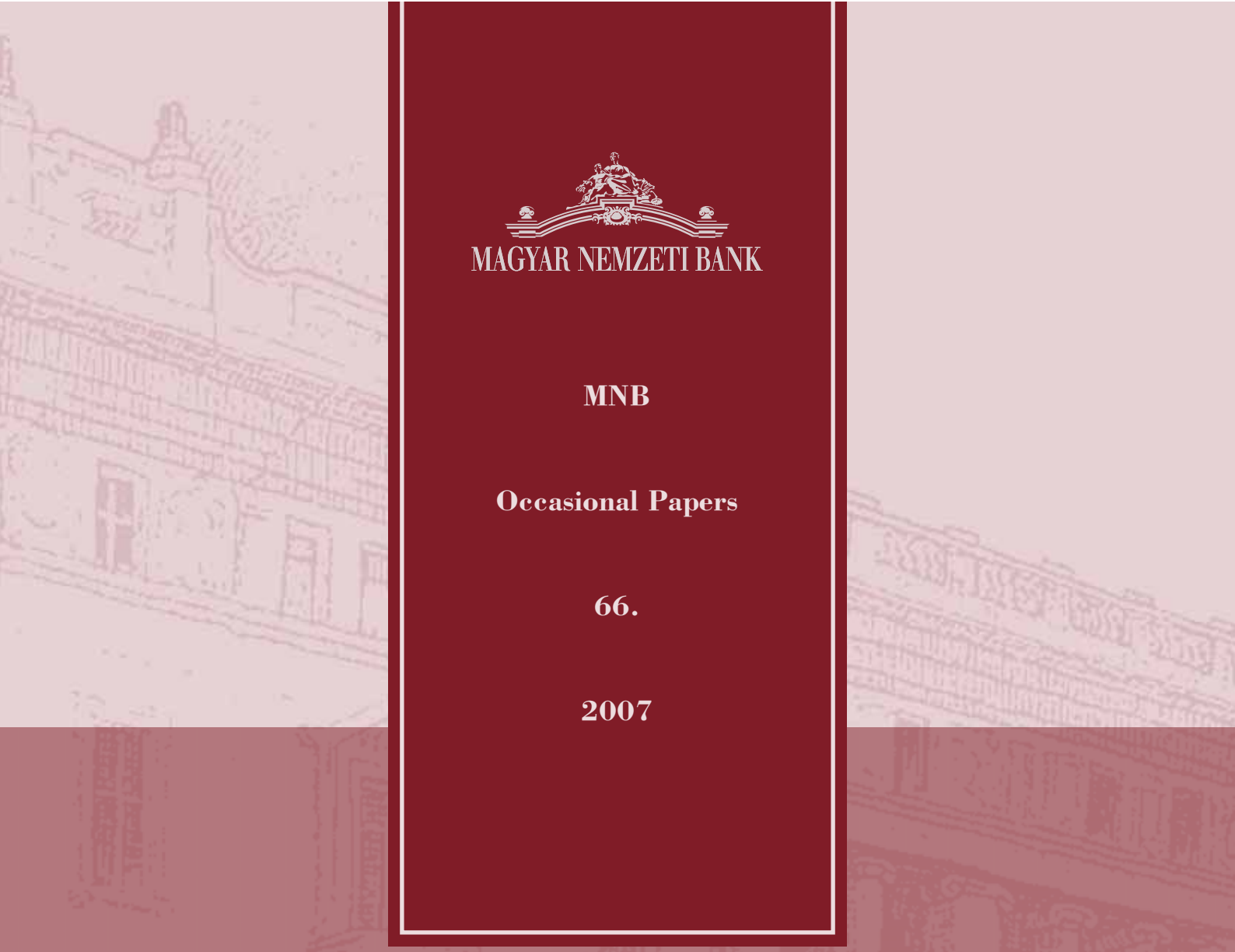

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GYŐZŐ EPPICH–SZABOLCS LŐRINCZ

Three methods to estimate the whitening-related distortion of the wage statistics

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Three methods to estimate the whitening-related distortion of the wage statistics*

(Három módszer a bérstatisztika fehéredés okozta torzítottságának becslésére)

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Contents

Abstract

We have received a number of queries recently from market researchers concerning our methods in order to determine the underlying wage process, with particular regard to the correction of whitening. The whitening estimation methods we have developed have been described in outline in the boxed sections of our Reports on Inflation. In this study, however, we would like to present the estimations so that they can be easily reproduced.

The study briefly describes our three methods designed to adjust the possible distortions of wage data. The whitening of the economy may cause such distortions. Since we do not directly observe the whitening process, we use indirect methods. A model of the wage data generation process is established in each case. There was a break in these processes during the second half of 2006. The time series, adjusted for whitening, yielded by a particular method is the fictitious wage time series, which would have been attained if there is no break in the data-generation process. The three methods are based respectively on wage differences by economic sector, labour force categories and the estimation of wage distribution. The three methods result in a similar estimate of whitening in terms of both its extent and time-pattern. The level of distortion may have been more significant in 2006, and gradually decreased subsequently. The wage indices have still shown a significant increase in their dynamics even after the adjustment for whitening. It is thus not true that the acceleration in the wage statistics published by the Central Statistical Office (KSH) has been entirely the result of the government measures aiming at the whitening of the economy.

JEL: J30, J31.
Keywords: whitening-effect, labour market, wages.

Összefoglaló

Az elmúlt időszakban számos kérdés érkezett hozzánk piaci elemzőktől az általunk használt, a bérek alapfolyamatát meghatározó módszerekre vonatkozóan, különös tekintettel a fehéredés korrekciójára. Az általunk kidolgozott fehéredési becslési módszereket bemutattuk már az Inflációs Jelentések egy-egy keretes írásában, azonban ez szükségképpen csak vázlatos leírást tett lehetővé. A jelen írásban úgy szeretnénk bemutatni a becsléseket, hogy azok viszonylag könnyen reprodukálhatók legyenek.

A tanulmányban röviden bemutatjuk a béradatok esetleges torzítottságát korrigáló három módszerünket. Ennek a torzításnak a gazdaság fehéredése lehet az oka. Mivel közvetlenül nem figyeljük meg a fehéredést, a módszereink indirektek. Mindhárom esetben felállítjuk a bérek adatgeneráló folyamatának egy modelljét. Ezen folyamatokban törést tapasztalunk 2006 második felében. Az egy adott módszer által kapott, fehéredéssel korrigált idősornak azt a fiktív béridősort nevezzük, amely akkor valósult volna meg, ha az adatgeneráló folyamatban nem következik be a törés. Az első módszer az ágazati bérkülönbségekre, a második a létszám-kategóriákra, míg a harmadik a béreloszlás becslésére alapul. A három módszer mind mértékében, mind lefutásában hasonló becslést ad a fehéredésről. A torzítás mértéke jelentősebb lehetett 2006-ban, majd fokozatosan lecsengett. A bérindexek még a fehéredési korrekció után is jelentősnek tekinthető dinamika-emelkedést mutattak a vizsgált periódusban. Így nem mondhatjuk, hogy a KSH által publikált bérstatisztikában megfigyelhető gyorsulás teljes egészében a gazdaság fehéredését célzó kormányzati intézkedések hatásának tudható be.

JEL: J30, J31.
Kulcsszavak: fehéredési hatás, munkaerő-piac, bérek.

1. Introduction

Since the second half of 2006, there has been a significant increase in the dynamics of institutional wages and salaries published by the Central Statistical Office (KSH). The same period has seen the implementation of a number of government measures aiming at the whitening of the economy. They have included action to battle bogus contracts, a mandatory contribution payment after double the minimum wage and the tightening of inspections by the tax authority. As a possible side-effect of these measures, the wage statistics of the KSH may have become distorted, typically upwards, during the period in question. That in turn could raise problems for the central bank, the wage system being one of the most important determinants of the inflationary pressures on both the demand and the cost sides. It is therefore important to find out the extent the wage dynamics can be attributed to whitening and to 'real' trends.

This study presents three methods developed by the MNB for the estimation of the extent of whitening. They are all indirect methods based on the identification of a structural break. Being indirect means that, rather than directly 'observing' the whitening process, certain phenomena are assumed to have come about as a consequence of whitening. A model symbolizing the data-generating process of wage dynamics is set up under each method. In mid-2006, there is a clearly recognizable break in these data-generating processes. That is followed by quantifying the wage dynamics that would have been attained if the data-generating process had not changed. This fictitious wage time series is called the whitening-adjusted wage index.

In the first and second methods, the structural break is represented by the significant change in the relative wage structures of, respectively, the various industries and the various company categories in terms of the number of employees. The third method adjusts the changes of wage distribution by employee number categories whenever they considerably differ from prevailing earlier trends.

The three methods result in a similar estimates of whitening in terms of both its extent and time-pattern. The level of distortion may have been more significant in 2006, and gradually decreased subsequently. The wage indices have still shown a significant increase in dynamics even after the adjustment for whitening. It is thus not true that the acceleration in the wage statistics published by the KSH has been entirely the result of the government measures aiming at the whitening of the economy.

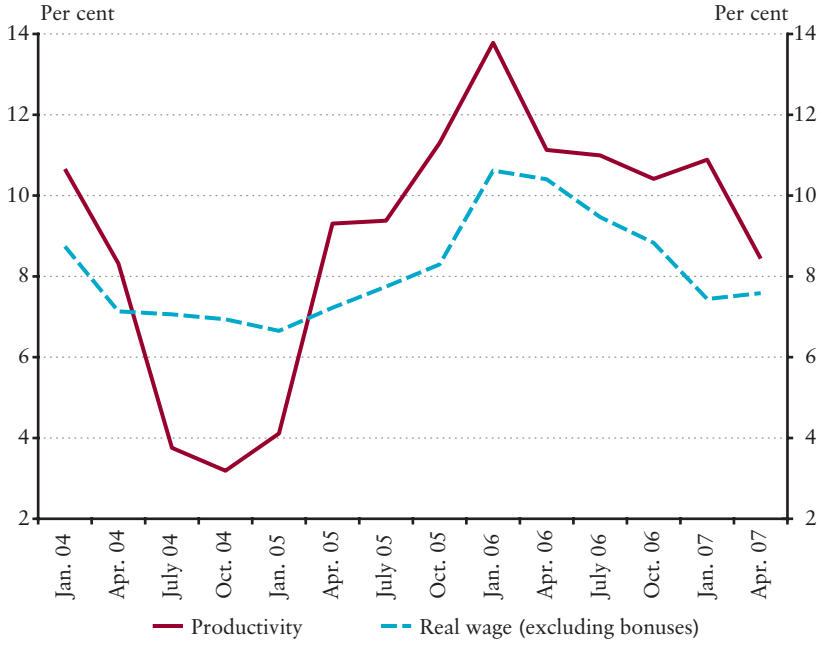
2. The industry-based method

In the industry-based method, it is presumed that the wage statistics has become significantly distorted since the second half of 2006 in certain industries whereas there has been no notable distortion in other industries. That assumption is based mainly on anecdotal evidence. It is clearly noticeable, however, that wage dynamics have shown a significant change in their trends in certain industries only, primarily in the service and construction sectors during the period under review. The rate of increase of real wages in the presumably non-whitening industries, mainly in the manufacturing sector, has not exceeded the increase of productivity and therefore wage data are less likely to be distorted in these industries.

Chart 1

Productivity and real wages in manufacturing

(Annual growth rates of seasonally adjusted data, per cent)



Note: real wages are regular wages deflated by the price index of tradeble goods.

Having identified the whitening industries, we try to explain the rates of increase of wages in these industries on the basis of other industries, for the period preceding the start of the presumed whitening process, i.e. before the second half of 2006. This is done by fitting simple linear regressions. In that manner, we describe a historical relationship between whitening and non-whitening industries. Since the data of the estimation period are not distorted by whitening, the relationship described can be considered stable.

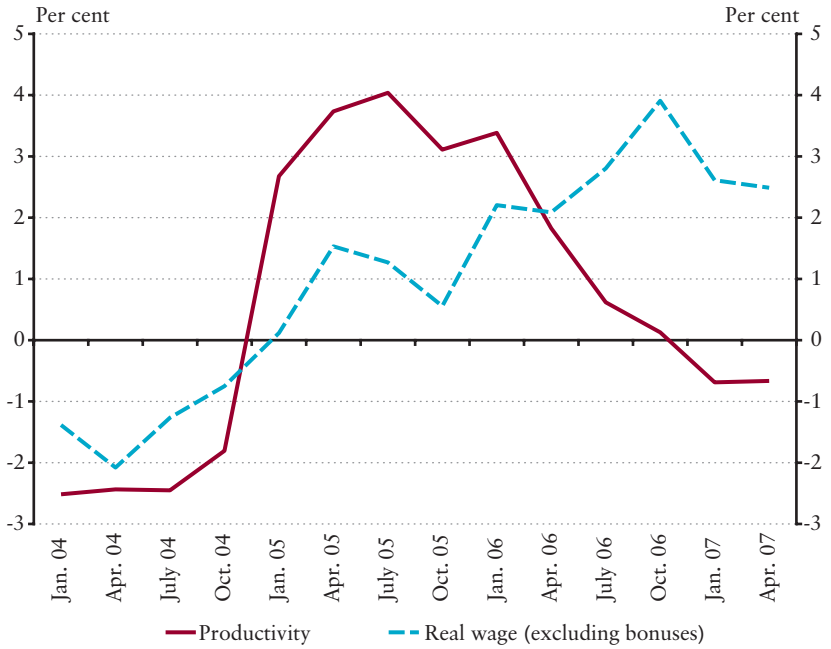
In the next step, we examine the wage dynamics forecast by the estimated regressions from the third quarter of 2006, using the actual wage data of non-whitening industries. This forecast tells us the most probable wage dynamics of whitening industries from the second half of 2006 if the historical relationship with the wage dynamics of non-whitening industries had not been broken.

The so forecasted dynamics are called the whitening-adjusted wage indices of the industries in question. This means the following. From the assumption that the explained variables of the regressions are, whereas the independent variables are not affected by whitening, it follows that the historical relationship ascertained for the earlier sample period will break up during the period in question. Therefore, until this historical relationship is re-established, there will remain a difference between the forecast and the actual wage dynamics. What follows from this and the other assumption that whitening had not been the

Chart 2

Productivity and real wages in the service sector

(Annual growth rates of seasonally adjusted data, per cent)



Note: real wages are regular wages deflated by the price index of services.

cause of any data distortion before the second half of 2006, is that the difference measured between the forecast and the actual data during the whitening period is equal with the effect of whitening.[1]

The disadvantage of the method may in part be due to the non-fulfillment of its assumptions. The assumption that the effects of whitening have appeared since the second half of 2006 can be defended by argument that, for our purposes, 'whitening' is essentially a detected, but not 'real', wage dynamics that has become present as a result of the government measures put into effect since summer 2006.

The selection of whitening industries, however, is a more problematic speculation. If the wage data of industries we have assumed to be non-whitening also contain whitening-related distortion, it returns whitening distortion to the already adjusted data. Therefore we have endeavoured to include a relatively broad range of industries in the adjustment. The selected industries cover 58 percent of the labour force of the entire private sector as appears in the institutional statistics, whereas in the service sector that rate is 93 percent.

However, similarly to the two other methods described in the study, this method also has the drawback of attributing each effect, which has changed the wage dynamics generating structure observed on the earlier sample section, to the effect of whitening. For example, the effects of the guaranteed wage minimum increases in July 2006 and January 2007 may also, if they are significant, appear as whitening effects on the basis of this method. That phenomenon raises problems if it is industry-specific and typically occurs in industries assumed to be whitening.

Speaking more generally, the sector-based method identifies any industry-specific wage shock of whitening industries, occurring during the forecast period, as whitening. Comparing its results with those of the other two methods, based on classification by labour force, may offer a solution to this problem. In the latter methods, the industry-specific shocks are spread out between the various labour force categories.

[1] The wage dynamics of presumably whitening industries may appear as explanatory variables in the regressions. That means that the forecast step must be simultaneously made. Each whitening industry has an estimated equation, used for the forecast. The forecasted values of the endogeneous explanatory variables (i.e. the wage dynamics of whitening industries with a specific equation) must appear at the forecast period. The fact, however, that these forecasts may depend on each other, represents a fixed-point problem to be solved through standard numerical methods. (See also footnote 7 of the Appendix.)

This is also true the other way round: labour force-specific but not whitening-related shocks may give rise to distortion in the labour force-based estimate, which, however, does not necessarily appear in the industry-based estimate. It is therefore worth comparing the results yielded by the various methods. If no significant difference is observed, one can claim that one's estimates do not erroneously identify as whitening wage shocks that are exclusively industry- or labour force category-specific and not due to whitening.

Industry-based estimates have been applied to the seasonally adjusted regular wages of the private sector, since these time series and the equations based on them are more stable than the full wage data. The method has been run on both monthly and quarterly data. The following industries have been assumed to be whitening: healthcare; other manufacturing industries; other services; construction industry; wood processing; paper manufacturing; publishing and printing; real property; economic services; trade; repair services; non-metal mineral products industry; transportation, warehousing, post and telecommunication; hospitality and catering.

3. Labour force-based methods

The KSH has been publishing wage and employment data by labour force categories of the private sector since 2003.[2] According to size, businesses are classified under the following labour force categories:

5-9 employees, 10-19 employees, 20-49 employees, 50-249 employees, 250-999 employees, over 1000- employees.

The initial idea of the following two methods to filter the whitening effect is based on the assumption that whitening is likely to have had a greater impact on smaller firms and therefore, by eliminating these through some method, one can arrive at the degree of the whitening effect. In the method described first, it is assumed a priori that the crucial part of whitening is attributable to businesses employing fewer than 20 workers. This ad hoc assumption is analogous with the selection of whitening industries under the sector-based method. For the second method, however, there is no need for such an a priori presumption.

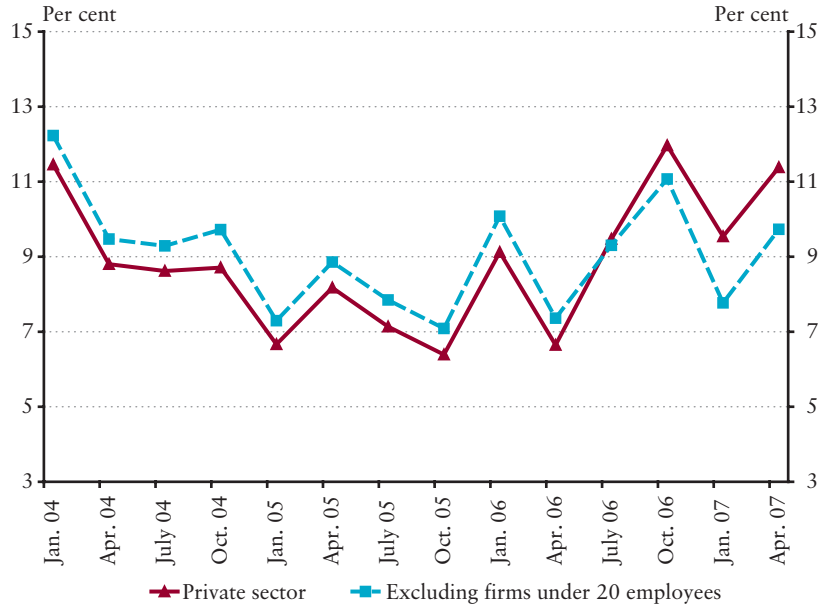
3.1. ESTIMATION OF THE WHITENING EFFECT BY ELIMINATING SMALL FIRMS

As the chart below reveals, the wage dynamics of the entire private sector has historically been lower than the wage dynamics of companies over 20 employees. The difference has remained more or less steady between the two rates of wage increase. Beginning in the third quarter of 2006, however, that historical correlation has been reversed.

Chart 3

Change in wages in the private sector

(Year/year rates of increase)



Why businesses under 20 employees?

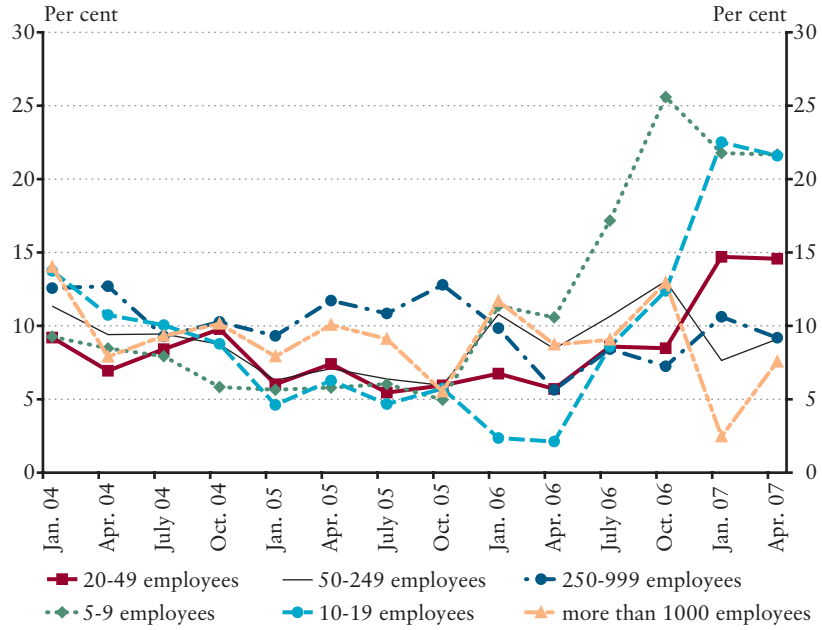
The next chart shows that the significant acceleration of wage dynamics has been observed since the third quarter of 2006 for firms with a labour force of 5 to 9 and 10 to 19. No similar phenomenon, or only to a negligible extent, has been observed for companies with a larger labour force.

[2] This means full payments, including bonuses.

Chart 4

Changes of wages in the various labour force categories

(Year/year rates of increase)



The estimation of the whitening effect.

On assessing the whitening effect, we have taken the following approach: the wage dynamics of firms with fewer than 20 employees has been adjusted back so that the difference between the wage dynamics for the entire private sector and among companies with over 20 employees should correspond to the historical mean.[3] The resulting year on year wage dynamics for the entire private sector have been multiplied by the wage level measured during the equivalent period of the previous year, which yielded the wage level adjusted for the whitening effect. The whitening factor is obtained as the ratio of the adjusted and the original wage levels.

While due to its nature, the method yields the lower estimate of the actual whitening factor (assessing a lower than actual effect), the result is still close to those of the other two methods (see below). That has confirmed the plausibility of our original assumption that small businesses have been the most affected by whitening.

It should also be noted that, in the sample, the employment of firms with fewer than 20 employees accounts for 19-22 percent of whole private sector. As mentioned above, in the industry-based method, the employment ratio of industries presumed to be whitening is over 50 percent. Apart from the similarity of the whitening estimates, that is another indication to the fact that the whitening of wages has not been universal, it has not affected all employees.

3.2. ESTIMATION OF THE WHITENING EFFECT BY WAGE DISTRIBUTION METHOD

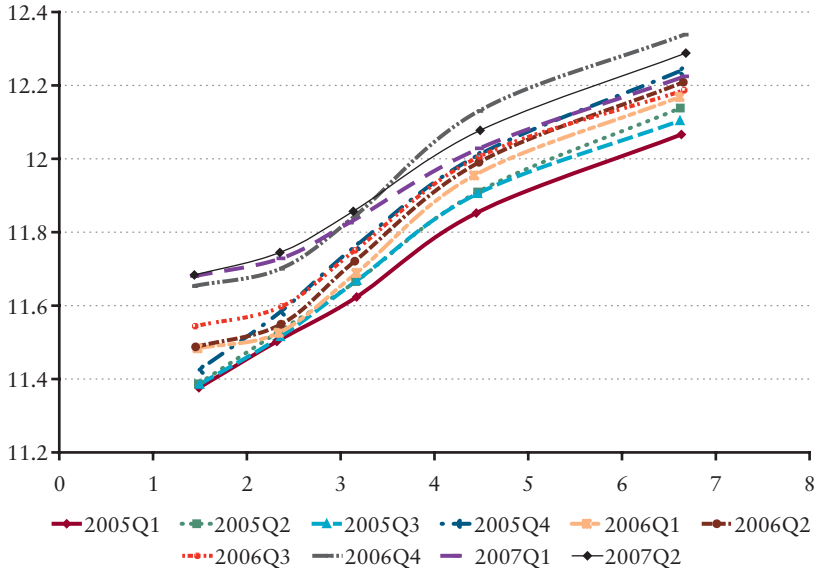
This process is based on the idea which says that the larger a business, the higher the average wages it pays. Therefore, on the basis of historical data you can estimate the effect of the average staff number on the average wage. In the event whitening has been substantial, one would expect that this correlation will have changed significantly since the third quarter of 2006 if not all labour force categories have been equally affected by whitening.

The above charts suggest that the impact of average staff numbers on the wages is not linear, i.e. the partial effect is smaller in larger company categories. However, the deflection of the earlier correlation is clearly visible during the whitening period, the difference being the most conspicuous in the lowest two labour force categories.

[3] The application of the historical mean is analogous with the running of regressions under the sector-based method. In more general terms, the same principle lies behind both methods, the difference depending on the basis of the classification of businesses (sector vs. staff number categories).

Chart 5

Correlation between average staff numbers and average wages from quarter to quarter
(Log-log scale)

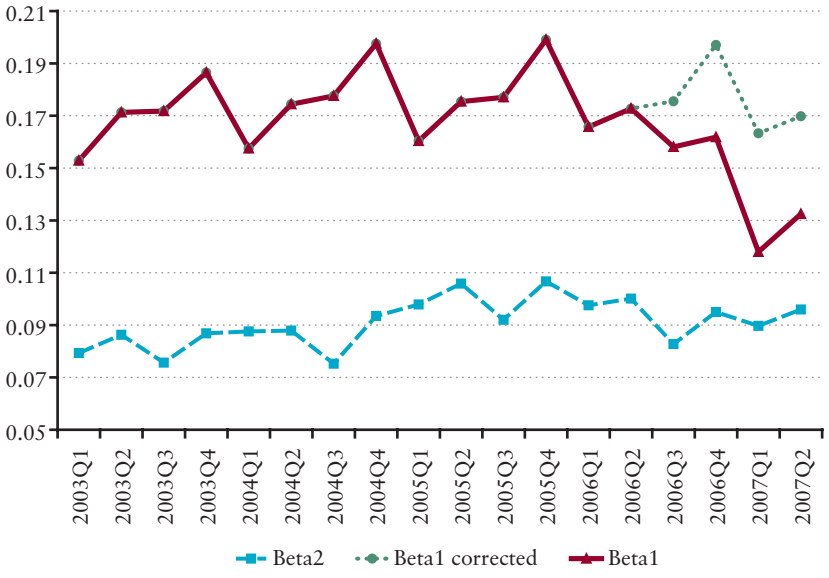


The estimation of the whitening effect

The following chart shows the partial impact on wages of the average staff number in the smaller and larger company categories (beta1 and beta2). The beta parameters are obtained by estimating a regression equation between the average staff number and the average wage for each quarter (see the Appendix). The steepness of the regression line does not appear to have changed significantly during the whitening period in the larger company categories, whereas there is a break during the period in question in the lower labour force categories.

Chart 6

Changes in the partial effect on average wages of the average staff numbers



Since the wage data have not been seasonally adjusted, seasonality also appears in the beta parameters. In order to calculate the whitening effect, a SARIMA (0 1 1)(0 1 0)4 model was used to forecast beta1 parameters for the 2006Q3-2007Q1 periods. This yielded the adjusted beta1 coefficients. Finally, the adjusted partial coefficients were used to calculate the hypothetical wages in the specific labour force categories if there had been no whitening. By weighting the labour force categories together, we obtained the adjusted wage level of the private sector. The whitening factor is obtained as the ratio of the adjusted and the original wage levels.

4. Results

The simplest way to compare the results yielded by the various methods is using the 'whitening factor'. As mentioned above, this is the ratio of the whitening-adjusted and the non-adjusted wage levels for a specific adjustment method. If, at any given moment, the method adjusts the wage index downward (i.e. it reveals an upward-distorting whitening effect), the whitening factor is below the 100-percent value. If continued whitening is revealed in the next period, the factor will be further decreased; otherwise it will remain stagnant.[4]

Chart 7

Whitening factors by the three adjustment methodologies

(Ratios of adjusted and non-adjusted wage levels in the private sector, based on quarterly data)

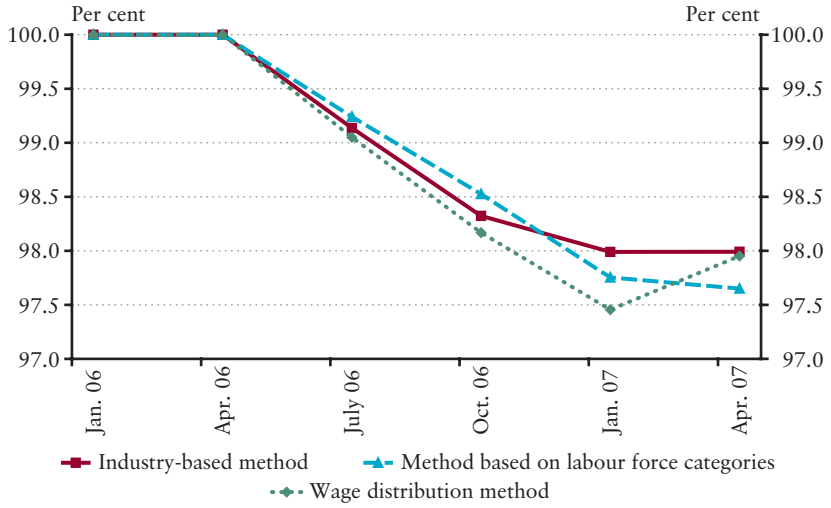
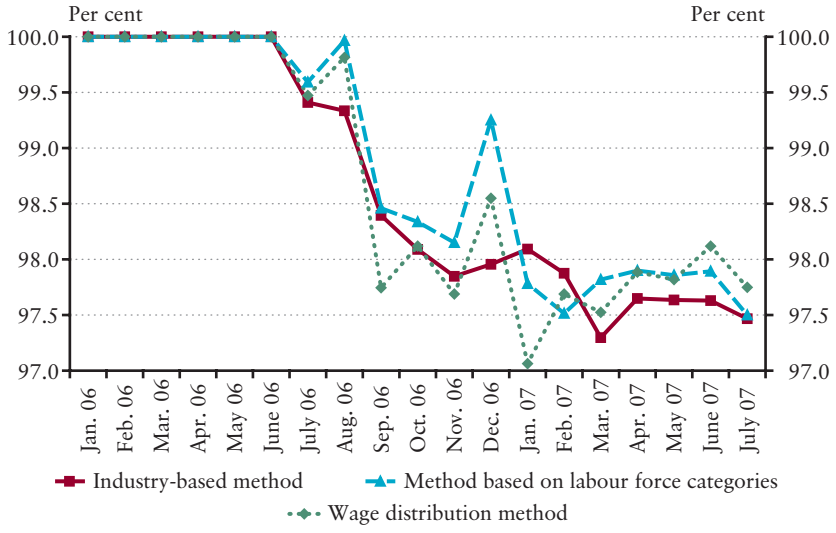


Chart 8

Whitening factors according to the three adjustment methodologies

(Ratios of adjusted and non-adjusted wage levels in the private sector, based on monthly data)



[4] Since the adjusted wage levels are estimates only, the factor is noisy too, even if the method does not reveal whitening. Stagnation is thus a noisy movement around a constant level.

The chart of quarterly factors shows that the three methods have identified a similar level of whitening in terms of both time-pattern and magnitude. Potential data distortion may have been more significant during the last two quarters of 2006. Following that period, the factor levels out. That means that the wage dynamics published by the KSH have, since early 2007, gradually approached the dynamics assumed to be 'real' by these methods. No further significant data distortion is then found during the second quarter.

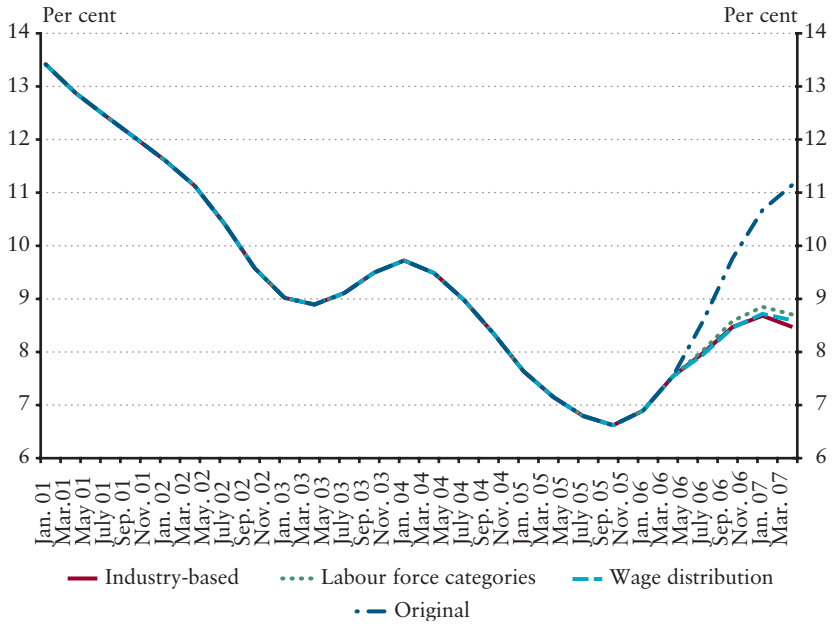
The same applies to monthly factors. Here, however, the time series are a lot more noisy, which is a natural phenomenon in one respect. From another aspect, there is particularly great noise at the labour force- and the distribution-based methods. Here, we had to rely on the seasonally not adjusted, full wage time series (including bonus payments). That explains the stragglers in December 2006, which are thus due to the higher-than-usual December bonus payments rather than to potential data distortion. The average correction typically results in a 1 to 3 percentage-points reduction in the annual wage dynamics. The similarity of the results yielded by different methods is an indication of the robustness of the adjustment.

It should also be noted that the forecasts published in our inflation reports are based on wages adjusted for whitening[5]. The actually published wage forecasts, however, include figures re-adjusted for whitening, i.e. consistent with the data published by the KSH (see the May report for example). To give an idea about magnitudes, in the August report, our forecasts for the annual average growth rates of the whitening-adjusted wage indices in the private sector were 8.1, 7.1 and 6.5 percent respectively for 2007, 2008 and 2009. The respective values re-adjusted for whitening are 9.7, 7.1 and 6.5 percent. As the whitening factors have tended to remain stable since the beginning of 2007 and no further whitening is assumed during the forecast period, in the 2008 and 2009 indices there is no difference between the whitening-adjusted and non-adjusted figures.

Chart 9

Wages in the private sector: original and adjusted time series

(Annual growth rates of the trends of seasonally adjusted, quarterly time series)



Note: The effect of the increase of the minimum wage has been eliminated from the time series and the, presumably temporary, change since mid-2006 in the seasonality of bonus payments has been adjusted.

[5] The fact that whitening has secondary cost-increasing effects is also taken into consideration.

5. Appendix

Industry-based method

In the industry-based method, the wage growth rate (y_i) of the i^{th} whitening industry is explained through a linear regression with a constant (μ_i), the wage growth rate of non-whitening industries (w^i) and the wage dynamics of the other whitening industries (y^{-i}):

$$y_{1,t} = \mu_1 + \beta'_{1,t} w_t + \beta'_{1,y} y^{-1}{}_t + \varepsilon_{1,t} + f_{1,t}$$
$$\vdots$$
$$y_{i,t} = \mu_i + \beta'_{i,w} w_t + \beta'_{i,y} y^{-i}{}_t + \varepsilon_{i,t} + f_{i,t}$$
$$\vdots$$
$$y_{I,t} = \mu_I + \beta'_{I,w} w_t + \beta'_{I,y} y^{-I}{}_t + \varepsilon_{I,t} + f_{I,t}$$

$$t = 2003.Q1, \ldots, 2007.Q2$$

The error terms are the ε's. The last term (f_i) of the equations represents whitening-related data distortion. Up to the second quarter of 2006 we have assumed its value to be zero whereas after that period it may be different. Based on the assumption, these terms can be disregarded for the assessment if the sample up to Q2 of 2006 is used. The constants include the parameters to be estimated and the pair of β parameter vectors in each equation. The forecast concerning the wage dynamics of whitening industries, based on the estimated parameter vector and the known wage dynamics of non-whitening industries constitutes the whitening-adjusted wage dynamics $(\hat{y}_{i,t})$:[6]

$$\hat{y}_{1,t} = \hat{\mu}_1 + \hat{\beta}'_{1,t} w_t + \hat{\beta}'_{1,y} \hat{y}^{-1}{}_t$$
$$\vdots$$
$$\hat{y}_{i,t} = \hat{\mu}_i + \hat{\beta}'_{i,w} w_t + \hat{\beta}'_{i,y} \hat{y}^{-i}{}_t$$
$$\vdots$$
$$\hat{y}_{I,t} = \hat{\mu}_I + \hat{\beta}'_{I,w} w_t + \hat{\beta}'_{I,y} \hat{y}^{-I}{}_t$$

$$t = 2006.Q3, 2006.Q4, \ldots$$

[6] Note that the vector containing the wage dynamics of all whitening industries, forecasted for the t^{th} time period $(\hat{y}_t)$, is the fixed point of the above system of equations.

The following table shows the specifications of the equations. The equations of two industries are presented for illustration.

Table 1

Variables in the equations for whitening industries

Explained variable (whitetning industry)	Explanatory variables	
	Non-whitetning industries	Whitening industries
Healthcare	fin.	transport
Other manufacturing	fin., text., agr.	
Other services	chem.	non-met., real est., faf.
Construction	electr.	ret., transport
Wood	mach.	other serv., real est.
Real estate	min., food, agr.	wood
Retail, repair	fin., mach.	health., other serv., transport
Non-metallic minerals	min.	wood
Transport	mach., met., educ.	
Hospitality and catering	chem., electr.	ret.

Each variable represents the simultaneous short-base (monthly or quarterly) growth rates of regular wages in the particular industry. Abbreviations: min.: mining; food.: food, beverage, tobacco; healthc.: healthcare; other serv.: other services; wood: wood, paper and printing industries; mach.: machine industry; real p.: real estate economic services; met.: metallurgy, metal-working; agr.: agriculture and fishery; non-met.: non-metallic minerals; edu.: education; fin.: financial activities; transport.: transportation, warehousing post and telecommunication; text.: textile, leather and footwear; chem.: chemical industry; electr.: electric energy, gas, vapour and water supply.

Table 2

Estimated equations of trade, repair services and real property economic services

Dependent Variable: KERJ
Method: Least Squares
Date: 09/10/07
Time: 15:22
Sample (adjusted): 2003Q2 2006Q2
Included observations: 13 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.041775	0.004303	9.707480	0.0000
EGS	-0.497396	0.089840	-5.536498	0.0009
EGYS	-0.312147	0.040234	-7.758291	0.0001
PENZ	-0.573882	0.071966	-7.974304	0.0001
GEP	0.439681	0.099586	4.415086	0.0031
SZALLR	-0.218932	0.068012	-3.218993	0.0147
R-squared	0.935433	Mean dependent var		0.017568
Adjusted R-squared	0.889313	S.D. dependent var		0.004701
S.E. of regression	0.001564	Akaike info criterion		-9.779096
Sum squared resid	1.71E-05	Schwarz criterion		-9.518350
Log likelihood	69.56413	F-statistic		20.28286
Durbin-Watson stat	2.242114	Prob(F-statistic)		0.000491

Table 2

Estimated equations of trade, repair services and real property economic services

Dependent Variable: ING
Method: Least Squares
Date: 09/10/07
Time: 15:22
Sample (adjusted): 2003Q2 2006Q2
Included observations: 13 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.009120	0.002158	-4.226139	0.0029
BANY	0.171970	0.033822	5.084514	0.0009
ELELM	-0.502584	0.122491	-4.103030	0.0034
FAF	0.723536	0.112380	6.438323	0.0002
MEZ	0.579327	0.108445	5.342116	0.0007

R-squared	0.955354	Mean dependent var	0.011497
Adjusted R-squared	0.933031	S.D. dependent var	0.013973
S.E. of regression	0.003616	Akaike info criterion	-8.123202
Sum squared resid	0.000105	Schwarz criterion	-7.905914
Log likelihood	57.80082	F-statistic	42.79711
Durbin-Watson stat	1.735743	Prob(F-statistic)	0.000019

Distribution-based method

In the wage distribution-based method, the logarithmized wage $(w^{i,t})$ of the i^{th} labour force category is explained through a linear regression whose variables include a constant (c_t) and the logarithm of the average labour force $(l_{i,t})$. Regression has been estimated for each t point of time.

$$w_{it} = c_t + (\beta_t + f_t)\, l_{it} + \varepsilon_{it}$$
$$t = 2003Q1, 2003Q2, \ldots, 2007Q2 \qquad (1)$$

Again, the symbol ε is used to mark the error terms, while f_t represents whitening-caused distortion. Up to the second quarter of 2006, we have assumed its value to be zero while it may be different afterwards. Thus equation (1) can be estimated without taking into account whitening-related distortion until Q2 of 2006. The time series between the first quarter of 2003 and the second quarter of 2006 of the estimated β_t parameters has been approximated by a SARIMA $(0\ 1\ 1)(0\ 1\ 0)_4$ process.[7] The values of the β_t parameter t=2006Q3, 2006Q4,.... have been derived as the forecasts of the equation (see the Beta1 time series in Chart 6[8]). Substituting these forecasts into equation (1) we obtain the wage distributions during the periods in question, whose expected values indicate the whitening-adjusted wage levels.

[7] $(1-L)(1-L^4)\beta_t = \mu + \eta_t + \theta\eta_{t-4}$, where η_t is the white noise, μ and θ are the parameters to be estimated and L is the delay operator.

[8] The estimates of the distribution-based method were performed using the lower four labour force categories. The Beta2 time series of Chart 6 shows the partial coefficients calculated on the basis of the other two labour force categories. The whitening adjustment was performed on the basis of the estimate according to Beta1.

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