x/c)^{1/e}$, where *c* is a constant and *e* is elasticity.

such that $a_r = 0$. If $a_r \neq 0$, with geometric mean no general conclusion can be drawn on the quickness of global score change due to a one percent increase of a variable, because this effect will depend on the algebraic sign of the ratio a_r/b_r: if positive, elasticity will be higher for high x_r values; if negative (as, for instance, with *Norm*), the opposite will hold.

It also follows that $e_{(G)i} > e_{(A)i}$ if $a_r + b_r x_{ri} < s_{(A)i}$, that is when the contribution that the *r-th* variable gives to the global arithmetic score of the *i-th* unit is lower than the average contribution (that corresponds to the score itself when it is measured through (2)). This result confirms the higher sensitiveness of geometric mean respect to those variables assuming relatively low levels on the unit taken into account.

We have that (4) is equal to $1 + \left(w_r/\mu_r s_{(A)i}\right)$ if we consider *Ind* method and to $1 + \left[w_r/(M_r - m_r)s_{(A)i}\right]$ if we consider *Norm* method, so that the gain will always be higher with *Ind*, because it will always be $(M_r - m_r) > \mu_r$. Generally speaking, the highest is the variation range of a variable, the highest will be the increase of final score (due to a one unit increase of this variable) got with *Ind* rather than *Norm*, unless with the increase of variation range also the mean increases at least in the same proportion.

While (4) and (5) indicate the overall growth of score for one point growth of a variable, elasticities (6) and (7) express the score *growth quickness* when a variable increases of 1%.

A possible feature - even though not necessary - of transformed variable (1) is that the *average incidence* of each new variable on the final score is (approximately) the same; otherwise, given weights *w*, some new variables will keep to have a most relevant influence than others on the final ranking. According to (3), the average relative incidence of the *r-th* new variable on the final score - evaluated as a geometric mean of the relative incidences calculated on all the single n units - will be given by:

$$\sqrt[n]{\prod_{i=1}^{n}\left(\frac{a_r + b_r x_{ri}}{s_{(G)i}}\right)} = \left(\frac{\prod_{i=1}^{n}(a_r + b_r x_{ri})^{w_r}}{\prod_{i=1}^{n}\prod_{h=1}^{k}(a_h + b_h x_{hi})^{w_h}}\right)^{\frac{1}{n}} = \ldots =$$

$$= \left[\prod_{h=1 h\neq r}^{k}\left(\prod_{i=1}^{n}(a_h + b_h x_{hi})\right)^{\frac{w_h}{n}}\right]^{-1} = \prod_{h=1 h\neq r}^{k}(G_{y_h})^{-w_h} \qquad (8)$$

where G_{yh} is the geometric mean of the *h-th* transformed y-variable. According to (8) - without considering the effect of different weights *w* - each variable will have the same average incidence on the final score if and only if each geometric mean is equal to the others, that is $G_{yh} = G$ for each *h*. That is the main reason because a transformation as (1) should lead to new *y*-variables characterised by the same mean. In order to do that, after *Norm* one can still apply *Ind* on normalised values (*Norm-ind* method), getting to method *V* in the next Table 6.

A similar result can be also got using (2), providing to consider - instead of the mean of the *n* relative incidences - the mean of the *n* differences between each individual global score and the addendum of this score referred to the *r-th* variable, that is:

$$n^{-1}\sum_{i=1}^{n}\left(\sum_{h=1}^{k}\frac{y_{hi}w_h}{k} - \frac{y_{ri}w_r}{k}\right) = \ldots = \frac{1}{k}\sum_{h=1 h\neq r}^{k}\left(n^{-1}\sum_{i=1}^{n}y_{hi}\right)w_h =$$

$$= \frac{1}{k}\sum_{h=1 h\neq r}^{k}A_{y_h}w_h \ . \qquad (9)$$

where A_{yh} is the arithmetic mean of the *h-th* transformed *y*-variable[2].

[2] Of course, also an opportune choice of weights could guarantee the same result: it would be sufficient to put $w_h = log(c)=log(A_{yh})$ and $w_h = c=A_{yh}$ for some constant *c*.

4. A more general not linear transformation

If x is a modality of whatever among k measured variables, one can define a transformation $y = f(x)$ such that this condition in satisfied:

$$\frac{y - m_y}{M_y - y} = \frac{p_x(x - m_x)}{(1 - p_x)(M_x - x)} \tag{10}$$

where m_y and m_x are the lowest (minimum) values assumed by y and x, M_y and M_x are the highest (maximum) values assumed by y and x and p_x is a smoothing coefficient applied to the difference between x and its minimum, ranging from 0 to 1. The highest is p_x, the lowest will be the relative weight assigned to (M_x - x). The simple idea underlying (10) is that, when p_x = 0,5, after the transformation in the new y-scale the ratio between the distance of the transformed y value respect to its minimum and the distance between its maximum and the transformed y value must be equal to the same ratio measured on the original variable x. From (10) we get the not linear transformation:

$$y = \frac{M_y p_x(x - m_x) + m_y(1 - p_x)(M_x - x)}{p_x(x - m_x) + (1 - p_x)(M_x - x)} \tag{11}$$

that can also be seen as a weighted arithmetic mean of M_y and m_y, that are the extreme values that can be assumed by y. In particular, if one put p_x = 0.5, or M_y = 1 and m_y = 0, we get respectively:

$$\begin{aligned} y &= \frac{M_y(x - m_x) + m_y(M_x - x)}{(M_x - m_x)}; \\ y &= \frac{p_x(x - m_x)}{p_x(x - m_x) + (1 - p_x)(M_x - x)} \end{aligned} \tag{12}$$

while if the new variable y must range within [0,1], the first of (12) reduces to the common:

$$y = \frac{(x - m_x)}{(M_x - m_x)} \tag{13}$$

The not linear transformation (11) cannot be seen as a particular case of (1). Recourse to the first transformation (12) for each of the k original variables guarantees that all the new y-variables will range in the same interval (m, M) if M_y and my are the same for each y, e.g. if $M_{yh} = M$ and $m_{yh} = m$
for each h. Since the second relation (12) can be written as:

$$y = \left[1 + \frac{(1 - p_x)(M_x - x)}{p_x(x - m_x)}\right]^{-1} \tag{14}$$

it follows that - given x, M_x and m_x - y will be as much higher as p_x will be high, meaning a larger weight assigned to the difference between x and its minimum rather than the difference between the maximum and x. That can be useful when the minimum is more representative of the whole x-distribution rather than the maximum, as it should happen when x- distribution is affected by a strong positive asymmetry, as in many empirical contexts. The evaluation of distance of minimum and maximum from the whole distribution is a particular case of the wider problem concerned with distance of one point from a cluster of points [17].

In the example from Table 3, we have 15 units and 2 variables A and B, that have same minimum (1.0), maximum (10.0) and mean (3.97). According to *Ind*, *Norm* and *Norm-ind* methods, unit 3 is always at the seventh place of the final score ranking (in particular, all methods lead to the same rankings for all units) and the relative weight of variables A and B on its score is always equal to 0,5. In reality, one can note that the intrinsic significance of "4" in the A ranking is higher than in the B ranking, because it is the second best value for A (determining the third place of this unit), while it is only the eighth value for B. Maximum for A is less representative of the whole distribution than for B - whose 15 values present a linear trend - while it happens for A only if unit 1 and 2 (having both the maximum = 10,0) are considered apart.

Generally, choice of p_x depends on how much is more important to stress distance from the lowest value instead of the gap respect to the highest one. In case of perfect symmetry, one can put $p_x = 0.5$: this choice is equivalent to the use of the ordinary transformation (13).

Table 3 - The need to assign different weights to the same modality in 2 rankings

Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	*Min*	*Max*	*Avg*
A	10,0	10,0	4,0	3,9	3,9	3,8	3,6	3,5	3,2	2,8	2,7	2,5	2,4	2,2	1,0	1,0	10,0	3,97
B	10,0	4,5	4,0	1,0	5,5	8,4	4,1	7,4	2,4	1,4	1,0	1,0	6,0	1,0	1,8	1,0	10,0	3,97
Rank*	1	2	7	10	5	3	8	4	9	11	12	13	6	14	15			

(*) According to *Ind*, *Norm* and *Norm-ind* methods

5. Optimal choice of coefficient px

The choice of p_x can be driven by various criteria. Herein we propose 6 possible formulas, on the basis of which p_x will vary in the interval [0,1]. If $q_{(0,50)}$ is the median, we have:

$$p_{x(1)} = 0,5\left(1 + \frac{\mu_x - q_{x(0,50)}}{\sigma_x}\right) \tag{15}$$

$$p_{x(2)} = 0,5(1 + a_1) \tag{16}$$

$$p_{x(3)} = 0,5(1 + a_2) \tag{17}$$

$$p_{x(4)} = 0,5\left(1 + \frac{n_{(x \le \mu_x)} - (n/2)}{(n/2)}\right) \tag{18}$$

$$p_{x(5)} = \frac{\sigma_{x(x \neq m_x)}}{\sigma_{x(x \neq m_x)} + \sigma_{x(x \neq M_x)}} = 0,5(1 + a_3) \tag{19}$$

$$p_{x(6)} = \frac{M_x - q_{x(0,50)}}{M_x - m_x} = \frac{M_x - q_{x(0,50)}}{(M_x - q_{x(0,50)}) + (q_{x(0,50)} - m_x)} = 0,5(1 + a_4) \tag{20}$$

The first three formulas are explicitly based on the *x*-distribution asymmetry evaluation; formula (18) is connected with the relative weight of units with *x*-values not higher than the mean (they are $n_{(x \le \mu_x)}$); formula (19) is based on the distance between the highest and the lowest value and the other units, while formula (20) compares distance between the maximum and the median with that between the median and the minimum. If a distribution is symmetric (for instance, in presence of uniform or normal distributions), all the previous formulas turn out to be equal to 0,5.

Formula (15) is strictly connected with the *Pearson's second asymmetry coefficient*, given by $3(\mu_x - q_{x(0,50)})/\sigma_x$, leading to a value p_x higher than 0,5 (that is, an overweighting of differences between the maximum and *x* rather than *x* and the minimum) when mean is higher than median, as it happens in the case of positive asymmetry. In formulas (16) and (17) the following identities hold:

$$a_1 = \frac{V_R - V_L}{V_R + V_L} \; ; \; a_2 = \frac{D_R - D_L}{D_R + D_L} \tag{21}$$

where V is a variability index, *D* is the simple average deviation from the median, while labels *R* and *L* indicate a right and a left tail of the *x*-distribution. If one supposes that all *x*-values have been ordered in a not decreasing rank, in a_1, V_L is a variability index calculated on the first (*n*/2) terms (if *n* is unpair, on the first (*n* + 1)/2), while V_R is a variability index calculated on the last (*n*/2) terms (if *n* is unpair, on the last (*n* + 1)/2). Similarly, in a_2, D_L (D_R) is the simple average deviation from the median calculated on the terms not higher (not lower) than the median.

Both a_1 and a_2 are asymmetry indicators ranging from -1 and +1 [17]: they will be zero in case of perfect symmetry, higher (lower) than zero in presence of positive (negative) asymmetry. As a consequence, $p_{x(2)}$ and $p_{x(3)}$ will range in the interval [-1; +1] as well. A well known limit of these asymmetry indicators is that they can be zero even when asymmetry is not null.

One could limit variability of $p_{x(2)}$ and $p_{x(3)}$ into a smaller range simply putting, for instance, $p_x = 0.5(1 + 0.5a)$, so that in this case p_x will range in the interval [1/4, 3/4].

As yet said, formula (18) evaluates the relative frequency of units having *x*-values lower that the mean. In formula (19) one can substitute the expected relative frequency (*n*/2) in case of symmetry with (*n* + 1)/2 if n is unpair. Even though both of them vary in the interval [-1, +1], estimates derived by (18) will range between (*n* + 2)/2n and (3*n* - 2)/2*n*, since $n_{(x \leq \mu x)}$ ranges between 1 and (*n* - 1).

In formula (19), $x(x6=m_x)$ and $x(x6=M_x)$ are the *x* standard deviations calculated excluding, respectively, minimum and maximum. The simple rationale is that ratio (19) will be as much higher than 0, 5 as the degree of distance of maximum from the remaining values will be higher than the minimum. This function will range between -1 and +1 and will be equal to 0, 5 in case of perfect symmetry. One can note that in (19) can be considered a further draft asymmetry indicator (a_3), basically dependent on the extreme values of *x*-distribution, given by:

$$a_3 = \frac{\sigma_{x(x \neq m_x)} - \sigma_{x(x \neq M_x)}}{\sigma_{x(x \neq m_x)} + \sigma_{x(x \neq M_x)}} \tag{22}$$

Also formula (20) can be seen as a draft asymmetry indicator, putting:

$$a_4 = \frac{(M_x - q_{x(0,50)}) - (q_{x(0,50)} - m_x)}{(M_x - q_{x(0,50)}) + (q_{x(0,50)} - m_x)} = \frac{M_x + m_x - 2q_{x(0,50)}}{M_x - m_x} \tag{23}$$

From Table 4 - referring to the same data of table 3 and using as *V* the *x*-variance - one gets that p(A) - the relative weight of the difference ($x - m_x$) for variable *A* - ranges from 0.59 (method (15)) and 0.79 (method (16)). Respect to *Norm*, the position of unit 3 in final rankings would pass from the seventh to the sixth using all methods except (15); the effective relative weight of variable *A* on its final score is always higher than 0.50, reaching 0.68 using (18). The same effect occurs - even on a larger extent - on the average score of all the 15 units as well. Using the same data of Table 1, one would still get values for p quite far from 0.5, except that with method (18).

Table 4 - Results of weighting systems from (15) to (20) (same data of Table 3)

Method	Rank unit 3	*Coefficient p*		*Unit 3*		*Avg of 15 units*	
		A	B	Rw (A)	Rw (B)	Rw (A)	Rw (B)
Norm	7	0,50	0,50	0,50	0,50	0,58	0,42
(15)	7	0,59	0,49	0,56	0,44	0,62	0,38
(16)	6	0,79	0,67	0,56	0,44	0,63	0,37
(17)	6	0,66	0,46	0,62	0,38	0,64	0,36
(18)	6	0,75	0,44	0,68	0,32	0,68	0,32
(19)	6	0,74	0,52	0,63	0,37	0,65	0,35
(20)	6	0,72	0,67	0,53	0,47	0,61	0,39

Avg = Average; Rw = Relative weight

In the context of performance evaluation, use of not linear transformations is not uncommon. For instance, we can consider the composite indicator used by the Italian financial newspaper *Il Sole 24 ore* in its annual report *Qualità della vita (Life Quality)* of the 103 Italian provinces. For each province, the synthetic score is got summing up 36 variables x_h transformed in this way: $y_h = x_h/M_h$ if x_h is a dimension considered positive for the construct under study; $y_h = m_h/x_h$ if x_h is a dimension considered negative. The main limit of this method is that the resulting score is not monotone, because for small values of some variable *h* it could decrease as x_h increases, as yet underlined in literature [3]. According to considerations of paragraph 2, even these transformations can lead to a bias if minimum and maximum are quite different from one variable to another.

Finally, another useful not linear transformation is not based on *Norm* criteria, but on the simultaneous evaluation, for each unit, both of the original *x*-value and the correspondent place in the ranking, according to the *new indicisation method*:

$$y^*_{hi} = \frac{x_{hi} r_{hi}}{\mu_{(xr)h}} = x_{hi} R_{hi} \qquad (24)$$

where r_{hi} is the place occupied by the *i-th* unit in the ranking of the *h-th* variable and $\mu_{(xr)h}$ is the mean of products between x_{hi} and r_{hi}. Through transformation (24) it is implicitly possible to take into account not only the *x*-level, but the relative distance of this value respect to the other observed *x*-values as well. On the other hand, in this context the only use of rankings *r*, without any reference to original *x*-values, could be partially misleading.

6. A resume of methods and properties

Table 5 resumes the main transformations applied in the context under study. For arithmetic mean, score changes for a one unit increase of a variable and elasticity have been formalised[3].

In addition to widely discussed transformations as *I* and *IV*, we also introduce *II* - which is based on *Ind* applied using the median instead of the mean - and *V* - which is based on the same transformation than *Norm*, but substituting M_h with the mean μ_h. As yet underlined, that is equivalent to use *Norm* and then to apply again the *Ind* method.

[3] The corresponding formulas for geometric mean, even though applied in paragraph 7, have not been showed.

Table 5 - Different methods for calculating synthetic scores Arithmetic mean

Code	Trasformed variable y_{hi}	Change for $\Delta x = +1$	Elasticity
I	$y_{hi} = \frac{x_{hi}}{\mu_h}$	$1 + \frac{w_h}{\mu_h s_i}$	$\frac{x_{hi} w_h}{\mu_h s_i}$
II	$y_{hi} = \frac{x_{hi}}{q_{h(0,50)}}$	$1 + \frac{w_h}{q_{h(0,50)} s_i}$	$\frac{x_{hi} w_h}{q_{h(0,50)} s_i}$
III	$y_{hi} = \frac{x_{hi}}{M_h}$	$1 + \frac{w_h}{M_h s_i}$	$\frac{x_{hi} w_h}{M_h s_i}$
IV	$y_{hi} = \frac{x_{hi} - m_h}{M_h - m_h}$	$1 + \frac{w_h}{(M_h - m_h) s_i}$	$\frac{x_{hi} w_h}{(M_h - m_h) s_i}$
V	$y_{hi} = \frac{x_{hi} - m_h}{\mu_h - m_h}$	$1 + \frac{w_h}{(\mu_h - m_h) s_i}$	$\frac{x_{hi} w_h}{(\mu_h - m_h) s_i}$
VI	$y_{hi} = \frac{x_{hi} - \mu_h}{\sigma_h}$	$1 + \frac{w_h}{\sigma_h s_i}$	$\frac{x_{hi} w_h}{\sigma_h s_i}$
$VII^{(1)}$	$y_{hi} = \frac{(x_{hi} - m_h)(M_h - m_h)}{\sum_{h=1}^{4} (M_h - m_h)}$	$1 + \frac{c(M_h - m_h) w_h}{s_i}$	$\frac{c(M_h - m_h) x_{hi} w_h}{s_i}$
$VIII^{(2)}$	$y_{hi} = \frac{p_h (x_{hi} - m_h)}{p_h (x_{hi} - m_h) + (1 - p_h)(M_h - x_{hi})}$	*Empirical eval.*	$\frac{p_h (1 - p_h)(M_h - m_h) x_{hi} w_h}{s_i z_{hi}^2}$
$IX^{(3)}$	$y_{hi} = \frac{y_{hi}^{(VII)}}{\sum_{h=i}^{n} \left(y_{hi}^{(VII)} / n \right)}$	*Empirical eval.*	*Empirical eval.*
X	$y_{hi} = x_{hi} R_{hi}$	*Empirical eval.*	*Empirical eval.*

(1) $c = [\sum_{h=1}^{n} (M_h - m_h)]^{-1}$; (2) $z_{hi} = [p_h (x_{hi} - m_h) + (1 - p_h)(M_h - x_{hi})]$;
(3) $y^{(VII)}$ indicates the x-transformation coded according to method VII

Method *III* corresponds to that used by *Il Sole 24 ore*, considering that in this context all the 4 parameters are positively connected with the overall quality, and is a particular case of *IV* when all minimums are equal to zero.

Method *VI* is the common standardisation: let's note that it is the only case when both positive and negative scores can happen and this is also the reason because this transformation cannot be applied when using a geometric mean.

Transformation *VII* was proposed by D'Esposito and Ragozini [8]; it derives from (1) if:

$$a_h = -m_h (M_h - m_h) \left[\sum_{h=1}^{k} (M_h - m_h) \right]^{-1}$$
$$b_h = (M_h - m_h) \left[\sum_{h=1}^{k} (M_h - m_h) \right]^{-1}.$$

In this case the weighting system is based on the variation range of each variable: the weight is higher for variables characterised by a higher variation range that is completely in contrast with the evaluations carried out along the previous paragraphs. This method seems less reliable than others (at least for the particular aim of this context), because it can add an explicit overweighting to the *implicit* one due to the different variation ranges, as remarked in paragraph 2.

Method *VIII* derives from the second formula (12), while *IX* is a simplified formula[4] obtained applying to transformation *VIII* the *Ind* method as for *V* when compared with *IV*.

Due to the complexity of not linear transformations as *VIII*, *IX* and *X*, in these cases score changes for a one unit increase (and elasticity as well for method *X*) cannot be explicitly derived, since empirical simulations have been carried out in order to estimate them conditionally to observed data.

Finally, method *X* is based on the not linear transformation (24), so that on the whole 3 of the 10 compared transformations are not linear. According to Aiello and Attanasio [1], all methods are: a) relatively easy to be implemented; b) comparable to original data; c) conservative respect to the original order of any batch of original data (percentiles are

[4] The exact formula would be more complex, since one should divide each term of the mean for its average that is given by the mean of *n* ratios.

transformed in percentiles); d) relatively resistant to outlier observations (even though that could be less true for methods *IV* , *V* and *VII*).

Comparisons among methods can be also based on a series of indicators that can be used to evaluate how much final scores are connected with multivariate information derived from original variables. One can take into account:

1. the average change of score due to a one point increase of a variable, calculated as a mean of the individual changes. This change could be quite different depending on the variable concerned.
2. the average elasticity of score respect to each variable, calculated as a mean of the individual elasticity. Different elasticities indicate that increases of 1% for some variables can be more convenient than for others, because produce quicker increase of final score.
3. the average relative weight of each variable on the final score, calculated as a mean of n individual incidences. It should not be very different from 1/*k* in presence of quite symmetric distributions. As a consequence, different average weights normally occur if some large units dominate the others and strongly influence maximum and the same mean for some variables.
4. the number of original variables for which the first *r* units in the final ranking have a rank lower that the mean (or the median).
5. Correlations between each original variable and final score. The average overall correlation of all the original variables with the final score (or the final ranking) should be high, because it would mean that the final synthetic score is quite representative respect to information concerned with the k original variables [9], [10].

In Table 5 the label *empirical evaluation* has been put when it is not possible to evaluate analytically mean of ratios, since *x* is present both at numerator and denominator.

7. A comparison study

Data used for the comparative simulation derived from the database managed by *Istituto Sperimentale per la Cerealicoltura - ISC* for the agriculture year 2003/2004. The specific frame was the *Rete di confronto varietale sulfrumento duro*, aimed at evaluating overall quality for 57 Italian durum wheat varieties.

The 4 variables considered are: hectolitric weight (HW), protein level (PL), gluten index (GI) and yellow index (YI). Since in this context methodological comparisons are more relevant than a strict interpretation of results from an operational point of view, weights *w* were all put equal to 0.25, in order to facilitate comparisons and interpretation of results.

In details, large values for HW[5] characterise quite good feed and growth durum wheat varieties. Large values of PL[6] underline the feeding and technological relevance of the variety. GI[7] measures the strength of gluten in fine flavours and classify them according to their pasta-making quality. For what concerns YI[8], values near to the minimum denote a yellow chromatic effect not very grateful for the typical consumer, and vice-versa.

These variables are quite different both in terms of mean and variation range (Table 6): the largest contrast is between PL (mean 13.04; variation range 5) and GI (mean 69.85; variation range 59.5). The highest positive asymmetry characterises PL (Pearson's second asymmetry coefficient is equal to 0.138), while YI density is almost symmetric. A negative asymmetry affects HW and, on a large extent, GI.

[5] Measured according to the normative UNI 10281: it is the weight in kilograms of a hectolitre of wheat.

[6] Measured according to the normative UNI 10274: it is the percentage of proteins in the dry matter.

[7] Measured according to the normative UNI 10690: it is the quantity and the features of gluten.

[8] Measured according to the normative UNI 10688: it evaluates the content of yellow pigments.

Table 6 - Main features of the 4 basic variables

Method	HW	PL	GI	YI
$Mean$	81,06	13,04	69,85	24,40
$Median$	81,10	13,00	70,90	24,40
Min	76,00	10,60	31,50	20,10
$Maximum$	85,00	15,60	91,00	29,60
$Max - Min$	9,00	5,00	59,50	9,50
$Asymmetry$*	-0,076	0,138	-0,229	0,006

(*) Measured by $3(\mu_x - q_{x(0,50)})/\sigma_x$

Rankings of durum wheat varieties obtained on the basis of criteria listed in Table 5 (performing 20 different methods, given the 6 options from (15) to (20) for methods *VIII* and *IX*) can be synthetically compared evaluating the *ρ-Spearman cograduation coefficient* among them (table 7). For simplicity, only results got using an arithmetic mean have been showed and commented.

Even though is not evident from the table, method based on *Ind* (*I*, *II*, *III*) lead to quite similar rankings (all the cograduation coefficients are equal to one), but they could significantly differ from those referred to normalised methods (*IV*, *V*, *VIII*, *IX*). For instance, method *I* (see [7]) leads to a ranking that has an average correlation with the others equal to 0, 8: this is the mean between correlation with normalised methods (0, 76) and the others (0, 88). If one excludes method *VII* - that seems to be misleading respect to the others - methods not based on *Ind* (from *IV* to *X*) lead to similar rankings; method *X* is a peculiarity, since it is not based on any normalisation or asymmetry evaluation.

Among the 6 options proposed in order to estimate the coefficients p_x (formulas from (15) to (20)), formula (19) leads to the most extreme p-values, quite different from the average values got using the other methods (Table 8). That can be due to the high relevance played by the two extreme values of distribution (minimum and maximum) on the asymmetry evaluation needed in order to estimate the smoothing coefficient. On the average of the 6 estimation criteria, p_x is higher than 0.5 for PL and YI, while is lower than 0.5 for HW and GI.

The most conservative method is the fourth, based on formula (18), because it leads to the lowest variability of coefficient among the 4 variables taken into account, meaning that taking into account only the number of units under and over the mean could not be enough to evaluate the real asymmetry level.

Table 7 - Correlation between rankings of durum varieties with different methods (arithmetic mean)

Method	Avg	Avg_1	Avg_2
I	0,80	0,76	0,88
II	0,80	0,77	0,89
III	0,79	0,75	0,88
IV	0,93	0,99	0,81
V	0,90	0,97	0,73
VI	0,92	0,98	0,77
VII	0,62	0,55	0,78
$VIII_{(1)}$	0,94	0,99	0,82
$VIII_{(2)}$	0,93	0,99	0,81
$VIII_{(3)}$	0,94	0,99	0,82
$VIII_{(4)}$	0,93	0,99	0,81
$VIII_{(5)}$	0,91	0,96	0,80
$VIII_{(6)}$	0,94	0,99	0,82
$IX_{(1)}$	0,91	0,98	0,75
$IX_{(2)}$	0,93	0,99	0,79
$IX_{(3)}$	0,92	0,98	0,77
$IX_{(4)}$	0,92	0,98	0,76
$IX_{(5)}$	0,91	0,95	0,81
$IX_{(6)}$	0,92	0,98	0,77
X	0,87	0,93	0,74

Avg=average; Avg_1=average correlation with normalised methods (IV, V, $VIII$, IX); Avg_2=average correlation with not normalised methods

Table 9 contains final positions for the 8 wheat varieties which, on the average of the 20 rankings compared, present 5 or more position changes from their average position (calculated as mean of 20 rankings). For instance, *Baio* would not pass the incentive threshold using criteria based on *Ind*, while it would turn out to be successful using all the other criteria (except *VII*): its ranking position is 29 with method *I* and 15 with method *IV*. Similar considerations can be done for *Durbel*, *Orobel*, *Plinio* and *Tresor*. A reverse situation occurs for *Bonzo*, *Gianni* and *Iride*.

Table 8 - Values of the smoothing coefficient p_x with different methods

Method	HW	PL	GI	YI	Cv
(15)	0,487	0,523	0,462	0,501	0,045
(16)	0,483	0,501	0,394	0,520	0,102
(17)	0,491	0,528	0,472	0,547	0,058
(18)	0,477	0,504	0,471	0,514	0,037
(19)	0,349	0,697	0,259	0,644	0,384
(20)	0,483	0,531	0,451	0,519	0,063
Avg	0,462	0,547	0,418	0,541	0,110

Cv=Coefficient of variation; Avg=Average

An emblematic example of possible biases derived form *Ind* is given by *Tresor*: this variety is at the 1^{th} place for HW and PL and at the 11^{th} place for YI. The only bad performance for GI (52^{th} place) leads to a quite low position in the final score got with

methods *I*, *II* or *III* (47th or 48th place), while all the other normalised methods assign to this variety a final position ranging from the 2nd and the 7th place.

Looking at *Durbel*, its performance is rather more controversial, since it presents 2 very good performances (YI: 1th place, and HW: 4th place) and 2 quite bad, but its position in final rankings got with methods *I*, *II* or *III* is not higher than the 45th. Moreover, only some of normalised methods assign to this variety a score higher than threshold: they are *V*, $IX_{(1)}$, $IX_{(2)}$ and $IX_{(6)}$. In particular, other varieties that do not pass the threshold using standard *Norm IV*, but perform over the mean using some of transformations from (15) to (20) are *Gianni* (over the mean with $VIII_{(2)}$ $VIII_{(5)}$ and $IX_{(5)}$) and *Orobel* ($IX_{(1)}$ and $IX_{(6)}$).

More generally, an overview of effects of different rankings on wheat varieties classification is resumed in the table 10. According to the use of an arithmetic mean, all methods but *VII* lead to a quite steady number of units having a score over the mean: it ranges from 22 (methods II, $VIII_{(1)}$, $VIII_{(4)}$, $VIII_{(5)}$, $VIII_{(6)}$, $IX_{(4)}$, $IX_{(5)}$, $IX_{(6)}$) to 25 (method *X*). In particular, method *X* (based on a conjoint use of *x*-levels and *x*-rankings) is the only one for which no unit with a score over the mean has 3 variables on 4 with a level under the mean (that is, all units with a score over mean have at most 2 variables under mean). The recourse to a geometric mean leads to a higher variability of the number of units having a score over the mean: in this case it ranges from 22 to 31 (methods *IV*, *V*, *VII*, $VIII_{(1)}$, $IX_{(1)}$), meaning that *Norm* produces higher positive effects for some varieties using geometric mean rather than arithmetic mean.

Table 9 - The varieties with the highest ranking changes with different methods (arithmetic mean)

Varibles and methods	*Durum wheat varieties and their ranking*							
	Baio	Bonzo	Durbel	Gianni	Iride	Orobel	Plinio	Tresor
HW	18	39	4	31	47	24	46	1
PL	26	10	53	44	41	33	51	1
GI	43	18	48	2	14	51	17	52
YI	7	52	1	49	28	2	50	11
I	29	**23**	46	**12**	**19**	52	37	47
II	28	**23**	45	**13**	**19**	52	37	47
III	29	**23**	47	**12**	**19**	52	34	48
IV	**15**	41	24	25	35	33	52	**6**
V	**14**	45	**18**	35	36	**21**	53	**2**
VI	**14**	43	**22**	31	37	26	52	**2**
VII	42	**18**	48	**2**	**14**	51	**17**	52
$VIII_{(1)}$	**15**	41	25	24	34	31	51	**7**
$VIII_{(2)}$	**17**	41	25	**21**	33	29	51	**3**
$VIII_{(3)}$	**15**	42	28	24	32	35	52	**7**
$VIII_{(4)}$	**15**	41	25	24	34	33	52	**3**
$VIII_{(5)}$	**20**	46	44	**16**	29	26	53	**3**
$VIII_{(6)}$	**16**	41	28	24	34	30	52	**7**
$IX_{(1)}$	**14**	45	**21**	34	36	**22**	53	**2**
$IX_{(2)}$	**15**	43	**23**	26	35	24	52	**3**
$IX_{(3)}$	**14**	45	24	33	36	25	53	**2**
$IX_{(4)}$	**14**	46	24	34	36	26	53	**2**
$IX_{(5)}$	**21**	44	36	**14**	27	31	51	**5**
$IX_{(6)}$	**14**	44	**22**	30	36	**24**	53	**2**
X	**17**	34	**19**	33	41	**25**	50	**3**

In bold varieties with a final score not lower than the average score

Table 10 - Comparison among original variables and final score with different methods

Methods	*Arithmetic mean*				*Geometric mean*			
	Over	3V under	Under	3V over	Over	3V under	Under	3V over
I	23	2	31	3	22	2	32	3
II	22	2	32	3	24	2	30	3
IV	23	1	31	0	31	2	23	3
V	24	1	30	0	31	2	23	3
VI	23	1	31	0	-	-	-	-
VII	28	1	26	4	31	2	23	3
$VIII_{(1)}$	22	1	32	0	31	2	23	3
$VIII_{(2)}$	23	2	31	1	23	2	31	1
$VIII_{(3)}$	23	2	31	0	23	2	31	0
$VIII_{(4)}$	22	2	32	0	22	2	32	0
$VIII_{(5)}$	22	3	32	2	22	3	32	2
$VIII_{(6)}$	22	2	32	0	22	2	32	0
$IX_{(1)}$	24	1	30	0	31	2	23	3
$IX_{(2)}$	23	2	31	1	23	2	31	1
$IX_{(3)}$	23	2	31	0	23	2	31	0
$IX_{(4)}$	22	2	32	0	22	2	32	0
$IX_{(5)}$	22	3	32	2	22	3	32	2
$IX_{(6)}$	22	2	32	0	22	2	32	0
X	25	0	29	0	24	2	30	2

Over=units score over mean; Under=units score under mean; 3V over=with 3 variables over mean; 3V under=with 3 variables under mean

For what concerns sensitiveness of final scores respect to changes of *x*-variables, from table 11 one can note that the use of normalised methods (*IV, VIII, IX*) rather than *Ind* (*I, II, III* only for geometric mean) remarks the effects on final score derived from a one unit increase of PL than an increase of any other variable, both if an arithmetic or a geometric mean is used. Using *Ind*, variability of effects is quite low, as well as when method *X* is used.

While recourse to *Ind* implies a quite similar elasticity of final score for each of the 4 variables (Table 12), normalised methods exalt elasticity respect to HW and under-evaluate that respect to GI that is the variable having the largest variation range, while PL and YI are in an intermediate position. Also in this case, these evidences both characterise the use of arithmetic or a geometric mean.

The relative weight of each variable on final score (Table 13) is quite near to 0.250 with *Ind*, while the standard *Norm IV* tends to increase the relative weight of gluten index (0, 300), that is just the variable with the largest variation range. Generally speaking, the new normalised methods *VIII* and *IX* reduce respect to *IV*, the overwhelming role played by GI, both if arithmetic or a geometric mean is used.

Since the overall average correlation between each of the original variables and final score can be seen as an index of information content kept by the final ranking (table 14), an additional point in favour of normalised transformations - under an arithmetic mean - is the higher average correlation reached using methods *IV* (0, 422), *VIII* (0, 418) or *IX* (0, 418) instead of any methods based on *Ind* (0; 309 at most). On this field the best criterion is *X*, reaching an average overall correlation equal to 0, 474. Results concerned with a geometric mean confirm that, with the exception of method *IV* (0.262, lower than 0.270 got with *Ind*) and, on a lesser extent, method *X* (still high correlation, but in line with normalised methods *VIII* and *IX*).

8. Main conclusions and future tasks

In order to better define and measure the *Quality Global Index* concerning Italian durum wheat varieties, and to distribute incentives according to a proper statistical ranking procedure, the paper proposes the use of normalised techniques (with the aim of sterilising

biases due to different variation ranges of basic variables) instead of methods based on *Ind* (all measures refer to their mean).

Table 11 - Change for _x = +1 with different methods

	Arithmetic mean					*Geometric mean*				
Methods	HW	PL	GI	YI	Cv	HW	PL	GI	YI	Cv
I	1,003	1,019	1,004	1,010	0,006	1,003	1,025	1,006	1,015	0,008
II	1,003	1,019	1,004	1,010	0,007	1,003	1,025	1,006	1,015	0,008
III	1,027	1,049	1,004	1,026	0,016	1,003	1,025	1,006	1,015	0,008
IV	1,053	1,095	1,008	1,050	0,029	1,048	1,085	1,012	1,061	0,025
V	1,051	1,105	1,007	1,060	0,033	1,048	1,085	1,012	1,061	0,025
VI	-	-	-	-	-	-	-	-	-	-
VII	1,006	1,003	1,040	1,006	0,015	1,048	1,085	1,012	1,061	0,025
VIII	1,052	1,092	1,006	1,055	0,029	1,049	1,090	1,014	1,059	0,026
IX	1,052	1,093	1,004	1,054	0,030	1,051	1,095	1,012	1,056	0,028
X	1,006	1,015	1,006	1,011	0,004	1,007	1,017	1,008	1,012	0,004

Cv=coefficient of variation; Methods *VIII* and *IX*: average of the 6 options from formula (15) to formula (20)

Table 12 - Elasticity with different methods

	Arithmetic mean					*Geometric mean*				
Methods	HW	PL	GI	YI	Cv	HW	PL	GI	YI	Cv
I	0,251	0,250	0,248	0,250	0,004	0,000	0,001	0,000	0,000	1,179
II	0,251	0,252	0,246	0,251	0,010	0,000	0,001	0,000	0,000	1,183
III	4,289	1,238	0,552	1,219	0,794	4,258	1,445	0,534	1,629	0,705
V	4,102	1,361	0,463	1,445	0,738	4,258	1,445	0,534	1,629	0,705
VI	-	-	-	-	-	-	-	-	-	-
VII	0,493	0,045	2,183	0,156	1,197	4,258	1,445	0,534	1,629	0,705
VIII	4,218	1,236	0,617	1,240	0,768	4,104	1,204	0,596	1,188	0,772
IX	4,089	1,192	0,589	1,194	0,772	4,039	1,190	0,579	1,172	0,772
X	0,253	0,247	0,252	0,249	0,010	0,005	0,013	0,005	0,010	0,384

Table 13 - Average relative weight of each variable on final score with different methods

	Arithmetic mean					*Geometric mean*				
Methods	HW	PL	GI	YI	Cv	HW	PL	GI	YI	Cv
I	0,251	0,250	0,248	0,250	0,004	0,251	0,251	0,248	0,251	0,004
II	0,251	0,252	0,246	0,251	0,010	0,251	0,252	0,245	0,251	0,011
III	0,242	0,254	0,264	0,240	0,038	0,279	0,247	0,230	0,244	0,072
IV	0,263	0,227	0,300	0,210	0,137	0,260	0,229	0,301	0,211	0,137
V	0,251	0,249	0,252	0,247	0,008	0,250	0,250	0,254	0,247	0,010
VI	-	-	-	-	-	-	-	-	-	-
VII	0,035	0,009	0,928	0,028	1,566	0,021	0,008	0,952	0,019	1,621
VIII	0,249	0,250	0,271	0,230	0,059	0,249	0,250	0,272	0,230	0,059
IX	0,248	0,252	0,265	0,236	0,042	0,247	0,252	0,265	0,236	0,043
X	0,253	0,247	0,252	0,249	0,010	0,256	0,260	0,250	0,233	0,041

Table 14 - Correlation between each variable and final score with different methods

	Arithmetic mean					*Geometric mean*				
Methods	HW	PL	GI	YI	Mean	HW	PL	GI	YI	Mean
I	-0,054	0,252	0,865	0,165	0,307	-0,112	0,191	0,904	0,097	0,270
II	-0,054	0,258	0,861	0,170	0,309	-0,112	0,191	0,904	0,097	0,270
III	-0,062	0,239	0,883	0,130	0,298	-0,112	0,191	0,904	0,097	0,270
IV	0,378	0,426	0,465	0,417	0,422	0,075	0,235	0,521	0,217	0,262
V	0,351	0,482	0,318	0,534	0,421	0,075	0,235	0,521	0,217	0,262
VI	0,451	0,448	0,351	0,450	0,425	-	-	-	-	-
VII	-0,092	-0,089	1,000	-0,183	0,159	0,075	0,235	0,521	0,217	0,262
VIII	0,374	0,418	0,467	0,414	0,418	0,357	0,413	0,467	0,397	0,408
IX	0,371	0,423	0,447	0,433	0,418	0,374	0,418	0,462	0,414	0,417
X	0,409	0,479	0,490	0,519	0,474	0,277	0,294	0,617	0,383	0,393

Empirical results showed relevant differences among durum wheat varieties rankings obtained with different methodologies, and underline the need to open a new discussion - on a national and an EU level as well - about the right procedure to be used to achieve to a satisfying synthesis of the 4 quality indicators taken into account.

With the purpose to assign incentives for quality improvement of durum wheat, *Ind* as proposed by government bodies often produces a significant change of the relative effective importance of the 4 original indicators used for the evaluation, respect to the theoretical one as indicated in the EU Regulation concerned. In particular, it assigns a too high weight to the GI and, as a consequence, a lower weight to the other indicators (HW, YI and, in particular, PL).

Of course, this bias would produce negative effects on the real effectiveness of some economic policy strategies concerning agriculture, that are necessary in order to reduce territorial differences and increase productivity in the EU geographical context.

Theoretical evaluations and an empirical attempt seem to encourage the use of a family of new normalised techniques, which take into account not only variation ranges, but the empirical frequency distribution form as well and, in particular, its asymmetry level.

Further reflections and proposals concerned the choice of a set of quality indicators for evaluating goodness of the overall compared methodologies.

Additional aspect that should be focused more in depth concern the following aspects:

- to reply the empirical test for a larger data set and simulating effects on final score due to an *ex-ante* exclusion from analysis of particular durum wheat varieties.
- to evaluate possible improvements in measurement of coefficient p_x and its sensitiveness respect to particular outlier observations that could occur in real practice.
- to find under which theoretical conditions (and how often they can happen in practice) compared methods can lead to quite similar results and, in particular, if the increase of the number of analysed units can favour stability of results whatever method is used.
- to verify at which extent different preliminary transformations of data can produce significant changes of results obtained applying to transformed data ordinary multivariate analyses.

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POSSIBILITIES OF COST OPTIMIZATION IN PUBLIC PASSENGER TRANSPORTATION FOR R.A.T. CRAIOVA

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Abstract:
The purpose of the article is to present a way of organizing the management accounting so that it should admit calculation cost for each formed cost center and finally, to determine the obtained result by comparing costs with achieved revenues. From the current way of collecting costs analysis, it is found that RAT Craiova has a concept for organizing its own management accounting facilitated by automatic data processing, but without a clearly defined purpose. In order to calculate the cost of each established center, we presented the use of tariff-hour-vehicle calculation method recommended in RAT Craiova activity because: provides an advisedly allocation of indirect costs using allocation bases chosen by the principle of causality; involves allocating labor costs and other direct expenses in relation with a more equitable criterion, which is driven kilometres, allowing therefore more accurate determination of the transportation route cost and the participation level of each route to the profit. Also in the research, we presented an optimization model to the result obtained by RAT Craiova through the correlation of the variable and fixed costs with the volume of activity, namely the use of transmission capacity and price tickets.

Keywords: road transport, cost center, profit center, variable costs, fixed costs, the relation cost-volume-profit

JEL Classification: C61, M41, M49

1. Introduction

Management accounting is the analytical representation of the entities interior processes which lead to qualitative and quantitative transformations in the patrimony mass. The acquired information is designed for administrators as interior beneficiaries who must answer the question of how to allocate and manage the resources used by investors in order to achieve performance.

This definition emphasizes that: the management accounting objective is to reflect the interior relations; it must be organized in relation to the management requirements; it must be organized in relation to the entity structure; it must be flexible, simple and operative.

Therefore, the following characteristics can be inferred: the provided information refer to processes and relations inside the entity; the information are designed for interior users (decision-makers at different hierarchical levels), for the orientation of decisions and aim to complete the data of the financial accounting; the organization is done depending on the specificity of the activity of each entity; the provided information must be up-to-date, relevant and easily obtained.

Taking into account these requirements, we will further analyze the notion of management accounting organization at RAT Craiova in order to establish if it can meet the need of informing all its users.

2. The critical analysis of the current organization conception of managerial accounting and possibilities of improvement

RAT Craiova, as any economic entity, organizes its management accounting in accordance with the legislation in force, in this case Law no. 81/1990 – "Accountancy Law", but also with the subsequent regulations, respectively, OMFP 1826/2003 and OMFP 3055/2009.

In present, RAT Craiova has its own conception of organizing the management accounts, being on one side facilitated by the autonomous data processing, and not having on the other side a clear purpose. The objective of this organization method is to compare the collected expenses with the incomes distributed at the level of the profit centers. On these grounds, in the case of incomes, a calculating distribution is being applied.

The expenses are collected within RAT Craiova on profit centers (sections) in which cost centers were established, plus three more independent cost centers, as follows:

1. Profit center 1 "Passenger transport with buses", with the following cost centers: 7 – TESA; 11 – Buses; 31 – Freight transport.
2. Profit center 2 "Passenger transport with tram", with the following cost centers: 7 – TESA; 9 – Trams; 39 – Freight transport.
3. Profit center 3 "Passenger transport with buses", with the following cost centers: 7 – TESA; 13 – Buses; 33 – Freight transport.
4. Cost center 21 – Periodical technical inspections.
5. Cost center 14 – Mechanical-energetic section.
6. Cost center 5 – Section of road safety exploitation.

In what the expenses are concerned, it results from the carried out analysis that the primary documents provide information not only for the financial accounting but also for the managements accounting, through their integrating codes which enable the identification of the following elements: management account, expense account from the financial accounting; the activity; the account pertaining to the operation that affected the expense in the financial accounting.

On the basis of the software available to RAT Craiova, the data can be processed (sorted and centralized) in five collecting situations called entity as follows:

- the material expenses situation and the manpower in which the total expenses collected in accounting are carried out on the expenses accounts of financial accounting and on activities;
- the material expenses situation and the manpower (three situations), one situation for each of the three sections in which the expenses are calculated analytically on the expenses accounts from the financial accounting and on the two activities of provision of services, passenger transport and freight transport;
- expenses distribution expenses in which the expenses are identified on the expenses accounts of I order from the financial accounting and on the three management accounts, respective 921 "Expenses of the basic activity", 923 "Indirect production expenses" and 924 "Indirect administration expenses".

Series of expenses neither can be identified on profit centers (sections) and nor they have a character of indirect administration expenses. For these particular expenses, the entity carried out a fundamental study on the basis of some elements specific to the activity, from which resulted the following coefficients (percentages):

- Section 1 (activity 11) = 0,56 or 56%
- Section 2 (activity 9) = 0,27 or 27%
- Section 3 (activity 13) = 0,17 or 17%

In what the incomes are concerned, the primary documents provide through the integrating codes information on: the incomes account of the financial accounting; the activity that generated the income; the account corresponding the action that affected the income in the financial accounting.

By processing these data, on the basis of the software, RAT Craiova obtains the following data on incomes:

- the situation of the sold tickets, in which the tickets sold in a month are divided on selling methods, and, in the end, they are distributed (on the basis of conventional coefficients) on three profit centers (sections);
- the incomes situation from tickets and transit passes, in which these kind of incomes (registered in 704 account) are analytically identified on the activities 11 (buses section 1), 9 (trams section 2) and 13 (buses section 3);

- the incomes account record on activities which centralizes all the incomes of the same activity on each incomes account from the notes of the accounts;
- the incomes situation, according to which at the level of whole section, all the incomes, related to the concerned activity, are centralized on each activity from all the incomes accounts.

We notice that, concerning the incomes recording, RAT Craiova adopted a monist accounting system. The incomes are identified due to the accounts of the 7 class of the General Accounts Plan in which they are analytically open on types of activities.

Another remark is referring to the fact that the management accounting does not use accounts of financial results that will compare the incomes with the expenses, on activities, and will determine the efficiency or inefficiency of every activity.

On the other side, the incomes have a direct character towards the profit centers only partially. Most of the incomes are distributed on activities on the basis of some conventional coefficients.

We also consider questionable the direct character towards the profit centers of incomes from the selling of tickets in stalls, on the basis of their distribution to routes, taking into account that a stall covers two or more routes that pertain to different profit centers.

Following this analysis, we can state that RAT Craiova meet most of the requirements on the management accounting organization with the aim of achieving a modern management.

Although the conception of managerial accounting organization meets almost completely the control necessities of the interior activity of the entity, from the analysis we have carried out, we observe that it can be improved so that the data on the costs of activities facilitate the decision making process aiming to increase the efficiency of the performed activities.

The improvements can be done following two directions:

- *The first improvement direction* refers to the reassessment of using the management accounts. On one side, it is compulsory to renounce to the static role of the management accounts which are currently used only in their debit part, and on the other side, we consider that the income accounts at the level of profit centers and the data comparison on an accounting manner should also be included in order to increase their informational role. We can achieve it using different variants. A more difficult variant proposes the inclusion of some management accounts which, in present, are not registered in the class 9 of the General Accounts Plan such as:

- "Interior deductions-sales";
- "Interior deductions-analytical results";
- "Results from sales".

A simpler variant, presented in this study, supposes the use of the existing management accounts, and some of them will receive new accounting roles and functions (accounts 921, 902, 903 and 931) taking into account that RAT Craiova is not an entity that manufactures material goods.

- *The second direction of improvement* aims to achieve the accounting finality which is lacking in the current organization system, respectively, the cost calculation on every profit center, as well as its comparison with the incomes registered at the level of the concerned center.

In this context, the specificity of the entity activity requires to use two calculation methods, namely:

- the tariff-hour-vehicle method (for services), in the case of passenger transport because it is a continuous activity and it is carried out with a certain rhythmicity;
- the order based method, in the case of freight transport because it is an occasional activity and it is carried out only on the base of orders or contracts.

If the *tariff-hour-vehicle* method (for services) is used, the cost center is represented by the type of vehicle/transport route.

Consequently, for each route or type of vehicle/transport route a different analytic will be established for the accounts:

- 921 "Expenses of the basic activity";
- 902 "Interior deductions on the obtained production";
- 903 "Interior deductions on the obtained result";
- 931 "Incomes from the basic activity".

To calculate the costs, it can be used as a cost carrier the covered kilometre or route, respectively, the complete road run by the bus/tram between the initial and final station. In consequence, all the direct costs can be calculated on each transport route, and the monthly variable cost on cost center is established in proportion to the number of routes.

By comparing the cost with the income distributed to every transport route, the result of the route can be established in the end of the month, and the cost center becomes a profit center.

If the order based method is used, the cost center is considered to be the order (contract) for the freight transport towards third parties, the cost carrier being the same as in the case of passenger transport, covered kilometre or route.

However, regardless the calculation method, the management accounting supposes the following operations concerning the expenses occasioned by the transport activity.

- Collecting the expenses during the month: consumables, manpower, amortization, electricity, insurance, interests etc:

%	=	901
921 „Expenses of the basic activity” analytic: the bus/tram route or order 922 „Expenses of the auxiliary activity” analytic: the activity 923 „Indirect production expenses” analytic: the section or activity 924 „General administration expenses”		„Interior deductions on the expenses”

- Deducting the auxiliary activities of the other sections and activities of RAT Craiova:

%		922
921 „Expenses of the basic activity” analytic: the bus/tram route or order 923 „Indirect production expenses” analytic: the section or activity 924 „General administration expenses”		„Expenses of the auxiliary activity” analytic: the activity

- Distributing the indirect expenses of the basis sections to the transport routes or orders:

921 „Expenses of the basic activity” analytic: the bus/tram route or order	=	923 „Indirect production expenses” analytic: the section or activity

- Registering the incomes distributed to the transport routes or orders:

931 „Incomes from the basic activity” analytic: the bus/tram route or order	=	902 „Interior deductions on the obtained incomes” analytic: the bus/tram route or order

- Deducting the expenses of the basic activity:

902 „Interior deductions on the obtained incomes” analytic: the bus/tram route or order	=	921 „Expenses of the basic activity” analytic: the bus/tram route or order

- Comparing the expenses and the incomes and establishing the result:

a) in case of loss:

903 „Interior deductions on the obtained result” analytic: the bus/tram route or order	=	902 „Interior deductions on the obtained incomes” analytic: the bus/tram route or order

b) in case of profit:

902 „Interior deductions on the obtained incomes” analytic: the bus/tram route or order	=	903 „Interior deductions on the obtained result” analytic: the bus/tram route or order

- The interface cost-incomes is registered:

901 „Interior deductions on the expenses”	=	% 931 „Incomes from the basic activity” analytic: the bus/tram route or order 903 „Interior deductions on the obtained result” analytic: the bus/tram route or order

or:

% 901 „Interior deductions on the expenses” 903 „Interior deductions on the obtained result” analytic: the bus/tram route or order	=	931 „Incomes from the basic activity” analytic: the bus/tram route or order

3. Using the relation cost – volume – profit in the management of RAT Craiova activity

The management of the entity can adopt some rational decisions only if it takes into account that the direct (variables) and indirect (fixed) exploitation expenses are in a permanent connection with the activity volume, respectively, with the degree of using the capacity of transport and with the tickets price.

The quantification of this correlation can be achieved by calculating the indicators: the profitability threshold, coverage factor, the dynamic safety coefficient and the safety interval (Călin, Man, and Nedelcu 2008, 285).

These indicators were calculated in Table 1, the analysis comprising the data for the two transport routes, 2R and 9, within profit center. It is very important for the entity management to know the four indicators because:

- the break-even shows the point from which any increasing of the passengers number on the route bring profit to RAT Craiova, and its activity becomes profitable, as well as any decrease of the passengers number brings losses on the concerned route, thus the activity of RAT being unprofitable, if the connection between the optimization factors of the activity is respected (costs, tickets price and the structure of transport routes). The profitability threshold can be established at the level of the center profit, the transport route or on the whole entity. Knowing the profitability threshold the tickets price can conversely established.
- the coverage factor expresses the potential profitability and represents the percentage of the necessary turnover for covering the indirect expenses and obtaining profit. This indicator can contribute to the decisions-making process of creating new passengers public transport routes or of renouncing at some existing routes.
- the dynamic coefficient of safety indicates the relative decrease of incomes so that RAT Craiova reach the break even and avoid losses.

- the safety interval has the same meaning as the dynamic coefficient of safety, but, in this case, the information are presented in absolute sizes and not in relative sizes.

Excepting the calculation of the four indicators for optimizing the result (Călin, Man, and Nedelcu 2008, 304-307) of the carried out activity, it is also important for RAT Craiova management to determine the influences of the factors modification on the profit that contributed to its calculation: the selling price of tickets, number of passengers, direct and indirect expenses.

Thus, we start from the existing situation presented in table nr. 1 (to simply the calculations we supposed that RAT Craiova has only routes 2R and 9 – the calculations are being made following the same methodology no matter the number of transport routes – and that it obtains incomes only from the selling of tickets on the two routes), according to which the entity registers the following indicators: profit 98,125 lei, coverage factor 45.30%, break-even 86,282 lei, the dynamic coefficient of safety 71.51%. The RAT Craiova management aims to increase the profit.

For this purpose, it can act on the optimization factors and can decide:

- either a tickets price increase, and in this case, in comparison with the initial situation, the value of all calculated indicators will increase, excepting the profitability threshold whose value will decrease (positive situation);
- either a degree of occupation increase, so an increase on the number of passengers, a situation in which will lead to an increase of the profit and of the dynamic safety coefficient, while the coverage factor and the profitability threshold will remain unchanged (positive situation);
- either a direct expenses reduction, which will lead to the same evolution of the calculated indicators as the first situation, namely the tickets price increases;
- either an indirect expenses reduction, a situation which will lead to an increase of the profit and the dynamic safety coefficient, while the profitability threshold decreases, and the coverage factor will remain unchanged (positive situation).

Cumulating the four decisions previously taken, the management board will achieve the expected result that is an increased profit, as well as a positive evolution of the other indicators specific to the relation cost – volume - profit, representing a favorable situation for the entity.

Yet, in the practical activity of RAT, some of the optimization factors can have an unfavorable influence on the profit, and, thus, it is important to determine it so that RAT management actions through a favorable decision of other optimization factors.

For example, if the price of tickets is reduced, the profit will decrease. This can be compensated either by reducing the direct expenses, or by reducing the indirect expenses.

Table 1. Optimization calculations of result RAT Craiova

Explications	Initial situation	Optimization factors				The final situation
		Ticket price increase	Number of passengers increase	Direct costs reduction	Indirect costs reduction	
1) Income from ticket sales:						
- route 2R: 208.845 x 1,2 lei	250.614	313.268	263.144	250.614	250.614	328.931
- route 9: 34.830 x 1,5 lei	52.245	62.694	54.857	52.245	52.245	65.830
Total	**302.859**	**375.962**	**318.001**	**302.859**	**302.859**	**394.761**
2) Direct costs						
- route 2R: 208.845 x 0,65 lei	135.609	135.609	142.537	114.865	135.609	120.608
- route 9: 34.830 x 0,86 lei	30.033	30.033	31.452	26.471	30.033	27.795
Total	**165.642**	**165.642**	**173.989**	**141.336**	**165.642**	**148.403**
3) Margin on direct costs						

Explications	Initial situation	Optimization factors				The final situation
		Ticket price increase	Number of passengers increase	Direct costs reduction	Indirect costs reduction	
- route 2R: 208.845 x 0,55 lei	115.005	177.518	120.607	135.749	115.005	208.323
- route 9: 34.830 x 0,64 lei	22.212	32.740	23.405	25.774	22.212	38.035
Total	**137.217**	**210.258**	**144.012**	**161.523**	**137.217**	**246.358**
4) Total indirect costs	39.092	39.092	39.092	39.092	34.092	34.092
5) Profit	98.125	171.166	104.920	122.431	103.125	212.266
6) Coverage factor	45,30%	55,92%	45,30%	53,33%	45,30%	62,40%
7) The break-even	86.282	69.900	86.282	73.298	75.246	54.628
8) Dynamic safety factor	71,51%	81,40%	72,86%	75,80%	75,15%	86,16%

Source: Adaptation by Călin, Man, and Nedelcu 2008. 305. Data were taken from the accountability of RAT Craiova, 2008.

In conclusion, the management of the modern entity is in the position to take rational decisions that will lead to the achievement of some optimum results only if we know the manner of action of each of the optimization factors and, especially, the reciprocal influences of the concerned factors.

Conclusion

For the cost optimization of the public passenger transport, the management of RAT Craiova must have managerial accounting which will provide it the relevant information.

The analysis of the current situation has emphasized the fact that RAT Craiova has its own conception of organizing the accounting management, in which the accounting accounts has only a statistic role, being used only their debit part. Furthermore, it is not calculated a real cost, but there is an extra-accounting comparison of the collected expenses with the incomes distributed on the basis of some conventional coefficient, at the level of the profit centers.

In this context, we considered that is necessary and we proposed the implementation of a managerial accounting by improving the current accounting management in three directions:

- reconsidering the use of management accounting by renouncing to their present static role and by distributing new accounting roles and functions (accounts 921, 902, 903 and 931) taking into account that RAT Craiova is not an entity that manufactures material goods.
- using the tariff-hour-vehicle method (for services) which lead a more precise calculation of the cost on the transport route and of the percentage of each route to the profit mass;
- using the cost-volume-profit model for optimizing the obtained results by correlating the variable (direct) expenses and the fixed (indirect) expenses with the activity volume, respectively with the degree of using the transport capacity and with the tickets price.

The improvement of the current management accounting through the three directions will enable RAT Craiova management to take some rational decisions in order to optimize the obtained result and, what is very important, to anticipate the consequences of such decisions.

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THE APPLICABILITY OF ARTIFICIAL NEURAL NETWORK METHOD UPON PREDICTION OF RATE OF STOCK RETURN: EXAMPLE OF 2008 FINANCIAL CRISIS

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Abstract:

Main target of this study is to set a model that will make predictions based upon financial statements and companies' rate of stock return in crisis periods when economic indicators are at high level and show sudden changes and to develop an artificial neural network model that has forecasting accuracy just as much as statistical models while setting this model. For this purpose, 20-period 400 data of 20 companies' 2006/Q1-2010/Q4 periods that carry on their services in food sector and have been treated at Istanbul Stock Exchange (ISE) in periods 2006-2010 in Turkey were calculated.

Artificial Neural Network (ANN) that was set in our study has 20-neuronal single hidden layer 21 input variables and one output variable. The model that we used is Multi Layer Perceptron Back Propagation Artificial Neural Network model. In our study, Mean Square Error (MSE) was determined as performance measurement with which training will be completed on achieving. With this model, Training Phase MSE value was found as 0.0309 and testing phase MSE value was 0.0502. It was determined that the developed multilayer perceptron model has had the capacity of forecasting 2008 crisis period successfully.

JEL Classification: G01, G17, M21

Keywords: rate of stock return, artificial neural network, financial crisis

1. Introduction

Evaluation of possessed savings in suitable investment tools is a hard process in terms of the investor. Evaluation of the company specific elements such as financial structure, liquidity, companies' profitability considering the predictions relevant to the economic and politic lives acquaint the investor with what assets' actual value should be. Evaluation ranges beginning from economy in general manner to the relevant sector and company. Since economic analysis includes economy's analysis as a whole, it is guiding for investors about whether a suitable investment exists or not and which investment tool should be invested. If the analysis features the stock exchange market, then choosing a suitable sector is in question. Selection of the sector will be made according to the criteria such as sector's growth potential, competitive capacity and profitability ratio (Yalçıner *et al.* 2005).

In crisis periods, with the prediction of businesses' financial conditions, models have been developed which will be helpful to the investor or organizations who will invest in it, to creditors and business managers. Forecasting rate of stock returns will be helpful for administrators to have enough time to take relevant precautions to the problem and to have the chance of save their company by estimating the problems that will be able to come up in the future.

Forecasting stock returns is an important notion in financial world and especially in developing economies such as Turkey. Basic view of finance mentions that share prices can be forecasted at a large extent using financial ratio that reflects firms' real financial conditions (Tesfatsion 2004, 3). For this reason, knowing the financial ratio that is efficient upon stock prices and determining in which period this rates are efficient have become more of an issue.

Main target of this study is to set a model that will forecast depending on companies' financial data and rate of stock return that have been declared to the public by themselves, that is financial statements, in crisis periods in which economic indicators are at high level and show sudden changes and while setting this model, to develop an artificial neural network that has prediction accuracy at least as much as statistical models.

Firms that belong to the food sector dealing in Istanbul Stock Exchange (ISE) in periods between 2006 and 2010 in Turkey are within the scope of this study. Rate of stock return of 20

companies in business in food sector have been tried to be forecasted with Artificial Neural Network in sourcing totally 20-period 400 financial statements and income statements for each company as of quarterly periods including 2006/Q1-2010Q.

2. Literature

There have been many studies that analyze the relations between financial ratio and stock returns. It is seen that different methods have been used in those studies. In literature research, primarily studies that have analyzed the relations between stock returns and financial ratio and then studies that have been carried out with Artificial Neural Network for forecasting stock return will be analyzed. Hull (1999) analyzed whether companies' stock returns can be explained or not with debt ratio considering those rates based on industry's average leverage ratio. It has been tried to determine whether companies' use of debt levels has had a cumulative profit upon stock returns.

Demir (2001) tested the effect of companies specific factors upon financial stock prices and direction of this effect with an empirical study and within this context 16 companies were selected for analysis among specific financial sector business firms dealing in Istanbul Stock Exchange. Each business firm's 6-month stock prices and leverage and return on equity, return on asset, dividend ratio, price/earnings, market value/book value, trading, earnings per share, net profit of growth increase, rate of growth on equity were used. In the study in which 1991-2000 periodic data and multiple regression analysis were used, it was verified that market value/book value, earnings per share, price/earnings ratio, return on equity, leverage ratio, net profit of growth increase, trading ratio and dividend ratio have been the rates that are efficient upon share prices.

Atiya (2001) used artificial neural network in his financial failure forecasting study that he carried out upon 491 business firms in America. In the study in which financial ratio has been used as the independent variable, accurate forecasting was achieved at the rate of 81.46%. Afterwards, forecasting was achieved using financial ratio and market indicators together and 85.5% accurate classification was achieved.

Özalp, and Anagun (2001) analyzed stock price forecasting problem and tried to forecast share price values dealing in food sector. In the study in which classical methods were compared to the artificial neural network model, there was acquired 7.55% less error value in artificial neural network model.

Welch (2004), in his study in which he analyzed the relation of companies' indebtedness ratio with their stock returns ascertained that stock returns explained 40% of indebtedness ratio dynamics.

Kim *et al.* (2004), as a forecaster of economic crisis, sought an answer to the question of how ANN will be used in early warning system's training. Authors acting from volatility of SMI, Stock Market Index, used logistic distribution, decision trees, neuro-fuzzy model and support vector machines, which are among data mining methods, along with ANN in order to make a better categorization in early warning system's training period. They precipitated that ANN and decision trees methods are very appropriate methods in categorization of analysis period as consistent, inconsistent and crisis periods.

Altay, and Satman (2005), tried to forecast ISE 30 and ISE all induces' returns using linear regression and multi layer ANN models. Although ANN models don't give better results for daily and monthly returns than the linear regression, it was precipitated that those models have been very successful at forecasting course of index returns. Huang *et al.* (2007) carried out a detailed analysis scrutinizing totally 123 articles that were written in recent years about forecasting financial and economic variables of ANN method. They revealed what kind of ANN methods were used, what methods were compared while model's performance had been evaluating and which input variables were chosen while forecasting foreign exchange rate, stock market index and economic variables. It was determined that in general terms macro economic variables such as long and short term interest rates, consumer price index, industrial production, public expenditure, private consumption expenditure, foreign exchange rate, gross national product were used while forecasting the course of stock market index. They precipitated that the most frequently used model in index forecasting studies has been Multi Layer Perceptron Model which is an ANN model and ANN model is more successful at forecasting index value according to the traditional models.

Muradoglu and Sivaprasad (2008) analyzed effect of firm indebtedness ratio upon stock returns in their study which they carried out in London Stock Exchange between 1980 and 2004. In their

study, they determined that there was a positive relation between indebtedness ratio and stock returns of public utility sector firms and a negative relation in all other sector firms.

Ünlu *et al.* (2009) used artificial neural network and linear regression so as to forecast long term returns of stocks that were offered to public for the first time and precipitated that the model which was developed with artificial neural network was better to forecast than the linear regression model.

Öz *et al.* (2011) tried to forecast 2007 stock returns 1 and 2 years in advance benefiting from 2006 and 2005 stock returns in their studies which target to be helpful about which stocks should be invested through the most appropriate model and about determining factors which have been efficient upon forecasting stocks' returns that were dealing in ISE 30 index. According to the analysis results acquired using discriminant analysis, activity turnover rate and leverage variables of 1-year earlier model were statistically significant at forecasting the stock returns in advance rather than the activity turnover rate, leverage and liquidity variables of 2-year earlier model.

Bayrakdaroglu (2012) aimed to test the presence of relation between stock returns and financial performance measurement employing panel logistic regression model and analyze measurements' explanatory power of stock returns. Annual data relevant to 96 companies that were dealing in Istanbul Stock Exchange Market between 1998 and 2007 were used. In consequence of the survey, it was noticed that stock returns could have been statistically explained with financial performance measurements in relevant period; however, this explanatory power was not at a high level. Rates that were used in this study were; Return on Asset (net profit for the period/ total assets), return on equity (net profit for the period/ equity), earnings per share (net profit for the period/ number of shares in circulation), price / earnings ratio (share's market value/ earnings per share), earnings before interest taxes, market value/book value, net profit.

3. Aim and scope of the study

3.1 Aim of the study

Main target of this study is to set a model that will make predictions based upon financial statements and companies' rate of stock return in crisis periods when economic indicators are at high level and show sudden changes and to develop an artificial neural network model that has forecasting accuracy just as much as statistical models while setting this model.

In accordance with this purpose, due to prediction of financial conditions, business managers will have enough time to take precautions in crisis periods and so that they will have the chance of saving their businesses. Such a forecast will be helpful for making right decisions accelerating credit institutions' resolution process. At the same time, contribution to the investment strategy that will be created for stocks will be provided in terms of the investors.

3.2. Scope of the Study

Business organizations that are in business in food sector dealing in Istanbul Stock Exchange (ISE) in periods between 2006 and 2010 are within the scope of this study. Totally 20-period 400 financial statements and income statements that belong to 20 companies carrying on its business in food sector were procured for each company which published their financial statements in 2006, 2007, 2008, 2009 and 2010 in quarterly periods. The companies whose financial and income statements were used within the scope of the study have been shown in Table 1.

Table1. Firms included in the study

ITEM NO	COMPANY	PERIOD	ITEM NO	COMPANY	PERIOD
1	ALYAG	20	11	MRTGG	20
2	BANVT	20	12	PENGD	20
3	DARDL	20	13	PETUN	20
4	ERSU	20	14	PINSU	20
5	FRIGO	20	15	PNSUT	20
6	KENT	20	16	SELGD	20
7	KERVT	20	17	SKPLC	20
8	KNFRT	20	18	TATKS	20
9	KRSTL	20	19	TUKAS	20
10	MERKO	20	20	ULKER	20

4. Data and methodology

4.1. Data

We used rate of stock return as the dependent variable and financial ratios as independent variable in the study. Rate of stock return (RSR), which is also the dependent variable, was calculated as below;

$$RSR: (SP_t - SP_{t-1})/SP_{t-1} \quad (4.1)$$

where:

SP_t=stock prices for t period

SP_{t-1}=stock prices for t-1 period

Independent variables that we included in the study are as shown in Table 2;

Table2: Independent variables included in the study

VARIABLES	RATE	FORMULA
X1	STL	Short Term Liabilities / Total Debt
X2	LTL	Long Term Liabilities / Total Debt
X3	LTL / E	Long Term Liabilities / Equity
X4	FAI	Tangible Fixed Assets / Total Assets
X5	TD / E	Total Debt / Equity
X6	Leverage	Total Debt / Total Passive
X7	Current	Current Assets / Short Term Liabilities
X8	Acid-Test	(Current Assets-Inventory) / Short Term Liabilities
X9	Cash	(Liquid Assets + Marketable Securities) / Short Term Liabilities
X10	NP / E	Net Profit / Equity
X11	ROA	Net Profit/ Total Assets
X12	NP / NS	Net Profit / Net Sales
X13	Asset Increase	Current Net Assets-Previous Net Assets) / Previous Net Assets
X14	OP	Operating Profit / Net Sales
X15	PTP	Pre-Tax Profit /Equity
X16	EBIT / NS	Earnings Before Interest and Tax / Net Sales
X17	ART	Net Sales / Average Trade Receivables
X18	IT	Cost of sales / Average Inventories
X19	ETO	Net Sales / Equity
X20	ATO	Net Sales / Total Assets
X21	EPS	Net Profit / Number of Shares

4.2. Methodology

There has not been any methodology that will be used for developing artificial neural network models. Setting a model that is appropriate to the problem field is a process that includes many trials and errors. Choosing artificial neural network that is appropriate to the structure of problem is very important to reveal excellent performance. The most frequently used network model in financial estimating implementations is Multi Layer Perceptron-MLP. MLP model includes one input, one or more inter layers and one output layer. In literature, it has been mentioned that if a single hidden layer network model is set with appropriate number of processors then it will give better results. For this

reason, single hidden layer network architecture has been preferred in this study. Structured network architecture has 20-neuronal single hidden layer 21 input variables and one output variable.

In selection of learning algorithms, network topology's decisiveness has been known. For this reason, Levenberg-Marquard algorithm which has especially been used in back propagation networks, which has given more successful results than other algorithms, and which consumes the sources less at computerizing and gives quick responses was chosen and Matlab 7.6 Neural Network Toolbar program was used for setting of models and forecasting.

Back propagation algorithm can be generalized as minimizing error sum of squares between network's real outputs and inputs that have been required to be achieved and rearrangement of network weights. Back propagation has been used as counseling learning rule in networks in which required outputs have been known along with inputs. In pre-training, network weights have been primarily chosen randomly for training and it is used for the purpose of measuring output values for new inputs. Feed forward proceeding has been performed in transferring of data which come to the entry layer into first hidden layer as introductory. After choosing the sample input set that will take place in the input layer and providing their entry to network, training and test phases have been fulfilled by the help of specified model.

Inputs in training set provide neurons in the network's input layer to produce an output. This output constitutes the input of subsequent layer's neurons. By this way, neurons of output layer have been provided to produce network's output. The output that the network produces and real values in the training set have been compared. The difference between them has been calculated. In order to minimize error, algorithm tries to backwardly reassure output layer weights (weights between last hidden layer and output layer). Then, whole weights in the end layer and in whole layers towards the input layer have been recalculated. This process lasts until algorithm termination criteria have been provided. With this algorithm, $\Delta w_{ji}(t)$ change in weights between *i* and *j* function elements (Sağıroğlu *et al*. 2003, 85-86). This expression;

$$\Delta w_{ji}(t) = \eta \delta_j x_j + \alpha \Delta w_{ji}(t-1) \tag{4.2}$$

is shown as here. Here,

η: learning coefficient
α: moment coefficient
δ_j: a factor that belongs to any neuron in inner or outer layer.

For outer layer, this factor is given as below.

$$\delta_j = \frac{\partial f}{\partial net_j}(y_j^{(t)} - y_j \tag{4.3}$$

Here;

$$net_j = \sum x_j w_{ji} \tag{4.4}$$

and if $y_j^{(t)}$ then *j* is processor element's target output.

This factor for neurons of the inner layer is,

$$\delta_j = \left[\frac{\partial f}{\partial net_j}\right] \sum w_{qi} \delta_q \tag{4.5}$$

given such.

In order to calculate net input, it is necessary to determine an additive function and in order to determine the output that the cell will produce against the net input that reaches to the cell, it is necessary to determine a transition function. For any network, there has been no formula to determine

these functions. In general, neurons of a network in the same or different layers can use different activation functions. As a result of tried out tests, the hyperbolic tangent activation function below has been used in the hidden layer in the study.

$$F(NET) = \frac{(e^{NET} + e^{-NET})}{(e^{NET} - e^{-NET})} \tag{4.6}$$

For evaluation of artificial neural network's approximate results, performance criteria are needed. In our study, Mean Square Error (MSE) was determined as performance criteria that the training will be completed when it has been reached. For minimizing MSE values along with the training phase, arrangement of connection weights (training) proceeding has been achieved. MSE's mathematical expansion which is one of performance functions that is commonly used for feed forward networks has been shown below.

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(t_i - g_i)^2 = \frac{1}{n}\sum_{i=1}^{n} e_f^2 \tag{4.7}$$

t_i : imputed value for i unit
g_i : real value for i unit
e_f : error of estimation
n : number of error terms

Data that take place in data set has been randomly categorized into two as training and test sets. Whereas training data set has been used for the purpose of developing artificial neural network models, test data set has been used intended for determining developed model's forecasting capacity. 75% of data set has been used as training and 25% as test set. In consequence of this, 300 training data and 100 test data have been acquired from total samples including 400 data in this study.

The model that was set has been trained as a result of 35 iterations and how MSE value has been minimized during this training proceeding was shown in Figure 1. As it can be seen from the graphic, by means of training proceeding, MSE value has ever decreased as being very fast in the first 5 circles and fixed in about 0.0309. So network's training has been completed.

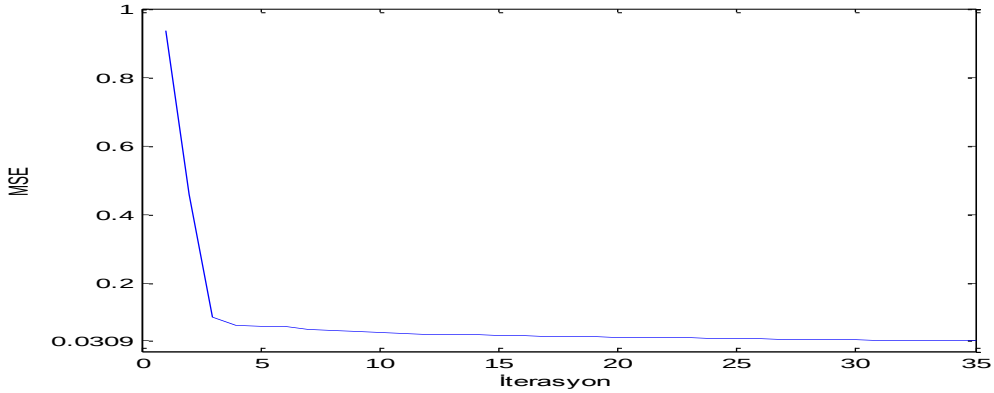

Figure 1. MSE Values during the training phase

Imputed values that the developed model acquired for training set and actual values have been comparatively presented in Figure 2.

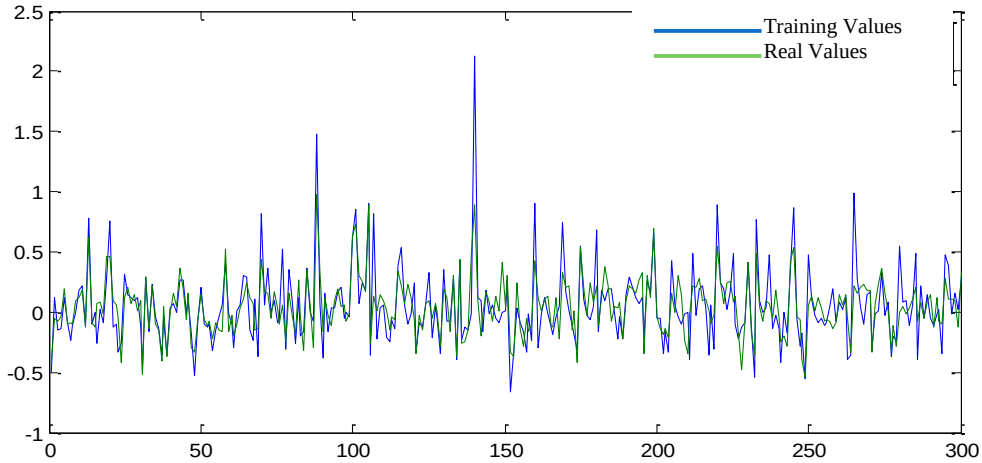

Figure2. Estimates of Artificial Neural Network Model for Training and Real Values

When Figure 2 has been analyzed, it has been noticed that ANN model has a highly successful performance in general terms. Forecasting values that the ANN model acquires are very close to the real values and fairly successful. Measured values of model's training phase and output values that the estimator produces have been shown in Table 3 in summary.

Table3. Model's Training Phase Results

Data No	Measured (Training) Value	Output (Real) Value	Data No	Measured (Training) Value	Output (Real) Value	Data No	Measured (Training) Value	Output (Real) Value
1	-0,5054	-0,4792	**91**	0,1608	0,2165	**211**	-0,3902	-0,0600
2	0,1196	0,0391	**92**	-0,1627	-0,0836	**212**	0,4867	0,3391
3	-0,1456	-0,1614	**93**	0,0360	0,0866	**213**	-0,0224	0,1467
4	-0,1364	-0,1527	**94**	0,0310	0,1061	**214**	0,1944	0,4562
5	0,1184	0,2155	**95**	0,1729	0,0707	**215**	0,2171	0,0620
6	-0,0941	-0,0472	**96**	0,2051	0,1257	**216**	0,0318	-0,0043
7	-0,2373	-0,0516	**97**	-0,0541	0,0285	**217**	-0,3565	0,1138
8	-0,1111	-0,1154	**98**	0,0000	-0,0184	**218**	0,0541	-0,0079
9	0,0000	-0,0059	**99**	-0,0381	-0,0068	**219**	-0,3026	0,0415
10	0,1852	0,2319	**100**	0,6166	0,4592	**220**	0,8889	0,5268
11	0,2188	0,1025	**161**	-0,2988	0,0402	**296**	0,3876	0,2450
12	-0,1154	-0,0790	**162**	-0,0174	0,0060	**297**	-0,0112	0,0396
13	0,7763	0,8701	**163**	0,1186	0,1383	**298**	0,1522	0,1427
14	-0,0963	-0,1409	**164**	-0,0152	0,0174	**299**	0,0189	-0,0781
15	0,0000	0,0652	**165**	-0,1308	-0,1254	**300**	0,2731	0,3054

After model's training phase has been completed, there has been proceeded to the test phase. The model that was set in consequence of the training needs to be implemented on test data set. Target of the test set is to examine whether network's learning has been sufficient or not and to measure model's generalization capacity. During this phase, network has been tested through the data that haven't been used in training phase. Analyzing the acquired output values, whether network's learning has been sufficient or not is determined.

After training of the model, MSE value for test data has been determined as 0.0502. Comparison of output and test data that the model produced after model training for test data has been shown in Figure 3.

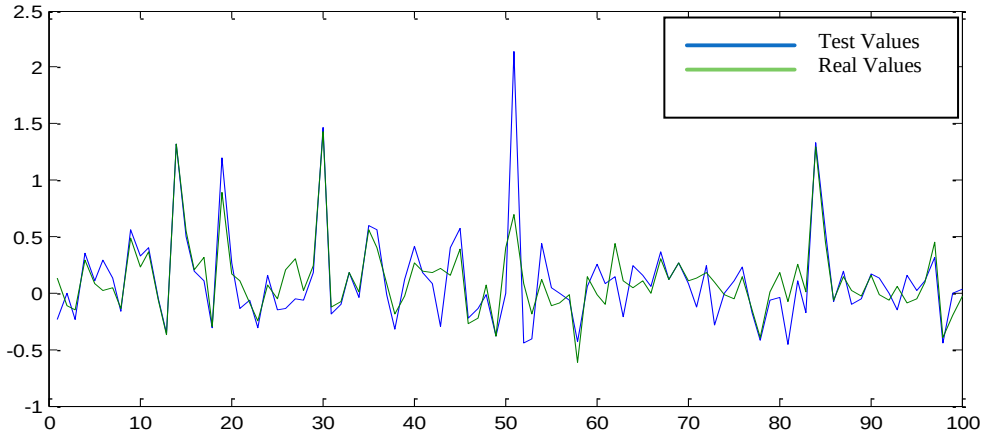

Figure3. Estimates of Artificial Neural Network Model for Test and Real Values

As it is seen in Figure 3, model's successful estimations have been understood in the graphic in which values that were acquired from ANN model's testing were compared to the real values. Test outputs and real values are in accordance with each other. Moreover, it is also very successful as test set and imputed values relevant to the previous data of the network. This shows that there is no memorization problem in the network. Model's test phases measured values and output values that the forecaster produced have been shown in Table 4 in summary.

Table4. Model's test phase results

Data No	Measured (Training) Value	Output (Real) Value	Data No	Measured (Training) Value	Output (Real) Value	Data No	Measured (Training) Value	Output (Real) Value
1	-0,2377	0,0314	**46**	-0,2275	-0,1936	**96**	0,1066	0,0922
2	0,0000	-0,1596	**47**	-0,1351	-0,2380	**97**	0,3175	0,3261
3	-0,2338	-0,1282	**48**	-0,0091	0,0073	**98**	-0,4435	-0,3534
4	0,3500	0,2879	**49**	-0,3872	-0,3943	**99**	-0,0057	-0,0812
5	0,1014	0,1133	**50**	0,0000	0,2287	**100**	0,0395	-0,0988

Conclusion

In crisis conditions in which economic indicators show high level and sudden changes, forecasting companies' stock rates of return and setting an artificial neural network which has forecasting accuracy as much as statistical models while making this prediction have been the main concern of this study. Artificial neural networks forecast value of dependent variables using the information that independent variables include.

In our study, MSE value has been determined as performance measurement with which the training will be completed when it is reached. Model's training data and post-training MSE value has been determined as 0, 0309 and MSE value for output that it has produced for post-training test data has been 0, 0502.

According to the results of the study, it has been ascertained that developed multi layer perception model has the capacity of forecasting 2008 crisis period successfully. With this study, it has been proved that artificial neural network is a method that can be used for forecasting of companies' stock rate of returns. In subsequent studies, the models can be developed more benefiting from different periods and providing more comprehensive data set.

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INFLATION AND UNEMPLOYMENT IN SWITZERLAND: FROM 1970 TO 2050

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Abstract

An empirical model is presented linking inflation and unemployment rate to the change in the level of labour force in Switzerland. The involved variables are found to be cointegrated and we estimate lagged linear deterministic relationships using the method of cumulative curves, a simplified version of the 1D Boundary Elements Method. The model yields very accurate predictions of the inflation rate on a three year horizon. The results are coherent with the models estimated previously for the US, Japan, France and other developed countries and provide additional validation of our quantitative framework based solely on labour force. Finally, given the importance of inflation forecasts for the Swiss monetary policy, we present a prediction extended into 2050 based on official projections of the labour force level.

Keywords: inflation, unemployment, labour force, forecasting, Switzerland.

JEL classification: E3, E6, J21.

1. Introduction

The Swiss National Bank (SNB) introduced a unique monetary policy framework in 2000. The new policy is based on inflation forecasts and utilizes various prediction methodologies (Baltensperger *et al.* 2007). There are two general approaches as related to conditional and unconditional forecasts. The former approach fixes a constant interest rate over the forecast horizon. The SNB unconditional forecast is calculated under the assumption of endogenous reaction of the nominal interest rate. Both forecasting techniques are based on structural models of the Swiss economy. In addition, unconditional methodology can use non-structural models. The SNB publishes its forecasts on a quarterly basis at a 12-quarter horizon. Lack (2006) presented a comprehensive study of the accuracy of the VAR inflation predictions and found that the best specifications are superior to the naive models of inflation, which became a benchmark model after the paper published by Atkeson, and Ohanian (2001).

Lack finds that the most relevant variables for explaining variation in inflation rate are mortgage loans and M3 money supply. It is further reported that real GDP and other real activity indicators only act to the detriment of the forecasting accuracy. Furthermore, Hock, and Zimmerman (2005) found that the 3-month LIBOR is superior to other market variables. Nevertheless, all market based forecasts are characterized by large systematic errors. Taking into account critical importance of accurate inflation prediction for the SNB's monetary policy any alternative model providing a more robust and accurate forecast must be carefully considered. Recently, we have revealed a quantitative link between the change rate of labour force and the inseparable pair of price inflation and unemployment in developed countries (Kitov 2006; Kitov, and Kitov 2010).

Originally, the model was introduced for the United States. The root-mean-square forecasting error (RMSFE) of the rate of price inflation at a 2.5 year horizon was of 0.8% between 1965 and 2004. This RMSFE is superior (at least by a factor of 1.5) to any other model at the same time horizon. Since the change in labour force is not among the predictors used by the SNB, it would be helpful to test the predictive power of this macroeconomic variable for the purposes of devising reliable monetary policy. Therefore, the main purpose of this study is to improve on the current accuracy of description of the past time series of inflation and unemployment using the change in labour force and to predict the future evolution of both variables using labour force projections.

In our previous studies, we have found that the revealed link is represented by a linear and lagged function. Furthermore, since the latter does not include any AR-components the relation

between labour force and inflation is a causal one. The corresponding model is completely deterministic with the change in labour force being the only driving force causing all variation in both unemployment and inflation beyond measurement noise. As prescribed by econometric methodology, the models for individual developed countries have been tested for cointegration. This test is mandatory since all involved macroeconomic variables are integrated of order 1, I(1).

A number of standard cointegration tests has been carried out and these tests rejected the null hypothesis of the absence of cointegrating relations (Kitov *et al.* 2007). Both the Engle-Granger and Johansen approaches have shown the presence of long-term equilibrium relations. Nevertheless, the change in labour force is likely a stochastic process. This subsequently causes inflation and unemployment, as dependent variables of the labour force, to exhibit stochastic properties.

In general, we have been following the approach to macroeconomic modelling of inflation and unemployment adapted in the mainstream economic and econometric research. Regarding the formal representation of inflation and unemployment time series, we follow up the approach of Stock, and Watson (2008) who conducted an extensive study of economic and financial variables and indices as predictors of inflation using the Phillips curve framework. For some reason the set of 200 predictors does not include the change in labour force.

In this paper, we aim to correct for this drawback and extend the predictors' set in order to conduct a similar statistical investigation for Switzerland. However, we completely ignore any autoregressive (AR) components in the underlying time series. Thus, our model does not belong to the class of Autoregressive Integrated Moving Average (ARIMA) or Unobserved Component - Stochastic Volatility (UC-SV) models. It is rather a model with degenerate stochastic components, except those associated with measurement noise.

The Phillips curve in Switzerland was modelled by Gerlach (2007), who addressed the question of how useful money growth is for explaining future price developments. The SNB used money growth targets until 1999. When the new policy framework focusing on inflation forecasts was introduced money growth has been used as a major indicator variable. To model the money growth influence on the Phillips curve the trend money growth was incorporated. This additional variable explained around 15% of variability in the original inflation time series. Although the author reports a better predictive power of the extended model, in fact it does not result in any marginal improvements relatively to the other predictors from the set proposed by Stock, and Watson (2008).

As expected from our previous experience for a number of developed countries, the change in labour force in Switzerland is characterized by a much better predictive power and inflation can be accurately forecasted even in the absence of its lagged or expected values, as would have been prescribed the Classical New Keynesian framework. For the rate of unemployment, the predictive power of labour force is also rather high. However, the rate of unemployment has been developing in a narrow channel with little variation, except for the leap from 1.7% in 1991 to 3.8% in 1993. Stable processes are harder to model due to extremely low resolution in the data (i.e. naive model or historical mean usually outperforms structural models).

The reminder of the paper is organized in five sections. Section 2 introduces the model. In many countries, the U.S. and Japan among others, the generalized link between labour force and the two dependent variables can be split into two independent relationships, with no apparent explicit link between inflation and unemployment. In France, only the generalized model provided an adequate description of the evolution of both dependent variables since the 1960s (Kitov 2007). In Section 2, we also present and statistically characterize various estimates of inflation, unemployment and labour force in Switzerland.

Section 3 discusses the Phillips curve and reveals the break in relevant time series around 1994. This year introduces a structural break in some relationships estimated in this study. In Section 4, the linear link between labour force and unemployment is modelled using annual measurements of both variables. Section 5 is devoted to the link between the rate of inflation and labour force. Instead of poorly constrained LSQ methods we apply a simplified version of the 1-D boundary elements method, namely the cumulative curves. Finally, Section 6 presents the generalized link between inflation, unemployment and labour force. In Conclusion, we present several long-term (through 2050) forecasts of inflation in Switzerland using labour force projections provided by the Swiss Federal Statistics Office (2011).

2. Model and data

As originally defined in Kitov (2006), inflation and unemployment are linear and potentially lagged functions of the change rate of labour force:

$$\pi(t) = A1dLF(t-t1)/LF(t-t1) + A2 \quad (1)$$

$$UE(t) = B1dLF(t-t2)/LF(t-t2)+ B2 \quad (2)$$

where $\pi(t)$ is the rate of price inflation at time t, as represented by some standard measure such as the GDP deflator (DGDP) or CPI; UE(t) is the rate of unemployment at time t, which can be also represented by various measures; LF(t) is the level of labour force at time t; t1 and t2 are potential time lags between inflation, unemployment, and labour force, respectively; A1, B1, A2, and B2 are country specific coefficients, which have to be determined empirically in the calibration procedures.

The latter coefficients may vary through time for a given country, as induced by numerous revisions to definitions and measurement methodologies of the studied variables, i.e. by genuine variations in measurement units. Note that in (1) and (2) the term dt in the relative rate of change of labour force is omitted as the resulting empirical model is based on annual readings and hence dt = 1.

Linear relationships (1) and (2) define inflation and unemployment separately. These variables are two indivisible manifestations or consequences of a unique process, however. The process is the growth in labour force which is accommodated in developed economies (we do not include developing and emergent economies in this analysis) through two channels. First channel is the increase in employment and corresponding change in personal income distribution (PID). All persons obtaining new paid jobs or their equivalents presumably change their incomes to some higher levels. There is an ultimate empirical fact, however, that PID in the USA does not change with time in relative terms, i.e. when normalized to the total population and total income. The increasing number of people at higher income levels, as related to the new paid jobs, leads to a certain disturbance in the PID. This over-concentration (or "over-pressure") of population in some income bins above its "neutral" long-term value must be compensated by such an extension in the corresponding income scale, which returns the PID to its original density. Related stretching of the income scale is the core driving force of price inflation, i.e. the US economy needs exactly the amount of money, extra to that related to real GDP growth, to pull back the PID to its fixed shape. The mechanism responsible for the compensation and the income scale stretching, should have some positive relaxation time, which effectively separates in time the source of inflation, i.e. the labour force change, and the reaction, i.e. the inflation.

The second channel is related to those persons in the labour force who failed to obtain a new paid job. These people do not leave the labour force but join unemployment. Supposedly, they do not change the PID because they do not change their incomes. Therefore, total labour force change equals unemployment change plus employment change, the latter process expressed through lagged inflation. In the case of a "natural" behaviour of the economic system, which is defined as a stable balance of socio-economic forces in the society, the partition of labour force growth between unemployment and inflation is retained through time and the linear relationships hold separately. There is always a possibility, however, to fix one of the two dependent variables. Central banks are definitely able to influence inflation rate by monetary means, i.e. to force money supply to change relative to its natural demand. To account for this effect one should use a generalized relationship as

represented by the sum of (1) and (2):

$$\pi(t) + UE(t) = A1dLF(t-t1)/LF(t-t1)+ B1\ dLF(t-t2)/LF(t-t2) + A2 + B2 \quad (3)$$

Equation (3) balances the change in labour force to inflation and unemployment, the latter two variables potentially have different time lags behind the labour force change. Effectively, when $t1 \neq 0$ or/and $t2 \neq 0$, one should not link inflation and unemployment for the same year. One can rewrite (3) in a form similar to that of the classical Phillips curve, but without the autoregressive terms:

$$\pi(t) = C1dLF(t-t1)/LF(t-t1) + C2UE(t+t2 -t1) + C3 \quad (4)$$

where coefficients C1, C2, and C3 are naive summations of coefficients from the above equations. Nevertheless, these will be determined using separate calibration.

The rationale behind the superiority of the empirical estimation is the presence of high measurement noise in all original time series. In some places, (4) can provide a more effective destructive interference of such noise than does (3). Consequently, the coefficients providing the best fit for (3) and (4), whatever method is used, may be different.

The principal source of information is the OECD database (http://www.oecd.org/) which provides comprehensive data sets on labour force, unemployment, GDP deflator, and CPI inflation. We also used the estimates reported by the U.S. Bureau of Labor Statistic (http://www.bls.gov) for corroboration of the data on CPI, unemployment and labour force. As a rule, readings associated with the same variable but obtained from different sources do not coincide. This is due to different approaches and definitions applied by corresponding agencies. This diversity of definitions is accompanied by a degree of uncertainty related to the methodology of measurements.

This uncertainty cannot be directly estimated but has an explicit effect on reliability of empirical relationships (Sims 2009). At first, we introduce various estimates of all involved variables. There are two time series for the rate of inflation and unemployment. The level of labour force is represented by annual and quarterly readings.

Figures 1 displays the evolution of two principal measures of price inflation in Switzerland: the GDP deflator, DGDP, and consumer price index, CPI. Both variables are published by the OECD. As it has been already discussed, we consider the DGDP time series a better representative of price inflation in a given country since it comprises all prices in an economy. The overall consumer price index is fully included in the DGDP, and thus, its behaviour represents only a part of the economy. Since labour force and unemployment do characterize the entire economy it is methodically better to use the DGDP for any quantitative modelling.

Figure 1 shows that the overall difference between the CPI and DGDP is not prominent but there are short periods of very large discrepancy: in the beginning of the 1970s, from 1985 to 1989, from 1991 to 1993, and around 2005. The DGDP time series starts only in 1971 whereas CPI is available since the 1950s.

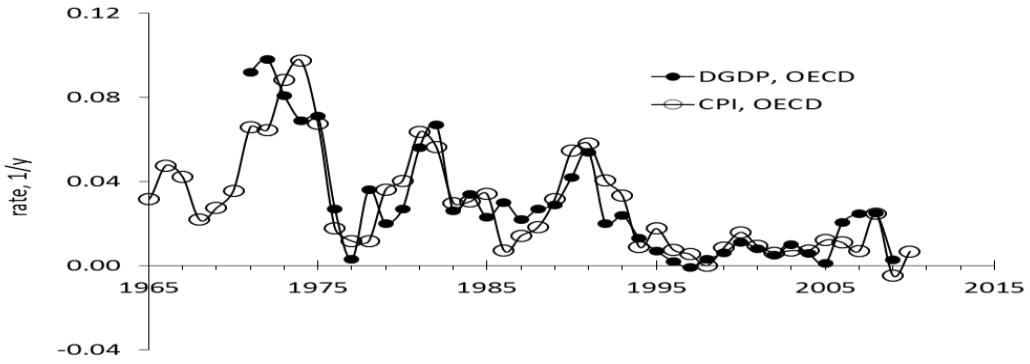

Figure 1. Two definitions of the rate of price inflation in Switzerland: the GDP deflator (available from 1971 to 2009) and CPI inflation (displayed from 1965 to 2010) as published by to the OECD.

The rate of inflation fell to $0.01y^{-1}$ in 1994 and has been oscillating around this level since. Between 1971 and 1993, inflation was fluctuating with decreasing amplitude with apparent trend persistent periods of around 8 years on average. There are three sharp peaks in 1974, 1982 and 1990. Smaller peaks were observed in 1999 and 2008. Such behaviour is different from that observed in most developed countries including those we analyzed previously. It is thus a challenge for our concept and an opportunity to validate the model.

For further econometrical analysis of the link with the labour force, one needs to estimate basic properties of both time series. The order of integration can be determined using unit root tests applied to the original series and their progressive differences. As a rule, the rate of inflation is a I(1) variable in developed countries. Switzerland is not an exception, as Table 1 clearly demonstrates. In particular, we report the results of the following tests: the augmented Dickey-Fuller (ADF), the DF-GSL, and the Phillips-Perron test. The DGDP series consists of only 39 readings and the results might not be reliable. Nevertheless, all tests do not reject the null of the presence of a unit root. For the CPI series with 50 readings the principal result is the same. Both _first differences (dDGDP and dCPI) are

characterized by the absence of unit roots, and thus, the original time series are integrated of order 1. For the period between 1971 and 2009, the RMS values for the DGDP and CPI are 0.262 and 0.257, respectively. For the naive prediction of inflation at a one-year horizon between 1972 and 2009, the RMS values (e.g. DGDP(t) - DGDP(t - 1)) are 0.1631 and 0.1630, respectively. We accept these latter values as the benchmark accuracy for any prediction.

Figure 2 depicts two estimates of the rate of unemployment as reported by the OECD. The first one is adherent to a standard measurement technique, UE, and the other is measured according to a new definition and is referred to as the harmonized rate of unemployment, HUE, as described by the OECD (2011). The difference between the two curves is almost negligible and thus without any potential loss of accuracy we employ the standard rate, UE, for the rest of the paper. The latter has been measured since 1975.

Table 1. Unit root tests of the original time series and their first differences.

	DF	DF-GLS (lag 2)	PP z(ρ)	PP z(t)
DGDP	-2.76 (-3.66)[1]	-2.82 (-3.77)	-8.26 (-18.08)	-2.68 (-3.66)
dDGDP	-6.73* (-3.67)	-4.43* (-3.77)	-40.05* (-18.01)	-6.79* (-3.67)
CPI	-2.45 (-3.59)	-3.66 (-3.77)	-13.88 (-18.83)	-2.68 (-3.59)
dCPI	-5.86* (-3.60)	-3.67 (-3.77)	-38.55* (-18.70)	-5.80* (-3.60)
UE	-0.83 (-3.69)	-2.42 (-3.77)	-2.20 (-17.18)	-1.00 (-3.69)
dUE	-3.37 (-3.67)	-3.45 (-3.77)	-17.98* (-17.74)	-3.32 (-3.69)
dLF/FL	-4.53* (-3.59)	-2.71 (-3.77)	-28.00* (-18.76)	-4.50* (-3.59)
d(dLF/LF)	-9.18 *(-3.60)	-4.81* (-3.77)	-55.27* (-18.70)	-9.73* (-3.60)

[1] 1% critical value; * - the null of a unit root is rejected.

The shape of the unemployment curve is rather peculiar and can be roughly represented by two quasi-constant segments: before 1991 and after 1993. The same overall structure is observed in Austria with the leap from 1.7% in 1981 to 4.2% in 1983. For Austria, this step was artificially introduced by the change in definition of the unemployment variable. Hence, one might expect the same cause behind the step in the rate of Swiss unemployment. Such artificial steps can be modelled by relevant changes in all coefficients in (2) and do not represent actual structural breaks in the original time series or the unemployment volatility associated with underground sector (Gaetano 2010). Therefore, the concept of unemployment has many aspects to elaborate on (Deutsch *et al.* 2007).

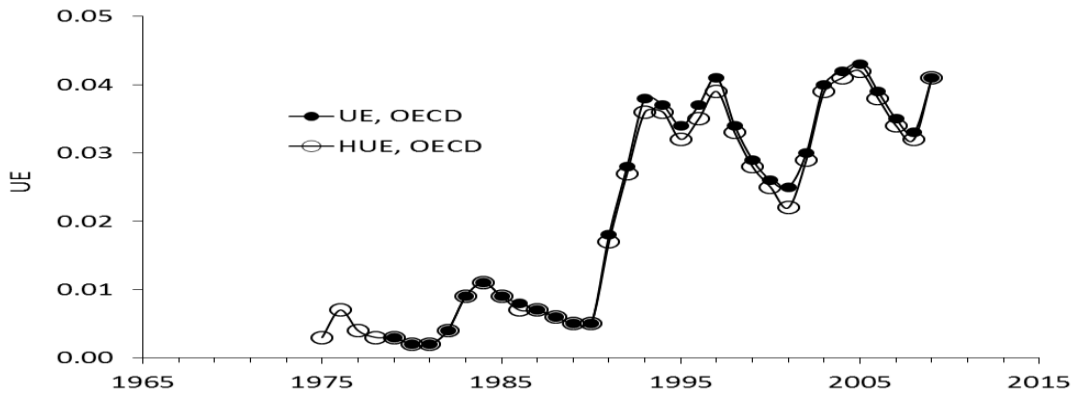

Figure 2. The rate of unemployment in Switzerland according to two OECD definitions.

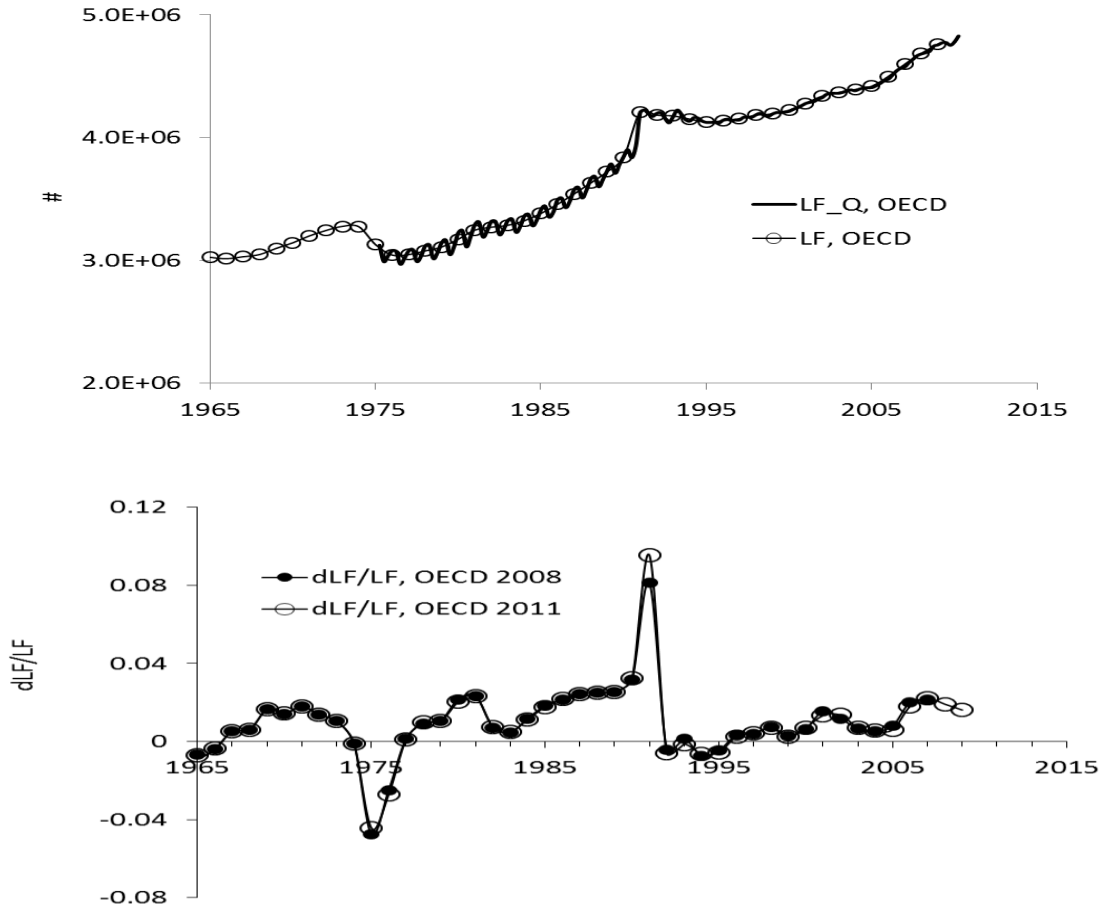

Figure 3. *Upper panel*: The level of labour force: annual, LF, and quarterly, LFQ, estimates. *Lower panel*: The rate of annual labour force change in Switzerland. For the annual change, two versions of labour force are presented: 2008 and 2011 vintages.

In Switzerland, the highest rate of measured unemployment was at the level of 4.3% in 2005, and the lowermost was registered in 1981 at 0.2%. This extremely low rate of unemployment was likely related to the definition and/or the measurement problems. In any case, the change in unemployment is so insignificant that one would not expect any quantitative modelling for the period after 1975 to produce any statistically robust results. Despite the step between 1991 and 1994, Table 1 demonstrates that the UE series is likely integrated of order 1, with the first difference series having unit roots or eigenvalues very close to 1.0. Yilanci (2008) found no unit roots in the monthly estimates of the unemployment rate in Switzerland between 1993 and 2008: the dramatic rise between 1991 and 1993 was safely ignored.

The level of labour force, LF, has been measured since the 1950s. Figure 3 depicts the annual and quarterly (since 1975) estimates of the LF and the rate of change in the annual levels, dLF/LF. Apparently, the labour force series has two, at least in part of artificial nature, breaks: one in 1974 of unknown nature and one in 1992, as the OECD (2008) informs:

> ***Series Breaks***. *From 1998, data are adjusted in line with the 2000 census. Prior to 1991, data refer only to persons who are gainfully employed at least six hours per week*.

In the lower panel of Figure 3, two versions of labour force change are presented: the 2008 and 2011 vintages. The difference in the change rate is minor over the entire period, except in 1991. This difference demonstrates the uncertainty in the labour force estimates conducted during the labour force surveys. Table 1, indicates that the annual dLF/LF is rather an I(1) process with unit roots or eigenvalues very close to 1.0. The first difference, d(dLF/LF), is an I(0) process with all tests rejecting the null hypothesis of a unit root. Since linear links between three I(1) processes will be estimated later, it is necessary to carry out specific tests for cointegration. Otherwise any statistical estimates can

be biased by stochastic trends in these time series. As mentioned above, small samples do not guarantee a higher reliability of statistical tests and we use quarterly estimates of inflation and labour force for unit root tests.

Table 2 lists some results of several unit root tests of the quarterly DGDP (119 readings at Q/Q basis) and dLF/LF (139 readings) series and their first differences. Monthly and quarterly estimates of the UE are also available; however, we do not expect the model of the UE to be a reliable one because of low variability in the data, and thus, low dynamic resolution in this time series. As for the annual estimates, both quarterly time series demonstrate the presence of unit roots in level and the absence of unit roots in the first differences. Therefore, both time series are generated by I(1) processes.

Table 2. Unit root tests of the quarterly estimates of the DGDP and dLF/LF and their first differences

	DF	DF-GLS (lag 4)	PP z(ρ)	PP z(t)
DGDP	-1.24 (-3.50)	-1.29 (-3.56)	-7.49 (-19.86)	-1.17 (-3.50)
dDGDP	-8.46* (-3.50)	-4.99* (-3.56)	-89.61* (-19.86)	-8.48* (-3.50)
dLF/FL	-2.09 (-3.497)	-1.93 (-3.53)	-18.28 (-19.93)	-2.66 (-3.50)
d(dLF/LF)	-9.32 *(-3.498)	-4.69* (-3.53)	-100.4* (-19.92)	-9.20* (-3.50)

3. The Phillips curve

The Phillips curve is a prominent statistical link between price inflation and unemployment. As a rule, it is represented by a scatter plot. In Figure 4, we illustrate the Phillips curve in Switzerland as time series of the rate of unemployment against the rate of CPI inflation reduced to the unemployment series by a linear relationship. The period between 1975 and 2009 has to be separated into two segments according to the artificial step around 1993:

$$UE(t) = -0.2CPI(t+1) + 0.014;\ t < 1994$$

$$UE(t) = -1.0CPI(t+1) + 0.04;\ t > 1993 \quad (5)$$

Both slopes in (5) are negative. For the period after 1993, the slope of -1.0 means that any increase in the overall price at a rate above $0.04y^{-1}$ would reduce the rate of unemployment to zero. When the rate of price inflation is zero, the rate of unemployment is constant at the level of 4%. Before 1993, both coefficients are much smaller, i.e. the change in unemployment was much less sensitive to the change in price. Obviously, the main reason for that was the past definition of an unemployed person, which included less people. The change in the coefficients is of purely artificial change in measurement units.

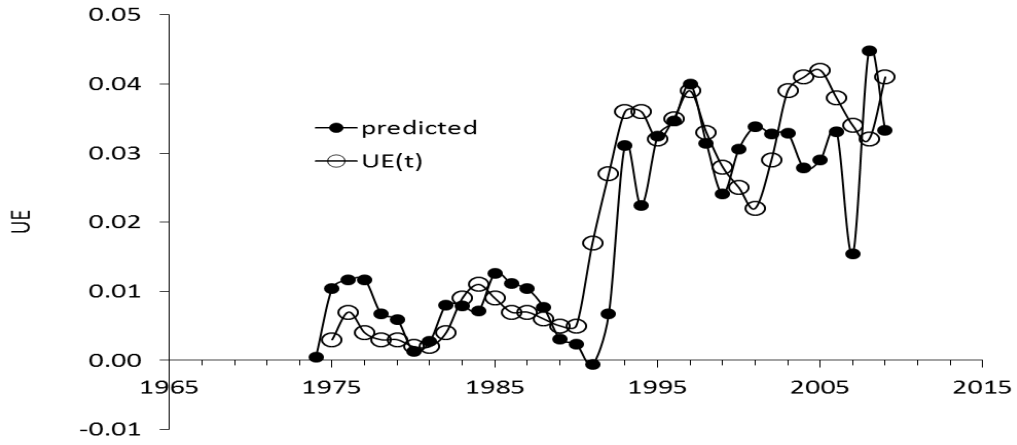

Figure 4. The Phillips curve in Switzerland between 1975 and 2009.

According to (5), the CPI lags behind the rate of unemployment by one year. This is a prominent feature of unemployment in Switzerland and completely corresponds to the conventional understanding of the Phillips curve - any change in the rate of unemployment causes a proportional change in the rate of price inflation. This is not a common feature in developed economics. In the U.S. and Italy, the change in unemployment lags behind inflation. In Japan, Austria and Australia, there is no lag between these macroeconomic variables. In any case, one can use this one-year lag and predict the CPI from the UE.

All in all, one can conclude that the Phillips curve does exist in Switzerland for the entire period between 1975 and 2009 as a single relationship between unemployment and lagged inflation, when the change in measurement units is compensated by the coefficients change in (5). Here, statistical assessments of the Phillips curve are skipped since the overall relationship contains an artificial major step which would bias any estimates. Note that the coefficients in (5) were estimated by visual fit between the observed and predicted curves, and thus, are not accurate.

4. Unemployment and labour force

After the Phillips curve, our approach dictates that we model the dependence of unemployment on the change in labour force. We proceed by replacing the rate of inflation with the rate of labour force change in (5) and then estimate new coefficients and lags. It has been empirically revealed and statistically tested that the rate of unemployment in developed countries is a linear lagged function of the change in labour force. In theory, there should be no reason why a similar link would not exist for Switzerland.

As expected, the same relationship is valid for Switzerland. The estimation method is as before - the trail-and-error one. For the annual readings in Figure 5, we do not use the cumulative curve approach and fit only peaks and troughs. The best-visual-fit equations for the period before and after 1991 (the start of the step in the unemployment curve) are as follows:

$$UE(t) = -0.1dLF(t)/LF(t) + 0.007;\ t < 1992$$

$$UE(t) = -0.5dLF(t)/LF(t) + 0.04;\ \ t > 1991 \qquad (6)$$

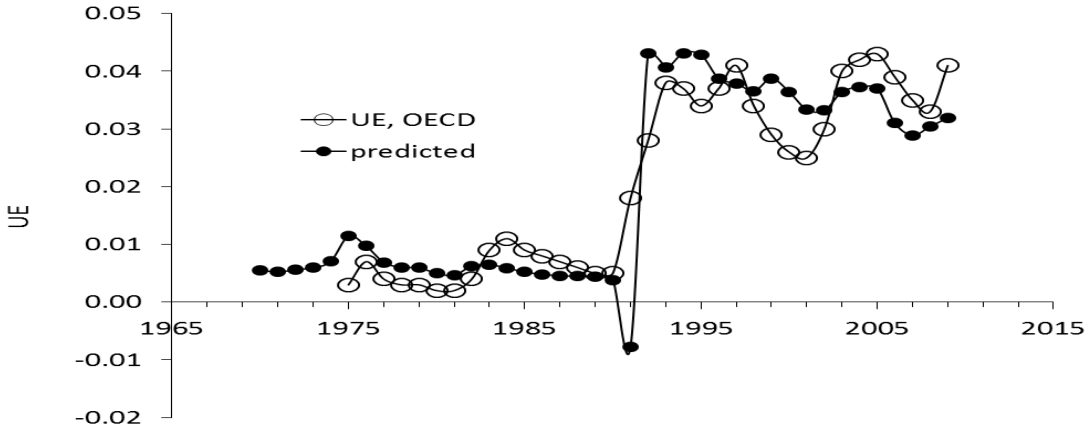

Figure 5. The measured rate of unemployment in Switzerland and that predicted from the change rate of labour force.

There is no time delay between the UE and dLF/LF. Therefore, the break in the Phillips curve observed in 1993 is shifted by one year in the past. This break corresponds to the major artificial step in the LF series. Thus, both time series share the same revision to definitions. Apparently, the slope in (6) is negative. Therefore, any increase in the level of labour force is reflected in a proportional and simultaneous fall in the rate of unemployment. This is a fortunate causality direction - more jobs are equivalent to less unemployed. When the level of labour force does not change over time, the rate of unemployment stays at a low mark of 4%. It is worth noting that (6) implies a nonlinear dependence on the rate of participation in labour force which is a common complication for economic sciences (Ungureanu, and Matei 2007). For a given absolute change in the level of labour force, say 100,000

per year, the reaction of unemployment with be different for the rate of participation 50% (in 1980) and 61% (in 2009). The higher is the participation rate the lower is the change rate, dLF/LF, and thus, the change in the rate of unemployment. It will be a difficult task to retain the rate of unemployment at the current low level - it is likely that the rate of participation is approaching the peak level and will start to decline in the near future.

5. Inflation and labour force

The existence of a deterministic link between labour force and price inflation has been found for many countries. Here we are following the estimation procedure based on cumulative curves, which was successfully employed in Kitov, and Kitov (2010). We start with the annual readings of CPI inflation as reported by the OECD. According to the spike in the dLF/LF (associated with the change in definition) in 1991 we have divided the period before and after 1991. An additional break was observed in 1979. Thus, we separate the overall relation into three segments. By fitting the cumulative curves, we have obtained the following empirical models:

$$CPI(t) = 1.9dLF(t-1)/LF(t-1) + 0.053;\ t < 1981$$

$$CPI(t) = 1.3dLF(t-1)/LF(t-1) + 0.008;\ 1992 > t > 1980$$

$$CPI(t) = 0.5dLF(t-1)/LF(t-1) + 0.006;\ t > 1991 \quad (7)$$

All slopes in (7) are positive and the lag is one year. Thus, any positive increment in labour force in Switzerland causes a proportional overall price increase in one year. Since 1991, the slope is +0.5 and 1% change in the LF has to result in 0.5% change in the rate of inflation. When the level of labour force is stable, the rate of inflation is only +0.6% per year. One can interpret this free term as a low level "intrinsic inflation persistence" in line with the conclusion made for Switzerland by Benati (2009), and Elmer, and Maag (2009) and speculate on the influence of the explicit inflation targeting on the long-term level of inflation (Libich 2006). Before 1991, the slope is larger reflecting relatively smaller absolute changes in the labour force under the previous definitions.

Figure 6 displays the observed CPI inflation curve and that predicted according to (7). Both, the annual and cumulative curves are in agreement. For the period between 1971 and 2009, the goodness of fit is very high: R^2 ann = 0.64 and R^2cum =0.997, respectively. If to consider that (7) does not use autoregressive properties of inflation, which usually bring between 70% and 90% of the explanatory power in the NKPC and other type macroeconomic models, this link is almost a deterministic one. Later in this Section we show that the series of inflation and the change in labour force are cointegrated. In Figure 7, we have smoothed the predicted and observed series with MA(3) since the original dLF/LF and CPI series are volatile due to insufficient resolution. This smoothing is not to remove stochastic component but to increase the baseline for the LF and CPI estimates. The overall improvement is striking, with all major peaks and troughs well predicted in time and amplitude. Thus, stochastic components in both time series are independent and likely related to measurements noise which is easily suppressed by smoothing. For the annual estimates, one has to admit that any economic research desperately needs accurate measurements to reveal robust statistical ties.

Figure 8 then illustrates the benefits of the cumulative curve approach. The relative modelling error, i.e. the error divided by the observed cumulative inflation, decreases over time. Despite the annual levels of price and labour force are not measured more accurately with time the overall change in the level is measured with increasing precision. As a consequence, the observed and predicted cumulative curves, i.e. the overall changes in price and labour force, do converge. They become indistinguishable, and so there does exists a strong a deterministic link between the overall price level and the level of labour force.

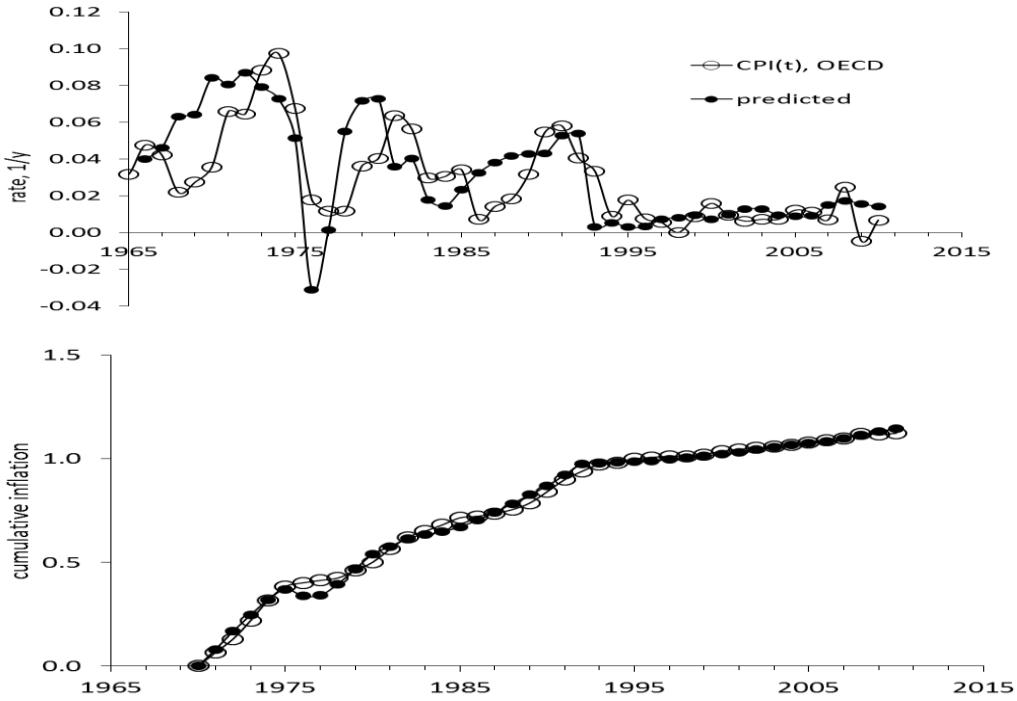

Figure 6. *Upper panel*: Annual readings of the observed and modelled rate of CPI inflation. According to the changes in labour force definition in 1979 and 1991, the predicted curve is a piecewise linear and lagged function. *Lower panel*: Cumulative curves of those in the upper panel since 1971.

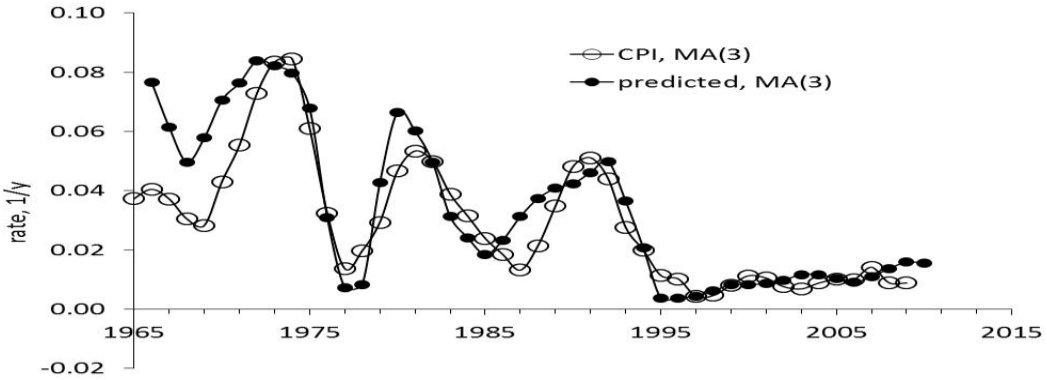

Figure 7. The observed and predicted rate of CPI inflation in Figure 6 smoothed with MA(3). The overall agreement is very good.

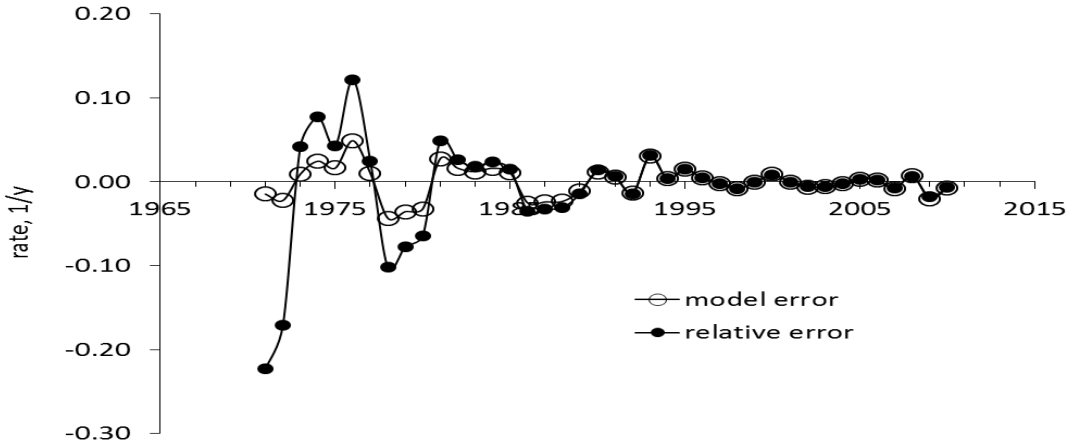

Figure 8. The model error and relative model error.

The observed CPI time series between 1967 and 2010 contains 44 readings. It is a small sample for statistical inferences. Nevertheless, we have conducted the Engle-Granger and Johansen tests for cointegration. Tables 3 and 4 list some principal results. At first, we test for unit roots the model residual error. All tests in Table 3 reject the null of a unit root. The only difference with the authentic Engle-Granger approach is that we have used the residual obtained by visual fit of the cumulative curves in Figure 6 instead of a linear regression. Our previous experience shows that linear regression is hardly the best way to estimate coefficients in (7). In any case, Table 3 implies that model (7) represent a long term equilibrium relation between inflation and the change in labour force. In the absence of AR-terms and the one-year lead of the dFL/LF, this relation is a causal one.

Table 3. Unit root tests of the model residual

DF	**-5.51***	**-3.63**
DF-GLS [lag]		
4	-3.1	-3.77
3	-2.804	-3.77
2	-4.318*	-3.77
1	-6.97*	-3.77
PP		
z(ρ)	-31.91*	-18.43
z(t)	-5.43*	-3.63

The Johansen test for cointegration results in rank = 1, i.e. one cointegrating relation between the observed and predicted time series, for both trend specifications: "*none*" and "*rconstant*". The largest lag in these tests is 2 years. Considering the principal results of both cointegration tests we can conclude that (CPI) inflation and labour force are cointegrated between 1967 and 2010. This validates the results of the estimated linear regression and other statistical inferences.

We have already estimated $R^2 = 0.64$ for the annual time series. Corresponding RMFSE, i.e. RMS value of the model error, is of $0.018y^{-1}$. This is the accuracy of the CPI inflation prediction at a one year horizon. As expected, a VAR model with maximum lag of 2 years, i.e. the inclusion of corresponding autoregressive terms in (7), provides only a marginal improvement on the deterministic model: $R^2 = 0.74$ and RMSFE = $0.013y^{-1}$.

Table 4. The Johansen rank test, maxlag = 2

none	**rank**	**LL**	**eigenvalue**	**trace stat**	**5% critical**
	0	220.6	.	34.7	12.53
	1	236.4	0.53	3.20*	3.84
	2	238	0.07		
rconstant	rank	LL	eigenvalue	trace stat	5% critical
	0	220.6	.	39.95	12.53
	1	236.4	0.53	8.44*	9.42
	2	238	0.18		

A VEC model with maximum lag 2 years and one cointegrating relation, results in a larger RMSFE of $0.014y^{-1}$. Statistically, a much better result is obtained when MA(3) of the predicted series is used. This is a correct operation since only past readings of the LF are used and the prediction is effectively an out-of-sample one. For the period between 1971 and 2010 we have obtained $R^2 = 0.80$ and RMSFE = $0.011y^{-1}$, with the naive RMSFE of $0.016y^{-1}$.

The goodness-of-fit for the cumulative curves is indistinguishable from 1.0. Therefore, it could be argued that measurements of the CPI in the long run are redundant and can be completely replaceable by the level of labour force, which is obviously much easier to estimate with a very high accuracy than inflation. Apparently, CPI is not an unambiguous macroeconomic variable and includes subjective judgments on hedonic pricing to correct for quality changes or when new goods and services are introduced.

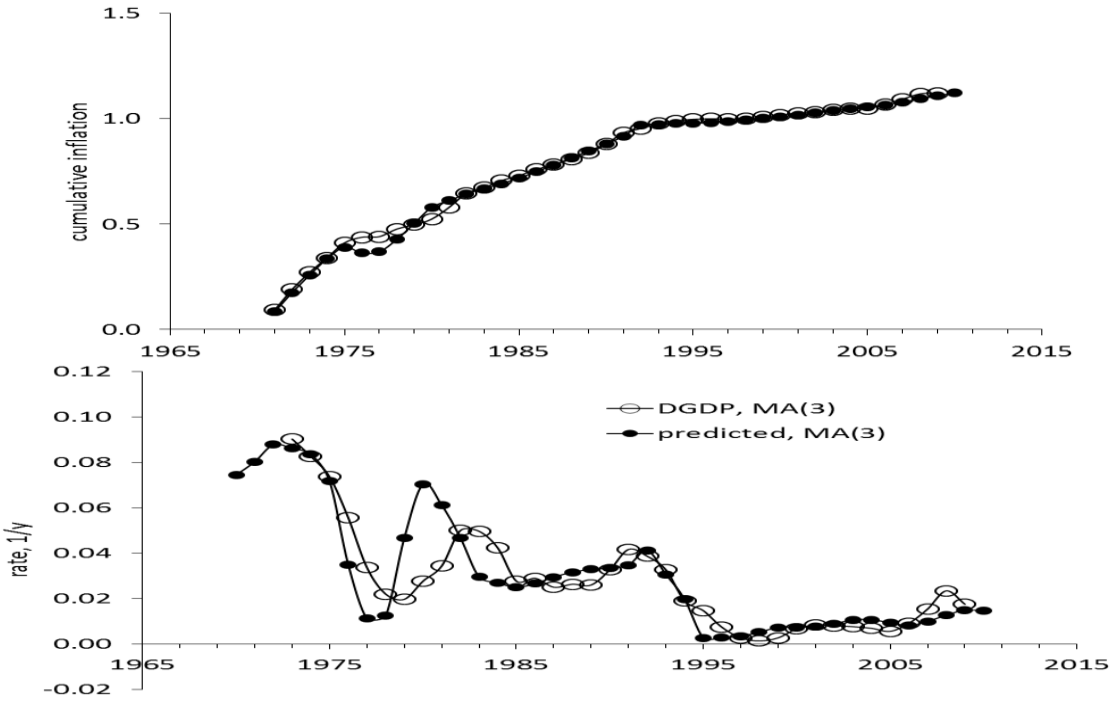

Figure 9. *Upper panel*: Cumulative curves of the observed and modelled DGDP between 1971 and 2009. *Lower panel*: The annual DGDP smoothed with MA(3) since 1973.

Now, we turn our attention to the second measure of inflation, the GDP deflator. The annual DGDP time series starts in 1971. The period between 1971 and 2009 is split into three segments and the (visual) best-fit linear lagged relationships are as follows:

$$DGDP(t) = 1.9dLF(t-2)LF(t-2) + 0.057;\ t < 1980$$

$$DGDP(t) = 0.5dLF(t-2)/LF(t-2) + 0.021;\ 1992 > t > 1980$$

$$DGDP(t) = 0.5dLF(t-2)/LF(t-2) + 0.006;\ t > 1991 \quad (8)$$

In (8) coefficients are slightly different from those in (7). The most prominent is the change in slope from +1.3 to +0.5 between 1980 and 1991. This effect is associated with low resolution for this particular period when dLF/LF was almost constant with a small trough around 1983. The change in slope can be replaced by a proportional change in free term - from 0.008 to 0.021. The curvature of the observed DGDP curve between 1980 and 1992 also adds to the change in the slope. Otherwise, both models are very similar and identical since 1992.

Figure 9 depicts the observed and predicted DGDP curves - cumulative and MA(3) ones. The length of the DGDP series is only 38 readings and all statistical inferences would be unreliable. For this reason, we skip cointegration tests and linear regression analysis. On the other hand, the CPI and DGDP curves in Figure 1 are very close, and thus, statistical results should be similar.

$$DGDP(t) = 1.9dLF(t-2)LF(t-2) + 0.057;\ t < 1980$$

$$DGDP(t) = 0.5dLF(t-2)/LF(t-2) + 0.021;\ 1992 > t > 1980$$

$$DGDP(t) = 0.5dLF(t-2)/LF(t-2) + 0.006;\ t > 1991 \quad (9)$$

The CPI annual series has 44 readings between 1967 and 2010. Small samples cannot provide robust statistical estimates and inferences. The OECD reports quarterly estimates of inflation and labour force that are however both noisy because of the significant measurement errors. As we use the cumulative curve approach these measurement errors have to be suppressed in the long run by

destructive interference. One can estimate relevant coefficients in (8) for the quarterly readings of the DGDP and dLF/LF.

Figure 10 presents both the quarterly and cumulative curves of the observed and predicted inflation rate. The quarterly measured inflation is smoothed with MA(4) and the predicted one with MA(8) because the original Q/Q growth rates are highly volatile. The agreement between the cumulative curves is again excellent.

6. The generalized model

We have estimated several individual links between labour force, unemployment and inflation. The change in labour force and the rate of inflation are cointegrated, as the Engle-Granger, and Johansen tests have shown. For the rate of unemployment, the model has no sense because of low resolution. In this situation, the generalized model is somewhat obsolete. However, we have estimated this model for methodological purposes as well as for the completeness of our concept. We split the entire modelling period into two segments and obtain the following relationship:

$$\begin{aligned} CPI(t) &= 1.8dLF(t-1)LF(t-1) - 6.0UE(t-1) + 0.04;\ t < 1989 \\ CPI(t) &= 0.4dLF(t-1)LF(t-1) - 0.7UE(t-1) + 0.03;\ t > 1988 \end{aligned} \quad (10)$$

Figure 11 presents the measured and predicted CPI inflation. As discussed above, the CPI does not represent the economy as a whole, and thus, the CPI evolution is not necessarily a one-to-one reaction to the change in labour force.

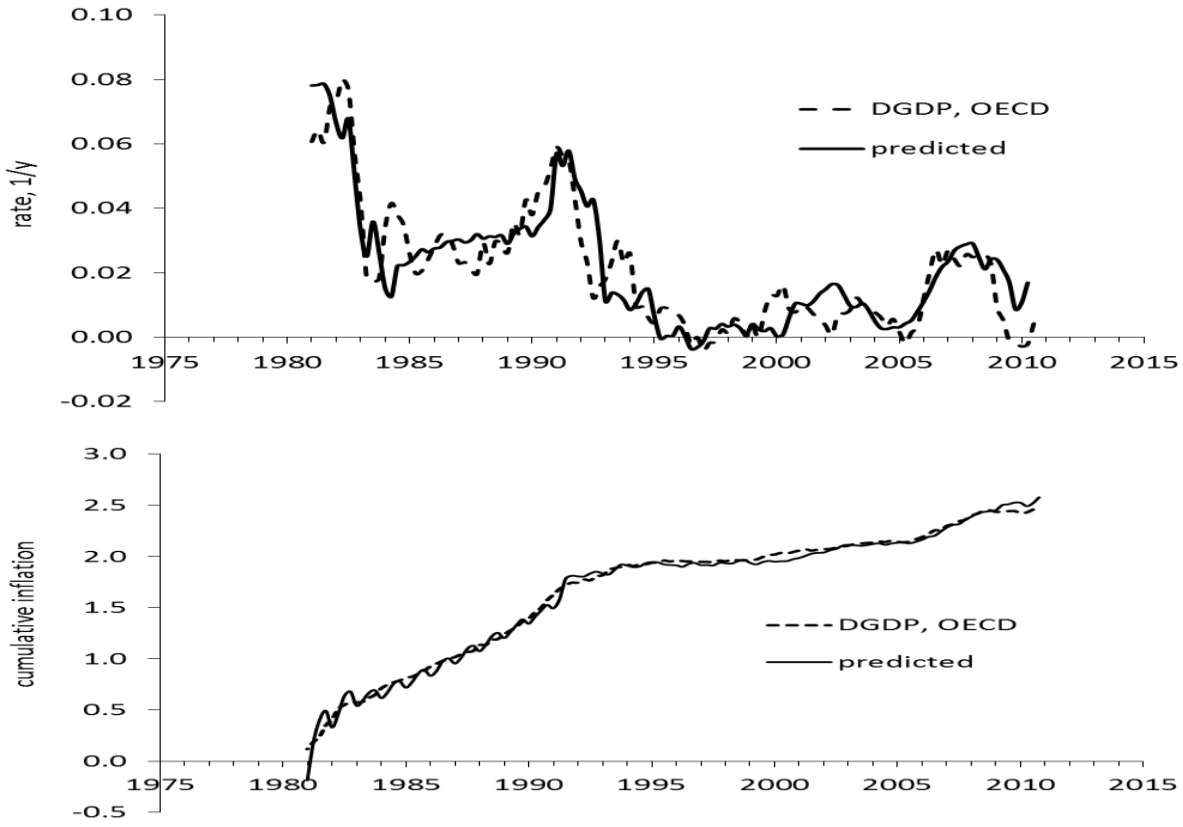

Figure 10. *Upper panel*: Quarterly readings of the observed and modelled rate of the overall price inflation as represented by the GDP deflator, DGDP.

According to the changes in labour force definition in 1992, the predicted curve is a piecewise linear and lagged function. *Lower panel*: Cumulative curves of those in the upper panel since 1981.

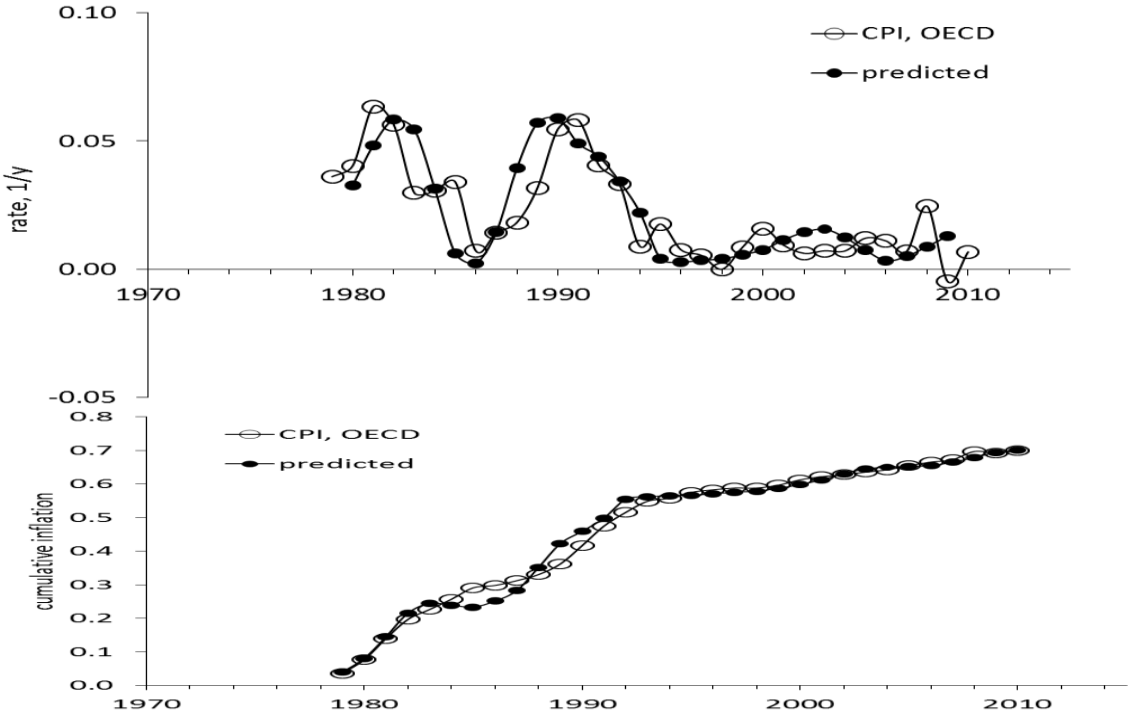

Figure 11. *Upper panel:* The rate of the overall price inflation, CPI, in Switzerland as predicted by the generalized model with a structural break neat 1993 related to the change in measuring units.

Notice that the predicted series is smoothed with MA(3). *Lower panel:* The relevant cumulative curves.

Conclusion

The rate of price inflation and unemployment in Switzerland is a one-to-one correspondence to the change in labour force. This conclusion validates earlier models for many developed countries: the U.S., Japan, Germany, France, Italy, Canada, the Netherlands, Sweden, Austria, and Australia. Switzerland was not studied in detail so far. The excellence of the obtained statistical and conceptual results compensates the delay in analysis.

Overall, we have established that there exist long term equilibrium relations the rate of labour force change and the rate of inflation. In this sense, money factor plays no significant role in the low inflation level observed in Switzerland since the 1990s, as suggested by Reynard (2006). The level of statistical significance of these cointegrating relations allows us to consider these links as deterministic ones, as adopted in physics. Unlike the New Keynesian Phillips curve models, the relationships proposed in this paper do not use autoregressive properties of any macroeconomic variable under consideration.

The change in labour force includes a strong demographics component and thus is stochastic to the extent the evolution of population in a given country is stochastic. Since the level of labour force is a measurable value one does not need to estimate its stochastic properties - they are obtained automatically with tedious routine measurements. The Swiss Federal Statistics Office (2011) provides several long-term projections of the labour force level. We have used three of these projections with high, low and middle fertility scenarios. Figure 12 depicts three predictions of inflation based on these projections and the most recent linear relationship between dLF=LF and CPI. In all cases, the rate of inflation will be below 1% per year in the next 40 years. There is no long term danger of deflation, however. Smooth and low price inflation in the decades to come will likely make aggressive reaction of the SNB, as based on the Taylor rule (Perruchoud 2009), less popular. Based on relationship (5), we expect the rate of unemployment in Switzerland to be slightly above 4.0% over the next four decades.

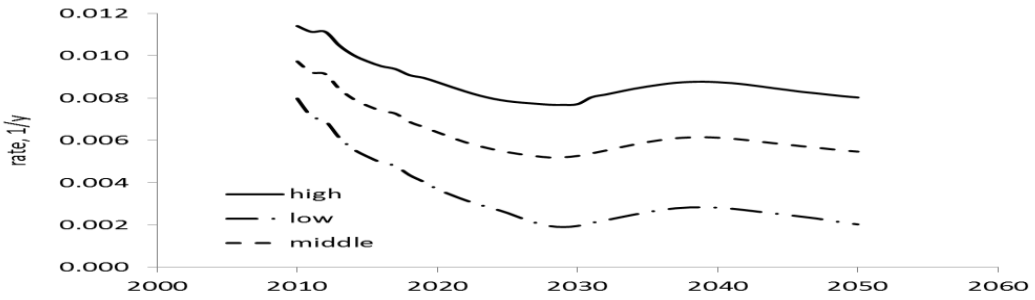

Figure 12. The prediction of CPI inflation between 2010 and 2050.

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THE RISK AND FRAUD FACTORS IN THE CONTEMPORARY FINANCIAL BANKING SYSTEM

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Abstract:

The research conducted by the banking system financial audit revealed major financial scandals that rocked the business world and created a chain reaction, litigation and social convulsions, failed investments, plus tens of thousands of unemployed. Bad loans speculate principle disregarded by economists, namely, that although man is a rational being and should act as such in economic decisions, their behavior differs depending on the amounts at stake and the position that are. Financial stability or profitability is threatened by the economic conditions of the industry or operating entity. In this context, we can include negative recurrent cash flows, resulting from the inability to generate operating cash flows, while also reporting increases in earnings.

Also, we can add the existence of excessive pressure on the leaders of banking companies from the requirements or expectations of third parties. All these factors can be classified according to three conditions of the fraud, such as: incentives / pressures, opportunities, attitudes/reasons. Some of these risk factors occur when there are distortions in the misappropriation of assets. Thus, bankers are scrambling to get as much, to as many, and the State was involved in this business in his way. Watching the similarity of the global market economy and the public square, the country, we can say that it is, always, a well organized group, only one crew member being in sight. Each investor seems to have a chance, because he participated willingly, notwithstanding the publicity and the border state. One thing is certain: for the big banks to collapse, they need some "help".

Keywords: capital, incertitude, profitability, risk, investment

JEL Classification: F33

1. Introduction

The research, conducted by the financial audit banking system, has revealed the major financial scandals that have rocked the business world and created chain reactions, litigation and social convulsions, failed investments, plus tens of thousands of unemployed. Bad debt loans speculate a principle disregarded by economists, namely, that although man is a rational being and should act as such, in economic decisions, their behavior differs depending on the amounts at stake and the position they hold. Thus, the same person who believes that a product of 3 euros is too expensive, if it becomes the owner of the company that sells the product will require more than 5 euros, which have long known the financial speculators. Major financial scandals and implicitly the causes behind the global economic crisis, are the result of important fraudulent maneuvers in the financial and banking system. By many financial maneuvers, fraud and error, many companies have managed to distort the reality regarding their performance and market position, misleading the perception of users.

2. General causes of fraud in the banking system

Directly or indirectly, the majority of the population was affected by the earthquakes produced in the business world. In this context, taking into account the links that exist between financial fraud and the global crisis, we can say that in a world of risk, the investor should pay attention to detail, forcing him to further inform before committing the capital in a company, even a very successful one. From the analysis of a multitude of frauds and distortions arising from the financial reports of the companies, detach risk factors and the fraud that caused crashes in big giant companies. The financial stability or profitability is threatened by the economic conditions of the industry or operating entity. In this context, we can enumerate the recurrent negative cash flows, resulting from the inability to generate operating cash flows, while also reporting increases in earnings.

The current economic and financial crisis appears to be unprecedented compared to other involutions of economic systems in general and the banking systems in particular. The economic recession extends into the U.S., Europe and Japan and outlines to be more painful than the economic

downturn in 1981-1982. A massive loss of confidence both in the business sector and in the consumers, both responding by restricting spending, is in full progress. U.S. government and some European governments, trying to restore stability, have nationalized important parts of their banking sectors in a measure that contradicts the very foundations of modern capitalism. The whole world seems to change its course today, heading towards a period when the state's role will be higher, and the private sector will be lower. Hence one of the fraud causes occurred in the modern banking system. This is probably one of the most important consequences of the current crisis.

The fundamental causes of the financial crisis are deeper and have brought their contribution in producing the crisis. One of the major causes of the financial crisis was ample liquidity created by the world's major central banks (FED, BOJ) and the willingness of oil and gas exporting countries to limit currency appreciation. Also, there was a saturation of savings generated by the increasing integration of countries into the global economy (Southeast Asia), with high accumulation rates but also the redistribution of global wealth and revenue towards the hard goods exporters (oil, natural gas etc.). Abundant liquidity and significant saturation with savings created important resources available for investment, including sophisticated financial instruments, not easily understood by some investors and bankers, but very easy to speculate and divert by some bank managers.

The existence of abundant liquidity, have resulted in very low interest rates and their low volatility. Combined, these consequences have led to increased appetite for assets with large gains in the banking system. In addition, the low market volatility has created the tendency to underestimate the true risk and a lack of vigilance of investors, heavily speculated by banks. Risk margins were also very low and non-discriminatory. Together, low interest rates, appetite for assets with high returns, low vigilance toward risk and low margins have masked the price signals in the financial markets and have led to insufficient understanding of the risks involved. [1]

3. The interdependence between fraud and external economic factors in the banking system

On this background have operated as aggravating, a series of microeconomic causes as well: frenzy securitization, cracks in the business model of rating agencies, rational outsourcing in terms of privacy, but socially inefficient and, finally, increased international competition for deregulation. I number myself among those who claim that signals about the crisis were made by economists, but were not taken into account. However, it must be said that the magnitude of the crisis was, until recently, obviously underestimated by everyone.

The consequence of the frenzy securitization was that once the crisis was initiated by the appearance of failure to pay rates on loans for houses, the financial market became non-transparent. The installation of distrust of investors quickly placed the securities issued by the vehicles (VSP), with a special purpose, in the risky category (the asset quality they financed was not clear) and refinancing became impossible. Because of the gap between the maturities: assets and liabilities, the VSP began to rely on funding lines from sponsoring banks. Finally, the demand for liquidity, combined with a loss of confidence between banks, has resulted in the pursuit of cash and the effective interest rate started to rise.

In the U.S. and some European countries, governments and central banks have responded by improving liquidity, providing government guarantees for loans, recapitalizing the financial institutions, ensuring the latest issued by insured banks, preventing the disorderly collapse of large interconnected companies, buying shares in banks, coordinating interest rate cuts. Although such measures have been implemented after 17 months of the outbreak turbulence, the market remains opaque, which amplifies the financial crisis and facilitates its entry into the real sector of economy, first in the U.S., then in other developed countries.

Furthermore, adding the existence of excessive pressure on the leaders of banking companies in compliance with the requirements or expectations of third parties. All these factors can be classified according to three conditions of fraud, in: incentives / pressures, opportunities, attitudes / reasons. Some of these risk factors occur when there are distortions in the diversion of assets. The fraud discovery puts a question mark on the ethic of the professions of accounting and audit, which shows that above all is the law. One of the causes of 2008 consisted in the fact that the U.S. banks and the mortgage of the State, granted loans without coverage, cashing fee, and then immediately selling them, with other fees, just as appealing. Thus, bankers were scrambling to get as much to as many, the State

was involved in this business as well. A banker and more investors, namely an organized group, which attracts people, simulate an initial gain and the uninitiated investors surely lose.

4. The importance of adopting the new Basel Agreement

Theoretically, the second pillar of the new Basel agreement is a set of principles, which stresses the necessity of the assessment of the banks' capital adequacy and supervision of this process in the respective organs. The principles cover the following:

- Banks must hold a trial to estimate the total capital given the risk profile as well as the strategy for maintaining the capital.
- The supervisory bodies should evaluate the bank's internal estimates on capital adequacy and the strategies as well as the ability of the Bank to monitor and ensure the compliance of the regulatory requirements.
- The supervisory bodies will ensure that local banks have a higher than minimum capital and will be able to require banks to maintain a higher level of minimum capital.
- The supervisory bodies should intervene in the Bank's activity in early stages in order to prevent and reduce the capital below the minimum, they must insist on the development and implementation of actions to increase capital.

Risk estimation and capital adequacy should be based not only on the control of the bank's compliance with minimum capital requirements. Under the new agreement - the competence of supervisors include the following tasks:

- Risks' control, remained outside the agreement (the bank's portfolio interest rate risk, business risk, strategic risk) or reflected incompletely (portfolio concentration risk) and system risks related to economic cycles.
- The control over the compliance, by the banks, of qualitative and quantitative criteria for the use of advanced methods for risk estimation.

The pillar II changes reached the stress testing procedure. The Committee is convinced that it is important for banks to adopt the ABRI approach for credit risk. Such banks will be required to present a conservative bank stress test, to assess the extent to which may arise capital requirements following stress-testing scenarios.

Banks and monitoring bodies must use the results of this test as a tool to ensure that the bank has enough capital. The supervisory bodies may require the bank to reduce the level of risk to the extent that bank's capital to cover the minimum capital requirements and results of the stress-testing. By the third pillar, the Committee proposes raising the level of market discipline by establishing a set of disclosure requirements in order to ensure bank's partners access to the key information on the risks of bank's structure and level of capitalization. The disclosure of information relative to risk weighted capital adequacy must take place at least every semester, and for larger banks - quarterly. The Committee believes that this disclosure is extremely important under the new agreement, which states the use of internal methods to assess requirements for capital. As a result, it will improve the risk management and the financial stability of banks. [2]

5. Determining the risk to the banking sector level

The banking system suffers major changes in approach to the evolution and tendencies up to 2008, reference year economically worldwide. If many of the risk approaches came as a recommendation, other imposed by the control and monitoring bodies, established at central and national level currently evaluate those models which, although expensive compared to traditional ones, will highlight more precisely the likelihood of the operational risk and impact, if applied according to the principles they have been prepared by, and harmonized with the practices in the field and with the particularities of the markets they will be introduced to.

Unfortunately last years' trend was one of expansion in retail banking and corporate banking both in the operational and on the credit side, and the banks in their quest for profit and market share have neglected or have been less interested in effective risk management. Today things have changed the orientation of the lending terms, conducive to lending taking place with greater caution. [3]

Of course, banks have reoriented gainful points of interest and market share through attractive packages, operational within the current account and trade facilities. Income from operations, less

risky than those of credit, should be monitored through advanced operational risk management. Basically attracting resources involves their attention in terms of operational management. If 20 years ago, attempted bank fraud was much lower, now banks must be protected from internal fraud attempts to foreign attacks on bank accounts and ATMs. This risk increases with continuous software development in the world, and banks should be aligned through advanced technologies and monitoring risk management. [4]

Counting on the state's ability to save them, bankers behave recklessly - a phenomenon known as "moral hazard". Nobody cares about economic rationality since any losses can be passed to the state. In fact, rationality is turned upside down. It becomes profitable to speculate, to get indebted because it is the only way you can win. If you sit on the side and behave prudently, you're only wasting an opportunity to lose (in relation to the others). Simply this is the logic that it works by.

The control and elimination of risk is an important step in the managerial and supervisory risk activities carried out by bankers. Its purpose is to minimize the costs associated with each type of risk identified in banking products and services. Usually the best time to onset the risk control is when an action is launched so that, through contract provisions, it is trying to control that risk. In addition, risk control is an ongoing and individual task, exercised within each bank, ensuring the central bank as well, in the first and second case, by specialized supervisory departments. Bank managers must determine the main types of activities, for each type of risk control, knowing their characteristics and their likely evolution. For example in order to control the market risk (the interest rate risk, the currency, etc.), for a bank or for the diversification of the portfolio.

Another problem that arises is the risk-assumed by bankers. They are familiar with taking risks in their daily work, but they are reserved in assuming all or part of accidental risks. We should not overlook the fact that we can meet with an unconscious assumption of risk, which means not being aware of that risk. Another issue to be addressed would be the action of reducing risk, avoid it as well as the risk factors. Adverse action of a risk factor can be reduced and / or in some cases be avoided by knowing the cause and remove it. This will involve the redesign of work flow and operations. Currently, some credit institutions that adopted a series of radical solutions, even going as far as to discard some unprofitable products / services or by generating venture. [5]

There are many cases in which a series of banking products and services were taken over by other institutions and companies (card operations carried out by department stores, a number of investments made by mutual funds, pension funds, study loans by a number of foundations, universities or companies), profitable banks, but risky too, such as, for example, the expansion and diversification of speculative operations on the international market. The reduction of the risk factors and / or their avoidance should have a beneficial effect on the total costs of the bank.

Another aspect of business risk management and banking supervision is the risk transfer. In the banks' practice there is the risk transfer system, using derivatives as well as the insurance system, insurance policies being considered as a means of transferring risk. The division and transfer of risk can be accomplished by an establishment of consortiums between several banks. In terms of avoiding the concentration of risk, the more co-debtors the bank has for the same debt, the less important is the insolvency of one of them. On the other part by its own regulations or those of the central banks, risk concentration is also avoided by limiting the loans to the same debtor. [6]

Risk identification also involves a proper training of those working in all departments of the bank, both for knowing the conditions, events, states that can give rise to specific risks and specific methods and techniques, for identification and monitoring of each type of risk. Knowing all the previous events in their own bank or other banks, that have led to the emergence of serious risk repercussions on the bank, in general, or on some banking activities and, therefore depending on each management exclusively. [7]

Thus, no other company is more at risk of fraud than banking organizations. In this area, the frequency of cases and the amounts involved are often much higher than in other areas.

No fraud in the banking sector can be done without one or more factors working inside a bank. For example, a used method is the granting of loans to companies under various false in acts - from the distortion of financial indicators to the declaration of assets that do not exist. It is teamwork, banking staff, working with debtors, a situation seen in other cases. Banking officers retain their percentage of the loan, and later, as agreed at the outset, the debtor pays the rates for three to four months, then he disappears. A different way of fraud, in fact one of the most common in the banking system is that

employees identify inactive accounts, the owner has not conducted operations for several months, and the idea that it is unlikely to use the account in the near future, transferring small amounts from several such accounts in his own account, establishes a set of interest on such a deposit, and then returns the money and collects interest.

Banking companies need to keep their image and prefer to solve their problems internally, because they work with drawn capital, with people's money, and the media coverage of such fraud would significantly blow their image, which would decisively affect the creation of deposits by customers. In this context, the bank's management makes a calculation to determine how important the damage is comparing it to how long and costly the court case might be. Most times it is determined that the risk of harming the image of a bank by potential processes is much too large to recover fraud caused by employees or employers, preferring to just dismiss them. [8]

As a result of gradually reducing the dependence on the banking system, by holding liquid assets, and the perception that the banks can borrow from the banking market at any time, they tend to look at the interest rate risk as being critical and to underestimate the liquidity risk which stresses the need for a larger perspective on the market. In this context, credit growth may seem sustainable at the level of each bank, but there is always the possibility for this development not to be confirmed at an aggregated level. Any perception of risk is thus inadequate since it is only focused on a past performance of sovereign individual loans and not on the broader risk of those who take the loan. [9]

6. Solutions to reduce the risk factors in the banking system

At present, reducing or eliminating risk factors faces the choice between several methods that must take into account the contemporary economic realities. No matter how many regulations are being brought, the tendency towards crisis is embedded into the system. It can be avoided only by reforming it from scratch. But providing a safety net for banks and their customers only leads to a deterioration of things, increasing the risk of systemic crises. In front of the unintended effects of their actions, the authorities have denied their own wisdom, responding to maintain status quo and advocating other measures.

That led to the present situation, the financial system represents the most regulated industry in the economy. Therefore, to put these crises on the account of the errors made by the involved agencies, thanks to the degree of freedom they enjoy shows a severe intellectual disability. The policy of prudential regulation feeds the vicious circle mentioned above: the banks have less incentives of adopting prudent behavior to the extent that the supervision exercised by public authority replaces private risk management. In other words, the state tries to limit moral hazard by a policy whose effects are only increasing this problem.

Without supervising authority, creditor as a last resort and governmental guarantees, banking risk is supported solely by bankers. Without a safety net, banks are stimulated to keep more capital in, for prevention.

State intervention has the unintended effect of replacing private and public responsibility, motivating banks to keep as little capital and increasing therefore the risk of financial fragility of the system. There is an asymmetry of responsibility. If the bank has profit, money is collected by its owners, if the bank loses, these will be divided between shareholders and the state (taxpayers). A solution would be a greater involvement of bankers in loss coverage, the state just playing a savior of last resort role. The safety net that the state tried to create in order to protect the interests of bank's customers was actually a safety factor achieved more in favor of the banking system. The factor that is the sole responsible for the fragility of the financial system by increasing the leverage is the incorrect monetary policy of major central banks. There should be a clearer delineation between the safety of a bank customer, and implicitly the banking system; and the responsibility factors involved in the development of a defective banking company. A greater accountability of these factors established by clear regulations in the banking sector would result in a lower or even unknown tendency to increased risk.

Thus, the appearance of the current economic crisis is the result of specific legislative measures which, intentionally or not, have affected the stability of the system by accumulating nonperforming assets. We refer primarily, here, to the policy inspired by the state, by which U.S. banks have granted preferential "below-standard" loans. The continuous decrease in the rate of bank capital is perhaps the most significant aspect of the banking system fragility. This evolution can only be explained in terms

of various incentives being put on the system, with the contribution of the monetary authority of the state. [10]

Conclusion

In this context, the main short-term challenge is finding solutions to restore confidence of investors and consumers. In the long term, the main challenge is to adjust the principles guiding the reform of the international financial system, mainly on transparency, improving accounting rules on securities, ensure proper regulation of markets, firms and financial products, ensuring the integrity of financial markets (on market manipulation and fraud), and strengthening cooperation between financial institutions of the world (modernization of the governance structures of the IMF and the World Bank). Business ethics is not missing from this list of future challenges. Regarding the similarity between the global market economy and the public square, as country, so we can say that it is, always, a well organized group, only one of the group's members being in sight. Each investor seems to have a chance, participating willingly, notwithstanding the publicity and the state's border. One thing is certain: all the big banks need help to collapse.

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MACROECONOMIC ASPECTS OF REAL EXCHANGE RATE VOLATILITY IN THE CENTRAL EUROPEAN COUNTRIES

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Abstract:

Exchange rate unexpected fluctuations determine economic development of countries the way quite similar to any other type of exogenous shocks. Unpredicted volatility in exchange rate short-run path affects macroeconomic performance the way that may be a subject of academic as well as economic policy discussions. Overall exposure of countries to negative implications of exchange rate volatility represents one of the areas of empirical investigations related to fixed versus flexible exchange rate dilemma. Rigorous analysis of various aspects of exchange rate fluctuations in terms of macroeconomic performance causal effects is considered to be a crucial outcome of not only exchange rate determining potential but also key information for exchange rate policy or policy decisions related to exchange rate regime shifts.

In the paper we analyze macroeconomic aspects of the real exchange rate volatility in the Central European countries. VAR (vector autoregression) methodology is implemented to estimate effects of the real exchange rate fluctuations on the selected main macroeconomic indicators variability. Structural exogenous shocks are identified by applying the Cholesky decomposition of variance-covariance matrix of the reduced-form VAR residuals. Variance decomposition and impulse-response functions of selected endogenous variables to positive one standard deviation real exchange rate shock are computed for two models covering time series for two periods - 2000-2007 (model A) and 2000-2011 (model B) to determine the role of economic crises on presented results (changes in the exchange rate determining potential during the crisis period are expected to be revealed). Ordering of the endogenous variables in both models is also considered to check the robustness of the empirical results of the estimated econometric model in the selected group of countries.

Keywords: exchange rate volatility, economic growth, economic crisis, vector autoregression, variance decomposition, impulse-response function

JEL Classification: F15, F36, F41, F43.

1. Introduction

Exchange rate unexpected fluctuations determine economic development of countries the way quite similar to any other type of exogenous shocks. Unpredicted volatility in exchange rate short-run path affects macroeconomic performance the way that may be a subject of academic as well as economic policy discussions. Overall exposure of countries to negative implications of exchange rate volatility represents one of the areas of empirical investigations related to fixed versus flexible exchange rate dilemma. Rigorous analysis of various aspects of exchange rate fluctuations in terms of macroeconomic performance causal effects is considered to be a crucial outcome of not only exchange rate determining potential but also key information for exchange rate policy or policy decisions related to exchange rate regime shifts.

Exchange rate appreciation (depreciation) may suppress economic activity in country causing foreign prices of goods to decrease in comparison with domestic prices of goods. As a result, exchange rate appreciation and subsequent decrease in foreign competitiveness of domestic goods on foreign as well as domestic markets shifts expenditures from domestic goods to goods produced abroad. Negative impact of exchange rate appreciation on the current account is significantly determined not only by a shift in demand preferences but also by the ability of domestic economy to shift unused production capacities to more perspective areas with growing potential.

While the traditional approaches emphasize negative effects of exchange rate appreciation on the real output in the domestic economy, alternative approaches (Mendoza, 1992) highlight the presence of some positive implications. Exchange rate appreciation causes the prices of exports to rise while it is generally expected the prices of imports are going to decrease. Considering lower exports and imports price elasticity (in short period), exchange rate appreciation causes net export to rise due

to export of goods increase while import of goods tends to decrease. As a result, the real domestic income rises.

At the same time, aggregate supply chain can accelerate a positive impact of exchange rate appreciation on performance of domestic economy. In the less developed countries with inputs being mainly imported (in general production of inputs in such countries is expected to be ineffective), exchange rate appreciation reduces costs of domestic companies. As a result, positive effects of costs reduction due to exchange rate appreciation obviously oversize a negative impact of the contractionary effects related to an increase in domestic tradable goods prices.

Finally we may conclude, exchange rate appreciation causes current account deficit (due to net export deficit) and costs of production reduction. Similarly, exchange rate depreciation causes an increase in net export and costs of production increase. Combined effects of demand and supply channels determines the overall determination potential of exchange rate volatility on real output and level of prices.

In the real word it seems to be necessary to consider the role of uncertainty that significantly affects the responses of demand and supply to any type of exogenous shocks. We expect both components are determined by rational expectations of market participants. Short-run real output variability is then affected by unexpected exogenous shocks on both aggregate supply and aggregate demand sides.

In the paper we analyze macroeconomic aspects of the real exchange rate volatility in the Central European countries (Czech Republic, Hungary, Poland, Slovak Republic). VAR (vector autoregression) methodology is implemented to estimate effects of the real exchange rate fluctuations on the selected main macroeconomic indicators variability. Structural exogenous shocks are identified by applying the Cholesky decomposition of variance-covariance matrix of the reduced-form VAR residuals. Variance decomposition and impulse-response functions of selected endogenous variables to positive one standard deviation real exchange rate shock are computed for two models covering time series for two periods - 2000-2007 (model A) and 2000-2011 (model B) to determine the role of economic crises on presented results (changes in the exchange rate determining potential during the crisis period are expected to be revealed). Ordering of the endogenous variables in both models is also considered to check the robustness of the empirical results of the estimated econometric model in the selected group of countries.

2. Overview of the literature

Effects of the real exchange rate volatility on the macroeconomic performance of countries at the different stages of business cycle are well document in the empirical literature.

Aguirre and Calderón (Aguirre and Calderón, 2005) analyzed the role of the real exchange rate in determining the real output volatility on the sample consisting of 60 countries implementing cointegration analysis using panel data.

Burdekin and Siklos (Burdekin and Siklos, 1999) investigated implications of the exchange rate regime shifts to price level development in the United Kingdom, United States, Canada and Sweden.

Domac, Peters a Yuzefowich (Domac, Peters and Yuzefowich, 2001) observed mutual relationships between the exchange rate regime and macroeconomic performance of the selected European transition economies (Czech Republic, Hungary, Estonia, Poland and Slovenia).

Ghosh, Gulde, Ostry and Wolf (Ghosh, Gulde, Ostry and Wolf, 1996) analyzed effects of the alternative exchange rate regimes on inflation and economic growth on the sample of 145 countries during the 30 years period.

Levy-Yeyati and Sturzenegger (Levy-Yeyati a Sturzenegger, 2001) observed implications of exchange rate volatility on domestic price level, money supply, real interest rates and real output in 154 countries since 1974 till 1979.

Arratibel, Furceri, Martin and Zdzienicka (Arratibel, Furceri, Martin and Zdzienicka, 2011) investigated relationships between exchange rates development and foreign direct investments, domestic loans and current account on the sample of 9 countries from the Central and Eastern Europe.

Lee a Chinn (Lee and Chinn, 1998) analyzed implications of real exchange rate fluctuations on the current account development in 7 most developed industrial countries.

Sek and Chuah (Sek and Chuah, 2011) explored causality between the exchange rate changes and the current account dynamics in 6 East Asian countries.

Arghyrou and Chortareas (Arghyrou and Chortareas, 2008) investigated effects of the exchange rate volatility on the current account adjustments in 11 Eurozone member countries.

Obstfeld and Rogoff (Obstfeld and Rogoff, 2005) focused their investigation on estimation of effects of global current account imbalances reduction on exchange rates (USD, EUR and Asian currency) equilibrium path in the model with alternative scenarios.

3. Econometric model

VAR models represent dynamic systems of equations in which the current level of each variable depends on past movements of that variable and all other variables involved in the system. Residuals of vector ε_t represent unexplained movements in variables (effects of exogenous shocks hitting the model); however as complex functions of structural shocks effects they have no economic interpretation. Structural shocks can be still recovered using transformation of true form representation into reduced-form by imposing a number of identifying restrictions. Applied restrictions should reflect some general assumptions about the underlying structure of the economy and they are obviously derived from economic theory. There are two general (most used) approaches to identify VAR models. Cholesky decomposition of innovations implies the contemporaneous interactions between the exogenous shocks and the endogenous variables are characterized by a Wald causal chain. Ordering of the endogenous variables than reflects expected particular economy structure following general economic theory assumptions. However the lack of reasonable guidance for appropriate ordering led to the development of more sophisticated and flexible identification methods - structural VAR (SVAR) models. Identifying restrictions implemented in SVAR models reflects theoretical assumptions about the economy structure more precisely.

We implement a VAR methodology to analyze macroeconomic aspects of the real exchange rate volatility in the Central European countries. Cholesky decomposition of variance-covariance matrix of the reduced-form VAR residuals is implemented to estimate effects of the real exchange rate fluctuations on the selected main macroeconomic indicators variability.

True model is represented by the following infinite moving average representation:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} = \sum_{i=0}^{\infty} A_i L^i \varepsilon_t = A(L)\varepsilon_t \quad (1)$$

where X_t represents n x 1 a vector including endogenous variables of the model, $A(L)$ is a n x n polynomial consisting of the matrices of coefficients to be estimated in the lag operator L representing the relationship among variables on the lagged values, ε_t is n x 1 vector of identically normally distributed, serially uncorrelated and mutually orthogonal errors (white noise disturbances that represent the unexplained movements in the variables, reflecting the influence of exogenous shocks):

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t\varepsilon_t') = \Sigma_\varepsilon = \mathrm{I}, \quad E(\varepsilon_t\varepsilon_s') = [0] \quad \forall t \neq s \quad (2)$$

Vector X_t consists of six endogenous variables - real output $(y_{r,t})$, money supply (m_t), core inflation (p_t), short-term nominal interest rates $(ir_{n,t})$, real exchange rate $(er_{n,t})$ and current account (cu_t). In the six-variable VAR model $(X_t = [y_{r,t}, m_t, p_t, ir_{n,t}, er_{n,t}, cu_t,])$ we assume five exogenous shocks that contemporaneously affects endogenous variables - demand shock $(\varepsilon_{y,t})$, nominal shock $(\varepsilon_{m,t})$, inflation shock $(\varepsilon_{p,t})$, monetary policy shock $(\varepsilon_{ir_n,t})$, exchange rate shock $(\varepsilon_{er_n,t})$ a current account shock $(\varepsilon_{cu_n,t})$.

The structural exogenous shocks from equation (1) are not directly observable due to the complexity of information included in true form VAR residuals. As a result structural shocks cannot by correctly identified. It is than necessary to transform true model into following reduced form

$$X_t = C(L)Y_{t-1} + e_t \tag{3}$$

where $C(L)$ is the polynomial of matrices with coefficients representing the relationship among variables on the lagged values and e_t is a n x 1 vector of normally distributed errors (shocks in reduced form) that are serially uncorrelated but not necessarily orthogonal:

$$E(e_t) = 0, \quad \Sigma_u = E(e_t e_t') = A_0 E(\varepsilon_t \varepsilon_t') A_0' = A_0 A_0', \quad E(e_t e_s') = [0] \quad \forall t \neq s \tag{4}$$

Relationship between reduced-form VAR residuals (e_t) and structural shocks (ε_t) can be expressed as follows:

$$e_t = A_0 \varepsilon_t \tag{5}$$

As we have already noted at the beginning of the chapter we implement a Cholesky identification scheme to correctly identify structural shocks. In order to identify our model there must be exactly $n^2 - \left[\left(n^2 - n\right)/2\right]$ relationships among the endogenous variables of the model, where *n* represents a number of variables. We have to impose $\left(n^2 - n\right)/2$ restrictions on the matrix A_0 based on the Cholesky decomposition of the reduced-form VAR residual matrix that define matrix A_0 as a lower triangular matrix. The lower triangularity of A_0 (all elements above the diagonal are zero) implies a recursive scheme (structural shocks are identified through reduced-form VAR residuals) among variables (the Wald chain scheme) that has clear economic implications and has to be empirically tested as any other relationship. Identification scheme of the matrix A_0 implies that particular contemporaneous interactions between some exogenous shocks and some endogenous variables are restricted reflecting causal (distribution) chain of interaction transmission. It is clear that the Wald causal chain is incorporated via convenient ordering of the variables.

Considering lower triangularity of a matrix A_0 the equation (5) can be rewritten as follows:

$$\begin{bmatrix} e_{y_r,t} \\ e_{m,t} \\ e_{p,t} \\ e_{ir_n,t} \\ e_{er_n,t} \\ e_{cu,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{y_r,t} \\ \varepsilon_{m,t} \\ \varepsilon_{m,t} \\ \varepsilon_{p,t} \\ \varepsilon_{er_n,t} \\ \varepsilon_{cu,t} \end{bmatrix} \tag{6}$$

Correct identification of the exogenous structural shocks reflecting Cholesky ordering of variables denotes following assumptions:

- Real output doesn't contemporaneously respond to the shock from any other endogenous variable of the model.
- Money supply doesn't contemporaneously respond to inflation, interest rates, exchange rate and current account shocks, while it is contemporaneously affected only by the real output shock.
- Inflation doesn't contemporaneously respond to the interest rates, exchange rate and current account shocks, while it is contemporaneously affected by the real output and money supply shocks.

- Interest rates don't contemporaneously respond to the exchange rate and current account shocks, while it is contemporaneously affected by the real output, money supply and inflation shocks.
- Exchange rate doesn't contemporaneously respond to current account shock, while it is contemporaneously affected by the real output, money supply, inflation and interest rates shocks.
- Current account is contemporaneously affected by the shocks from all of the endogenous variables of the model.

After initial period endogenous variables may interact freely without any restrictions.

Estimated VAR model is used to compute variance decomposition and impulse response functions to analyse the contribution of the exchange rate shock to variability of endogenous variables (real output, money supply, inflation, interest rates and current account) as well as responses of endogenous variables to one standard deviation positive exchange rate shock in the Central European countries. To check the robustness of the empirical results we estimate the model considering different ordering of the endogenous variables in both models (model A (2000Q1-2007Q4) and model B (2000Q1-2011Q4)):

- model A1, B1 $\left(X_t = \left[y_{r,t}, m_t, p_t, ir_{n,t}, er_{n,t}, cu_t\right]\right)$
-
- model A2, B2 $\left(X_t = \left[y_{r,t}, er_{n,t}, m_t, ir_{n,t}, p_t, cu_t\right]\right)$
-
- model A3, B3 $\left(X_t = \left[y_{r,t}, p_t, m_t, ir_{n,t}, er_{n,t}, cu_t\right]\right)$

4. Data and results

To estimate effects of the real exchange rate variability on the macroeconomic performance (represented here by selected macroeconomic indicators) in the Czech republic, Hungary, Poland and Slovak republic we use quarterly data with period 2000Q1-2007Q4 (model A) consisting of 32 observations and with period 2000Q1-2011Q4 (model B) consisting of 44 observations for the following endogenous variables - real output (nominal GDP deflated by GDP deflator), money supply (monetary aggregate M3), inflation (core inflation), short-term interest rates (interbank offered rates with 3 months maturity[9]), exchange rate (real effective exchange rate) and balance of payment's current account (Figure 1).

[9] Short-term interest rates in the Slovak Republic (BRIBOR) we replaced by EURIBOR since 2009.

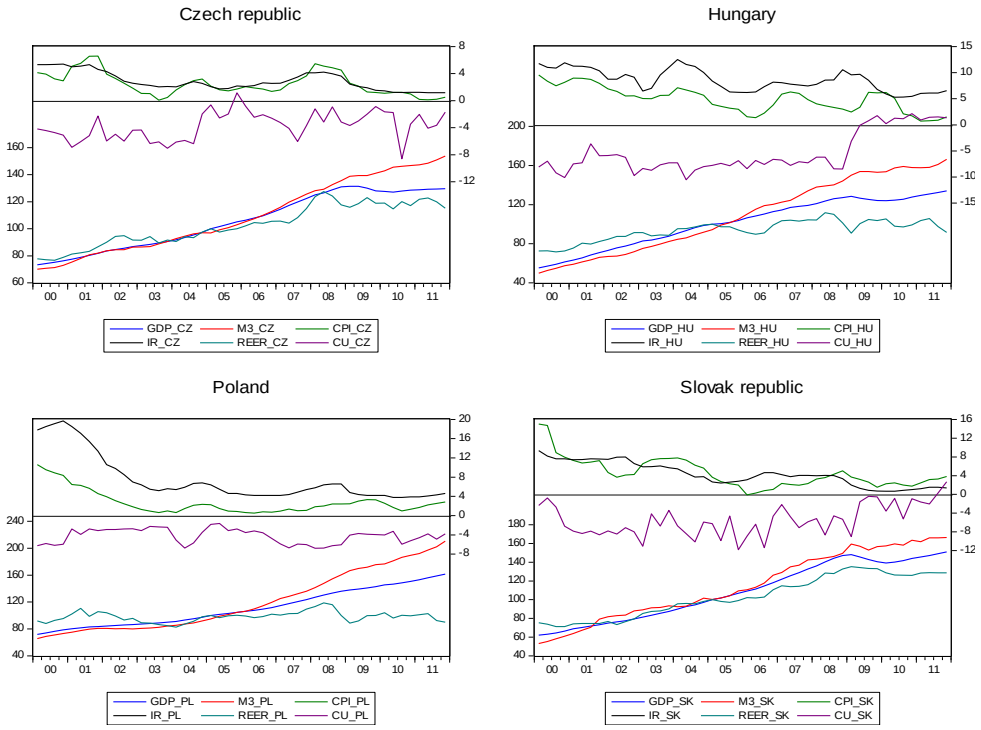

Figure 1 Real output, money supply, inflation, interest rates, real effective exchange rate and current account in the Central European Countries (2000Q1-2011Q4)

Note: Endogenous variables - gross domestic product (GDP), money supply (M3) and real effective exchange rate (REER) are expressed as indexes (left axis in figures) (2005 = 100). Inflation (INF) and interest rates (IR) are expressed in percentage (right axis in figures). Current account is expressed as percentage share in GDP (CU) (right axes in graph).

Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2012).

Estimation of two models is in line with the primary objective of the paper to estimate effects of the real exchange rate variability to real output, money supply, inflation, interest rates and current account considering possible implications of economic crisis on presented results. Time series for all endogenous variables were drawn from IMF database (International Financial Statistics, June 2012). Time series for real output, money supply and inflation were seasonally adjusted.

To correctly identify exogenous shocks hitting the model as well as to compute variance decomposition and impulse-response functions it is necessary VAR model to be stationary. To check the model it is necessary to test the time series for unit roots and cointegration.

A. Unit Root Test

The augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests were computed to test the endogenous variables for the unit roots presence. Results of unit root tests are summarized in the table 1 (detailed results of unit root are not reported here to save space. Like any other results, they are available upon request from the author).

Table 1 Unit Root tests

Country	model	Order of integration of endogenous variables											
		GDP		M3		CPI		IR		REER		CU	
		ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
Czech republic	A	I(1)	I(1)	**I(0)**	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Hungary	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	**I(0)**	I(1)	I(1)	I(1)	I(1)	I(1)
Poland	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	**I(0)**	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Slovak republic	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Source: Author's calculations.

Both ADF and PP tests indicate that most of the variables are non-stationary on the values so that the null hypothesis of a unit root cannot be rejected for any of the series. Testing variables on the first differences indicates the time series are stationary so that we conclude that the variables are I(1).

B. Cointegration Test

Because there are endogenous variables with a unit root on the values it is necessary to the test the time series for cointegration using the Johansen and Juselius cointegration test (we found reasonable to include variables I(0) for testing purposes following economic logic of expected results). The test for the cointegration was computed using two lags as recommended by the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion). Results of cointegration tests are summarized in the Table 2 (detailed results of cointegration tests are not reported here to save space. Like any other results, they are available upon request from the author).

Table 2 Johansen and Juselius cointegration tests

Country	Number of cointegrating equations											
	model A1		model A2		model A3		model B1		model B2		model B3	
	trace Stat	max eigvalue stat	trace stat	max eigvalue stat	trace stat	max eigvalue stat	trace stat	max eigvalue stat	trace stat	max eigvalue stat	trace stat	max eigvalue stat
Czech republic	0	0	0	1	1	0	0	0	1	0	0	0
Hungary	0	0	0	1	0	0	0	0	0	0	0	1
Poland	0	0	0	0	0	0	0	0	1	0	0	0
Slovak republic	0	0	1	0	1	0	0	0	0	0	0	1

Source: Author's calculations.

The results of the Johansen cointegration tests confirmed the results of the unit root tests. Both trace statistics and maximum eigenvalue statistics (both at 0.05 level) indicate that there is no cointegration among the endogenous variables of the model.

C. VAR stability

To test the stability of the VAR model we also applied a number of diagnostic tests. We found no evidence of serial correlation, heteroskedasticity and autoregressive conditional heteroskedasticity effect in the disturbances. The model also passes the Jarque-Bera normality test, so that errors seem to be normally distributed. The VAR models seem to be stable also because the inverted roots of the model for each country lie inside the unit circle (Figure 2).

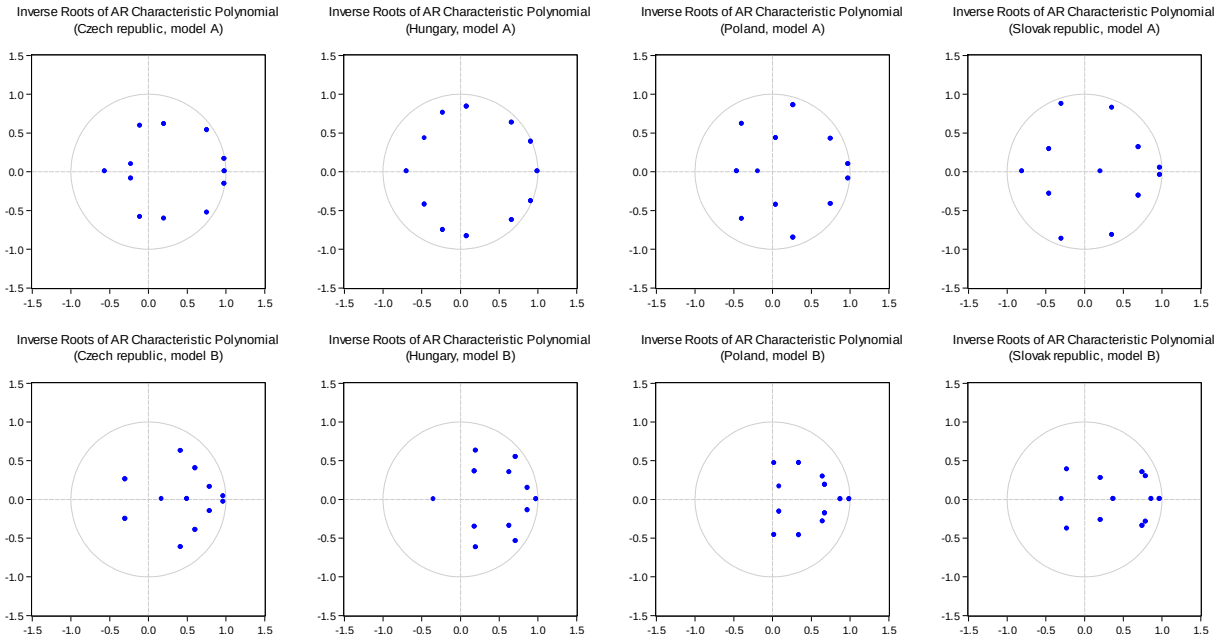

Figure 2 VAR stability condition check

Source: Authors calculation.

Following the results of the unit root and cointegration tests we estimated the model using the variables in the first differences so that we can calculate variance decompositions and impulse-response functions for all four countries from the region of the Central Europe. In line with the main objective of the paper we focus on interpretation of the real exchange rate shock contribution to the real output, money supply, inflation, interest rate and current account conditional variance. At the same time we analyse responses of real output, money supply, inflation, interest rate and current account on the positive one standard deviation exchange rate shock. We also observe effects of economic crisis on the exchange rate determination potential in the Central European countries by comparing the results for models estimated using time series for two different periods - model A (2000Q1-2007Q4) and model B (2000Q1-2011Q4).

Changed ordering of the variables didn't seem to affect the results of the analysis. Considering variance decompositions and impulse-response functions are not very sensitive to the endogenous variables ordering we present the results of the models (model A1 and B1) with default ordering of the endogenous variables (detailed results for models A2, A3, B2, B3 are available upon request from the author).

D. Variance decomposition

In the figure 3 we summarize variance decomposition of the endogenous variables for the model with pre-crisis time series (model A1) in the Central European countries.

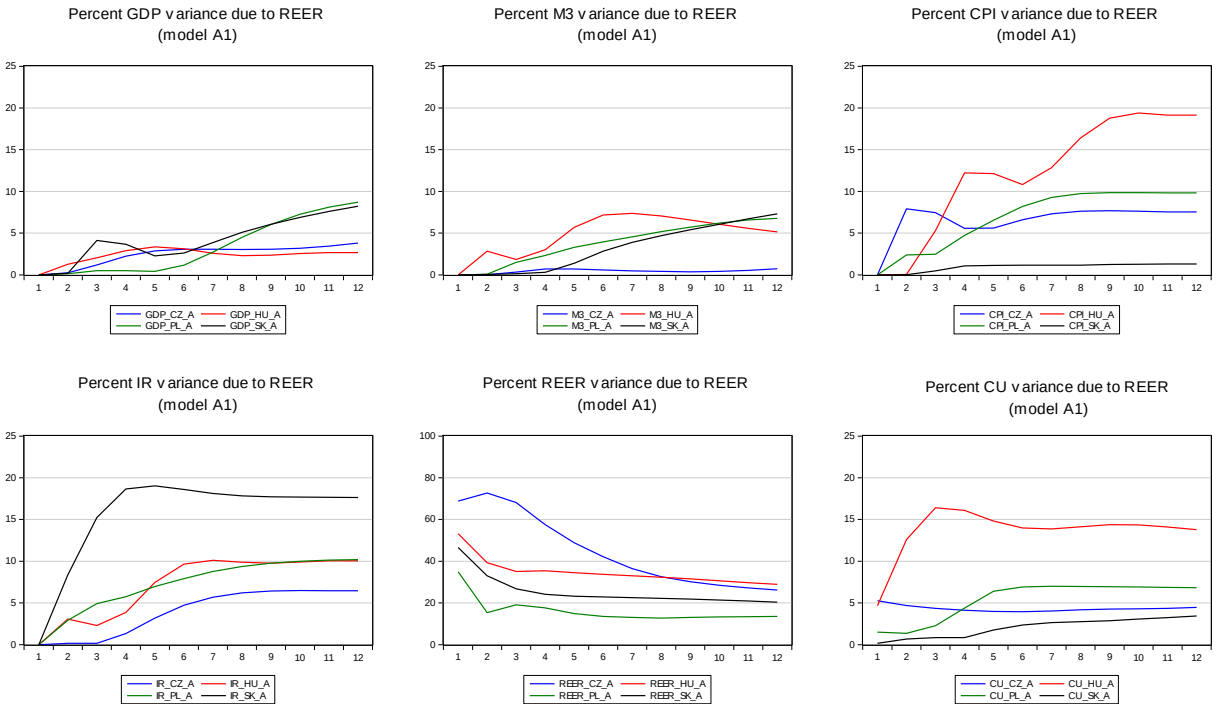

Figure 3 Variance decomposition of endogenous variables (2000Q1-2007Q4)

Note: Curves represents a relative contribution of the exchange rate shock to the endogenous variables conditional variance in each individual country from the Central Europe.

Source: Authors calculation.

The Figure 3 shows estimated variance decomposition of the endogenous variables to the Cholesky positive one standard deviation REER shocks in the Central European countries during the pre-crisis period. The contribution of the exchange rate shock to the *real output (GDP)* conditional variance immediately after the shock seems to be quite small in all four countries. Although the relevancy of the shock slightly rose within one year lag even after two years it didn't exceed five percent. While in the Czech Republic and Hungary the contribution of the exchange rate shock to the GDP variability remained stable in the long-run, in Poland and the Slovak Republic we have experienced a rising trend. Quite similar picture we have observed from variance decomposition of *money supply (M3)* in the short-run. While in Hungary the contribution of the exchange rate shock increased over time (during first six quarters) in the Czech Republic it remained negligible even in the long-run. On the hand after first few quarters the contribution of the exchange rate shock continuously rises in Poland and the Slovak Republic. Quite differing results we have obtained from the variance decomposition of *inflation (CPI)*. Relative importance of the exchange rate shock rises over time in all countries but the Slovak republic. The most significant increase in the exchange rate shock relative contribution to CPI variability we have observed in Hungary. Variance decomposition of *interest rates (IR)* revealed fairly large importance of positive exchange rate shock in determining short term interest rates in the Slovak republic. With much less but still significant contribution the exchange rate shock affected interest rates in Hungary and Poland. Delayed increase in the exchange rate shock relevancy we have experienced in the Czech Republic. While the immediate contribution of the exchange rate shock to the current account (CU) conditional variance seems to be quite similar, within one year after the shock it has significantly changed in all four countries but the Czech Republic.

In the Figure 4 we summarize variance decomposition of the endogenous variables for the model with extended time series (model B1) in the Central European countries.

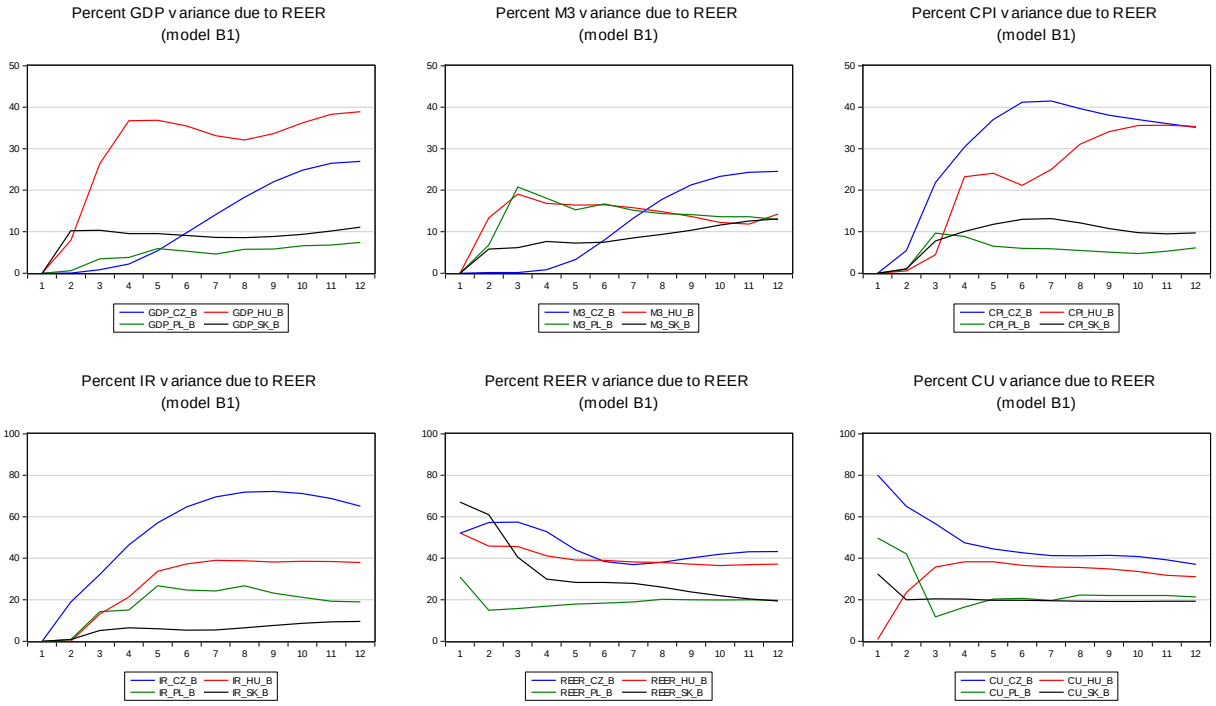

Figure 4 Variance decomposition of endogenous variables (2000Q1-2011Q4)

Note: Curves represents a relative contribution of the exchange rate shock to the endogenous variables conditional variance in each individual country from the Central Europe.

Source: Authors calculation.

The Figure 4 shows estimated variance decomposition of the endogenous variables to the Cholesky positive one standard deviation REER shocks in the Central European countries during the extended period. Relative contribution of the exchange rate shock to the endogenous variables conditional variance markedly changed. The role of the exchange rate shock in determining *real output (GDP)* the most significantly rose in Hungary. Together with the Slovak republic an increased contribution of the shock became already clear after the initial period. While in Poland we have observed the decreased contribution of the exchange rate shock to GDP variance in the long-run, in the Czech Republic its relevance steadily rose since third quarter after the shock. *Money supply (M3)* seems to more sensitive to the positive exchange rate shock in the extended period too. The early effect is clear especially in Hungary, Poland and the Slovak republic, while in the Czech Republic the contribution of the shock increased especially in long-run. Substantial increase of sensitivity to the base period extension we have observed in decomposing the conditional variance of *inflation (CPI)*. Medium-run effects are clear especially in Czech Republic and Hungary. The contribution of the exchange rate shock in the long-run slightly decreased in Poland, while in the Slovak republic remained quite stable since the end of the fourth quarter after the shock. Variance decomposition of short-term *interest rates (IR)* revealed a noticeable increase of the exchange rate shock contribution in all countries but the Slovak republic. The most significant change we observed in the Czech Republic with reduced delay at which the contribution of the exchange rate shock to the interest rates variance started to grow notably. Finally, the contribution of the one standard deviation positive exchange rate shock to the *current account (CU)* variability in the model B significantly grew in the all four Central European countries too. The crisis period increased the effect of the shock especially in the Czech Republic and Hungary.

Results of the endogenous variables variance decomposition reflecting the relative contribution of the exchange rate shock in their variability in the model A for pre-crisis period and the model B for extended period may be concluded as follows. Relative contribution of the exchange rate shock to the endogenous variables variance increased in most cases. As the most probable vehicle of accelerated effects of the exchange rate shock to the real performance of the Central European

countries we emphasize an increased contribution of the shock to the current account development. The role of the exchange rate shock in determining the current account significantly rose in all four countries.

As the most crucial outcome we emphasize an increased contribution of the exchange rate shock to the endogenous variables conditional variance in the short-run in model B. In general, various effects of higher exchange rate volatility in the Central European countries increased overall exposure of their economies to the unpredicted short-run changes in the traditional key determinants of the macroeconomic performance. The only exception represents the variance decomposition of short-term interest rates in the Slovak republic. We suggest it is generally expected implication of the Slovakia's euro adoption in 2009. Decreased contribution of the exchange rate shock to the interbank interest rates (replaced by Eurozone interbank interest rates since 2009) in the Slovak republic can be explained in several ways. In the first place we emphasize higher level of European Central Bank (ECB) discretion in key interest rates adjustments during the crisis period causing Eurozone interbank interest rates being much less determined by the exchange rate path. Interbank interest rates of Eurozone seem to be much more sensitive to the endogenous determinants (i.e. real output, employment, productivity, inflation, fiscal deficit, etc.) during the crisis period in comparison to the exogenous shocks (i.e. unpredicted exchange rate shifts). Considering this interpretation, higher contribution of the exchange rates shocks to domestic interest rates variability in individual countries (like the Czech Republic, Hungary and Poland in our model) seems to be reasonable.

At the same time we have observed remarkable changes in the exchange rate shock contribution to the endogenous variables variance in the Slovak republic during the extended period (in comparison with the per-crisis period). The main aspect of the variance decomposition analysis for the extended period is the significant stability of the exchange rate shock contribution to the main macroeconomic indicators variability in the Slovak republic. Here again we expect the most common explanation is Eurozone membership. While the loss of mutual interconnections between the exchange rate path and the macroeconomic indicators is considered to be one of the main trade-off to common currency benefits, stable exchange rate expectations anchored by the euro credibility may still reduce the way the new Eurozone member country suffers from sacrificing their monetary sovereignty.

E. Impulse-response function

In the Figure 5 we summarize impulse-response functions of the endogenous variables for the model with pre-crisis time series (model A1) in the Central European countries.

The Figure 5 shows estimated responses of the endogenous variables to the Cholesky positive one standard deviation REER shock in the Central European countries during the pre-crisis period. It seems to be clear that the exchange rate shock was followed by the *real output (GDP)* decline in the all four Central European countries. This investigation is in line with a general empirical experience considering the exchange rate appreciation causes a drop in the real output through the current account deficit. At the same time we observed a little difference in the initial lag that was followed by the GDP decline after the exchange rate shock in each particular country. While in Hungary and Poland real output declined almost immediately with one quarter lag, in the Czech Republic and the Slovak republic the negative effect of the shock was lagged by two quarters. The exchange rate seems to be neutral in determining the real output in the long-run as its effect was subsequently disappearing since the first year after the shock. Quite similar picture we observed from the overview of the *money supply (M3)* impulse-response functions. While in general the exchange rate shock was followed by the money supply decrease, the length of lag in the responses notably differed in comparison with the real output responses in all four countries (decrease in the money supply outran the real output fall in the Czech Republic while in Poland and the Slovak republic responded with the lag) but Hungary. We suggest that changes in the money supply caused by the exchange rate shock could be only partially explained by related changes in the transaction demand for the money. As a result, the exchange rate shock caused liquidity preference changes. We suppose that is why the subsequent money supply decrease could not be clearly explained by the real activity shifts only (related portfolio adjustment motives may be considered to explain subsequent changes in the international capital flows).

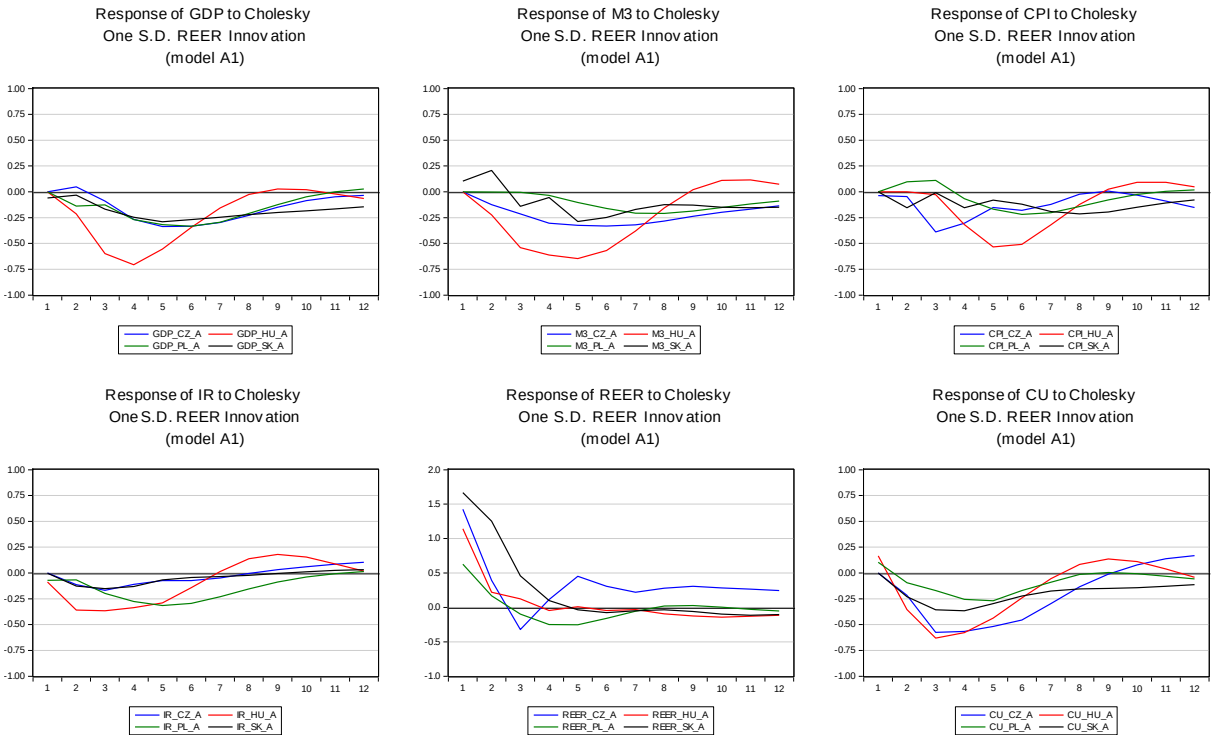

Figure 5 Responses of endogenous variables to REER shock (2000Q1-2007Q4)

Note: Curves represents responses of the endogenous variables to the one standard deviation positive exchange rate shock in each individual country from the Central Europe.

Source: Authors calculation.

Negative effect of the exchange rate shock continuously died out and became neutral in the long-run. In general the exchange rate shock caused a decrease in the *inflation (CPI)* in all four countries but with a different length of the lag. While in the Czech Republic, Poland inflation started to fall after one quarter, the positive effect of the exchange rate shock to the price level in the Czech Republic became clear after two quarters and in Hungary after four quarters. On the other hand the size of the effect seems to be the most notable in Hungary. In the long-run the overall effect of the exchange rate shock to the domestic prices remained neutral. After the positive exchange rate shock short-term *interest rates (IR)* decreased in all four countries. Although the positive impact on the interest rates occurred one quarter after the shock the size of the effect differed among the countries. The most significant decrease in the short-term interest rates we observed in Hungary and with slightly reduced intensity as well as durability in the Czech Republic and the Slovak Republic. At the same time, much more persisting positive effect of the exchange rate shock to the short-term interest rates we experienced in Poland. Overall effect of the shock completely died out after around fifteen quarters. One standard deviation positive exchange rate shock was accompanied with a sharp worsening in the current account in each particular country. The size of the negative effect culminated at the end of the first year after the shock while it was significantly reduced till the end of the second year after the shock. We suggest that changes in the international competitiveness of the Central European countries represent the most crucial channel the exchange rate shock (negatively) affects the real output in the short-run while the price effects (disinflation) of the exchange rate appreciation (positively) affects the real output in medium-term.

In the Figure 6 we summarize impulse-response functions of the endogenous variables for the model with extended time series (model B1) in the Central European countries.

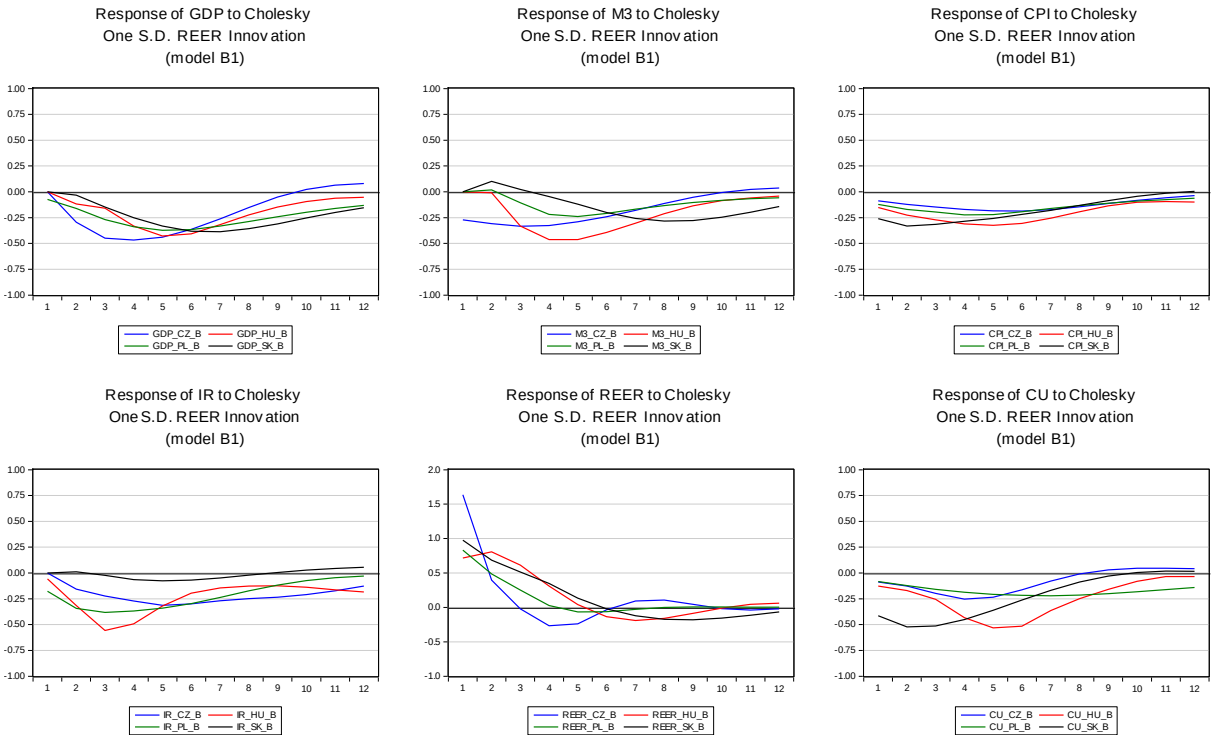

Figure 6 Responses of endogenous variables to REER shock (2000Q1-2011Q4)

Note: Curves represents responses of the endogenous variables to the one standard deviation positive exchange rate shock in each individual country from the Central Europe.

Source: Authors calculation.

The Figure 6 shows estimated responses of the endogenous variables to the Cholesky positive one standard deviation REER shock in the Central European countries during the extended period. Crisis period affected responses of endogenous variables to the exchange rate shock. *Real output (GDP)* decreased in all four countries with slightly reduced lag. At the same time the durability of the GDP response increased in Hungary, Poland and the Slovak Republic while its reduction we experienced only in the Czech Republic. Despite the long-run neutrality of the exchange rate shock its short-term potential to determine the real output in the Central European countries increased as a result of the crisis period effects. Quite distorting effects (in comparison with the pre-crisis results) we observed in the responses of the *money supply (M3)*. While the changes in the intensity of the effect don't seem to be meaningful, we emphasize substantial changes in the behavior of the money supply responses (lag length, path of response) as well as the durability of the effect caused by the exchange rate shock. It seems the lag in the money supply response reduced in the Czech Republic (money supply decreased immediately after the shock) and Poland.

On the other hand slightly lagged response we experienced in Hungary and the Slovak Republic. We suggest distorting effects of the money supply response to the exchange rate shock (changes in the transaction demand for money became much less important in determining the response of the money supply) originated in the international capital flows adjustments reflecting price effects on the value of capital assets. Significant reduction in the lagged response to the exchange rate shock we observed from the impulse-response functions of *inflation (CPI)* in all four Central European countries. Because the price effects of the exchange rate shock during the crisis period seems to be more persisting (and slightly more intensive) we expect that the price mechanisms of the domestic markets tends to be more sensitive to unpredicted exchange rate shifts. Responses of short-term *interest rates (IR)* to the positive exchange rate shock seem to be also affected by the crisis period. The intensity of the effect seems to be higher in all countries but the Slovak republic. We suggest that the

unpredicted exchange rate shifts during the crisis period determines (especially) short-term interest rates with higher intensity in individual Central European countries with monetary sovereignty[10].

However this is not a case of the Slovak Republic that became the Eurozone member country in 2009. We assume the reason why the interest rates[11] in the Slovak Republic responded to the exchange rate shock (considering the model B1 with data sets for the extended period) with significantly lower intensity is a much higher degree of a discretion in the ECB's interest rate policy that weaken the causality relationship between the Euro exchange rate shifts and the interest rates path especially in the short-run. Impulse-response functions of the *current account (CU)* revealed the following conclusions about the exchange rate shock determining potential. Lag length in the current account response slightly reduced in the Czech Republic, Hungary and Poland in comparison with the pre-crisis period. While the short-term responsiveness (within one year after the shock) of the current account decreased, the durability of the effect increased in Hungary and Poland.

On the other hand the significant immediate increase in the current account responsiveness to the exchange rate shock we observed in the Slovak Republic. Extended period covering the euro adoption since 2009 revealed increased sensitivity of the Slovakia's current account and subsequently the real output development to the unpredicted exchange rate shifts in the short-run. The one standard deviation exchange rate shock seemed to be neutral in determining the leading path of all endogenous variables in the long-run in all four Central European countries.

Conclusion

Exchange rates determined the main macroeconomic indicators in four Central European countries in the line with the general empirical investigations though we observed some specific implications of the distorting effects caused by the unpredicted exchange rate shifts in the crisis period that may be a subject of a further academic discussion focusing on the wide causalities of the economic crisis. Variance decompositions and impulse-response functions computed from estimated VAR model revealed notable differences in the behavior of the selected macroeconomic indicators after being hit by the one standard deviation positive exchange rate shock as well as in the its contribution to their variability.

Considering the complexity of the particular results presented in the paper we highlight the distorting effects of the crisis period that contributed to the significantly different way the short-term interest rates were determined in the group of three Central European countries (the Czech Republic, Hungary and Poland) in comparison to the Slovak republic. We suggest that the Slovakia's Eurozone membership since 2009 and related loss of the monetary sovereignty probably represents the key aspect of the different exchange rate determining potential in relation to the interest rate development. Decreased contribution of the exchange rate shock to the interbank interest rates (replaced by Eurozone interbank interest rates since 2009) in the Slovak republic can be explained in several ways.

In the first place we emphasize higher level of European Central Bank (ECB) discretion in key interest rates adjustments during the crisis period causing Eurozone interbank interest rates being much less determined by the exchange rate path. Interbank interest rates of Eurozone seem to be much more sensitive to the endogenous determinants (i.e. real output, employment, productivity, inflation, fiscal deficit, etc.) during the crisis period in comparison to the exogenous shocks (i.e. unpredicted exchange rate shifts). Considering this interpretation, higher contribution of the exchange rates shocks to domestic interest rates variability in individual countries (like the Czech Republic, Hungary and Poland in our model) seems to be reasonable.

At the same time we have observed remarkable changes in the exchange rate shock contribution to the endogenous variables variance in the Slovak republic during the extended period (in comparison with the per-crisis period). The main aspect of the variance decomposition analysis for

[10] The current exchange rate regime in the Czech Republic, Hungary and Poland (managed floating) allows their exchange rates to freely float; their path is still significantly determined by the euro exchange rate that is positioned as the reference currency. Despite this fact we suggest that in the time of the crisis period the exchange rates of all three Central European countries diverged from the euro leading path causing distorting effects on domestic interest rates as well as other macroeconomic indicators.

[11] Since 2009 the domestic interest rates in the Slovak republic (BRIBOR) were replaced by the Eurozone interest rates (EURIBOR).

the extended period is the significant stability of the exchange rate shock contribution to the main macroeconomic indicators variability in the Slovak Republic. Here again we expect the most common explanation is Eurozone membership. While the loss of mutual interconnections between the exchange rate path and the macroeconomic indicators is considered to be one of the main trade-off to common currency benefits, stable exchange rate expectations anchored by the euro credibility may still reduce the way the new Eurozone member country suffers from sacrificing their monetary sovereignty.

As of the changed way the short-term interest rates responded to the one standard deviation positive exchange rate shock we suggest that the unpredicted exchange rate shifts during the crisis period determined (especially) short-term interest rates with higher intensity in individual Central European countries with monetary sovereignty (the Czech Republic, Hungary, Poland). However this is not a case of the Slovak republic that became the Eurozone member country in 2009. We assume the reason why the interest rates in the Slovak republic responded to the exchange rate shock (considering the model B1 with data sets for the extended period) with significantly lower intensity is a much higher degree of a discretion in the ECB's interest rate policy that weaken the causality relationship between the Euro exchange rate shifts and the interest rates path especially in the short-run.

Acknowledgement

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FINANCIAL STRENGTH AS AN INDICATOR FOR MEASURING BANK COMPETITIVENESS: AN EMPIRICAL EVIDENCE FROM INDIAN BANKING INDUSTRY

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Abstract

Liberalization and globalization has led Indian banking companies to focus on quality of service, speed and cost to face severe competition. The paper measures the bank competitiveness among the select Indian commercial banks in terms of financial strength. A bank is said to be competitive if it is financially strong. Financial strength of the bank is measured in terms of financial ratios viz. efficiency ratio, profitability ratio, capital adequacy ratio, income-expenditure ratio, deposits and return ratios. Factor analysis is used to structure and detect the components of financial strength. The competitive position mapping of the public sector, private sector and foreign banks is obtained by applying discriminant analysis. It is found that foreign banks are the most competitive compared to the private and public sector banks in terms of the profitability ratio, returns ratio and capital adequacy ratio.

Keywords: competitiveness, Indian commercial banks, financial ratios, financial performance, factor analysis, discriminant analysis.

1. Introduction

Competitiveness is a dynamic concept, expressed as the ability of firms to react to changing economic and technological development. The competitiveness of a firm is reflected in its superiority in production resources, managerial capabilities, innovativeness, customer relationship marketing, long term planning which help the firm to sustain in the market. This paper attempts to measure competitiveness among Indian commercial banks. Due to globalization and liberalization, Indian banks are forced to develop controlling and management methods that ensure a quick reaction to market and product changes. This has made the banks to transform the available capital to the most profitable transactions in order to gain financial strength. It is, therefore, necessary for banks to assess their financial position accurately to sustain in the growing competitive financial market.

The impact of regulatory changes on banks can be judged by the gross measures of performance, such as profitability, capital adequacy, income-expenditure, cost, deposit and efficiency ratios. The purpose of the paper is to identify the components of financial strength; to measure competitiveness among the banks with the help of factor analysis and discriminant analysis; and to map the competitive positions of the public, private and foreign banks.

1.2 The Indian Banking System

The Indian Banks is structured into three sectors via, the public sector, the private sector and foreign sector banks. There are twenty seven public sector banks: eight state banks (SBI & seven associates) and nineteen nationalized banks, twenty nine private banks (twenty one old private banks and eight new private banks) and thirty foreign banks as on 2009. The liberalization and globalization has led to many changes in the Indian banking sector. The Narasimham Committee Report (1991) pointed out that the major reform process in the Indian banking industry would improve the operational and allocative efficiency of the financial system. As a result, the agendas of reforms in the financial sector were to administer the interest rate structures, reserve requirements for banks, strengthening the capital base of the financial institutions, facilitating the entry of new institutions, exploring indirect monetary policy instruments and strengthening prudential regulations. Due to these reforms, the banking sector in India has undergone many changes. Entry of private and foreign banks created a competitive scenario for the public sector banks. The composition of the Indian banking sector changed with the emergence of new private and foreign banks. The new private banks expanded

extensively in the retail market as well as their market share increased at the expense of nationalized banks (Petya 2003). A new milestone in the history of Indian banking industry took place in December 1993, State Bank of India became the first public sector bank to raise capital from the public. In 1994, all nationalized banks were allowed to rise up to 40% of their market. As in 2009, in total seventeen public sector banks and eighteen private sector banks were listed in the Indian stock market. The entry of new private sector and foreign banks, introduction of new products, development in information technology and operational freedom to banks have ensured a competitive environment in Indian banking industry.

2. Literature Survey

Financial measures as a tool of performance evaluation of financial institutions, has received greater attention over the past several years. There is several research methods applied to financial performance evaluation with the help of various financial ratios. These methods include: Multivariate statistical analysis (Fielding *et al.* 1985; Kosmidou, Pasiouras, Zopounidis, and Doumpos 2006), Data envelopment analysis (Grosskopf, and Valdmanis 1987; Seiford, and Zhu 1999; Lin 1998; Ho, and Zhu 2004; Wai, and Brian 2004), Analytic hierarchy process (Lin 2000; Shih 2000); Fuzzy Set theory; Grey relation analysis (Ho, and Wu 2006); Balanced score card (Maisel1992); CAMEL model, Free Disposal hull analysis, Neural Network Analysis (Montuiho, and Phillips 2002) and Financial statement analysis (Pantalone, and Platt 1987; Espanhbodi 1991).

Many comparative studies have been conducted to evaluate the financial performance between domestic banks and foreign banks (Claessens, Asli, Kunt, and Harry 2001; Jeon, and Miller 2002; Tufan, Hamarat, Cristea, and Vasilescu 2007). Demirguc-Kunt, and Huizinga (1998) conclude in their report that foreign banks have greater profitability margin than the domestic banks in developing countries. Enormous research has been carried out in analyzing the financial performance and efficiency of Indian commercial banks based on the ownership pattern by using DEA method (Sarkar, Sarkar, and Bhaumik 1998; Petya 2003; Bikram De 2003, Gupta, and Jain 2004; Mahesh, and Meenakshi 2006; Sathye 2005; Tissa, and Edirisuriya 2004; Amita 2004; Mitali sen 2004; Shanmugam, and Das 2004; Goyal *et al.* 2004; Bodla, and Verma 2007). De (2007) measured profitability of Indian Commercial Banks by considering NPA, operating cost and net interest margin as key determinants, and it was found that the private sector banks were more efficient then the public sector banks. The other variables which determine the performance of the banks are non-interest income, net profit, provision and contingencies, operating expenses. In assessing the impact of these financial variables on banks would make us understand the impact of the entry of foreign banks on domestic banks. Thus, motive of the paper is to measure competitiveness of select Indian commercial banks in terms of financial strength.

3. Data and Methodology

Four banks each representing the public, private and foreign sector banks were selected for the study. State Bank of India (SBI), Punjab National Bank (PNB), Bank of Baroda (BOB), Central Bank of India (CBI) under the public sector banks. The private sector banks are Housing Development and Finance Corporation (HDFC), Industrial Credit and Investment Corporation of India (ICICI), Axis Bank (AXIS) and Federal Bank (FEDERAL). The foreign banks are Royal bank of Scotland (RBS), Citibank (CITI), Hong Kong and Shanghai Banking Corporation (HSBC), Standard Chartered Bank(STD). The banks are being selected based on the highest deposit volume in their respective sector as in 2009. The data were collected from RBI websites. The competitiveness of the selected banks were measured with the help of twenty one ratio, structured into seven broad ratios namely, efficiency ratio, profitability ratio, capital adequacy ratio, income-expenditure ratio, deposits ratio and returns ratio. The period of the study is from 1999 to 2009. Factor analysis is applied to the set of twenty one ratios in order to define the six ratios. The competitive Z-score for the financial strength variable is calculated as:

$$Z = \frac{\sum_{i=1}^{n} W_i F_i}{X} \qquad \textit{where,}$$

W_i (i=1-3…….,n) : percentage of variance obtained from the factor analysis.

F_i (i=1,2,……..,n) : factor score of the obtained component of the bank.
X : total cumulative score in percentage from the rotated sum of squared loadings. (Man, & Qian 2007).

The study proves that financial ratio is an important indicator for analyzing the competitiveness of select commercial banks in India (Li, and Lin 2005; Wang, and Li 2007; Tufan, Hamarat, Cristea, and Vasilescu 2007). Discriminant analysis is used to validate the classification of the public, private and foreign sector banks. Researchers have used discriminant analysis to discriminate between failure and successful banks (Spahr 1989; Hamilton, and Khan 2001; Hsing, Hsing, Lange, and Gibson 2001) and also to distinguish between competitive and non-competitive banks. The study uses discriminant analysis for constructing competitive mapping for the public sector, private sector and foreign banks.

3.1 Ratio description

Efficiency ratio: non-performing asset (NPA), business per employee (BPE) and profit per employee (PPE). *Profitability ratio*: gross profit ratio, operating ratio and net profit ratio. *Capital Adequacy ratio*: Tier I Capital and Tier II Capital. *Income-Expenditure ratio*: interest income ratio, non-interest income ratio and net interest margin ratio. *Deposits ratio*: volume of credit, cash, investment, term deposit (TDTD) in relation to total deposits. *Returns ratio*: return on investment, equity, advances and assets.

4. Data analysis

Table1. Rotated Component Matrix for Financial Strength Variable

Ratios	Component					
	1	2	3	4	5	6
Operating ratio	.888	.219	.061	.223	.055	-.081
Return on asset	.111	.066	.863	.149	.093	.194
Gross profit ratio	.861	.116	.016	.318	.103	-.130
Profit per employee	.211	.847	-.110	.019	.246	.222
Net profit ratio	.844	.172	-.101	.246	.063	.008
Return on equity	.059	.132	.781	-.086	-.316	.022
Noninterest income	.028	.349	.117	-.107	.149	.741
Business per employee	.152	.726	-.303	-.209	.315	.282
Credit plus investment to deposit ratio	.225	.000	-.121	.953	.036	.000
Deposit liability	-.441	-.089	.068	-.822	-.216	-.077
Invest to deposit	-.014	.051	.115	.784	-.163	-.094
Credit deposit ratio	.333	-.052	-.231	.749	.154	.065
Return on investment	-.059	-.116	.898	.096	.001	-.072
Interest income	-.037	.086	.059	-.312	-.082	.814
Return on advance	.300	-.105	.810	-.082	.035	.162
NPA	-.581	.584	-.100	-.068	-.093	.071
TDTD	-.055	.000	.338	-.882	-.067	-.152
Net interest margin	.544	.084	.081	-.002	.074	.760
Tier1	-.009	-.022	-.143	.034	.864	-.020
Tier2	-.418	-.153	-.184	-.112	.693	-.062
Cash deposit ratio	.097	-.020	.120	.943	.009	.112

The research study tries to present the competitive position of the banks with respect to the financial ratios. Factor analysis is applied with the principal component method and the varimax rotation. The results of the study are discussed in this section.

Table 1 presents the rotated component matrix for financial strength variable. In the first component operating profit, gross profit and net profit ratio has the highest factor loadings; it is termed as the profitability ratio. Profit per employee, business per employee and non-performing asset dominated the second component with the loadings, it is denoted as the efficiency ratio. Return on asset, return on equity, return on investment and return on advances has the highest correlation score in the third component, hence it is identified as returns ratio. The fourth component factor loadings

were high on credit plus investment to deposit ratio, deposit to liability, investment deposit, credit deposit, term deposit to total deposit and cash deposit, it is denoted as deposits ratio. In the fifth component, tier1 and tier 2 has a significant impact, it is denoted as the capital adequacy ratio. Non interest income, net interest income and net interest margin has the highest effect in the sixth component, denoted by the income-expenditure ratio. The consolidated result of the factor analysis is shown in Table. 2.

Table 2. The results of factor analysis for financial strength variable

Financial strength variables	Ratios	Loading value	Eigen values	% of variance	Cronbach's Alpha value
Profitability ratio	Operating ratio	.888	8.174	31.727	.910
	Gross profit ratio	.861			
	Net profit ratio	.844			
Efficiency ratio	Profit per employee	.847	3.018	14.897	.910
	Business per employee	.726			
	Non-performing asset	.584			
Returns ratio	Return on asset	.863	2.281	13.787	.702
	Return on equity	.781			
	Return on investment	.898			
	Return on advances	.810			
Deposits ratio	Credit plus investment to deposit	.953	1.430	8.621	.700
	Deposit to liability	-.822			
	Investment to deposit	.784			
	Credit deposit ratio	.749			
	Term deposit to cash deposit	-.882			
	Cash deposit	.943			
Capital adequacy ratio	Tier 1	.864	1.375	7.896	.853
	Tier 2	.693			
Income-expenditure	Non interest income	.741	1.0447	5.560	.745
	Net interest income	.814			
	Net interest margin	.760			
		Cumulative variance		82.488	

Table 2 reveals the extracted components and their loading values, eigen values, variance per cent age and Cronbach's alpha coefficient. The profitability ratios have the highest variance per centage (31.727) and the highest eigen value (8.174) with 0.910 as Cronbach's alpha coefficient. The eigen value for the efficiency ratio is 3.018 with 14.897 percentage of variance, and 0.910 is alpha value. The returns ratio is the third component extracted with the eigen value of 2.281, 13.787 as per cent age of variance and alpha value at 0.702. The fourth component, deposits ratio is extracted with the eigen value of 1.430; percentage of variance is 8.621and 0.70 is the Cronbach's alpha coefficient. The capital adequacy ratio is formed with 1.375 eigen value, 7.896 as variance per cent age and 0.698 is the alpha value.

The sixth variable denoted as the income-expenditure ratio is extracted with the eigen value of 1.044, 5.560 as their percentage of variance and the Cronbach's alpha coefficient is 0.745. All the variables Cronbach's alpha coefficients are within the standard value of 0.70 and thus indicating a good reliability of the components chosen (Nunnaly's 1978).

4.1 The competitive Z-score of the select commercial banks in India

With the help of the factor (regression) scores obtained by using principal component analysis with varimax rotation, the competitiveness of the select commercial banks in India is measured. The competitive Z- score is calculated, and the results are shown in Table 3.

Table 3. Regression score and the competitive Z- score for the select commercial banks in India.

BANK	Profitability ratio	Efficiency ratio	Returns ratio	Deposits ratio	Capital adequacy ratio	Income-expenditure ratio	SCORE	RANKING
STD	1.37593	0.90174	0.73269	0.49882	-0.61473	-0.20521	0.7939	1
CITI	1.74808	-0.44519	0.17684	0.03086	0.66854	0.66857	0.7337	2
RBS	0.34998	1.51186	0.00005	0.49568	0.43377	-0.06348	0.4967	3
HSBC	0.12388	0.22269	-0.00269	0.37294	0.76815	-0.5883	0.1602	4
HDFC	0.12887	-0.15427	-0.56884	0.99627	0.01963	0.19402	0.0457	5
ICICI	-0.33289	0.87348	-0.51824	-1.82221	0.6104	0.26153	-0.1713	6
FEDERAL	-0.22839	-0.64569	-0.27982	-1.42154	-0.36541	0.88179	-0.1996	7
AXIS	-0.6678	-0.4982	0.12799	0.88383	-0.53035	0.4898	-0.2508	8
PNB	-0.23842	-0.53559	0.55649	-0.82712	-0.169	-0.89819	-0.2585	9
SBI	-0.83271	-0.15056	-0.21004	0.42053	-0.10052	-0.19431	-0.3613	10
BARODA	-0.57127	-0.70994	-0.17415	-0.07239	-0.02216	-0.90699	-0.4478	11
CENTRAL	-1.31205	-0.37034	0.15972	0.44433	-0.69832	0.36077	-0.5409	12

4.1.1 Bank-wise analysis

The Table 3 reveal that Citibank has the highest regression score (1.74808) for the profitability ratio, and the next three position has been acquired by the foreign sector banks namely Standard chartered bank, RBS and HSBC. The fourth position is obtained by HDFC of the private sector bank. RBS (0.90174) is considered the best bank in the efficiency ratio followed by Standard Chartered Bank, ICICI and HSBC. In the returns ratio, Standard Chartered Bank has obtained the highest score (0.73269) followed by Federal bank, Citibank, CBI, PNB and RBS. HDFC with the score of 0.99627, is found to be the most efficient bank in the deposits ratio followed by PNB, STD, RBS, SBI, HSBC and Citibank. In the Capital adequacy ratio, the highest score is obtained by HSBC (0.76815), followed by Citibank, ICICI, RBS and HDFC.

Table 3 reveals that the highest competitive score (0.793987) is obtained by Standard Chartered Bank and inferred that Standard Chartered Bank is most efficient bank in the Indian banking sector in terms of financial strength. The second position is acquired by Citibank with a score of 0.733798. The third and fourth position is obtained by RBS and HSBC with the scores of 0.496703 and 0.160268 respectively. The first four banks are highly competitive and to be noted that they are all foreign banks. HDFC is the only non foreign bank which secured positive value (0.04571) and considered to be moderately competitive.

4.1.2 Sector- wise analysis

After analysing the bank-wise competitiveness, the next motive is to investigate the sector-wise financial strength. The financial strength among the sectors is analysed with respect to six ratios extracted from factor analysis.

Table 4. Sector-wise ANOVA results for financial strength variable

	Profitability ratio	Efficiency ratio	Returns ratio	Deposits ratio	Capital adequacy ratio	Income-expenditure ratio
Public sector	-.84596	-.43226	-.02412	.41908	-.33784	-.06268
Private sector	-.05351	-.11552	-.20260	-.76865	.02390	.10979
Foreign sector	.89947	.54778	.22672	.34958	.31393	-.04711
Significant value (F-test)	.000*	.000*	.156	.000*	.013**	.698

Significant @ 1%*, Significant @ 5%**

Table 4 presents the sector-wise mean value for six financial strength components. The foreign sector banks are financially stronger in all the components except income- expenditure ratio. Private sector banks have got the edge over the foreign banks in the income-expenditure ratio. Public sector banks as they have the commitment towards the priority sector and regional rural development were not able to gain financial strength due to low profitability and accumulation of nonperforming assets. It is proven from ANOVA test that there is significant difference among the public sector, private sector and foreign sector banks with respect to profitability ratio, efficiency ratio, deposits ratio, and capital adequacy ratio. Further, there is no significant difference among the three sectors of the bank with respect to returns ratio and income- expenditure ratio. ROC curve is drawn for each sector of the bank, is depicted in the Figure 1 (a, b, & c). It reveals that the public sector banks have only the deposits ratio closer to the efficiency border. Likewise, the private sector banks have positive effect of profitability ratio and income-expenditure ratio on the financial strength. Finally, foreign sector banks are the most efficient bank as five out of six ratios have positive impact and profitability ratio is the most significant one in building their financial strength.

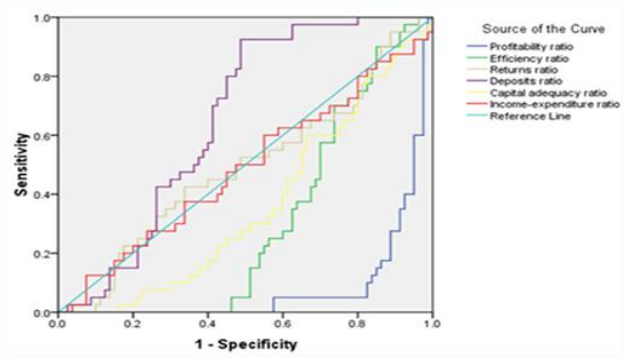

Figure 1a. ROC curve for public sector banks

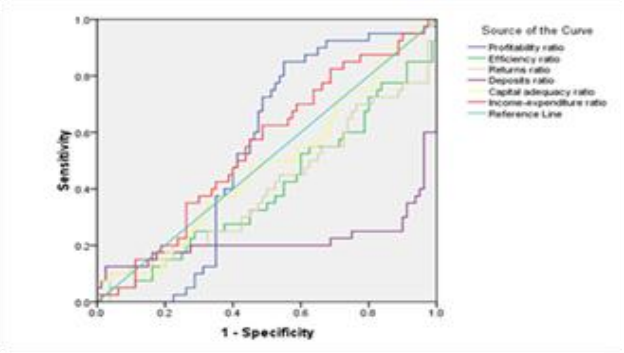

Figure 1b. ROC curve for private sector banks

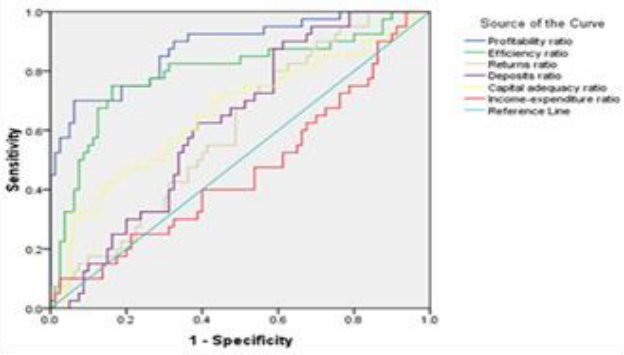

Figure 1c. ROC curve for foreign banks

4.2 Competitive mapping

To compare the financial strength of the public, private and foreign sector banks, discriminant analysis is applied. The Box's M tests the assumption of equality of covariance across groups. The p

value is found to be less than 5% level of significance. Therefore, the data is considered fit for discriminant analysis. (Hua, Xiong, and Dougherty 2005; Dixon, and Brereton 2008; Filiz, and Yaprak 2009).

Table 5 Eigen values and Wilks' Lambda Value in discriminant analysis for financial strength variable among three sectors of banks.

Function	Eigen value	Wilks' Lambda	Canonical correlation	Chi-square	Sig.
1 through 2	11.939	.036	.961	21.569	.034
2	1.134	.469	.729	4.927	.425

Box's M test Sig.: .000

Table 5 reveals that the discriminant model has extracted two functions. The first function is extracted with the eigen value of 11.939 and the canonical correlation between the discriminant scores, and the model is 0.961. The function two is extracted with an eigen value of 1.134, and the canonical correlation value is found to be 0.729. It is also observed that Wilk' Lambda values measure the effectiveness of separating each sector; smaller values of Wilk's Lambda values indicate greater discriminatory ability of the function.

Finally, the chi-square value tells us whether the function possesses the power to discriminating the three sectors of banks. Table 5 it is observed that in function 1 through 2, chi-square value is significant ($p < 0.05$), but for function 2, it is found to be insignificant ($p > .05$). Therefore, the first function is found to be more significant in discriminating the three sectors of banks.

Table 6. Canonical discriminant function coefficients for financial strength variables

Ratios	Functions 1	2
Profitability ratio	.945	-.520
Efficiency ratio	.879	-.087
Returns ratio	1.142	.871
Deposits ratio	.438	.937
Capital Adequacy ratio	1.303	.546
Income-Expenditure ratio	.237	.362

Table 6 shows the canonical discriminant function coefficients. In function 1, returns ratio has the highest discriminatory power with the coefficient of 1.142 followed by capital adequacy ratio, profit ratio, efficiency ratio and deposits ratio. Income – expenditure ratio is found to possess low discriminating power with a coefficient of 0.237. Function 2 is ignored for discriminating as it did not possess the satisfactory p-value. Therefore, based on the canonical discriminant function and group centroid (Table 7), the competitive position mapping is obtained. Figure 2 depicts the competitive position of the three sectors of banks in terms of six financial strength components.

Table 7. Functions at group centroids

sector	Function 1	2
Public sector	-1.996	.588
Private sector	-.314	-.964
Foreign sector	2.311	.376

Figure 2 reveals that the foreign banks are the most competitive bank in Indian banking industry as their group centroid value is 2.311 in the function 1.

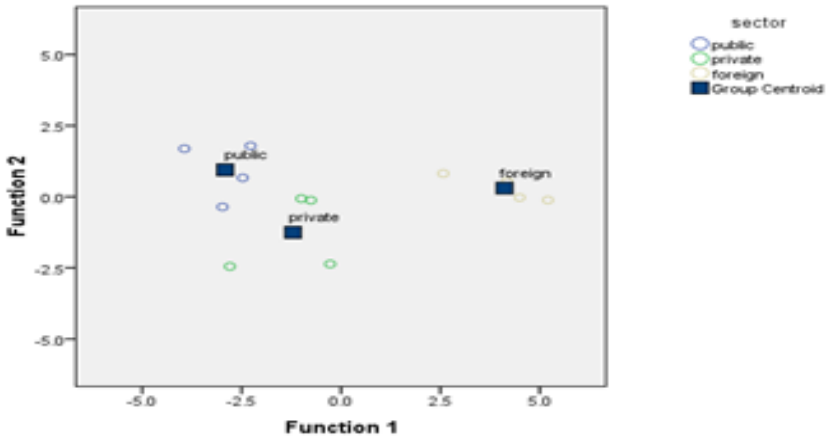

Figure 2. Canonical discriminant functions for financial strength variable

The private sector banks are found to be better off due to their higher profitability and efficiency than the public sector banks. The public sector banks due to their lower asset quality, productivity, share of younger customer and share in fee based wholesale, and retail banking products were not able to cope with the competitive pressure created by the private sector and foreign banks.

Summary and Conclusion

The financial strength variable is considered as a significant factor in analysing the competitiveness among the select commercial banks. Bank-wise and sector wise analysis is performed. Factor analysis and discriminant analysis is applied to enhance the validity of the results. Competitive Z-score is obtained to measure the competitive position of the select commercial banks. Standard Chartered Bank is the most competitive bank followed by Citibank, RBS and HSBC. HDFC bank is the only bank found to be effective among the private and public sector banks in Indian banking industry. The sector-wise analysis reveals that there is significant difference among the public, private and foreign banks with respect to profitability ratio, efficiency ratio, deposits ratio and capital adequacy ratio. And it is also observed that there is no significant difference among the three sectors of banks with respect to returns ratio and income-expenditure ratio. On the whole, foreign banks are found to be the most competitive bank compared to the public and private sector banks.

Therefore, the findings assert that presence of foreign banks has made the domestic banking industry more competitive and also forced the domestic banks to function more efficiently and effectively. But over the study period it can be observed that profitability, and bank spread has reduced particularly for the public sector banks due to high operating cost, non-performing assets, priority sector lending and investment in government securities.

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INTERNAL AUDIT AND CORPORATE GOVERNANCE IN TIME OF ECONOMIC CRISIS

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Abstract:

Economy implies a uniform system of human activities, including finance and credit, so it cannot be treated alongside the economic and financial aspects, but in their systemic unity, as a whole, representing the vital and permanent domain of society, economic activity being directly or indirectly involved in satisfying the needs of society and representing the general foundation in the lives of all people. Modern market economy, including finance, is a mixed system, which combines economic freedom with government intervention. Particular attention must be paid to corporate governance, a very broad concept that includes a strong and effective oversight of how something is designed, managed, controlled or managed in order to protect the components of such areas, organizations or institutions. In practice, implementing and developing the concept particularly influenced the nature and evolution of internal audit. Lately, internal audit has evolved very much because the concept of governance, which has influenced and empowered in greater management assessment and risk management. The audit will inevitably be put under public pressure, since it is the function that can bring a surplus of transparency in a world so controversial.

Keywords: internal audit, corporate governance, economic crisis, risk management

JEL Classification: M14, M42

1. Introduction

The challenges raised by the economic environment are directly reflected in the auditor's effort to evaluate the impact on the entity's financial position and performance. Understanding the risks to which the entity is exposed to following the economic climate and the methods to manage those risks becomes a key part of the audit engagement contributing to the delivery of quality services, enhancement of business relations based on mutual trust. In the most recent international speciality literature, the deficiencies of risk management are included in the category of the main factors that caused the current economic crisis [Pop and Bota-Avram, (2009)]. So, the risk management strategies became top priority. Given to the increasing responsibility that internal audit has or, at least, it should have to streamline the risk management, a proper attention should be directed to identify the role of internal audit activity in triggering the economic crisis.

The economic crisis is a state of difficulty of economic activities, a sudden rupture in economic activity, reflected in the slowdown, stagnation or decline of economic activities. It is a daunting juncture for the economy as a whole, for some sectors, regions, etc. A disease of the economy's body marking the breaking of economic balance, especially between production and consumption, supply and demand, with direct effects on prices, occupancy and use of production factors. The change is one of the most important elements of a manager's activity, for the organization to survive and adjust to the evolution of the society events. One can find it in the main interest themes of the social sciences: economy, sociology, political, psychology, management. The answer to the question: "What do we have to change first in an organization" is the one which differentiates the theories about the change, and it can be determined by the technological structure or by individuals? [Bardas and all, 2011].

2. Internal audit and corporate governance facing the economic crisis

A particular attention in now-a-days economic situation must be paid to corporate governance. Governance is a very broad concept that includes a strong and effective oversight of how something is designed, managed, controlled or managed in order to protect the components of such areas, organizations or institutions.

Debates around corporate governance intensified during 90's, first in Anglo-Saxons countries, then in continental Europe and further on international level, based on a primordial situation focalized on analysing managers power and their limitations among every patrimonial entity.

The financial aspect of corporate governance lies in the use of this concept in practice of auditors, as prescribed by the International Standards on Internal Audit. Corporate governance represents a central and dynamic aspect of the economic reality, being increasingly sensed in numerous countries. Derivate from the Latin word *gubernare*, in Romanian the term of governance is synonymous with the term of administration, implying all the activities that enter in management field on an entity's level.

Corporate governance of Romanian enterprises and thus their performance trend can be analysed and understood only through the development process of reform in the context of transition from planned economy to market economy, which led to profound changes in the microeconomic universe. In fact, the corporate sector has really emerged from the process of privatization of state enterprises, which were centrally managed based on some binding plans and not on requirements generated by the natural laws of economy.

In practice, implementing and developing the concept particularly influenced the nature and evolution of internal audit. It has acquired new meanings over the years, and also broadening the scope of work and coverage of the activities audited. Worldwide interest in governance over the past 25 years fuelled internal audit.

Lately, internal audit has evolved very much because the concept of governance, which has influenced and empowered in greater management assessment and risk management.

Internal audit is an independent activity, objective, assurance and consulting, designed to create value and improve an organization's operations. It assists the organization in achieving its objectives by implementing a systematic and disciplined approach in evaluating and improving the effectiveness of risk management, control and governance processes [Bunget et *al*, (2009)].

Therefore, internal auditing represents a function integrated in the company, when the external auditing represents an independent function whose mission is to certify the accuracy of the accounts, results and financial situations, and more precisely to certify the sincerity and a truthful image of the financial situation and (if we retain the definition of the authorized accountants) to certify the regularization, ingenuity and fair picture of accounts and financial situation.

The concept of corporate governance is sustained by internal audit, which has an important role in assisting the reorganization of the internal control system and in advising general management.

In today knowledge-based society it can be identified a number of five tendencies, as: globalization, changes in risk management, technological progress, organizational talent and capacities, changes regarding internal audit role. All of these are expected to have an important impact over internal audit during the following years. That's way it is essential the proper understanding of these tendencies, and also of their implications, in such way so that internal audit could supply the help needed in identifying and managing risks; so in the end internal audit has an effective contribution in adding plus value to economic entities [Pop and Bota-Avram, (2009)]. The internal audit must guarantee the reasonable safety that the operations performed, the decisions made are under control and that in this way it contributes to the improvement of management decisions regarding the achievement of tasks set by companies [Terci, (2009)].

Machiavelli's maxim "the one who takes it for just what he thinks is real, but it is not, it surely to reach failure" applied to internal auditor, highlights the danger of preconceived ideas and absolute necessity of practicing validation. Main points that delimit the internal audit definition are: management assistance, without judging employees, total independency. The internal auditor will assist managers, in that it allows through their opinions and successive approaches, improvement of decisions that are about to be made. The notion of assisting managers finds itself in a permanent evolution. The actual economic crisis excluded any reference regarding affiliation of internal audit and control which was leading to confusions and has been replaced with a proper word: consultant. In that, internal auditor assists, recommends, conciliates, but not decide.

The installing of a system in order to prevent fraud remains in the responsibility of the management within the organization and internal audit provides assistance in assessing risks and strategies for corporate control, suggesting the proposals, recommendations and solutions to diminish the threat of fraud, and improve the control strategy.

In an era of almost instantaneous transmission of information, as well as increasingly blurred lines of distinction between different schools of political thought, the auditor also has to keep abreast of developments and the wide ranging global debates on the most appropriate responses to the severe crises that seem to develop so rapidly.

An internal audit function could be viewed as a first line defence against inadequate corporate governance and financial reporting. With appropriate support from the Board of Directors' Audit Committee, the internal audit staffs is in the best position to gather intelligence on inappropriate accounting practices, inadequate internal controls, and ineffective corporate governance.

Internal auditors' unique full-time focus on risks and controls is vital to sound governance process and to sound financial reporting. According to statistics from international news and information organization Bloomberg News, in more than half of the 673 largest bankruptcies of public corporations since 1996, external auditors provided no cautions in annual financial statements in the months before bankruptcy. Many of bankruptcies in history, including Enron, Global Crossing Ltd., and Kmart Corp., followed annual reports with clean audit opinions from the external auditors. Although external auditors' independence is protected to some degree, they still face many of the same issues as internal auditors when it comes to undue management influence.

There are many roles that internal audit can fulfil in respect of the risk management process implemented within the organization.

Today, internal audit assumes at least two important roles in respect of the risk management. First, internal audit can act as an advisor helping the organization in respect of risk awareness. This can be done by improving the management understanding of the major risks facing the organization. It should be mention that the risk management process can be used by internal auditors in identifying areas for review. In these ways the internal auditors can focus their activity on the key systems and controls within the organization [Constantin and Alexandru, (2011)].

Second, internal auditors can act as trainers in risk management workshops. In this way internal auditors aid line managers understand better organizational risks and controls. This is how internal audit can help the managers to identify various risks [Constantin and Alexandru, (2011)].

Nevertheless, it should be mention that the internal audit can't assume and be responsible for effectiveness of risk management. That is the responsibility of the top management and operational management. However, assurance on the risk management process can be provided by the internal audit. During the assessment activities, internal audit can also give advice on this field.

Although internal audit activity has such an important role in a company, at least an ambiguity can be found in its area of definition. It was brought into discussion the concept of total independency of the internal auditor. With this concept it follows to underline the function independency, the lack of pressures over it. But taking into account that internal audit department is subordinated to managers and that in some institutions mainly public institutions internal auditors are entitled with some quests regarding coordination, conceiving some procedures, etc. can we still speak about total independency? The responsibility of control registers ambiguity.

In the light of those presented, it is obvious that the period before the economic crisis to be propagated was characterised by the increasing role of internal audit in the risk management process. Assuming an active implication of the internal audit in risk management processes we can affirm that the level of these risks should have been maintained at a reasonable level, which could be translated by the fact that internal audit could have contributed in the early identification of those risks that further generated the avalanche of negative phenomenons starting 2007. So, new questions arise at the horizon. How internal audit should react in combating the negative effects of crisis?

In time of challenges, risk management is an essential preoccupation. Companies must identify the significant risks they confront; to evaluate the potential impacts of those risks and adopt the most efficient measures in case of unpredicted events [Toader, (2009)]. Managers must analyse which one of the risks were amplified as a result of the economic environment decrease. At the same time, managers must evaluate all the available information regarding significant risks and make sure that the main premises are correctly tested.

Though the role of a skilful risk management it was clearly shown and extolled, many commissions and institutions analysed the main causes of the outbreak and spread of the crisis reaching to a common point: a faulty risk management had a determinant contribution in generating the actual crisis. So, one of the negative elements identified in companies strong affected by the

economic crisis, was the managers failure in managing risks, in identifying them, mainly because of a high complexity of the services provided and the risky nature of the business. Therefore, revising procedures regarding risk management process, in order to improve its effectiveness, becomes an imperative demand.

According to IIA (Internal Audit Institute) "Internal audit activity should help the economic entity through risks identification and evaluating significant exposures to risk and contribute to improving management systems and risk control". In other words, it is expected for internal audit to transmit to the managers the results of the monitoring activity of the risk management system.

Analysing the potential causes of the global economic crisis in terms of internal audit, the following situations are considered to have stayed at the base of out breaking of these negative events:

- The Department of Internal Audit was not paying attention in assuring conformity with the Standards of Internal Audit, this lack of attention being spread to the top management;
- The Department of Internal Audit evaluated the risk management process and have sent the evaluations to the management regarding possible threats, but not capable enough to identify risks and report them in time;
- The Department of Internal Audit evaluated risks, but did not report them to the management;
- The Department of Internal Audit followed the Standards, evaluating and reporting the identified risks, but the management ignored these reports, not giving due attention to them.

Conclusion

It becomes obviously the role of internal audit in risk management that should become strategic. In the future, internal audit activity would gain some new expectations from management and audit committees.

The audit will inevitably be put under public pressure, since it is the function that can bring a surplus of transparency in a world so controversial. The presence of the auditor in such a context the answer "governing principles" to ensure transparency of transactions of public organization and management need to bring extra security, which would allow the organization to have the courage to implement the strategy correctly and efficiently.

Ignoring the internal audit function can lead to real disasters in financial terms and not a few have been cases where the collapse of giant companies resulted in a number of negative chain and entailed thousands and sometimes even millions of creditors, suppliers, employees and investors injured, with effects that have lasted for years.

However, as noted, none of these features, relatively modern, of an economic entity cannot timely identify a potential crisis on its own, much more could not manage it. Every department, every function that is found in a company must be interwoven with other functions, there are interdependent. We, humans are the perfect example of interdependency. A person is not built to stand alone, needs connections with others in order to create something, needs communication, no man could ever build The Great Wall by itself. We need each other. So the departments of an economic entity; cannot exist separately, cannot develop separately, they must communicate in order to deal with a dynamic economic environment. Can we nominate which one of the body components is more important? Can we tell which company department, or function is the most important? No. They must function as a whole. If one of the departments misfires, is reflected in all business activities. Solution is found in employee training, in improving their future as professional with the hope that significant risks will not only be discovered in time, but managed in an effective and fair way.

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IDENTIFYING THE FACTORS AFFECTING THE CONSUMER CREDIT CARD OWNERSHIP: EMPIRICAL EVIDENCE FROM TURKEY

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Abstract:
In this study, factors that determine consumers' ownership of credit card have been analyzed using Binom Logit Model. For this purpose, 18 and over population was taken into consideration with the questionnaire method in Sivas, a province in Turkey, in 2011. Sample size was determined with Probability Sampling Method. Dependent variable of the study is to have or not to have a credit card. Independent variables include consumers' social, economic and demographical attributes. It has been determined that upon credit card ownership; variables including gender, education level and age of household head, marital status, employment of housewife, the number of people in the family with an income, usefulness of the credit card and payment of debts on time have statistically important effects.

Key words: *credit card ownership, consumer, socio-economic factors, logit model, Turkey*

JEL Classification: D12, D14, C35

1. Introduction

A common unit of measure is always needed for actualizing exchange in economic life. And this unit of measure is called money. It has been noticed that many materials have been used as money through the human history. In parallel with the improvement of the technology mediums of exchange have changed in form and size. Credit cards are mediums that provide consumers to purchase goods and service without carrying cash with them. It is a kind of payment instrument which delays the payment of good and service charges that the consumers want to purchase for a specific period of time or splits the purchase into installments in return for a specific interest and also provides convenience of withdrawing cash.

Plastic cards have been transformed into virtual cards with the development and popularization of the internet and have started to be used more commonly. Beside this, banks' transaction costs have reduced and more economical trade's way has been paved. Under this circumstance, increase of trade and consumption is inevitable. Banks which carried on their business more on corporate banking until 1990s fulfilled the loan demands of big firms' and intensified their activities on these fields. However, after 1990s, banks' intensifying their activities on private banking and generating an important part of their income from this area of activity has caused their locating whole transactions in the sector to this area. In terms of private banking, banks primarily have given importance to the development of technological infra-structure, and then have released their range of products to the public. Banks where the most money have been treated and with intensive effect upon the economy has diversified their products so as to make their customers use more money and after carrying out several studies for substituting the money in terms of being integrated with the world they have accomplished the success in the end (Kukrer 2006, 1).

The new economy in the information society creates a new business environment. What is different is that more and more business gets transacted in a computer mediated environment. Transactions, bill payments, purchasing, reservations (hotels, traveler cinema tickets) are done electronically. A Credit Card is an electronic payment system that is used more than two decades.

Since the beginning of the 80s the credit card industry has expanded worldwide both in terms of new card account sand of credit card usage (Mavri, and Ioannou 2004, 29–44).

Credit cards serve as a payment device, a source of revolving credit and a life style-facilitating technology. Consumers use credit cards as an easy mode of payment in lieu of cash or cheques for routine purchases as well as fortran sactions that would otherwise be inconvenient or perhaps impossible. Consumers also use credit cards as a mode of financing and elect to pay interest charges on the unpaid balance. When consumers use credit cards as a mode of financing, credit cards compete with bank loans and other forms of financing. Credit card ownership and use have increased substantially over the past decades, and credit card service has become one of the most lucrative financial services (Wickramasinghe, and Gurugamage 2012, 80–89).

Historical development of credit cards put into service of consumers in terms of Turkey and the World has been given in Table 1.

Table 1. Gelişimi Historical Development of Credit Card in Turkey and in the World

Date	Development	Date	Development
1887	Idea of paying with credit card instead of in cash was indicted for the first time by American author Edward Bellamy in his book "Looking Backwardor Life in The Year 2000".	1992	Putting "Photo credit card" into use in Turkey for the first time in the world.
1894	In the USA, Hotel Credit Letter Company put the world's first "payment card" into service which is only valid in some specific hotels for the prominent businessmen of the period. With this card, people first introduced with another kind of payment system except from cash payment.	1993	BKM Switch System's putting into practice
1914	Western Union Bank introduced world's the first "credit payment card" with "buy now pay later" slogan.	1994	Beginning of the first "feature card" in Turkey
1924	General Petroleum Company put the petrol card into service which provides payment except from cash in gas stations of specific states in the USA.	1998	Card users' introducing with earning mile and cash back point, and installment practices which will be their indispensable preference in following years
1956	Years when credit cards take place of cash payment in the USA. Hundred of banks from Bank of America to Chase Manhattan started to distribute credit cards to their customers. "30-day non-interest account practice" was started for the first time in the world by a USA bank. Spread of credit cards to Europe which takes place of cash slowly. First distribution of credit card in Europe by English Barclays Bank	2001	Creating EMV domestic standards for Chip&PIN application.
1968	Arrival of card payment system to Turkey. Our meeting with first Diners Club and then American Express cards.	2002	BKM EMV chip certification system's activation.
1975	Credit cards' being started to be used by a limited surrounding with activation of Eurocard and Master Card	2003	Acceleration of preparations to commence chip&PIN application by Interbank Card Center and member institutions.
1983	MasterCard's and then Visa cards' being started to exist in the system in Turkey, acceptance of credit cards by larger masses.	2004	Start of "Bank Card Awareness-Raising Campaign" in which Okan Bayulgen took role in order to popularize use of bank cards in shopping,
1987	Swift proliferation of card payment systems. Increase of credit card numbers and usage endorsement and first ATM's being put into service in Turkey.	2005	First use of "prepaid smart cards" by Turkish Armed Forces. First contactless highway application's being put into service (KGS).
1988	Store credit cards' commencing to the system and popularization along with the credit cards.	2006	"Contactless credit card"s being put into service in Turkey. Turkey's starting chip&PIN application as the 3rd country

Date	Development	Date	Development
			after France and England.
1990	Establishment of Interbank Card Center (BKM)	2007	On 31 June 2007, completion of chip &PIN transition period
1991	After establishment of Interbank Card Center (BKM), mobility in Turkish card payment system and start of growth. First electronic POS terminal's being put into service	2008	A first in the world by BKM and TURKCELL.Integration of 3D Secure and Turkcell mobile signature.

Source: Interbank Card Center, http://www.bkm.com.tr (accessed on 10 March 2012).

In his study, Kukrer (2006) determined that shopping done using credit cards and withdrawn cash advances increased eight fold from 2000 to 2005. Credit cards have important effects upon countries' macro-economic indicators, in fact. Explosive improvement of credit card sector with each passing day necessitates more due consideration that must be given to this subject. Although credit cards were introduced to Turkey late like many other technological products, their actualizing was highly quick. It quickly became an inevitable part of our financial life.

Table 2. Distribution of used credit card types by years in Turkey (2005–2011)

Year	Visa			MasterCard			Other			Total		
	Item	%*	Rise**	Item	%*	Rise**	Item	%*	Rise**	Item	%*	Rise**
2005	15990	53.3	-	13963	46,6	-	25	0.1	-	29978	100.0	-
2006	17800	54.9	11.3	14623	45.1	4.7	10	0.0	-61.1	32433	100.0	8.2
2007	20879	55.9	17.3	16417	44.0	12.3	40	0.1	304.1	37335	100.0	15.1
2008	24332	56.1	16.5	18825	43.4	14.7	237	0.5	498.0	43394	100.0	16.2
2009	25201	56.8	3.6	18713	42.2	-0.6	479	1.1	102.0	44393	100.0	2.3
2010	27378	58.3	8.6	19126	40.7	2.2	452	1.0	-5.5	46956	100.0	5.8
2011	29478	57.4	7.7	21370	41.6	11.7	513	1.0	13.4	51361	100.0	9.4

* Shows percentage of expenses with credit card within total.
** Shows annual variation of shopping done using a credit card and withdrawn cash advance.

Source: Interbank Card Center, http://www.bkm.com.tr (accessed on 10 March 2012).

In Turkey, number of current credit card has continued to increase by years. Visa and Mastercard attract attention as being generally used credit card types. As of 2005, total number of those two cards is 30 million. This number was over 50 million as of 2011 year-end. This situation was shown in Table 2. Use of credit cards has been encouraged spending excessively upon advertising by banks and financial institutions and use rate of credit cards has been tried to be increased day by day. It can be seen in Table 2 that total of shopping done using credit card and withdrawn cash advance increased by 71% between 2005 and 2011 period. When credit cards are evaluated in terms of their types, it can be noticed that use of Visa has increased in Turkey more; however, use of Mastercard has decreased. While ownership of Visa was 53.3% in 2005, this rate rose to 57.4% in 2011. In the same way, for Mastercard, those rates are 46.6% and 41.6%, respectively.

Distribution of credit cards used in Turkey according to annual return was analyzed and shown in Table 3. When the table has been analyzed, it is seen that as of 2005 86 billion Turkish Liras were endorsement was obtained. While approximately 90.2% percent of this endorsement was shopping expenses and the rest 9.8% was cash advance. Within the analyzed period, endorsement amount showed nearly 3.5 times more increase. Again during this period, shopping with credit card and cash advance definitely showed increase, but there isn't a significant change proportionately.

Table 3. Distribution of credit card endorsements used in Turkey by years (2005–2011)
(- million TL - including use of tourists)

Years	Shopping			Cash Advance			Total		
	Endorse	%*	Rise**	Endorse	%*	Rise**	Endorse	%*	Rise**
2005	78042	90.2	-	8452	9.8	-	86494	100.0	-
2006	99082	90.8	27.0	10077	9.2	19.2	109159	100.0	26.2
2007	128787	90.2	30.0	14000	9.8	38.9	142787	100.0	30.8
2008	166725	89.4	29.5	19824	10.6	41.6	186549	100.0	30.6
2009	184433	90.1	10.6	20309	9.9	2.4	204742	100.0	9.8
2010	215375	91.1	16.8	21097	8.9	3.9	236472	100.0	15.5
2011	267372	91.0	24.1	26447	9.0	25.4	293819	100.0	24.3

* Shows percentage of expenses with credit card within total.
** Shows annual variation of shopping done using a credit card and withdrawn cash advance

Source: Interbank Card Center, http://www.bkm.com.tr (accessed on 10 March 2012).

The aim of this study is to identify factors affecting consumer's credit card ownership. It is thought that factors as age, gender, education level, marital status, car ownership, home ownership, operating status effect to consumer credit card ownership in the study.

For this aim, we applied questionnaire to have a set of data. Consumer credit card ownership or (not) as dependent variable and, gender, education level, marital status, car ownership, home ownership, operating status as independent variable was used in this study.

2. Data and Method

In order to acquire the set of data that would be used in the study, questionnaire was conducted. Questionnaires were performed upon 18 and over consumers residing in Turkey's province of Sivas in 2011. In order to implement the result more significantly, adults over the age of 18 were included within the scope of the study. According to information obtained from Address-Based Population Registration System (ANKS) Database, population of Sivas city center was 345762 in 2011 (TurkStat 2012). Within research area, population over the age of 18 creates nearly 60% of total population. Sample number was determined using Probability Sampling Method based on the formula given below (Yamane 2001):

$$n = \frac{N * t^2 * p * q}{d^2 * N + t^2 * p * q} \qquad (1)$$

In equation. (1), n = The Number of Sample Size, N = Population size (number of 18 and over population in the center of Sivas), p = Rate of credit card ownership, q = Rate of not having credit card ($1 - p$), t = %($1 - \alpha$) level t test value, α = Significance level, d = Margin of error (tolerance).

In order to study with as a big sample as possible, rate of having or not having a credit card in household of Sivas county town has been accepted as 0.5, sample size which will represent the main mass with 5% significance level and 4% margin of error has been calculated as nearly 600.

In accordance with the subject of the research, logit model has been used as a function of social, economic and demographical properties which are considered to effect consumers' decision on credit card ownership.

The dependent variable in the study is having and not having credit card of consumers who reside in Sivas county town. Model's dependent variable has been measured with a nominal scale. Many independent variables considered to have a relation with the dependent variable have been included to the analysis. Independent variables included in the study were measured with a constant, nominal and ordinal scale. Logit model has recently been used commonly in different disciplines by many researchers (Pulina 2010; Matin *et al.* 2012; Moser, and Raffaelli 2012; Aprile, Caputo, and Nayga Jr 2012). Dependent variable in logit model is discrete and appraisal probability values are

between 0 and 1. Logit model which depends on cumulative logistic probability function is expressed as below (Gujarati 1995).

$$P_i = F(Z_i) = F(\alpha + \beta X_i) = \frac{1}{(1 + exp^{-(Z_i)})} = \frac{1}{1 + exp^{-(\alpha+\beta X_i)}} \quad (2)$$

In Eq. (2); P_i expresses i numbered individual's possibility of credit card ownership, F, cumulative probability function, α, equation's stability coefficient, β, parameters that can be predicted for independent variables expressing credit card ownership and X_i, i numbered explanatory variable.

When Eq. (2)'s both side logarithms have been acquired the logit model below is obtained.

$$L_i = Ln\left[\frac{P_i}{1 - P_i}\right] = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \quad (3)$$

In Eq. (3), the dependent variable (Zi) expresses natural logarithmic value of credit card ownership rate to being not owner. In this study, as dependent variables, families with credit card are accepted as 1 and families without credit card are accepted as 0.

Economic, social and demographical factors such as gender, age, marital status, educational status, employment status of household head, employment status of housewife, number of family numbers, home ownership, car ownership, household's average monthly income, number of people in the family with an income, rental status of residence which effect families' credit card ownership have been included to the model. Besides, explanatory variables such as usefulness of the credit card, reliability of the credit card, credit card's increasing expenses, recommending credit card to others, payment of debts on time which are considered to be effective upon credit card ownership were included into the model, as well. Some of those variables are the ones used in previous studies (Pulina 2010; Oktay *et al.* 2009; Kukrer 2006; Abdul-Muhminand Umar 2007; Wickramasinghe, and Gurugamage 2011; Mavri, and Ioannou 2004; Sulaiti *et al.* 2006; Kaynak, and Harcar 2001; Loke *et al.* 2011).

In Table 4; explanatory variables, their definitions, arithmetic means and standard deviations were presented. All variables used in the study are discrete. The primary hypothesis in the research is consumers' credit card ownership's differing according to economic, social and demographical factors. Gender has been thought as an important determinant especially in developing countries like Turkey for credit card ownership and usage. It has been expected that male consumers are more likely to have credit cards than the male consumers. In previous studies, it was specified that most of credit card consumers are males (Adcock *et al.* 1977; Pulina 2010), single males use more credit card than the female counterparts (White 1975) in some studies, it can be seen that the variable of gender is not statistically significant (Kaynak, and Harcar 2001).

Table 4. Definitions and descriptive statistics of explanatory variables

Variable definitions	Variable name	Mean	Standard deviation
Gender of the household head (male=1; female=0)	GENDER	0.5567	0.49719
Age of the household head	AGE		
Between 18 and 25 years old	AGE1*	0.1367	0.34378
Between 26 and 35 years old	AGE2	0.4117	0.49255
Between 36 and 45 years old	AGE3	0.2200	0.41459
Between 46 and 55 years old	AGE4	0.1850	0.38862
Older than 55 years old	AGE5	0.0467	0.21110
Marital status of the household head (married =1; unmarried=0)	MARIAGE	0.7150	0.45179
Education level of household head	EDU		
Elementary school or less=1; otherwise=0	EDU1*	0.2017	0.40158
Secondary or high school=1; otherwise=0	EDU2	0.3133	0.46424
University degree=1; otherwise=0	EDU3	0.4850	0.50019
Employment of household head (yes=1; no=0)	HEMP	0.7567	0.42945
Employment of housewife (yes=1; no=0)	WEMP	0.3833	0.48660
Number of the members in the family	NHH	3.9617	1.47891

Variable definitions	Variable name	Mean	Standard deviation
House ownership (yes=1; no=0)	HOWN	0.5933	0.49162
Car ownership (yes=1; no=0)	COWN	0.6133	0.48739
Household income groups	INC		
≤ 1000 TL=1; otherwise=0	INC1*	0.1600	0.36691
1001 TL-2000 TL=1; otherwise=0	INC2	0.3150	0.46490
2001 TL-4000 TL=1; otherwise=0	INC3	0.3567	0.47941
≥ 4001 TL=1; otherwise=0	INC4	0.1683	0.37447
The number of people in the family with an income	NPFINC	1.5283	0.60812
Households paying rent (yes=1; no=0)	RENT	0.4200	0.49397
Usefulness of the credit card yes=1; no=0)	UCARD	0.5533	0.49756
Reliability of the credit card yes=1; no=0)	RCARD	0.4567	0.49853
Credit card ownership increase expense (yes=1; no=0)	ECARD	0.8450	0.36221
Recommending credit card to others (yes=1; no=0)	ACARD	0.2817	0.45019
Payment of debts on time (yes=1; no=0)	TIMEPAY	0.8083	0.39394

* Reference category from the models to avoid multi-co-linearity problem.

It is thought that educational status is not a significant factor for credit card ownership. It has been expected that as the educational status increases, possibility of credit card ownership increases, as well. Previous studies affirm that there is a correlation between credit card ownership and educational status (Awh, and Waters 1974; Adcock *et al.* 1977; Canner, and Cyrnak 1985; Kaynak, and Harcar 2001) and consumers with high educational status own more credit cards (Danes, and Hira 1990; Barker, and Sekerkaya 1992; Wickramasinghe, and Gurugamage 2009; Abdul-Muhminand, and Umar 2007; Oktay *et al.* 2009).

In this study, household's average monthly income was included in the model as dummy variable. It has been expected that as the income increases possibility of credit card ownership increases, as well. Those are the studies that determine a positive correlation between credit card ownership and usage and income (Wasberg, Hira, and Fanslow 1992; Danes, and Hira 1990; Barker, and Sekerkaye 1992; Wickramasinghe, and Gurugamage 2009; Kaynak, and Harcar 2001; Loke *et al.* 2001; Abdul-Muhminand, and Umar 2007; Oktay *et al.* 2009).

Working at a job is a factor that increases the income of a family. Employment of a housewife is a factor that increases family's income and accordingly causes increase of expenses, as well. There has been expected a positive correlation between credit card ownership and employment status of household head and housewife.

Variable of age was also included in the model. Variable of age has also been included in other studies (Loke *et al.* 2011; Kaynak, and Harcar 2001; Abdul-Muhminand Umar 2007; Wickramasinghe, and Gurugamage 2009). There has been expected a positive correlation between credit card usage and age. However, credit card ownership of very old consumers is expected to have a negative correlation. Marital status and number of the members in the family are other demographical factors that effect credit card ownership. Delener, and Katzenstein (1994) stated in their study that aforesaid factors affect credit card ownership and usage. Again in the same study, it was determined that married consumers have fewer credit cards than single or divorced consumers. In their study, Wickramasinghe, and Gurugamage (2009) found that there has been a positive correlation between being married and credit card ownership.

Apart from those, there has been expected a positive correlation between number of employees bringing in money to the family, home ownership, car ownership, usefulness of credit card, reliability of credit card and recommending credit card to others which have been included to the study. There has been expected a negative correlation between credit card ownership and payment of debts on time and rental status of the domicile. In their study, Oktay *et al.* (2009) determined that payment of debts on time and usefulness of credit card has positive effects upon credit card ownership.

Summery related to variables used in binom model were shown in Table 4. According to research results, 63.14% of consumers participated in the questionnaire are between 26 and 45 years old; 48.5% have been university graduates; 38.33%'s wives work; 59.33% own house; 35.67%'s income is over 2000; 55.33% find credit vary useful; 45.67% find credit card reliable. While 84.5% of

consumers believed that credit card ownership increases expenses, 28.17% stated that they could recommend credit card ownership to others. Average household size has been determined as 3.96%.

3. Empirical Findings

Possibility of consumers' not having a credit card has been predicted with binom logit. Model's maximum likelihood estimate results were given in Table 5.

Table 5. Logit results for consumer credit card ownership

Variables	Coefficients	Standard error	Significance level	Odds ratio	Marginal effects
GENDER	0.653*	0.347	0.059	1.922	0.056
AGE2	1.880***	0.589	0.001	6.556	0.162
AGE3	1.695**	0.695	0.015	5.444	0.146
AGE4	3.694***	0.739	0.000	40.219	0.317
AGE5	1.380**	0.893	0.122	3.975	0.119
MARIAGE	2.300***	0.548	0.000	9.977	0.198
EDU2	0.123	0.379	0.745	1.131	0.011
EDU3	1.004**	0.416	0.016	2.730	0.086
HEMP	0.612	0.417	0.142	1.844	0.086
WEMP	-1.126**	0.497	0.024	0.324	-0.097
NHH	0.014	0.100	0.889	1.014	0.001
HOWN	-0.048	0.601	0.936	0.953	-0.004
COWN	0.357	0.318	0.263	1.428	0.031
INC2	-0.604	0.383	0.115	0.547	-0.052
INC3	-0.214	0.464	0.645	0.808	-0.018
INC4	-0.378	0.737	0.609	0.686	-0.032
NPFINC	0.974***	0.342	0.004	2.649	0.084
RENT	0.129	0.593	0.827	1.138	0.011
UCARD	3.561***	0.559	0.000	35.202	0.306
RCARD	0.799	0.509	0.116	2.224	0.069
ECARD	0.727	0.466	0.119	2.070	0.062
ACARD	0.778	0.592	0.189	2.178	0.067
TIMEPAY	-0.766**	0.368	0.038	0.465	-0.066
Constant	-6.214***	1.199	0.000	0.002	-0.534

Note: Log likelihood: -175.088. Restricted log likelihood: -349.955.Chi-square (23): 349.734;
P-value: 0.0000.
Correctly prediction: 86.5%.
*, ** and *** indicate statistical significance at the 10%, 05%, and 1% levels, respectively.

Likelihood ratio test shows whether whole coefficients in the binom model are different from zero or not. Chi-square value measured in the model was 349.734 and found significant at 1% significance level. At the same time, model correctly precipitated 86.5% of observation values.

In the model, 11 coefficients of 23 variables were statistically significant at 10% significance level. Gender, age of household head, educational status, marital status, employment status of housewife, number of employees with an income, usefulness of credit card ad payment of debts on time have statistically important effects upon credit card ownership.

Coefficient of gender variable is marked as negative and statistically significant at 10% level. Possibility of credit card ownership is higher in males than females. The reason of such a situation can arise from male's being the household head and male's spending on their own.

Variable of age was included in the study in five categories as dummy. Whole co-efficiencies related to age variable have been marked as positive and found significant at 10% significance level. As expected, as consumers' age increases their possibility of credit card ownership increases, as well. When age variable's marginal effects were analyzed, possibility of credit card ownership of consumers over 55 is 11.9% higher than the consumers below 26. Similarly, when it is compared with a consumer below 26, possibility of credit card ownership is 16.2% higher in 26-35 age group, 14.6% higher in 36-45 age group and 31.7% higher in 46-55 age group 46–55.

Marital status included in the study as dummy variable is marked as positive and statistically significant. Credit card ownership possibility of a married consumer is 19.8% higher than a single consumer. Consumers' educational status was included in the study as dummy variable, as well. Marks of dummy variables' co-efficiency were positive as expected; however, EDU2 variable could not be found as significant at desired significant level. According to model results as the educational status increases credit card ownership possibility increases, as well. Credit card ownership possibility of a university graduate consumer is 8.6% higher than a primary school graduate.

Employment status of the household head and housewife was included in the logit model. However, working of the household head variable could not be found statistically significant at significance level in spite of being marked as positive employment of housewife variable is marked as negative and statistically significant. According to logit model result, employment of housewife has a reducing effect upon credit card ownership. When this variable's marginal effect has been analyzed credit card ownership possibility of a consumer whose wife work is 9.7% higher than the consumer whose wife does not. There has been found a result in contrast to this hypothesis.

According to logit model results, there has been determined a positive correlation between credit card ownership and number of family members with an income. One unit increase of number of family members with an income will also increase possibility of credit card ownership by 8.4%.
Credit cards function as a sort of money. Consumers' use of credit cards instead of carrying money with themselves is one of the important services that the technology renders to people. Whereas some of the consumers accept the usefulness that credit cards provide, the others deny. For this reason, the correlation between usefulness of credit card and credit card ownership has been researched and it has been included in the logit model as dummy variable. According to model results, the mark of usefulness of credit card variable is positive and statistically significant.

Whether there has been a correlation between payments of debts on time and credit card ownership has been researched and included in the logit model as dummy variable. According the model results, mark of aforesaid variable is negative and statistically significant. It can be said that credit card ownership possibility of consumers who pay the debts on time decreases. Consumers who pay their debts on time can be the ones who prefer to pay cash. What can be inferred from this is that, low-income families can prefer ways such as installment and debt relief, etc. using credit cards.

Apart from the variables mentioned above, many variables were included in the study as it is seen in Table 2; however, since they haven't been found statistically significant, they have not been implemented.

Conclusion

As a result of the study, gender, age of household head and educational status, marital status, employment status of the housewife, number of family members with an income, usefulness of credit card and payment of debts on time all have statistically significant effects upon credit card ownership. Co-efficiency of gender variable is marked as negative and statistically significant at 10% level. Credit card ownership possibility of males is higher than the females. When age variable has been analyzed, it can be said that as the age of consumers increases credit card ownership possibility increases, as well.

Credit card ownership possibility of a married consumer is 19.8% higher than the unmarried consumer. When educational status another variable has been analyzed as the educational status increases credit card ownership possibility increases as well. And about the university graduate variable in the study, credit card ownership possibility of a consumer is 8.6% higher than the elementary school graduate consumer.

For employment status of the housewife variable, credit card ownership possibility of a consumer whose wife works is 9.7% less than the one whose wife does not work. There has been acquired a result in contrast to expected hypothesis. When number of family members with an income variable has been analyzed, one unit increase about the number of family members with an income will increase the credit card ownership possibility by 8.4%. Usefulness of credit card variable's co-efficiency mark is positive and statistically significant. Credit card ownership possibility of consumers who pay their debts on time can be said as decreasing. Families who do not pay their debts on time and with a low-income can prefer ways such as installment and debt relief, etc.

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