companies' financial indicators was more often than a deterioration.

Further, we build models that explain the dependence of the financial perspective (dependent variable) on other perspectives (independent variables) within the framework of a socially oriented balanced scorecard.

Table 4

Correlation matrix of the socially oriented BSC perspectives

	Year	y	x1	x2	x3	x4
Year	1					
y	0.20	1				
x1	0.02	0.36	1			
x2	0.34	0.10	-0.31	1		
x3	0.26	0.09	-0.39	0.31	1	
x4	-0.02	0.50	0.14	-0.02	0.27	1

Source: Authors' own calculations

Figure 1 shows the results of building a simple linear regression that does not consider the panel data structure. This model is the simplest one and it serves as a starting point for analyzing the effectiveness of more complex models [3; 4].

Since all independent variables' values in the model above are normalized, we can consider their coefficients as indicators of the variables' importance. In Figure 1 it appears that coefficients for variables x_1 (learning and growth perspective) and x_4 (relational perspective) are the biggest. This corresponds to conclusions from the correlation analysis.

```
. reg y x1 x2 x3 x4
      Source |       SS           df       MS      Number of obs   =        36
-------------+----------------------------------   F(4, 31)        =      4.76
       Model |  .480091754         4  .120022939   Prob > F        =    0.0041
    Residual |  .780857709        31  .025188958   R-squared       =    0.3807
-------------+----------------------------------   Adj R-squared   =    0.3008
       Total |  1.26094946        35  .036027128   Root MSE        =    .15871

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .7563137   .3194356     2.37   0.024     .1048205    1.407807
          x2 |   .2585708   .1889066     1.37   0.181    -.1267067    .6438483
          x3 |   .0683021   .1977671     0.35   0.732    -.3350465    .4716508
          x4 |   .7255388   .2577642     2.81   0.008     .1998251    1.251252
       _cons |  -.4647725   .2386754    -1.95   0.061    -.9515543    .0220092
------------------------------------------------------------------------------
```

Fig. 1. Simple linear regression model parameters

Source: Authors' own calculations in STATA

The R^2 coefficient of determination is the main indicator of regression model quality. In Figure 1 it is designated "R-squared" due to peculiarities of the applied statistical analysis software STATA. The R^2 value of 0,3807 means that the proportion of the variance for a dependent variable (financial perspective) is explained by independent variables in a regression model by 38,07%. This is a rather low result. Building models, which consider the panel data structure, can improve it.

First, it is necessary to determine which of the panel regression models either fixed effects, or random effects is preferable in the case under consideration. We analyze this in terms of the sample ratio and the general population.

Below we consider the procedure for choosing between fixed and random effects models based on the Hausman test. For this purpose, we calculate the parameters of fixed effects panel regression (Figure 2), random effects panel regression (Figure 3), and the Hausman test (Figure 4).

The Hausman test allows us to test the plausibility of a hypothesis that deviations u_c (expression 8) can be considered as random effects, with the alternative hypothesis that they are fixed effects.

The calculated p value estimated at a significance level of 0.05 is the result. If the p value is less than 0.05, we reject the null hypothesis and conclude the need to consider observed deviations as fixed effects. Since *Prob> chi2 = 0.030 70* in Figure 4, we should reject the random effects hypothesis and consider a fixed effects model.

Building such a model is in the same manner as a linear regression except one. Dummy variables are additionally introduced into the model. Their number corresponds to the panels' number. These variables take on the value 1 for one specific "own" panel and 0 in all other cases.

```
. xtreg y x1 x2 x3 x4, fe

Fixed-effects (within) regression               Number of obs      =        36
Group variable: c                               Number of groups   =         4

R-sq:                                           Obs per group:
     within  = 0.4112                                         min =          9
     between = 0.4452                                         avg =        9.0
     overall = 0.1807                                         max =          9

                                                F(4,28)            =      4.89
corr(u_i, Xb)  = -0.2824                        Prob > F           =    0.0041

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.0569368   .4032257    -0.14   0.889    -.8829073    .7690336
          x2 |  -.0815518   .2380159    -0.34   0.734    -.5691053    .4060016
          x3 |   .2556021   .2029501     1.26   0.218    -.1601224    .6713265
          x4 |   .8547307   .2422505     3.53   0.001     .3585031    1.350958
       _cons |  -.0667149   .2573238    -0.26   0.797    -.5938188     .460389
-------------+----------------------------------------------------------------
     sigma_u |  .13531824
     sigma_e |  .14369428
         rho |  .47000674   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(3, 28) = 3.27                       Prob > F = 0.0357

. estimates store sh_fe
```

Fig. 2. Fixed effects panel regression parameters

Source: Authors' own calculations in STATA

```
. xtreg y x1 x2 x3 x4, re

Random-effects GLS regression                   Number of obs     =         36
Group variable: c                               Number of groups  =          4

R-sq:                                           Obs per group:
     within  = 0.3060                                         min =          9
     between = 0.8745                                         avg =        9.0
     overall = 0.3807                                         max =          9

                                                Wald chi2(4)      =      19.06
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0008

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .7563137   .3194356     2.37   0.018     .1302315    1.382396
          x2 |   .2585708   .1889066     1.37   0.171    -.1116793    .6288209
          x3 |   .0683021   .1977671     0.35   0.730    -.3193142    .4559185
          x4 |   .7255388   .2577642     2.81   0.005     .2203301    1.230747
       _cons |  -.4647725   .2386754    -1.95   0.051    -.9325678    .0030227
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .14369428
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store sh_re
```

Fig. 3. Random effects panel regression parameters

Source: Authors' own calculations in STATA

```
. hausman sh_fe sh_re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     sh_fe        sh_re        Difference          S.E.
-------------+----------------------------------------------------------------
          x1 |   -.0569368     .7563137       -.8132506        .2460729
          x2 |   -.0815518     .2585708       -.3401227         .144796
          x3 |    .2556021     .0683021           .1873        .0455733
          x4 |    .8547307     .7255388         .129192               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       10.66
                Prob>chi2 =      0.0307
                (V_b-V_B is not positive definite)
```

Fig. 4. Hausman test to compare fixed vs random effects panel regression

Source: Authors' own calculations in STATA

In the case, four data panels correspond to the number of companies under research. Therefore, we should introduce four dummy variables: *i* – Ilyich Iron & Steel Works; *a* – Azovstal Iron and Steel Works; *mi* – Metinvest Group; *am* – ArcelorMittal Kryvyi Rih.

Figure 5 shows the results of building a fixed effects panel regression model.

```
. reg y x1 x2 x3 x4 i az mi am
note: am omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =        36
-------------+----------------------------------   F(7, 28)        =      4.72
       Model |  .682804161         7  .097543452   Prob > F        =    0.0013
    Residual |  .578145302        28  .020648046   R-squared       =    0.5415
-------------+----------------------------------   Adj R-squared   =    0.4269
       Total |  1.26094946        35  .036027128   Root MSE        =    .14369

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.0569368   .4032257    -0.14   0.889    -.8829073    .7690336
          x2 |  -.0815518   .2380159    -0.34   0.734    -.5691053    .4060016
          x3 |   .2556021   .2029501     1.26   0.218    -.1601224    .6713265
          x4 |   .8547307   .2422505     3.53   0.001     .3585031    1.350958
           i |  -.2880912   .0989879    -2.91   0.007    -.4908587   -.0853236
          az |  -.2832743   .1121061    -2.53   0.017    -.5129133   -.0536352
          mi |  -.2165762   .0990564    -2.19   0.037     -.419484   -.0136684
          am |          0  (omitted)
       _cons |   .1302705   .2951979     0.44   0.662     -.474415     .734956
------------------------------------------------------------------------------
```

Fig. 5. Fixed effects panel regression model parameters

Source: Authors' own calculations in STATA

As follows from Figure 5, considering fixed effects made it possible to improve the R^2 coefficient of determination value from 0.3807 to 0.5415 for the simple linear regression model. This means that proportion of the variance for a dependent variable (financial perspective) is explained by 54,15% by the model, which is a statistically significant result. It should be noted that after fixed effects adjustment with dummy variables coefficients, coefficients of independent variables changed significantly compared to simple linear regression model.

For ease of comparison, Table 5 summarizes these coefficients from Figures 4, 5 and calculations of their change.

Table 5
Independent variables coefficients of different types of regression models

Independent variables coefficients	Simple linear regression model	Fixed effects regression model	Δβ	Growth rate β
Learning and growth perspective (β1)	0,76	-0,06	-0,81	-107,5%
Environmental perspective (β2)	0,26	-0,08	-0,34	-131,5%
Internal process perspective (β3)	0,07	0,26	0,19	274,2%
Relational perspective (β4)	0,73	0,85	0,13	17,8%

Source: Authors' own calculations

Table. 5 shows that the coefficient of the variable "relational perspective" changes the least. Moreover, its importance has grown, which indicates a high degree of relationship between this perspective and company financial results.

The coefficient value of the variable "learning and growth perspective", which was the highest in the simple linear regression model, after fixed effects adjustment significantly decreases and even becomes negative. Thus, the analysis shows that this perspective is not strongly related with the financial one.

The coefficient value of the variable "ecological perspective" also significantly decreases and goes negative.

However, according to the table 5, there is an increase in the coefficient of the variable "perspective of internal processes". This variable is ranked second in importance in the fixed effects panel regression modeling.

The research has revealed a strong and statistically significant relationship between the relational perspective and company financial results in the socially oriented balanced scorecard. This means that the costs for creating and maintaining a positive image of metallurgical companies are fully justified by improving their bottom line. In addition, initiatives to improve the perspective of internal processes are of great importance, that is, investments in labor protection, industrial safety, and energy conservation.

5 Conclusion

Determining the impact of socially responsible initiatives on the company financial performance is an important factor in introducing the concept of strategic corporate social responsibility management into the corporate governance system.

Based on the proposed methodology for assessing the impact of corporate social responsibility on corporate financial indicators, this paper analyzes the relationship between socially oriented and financial perspectives within the framework of a socially oriented BSC. The research methodology includes correlation and regression analysis with panel data techniques for a sample of four dominant market participants in the Ukrainian metallurgy: PJSC Azovstal Iron and Steel Works, PJSC Ilyich Iron & Steel Works (MMKI), PJSC ArcelorMittal Kryvyi Rih (AMKR), and Metinvest Group.

The results of building linear and panel regression models with fixed and random effects are given. Considering panel effects made it possible to obtain more accurate estimates of coefficients for the regression model's independent variables compared to simple linear regression model.

The research has revealed a strong and statistically significant relationship between the relational perspective and company financial results in the socially oriented balanced scorecard. The relational perspective characterizes the level of satisfaction of various stakeholder groups with the company activities in the field of corporate social responsibility.

The research has made its contribution to confirm the importance of implementing corporate social responsibility programs and projects as a factor improving not only the company's image, but also the bottom line. In the long term, this leads to sustainable business development and the competitiveness growth.

The statistical methods are the main in the proposed methodology for assessing the impact of corporate social responsibility on corporate financial indicators because they are most fully documented in terms of assessing the reliability of results. Future research directions are comparing the effectiveness of statistical methods with alternative methods, e.g. data mining techniques, in terms of forecasting accuracy.

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