

Hüttner, Frank; Sunder, Marco

**Working Paper**

## Decomposing R2 with the Owen value

Working Paper, No. 100

**Provided in Cooperation with:**

University of Leipzig, Faculty of Economics and Management Science

*Suggested Citation:* Hüttner, Frank; Sunder, Marco (2011) : Decomposing R2 with the Owen value, Working Paper, No. 100, Universität Leipzig, Wirtschaftswissenschaftliche Fakultät, Leipzig

This Version is available at:

<https://hdl.handle.net/10419/52301>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

UNIVERSITÄT LEIPZIG

**Wirtschaftswissenschaftliche Fakultät**  
**Faculty of Economics and Management Science**

Working Paper, No. 100

Frank Hüttner /  
Marco Sunder

**Decomposing R<sup>2</sup> with the  
Owen value**

Oktober 2011

ISSN 1437-9384

# Decomposing $R^2$ with the Owen value

Frank Huettner  
*fhuettner@wifa.uni-leipzig.de*

Marco Sunder  
*sunder@wifa.uni-leipzig.de*

October 14, 2011

## Abstract

We provide an axiomatization-based justification for applying the Owen value to decompose  $R^2$  in OLS models if prior knowledge can be used to form groups of regressor variables. The assumptions made by the axioms are not only plausible with respect to the variables but also clarify the meaning of the exogenous grouping of variables.

**Keywords:** Shapley value, Owen value, OLS, variance decomposition, German Socio-Economic Panel

**JEL classification:** C20

**Word count:** 3453

## 1 Introduction

The Shapley (1953) value can be used to decompose goodness-of-fit measures of regression models—such as  $R^2$ —into contributions of individual regressor variables (Chevan and Sutherland, 1991; Johnson and LeBreton, 2004). In many practical applications there are good reasons to think in terms of groups of regressors if they represent similar explanatory concepts, e.g. a polynomial in labor market experience, dummy variables created from a categorical variable, or savings and investment rates in a growth model. In such situations, it is desirable to decompose the model's  $R^2$  into contributions of groups and—if of interest—to allocate each group's share to its constituent variables. The Owen (1977) value provides an obvious candidate for a decomposition procedure incorporating exogenously defined groups (Shorrocks, 1999).

An obstacle to wide-spread application of  $R^2$  decomposition in applied work may have been confusion about the implied assumptions. We argue that the Owen value  $R^2$  decomposition arises under very mild and plausible assumptions. It is also attractive in many practical settings inasmuch as it usually allows for models with more regressor variables if not all groups contain only a single variable. If all groups are singletons, though, the Owen value coincides with the Shapley value. Thus, the proposed procedure can be regarded as a generalization of the Shapley value  $R^2$  decomposition. After a presentation of the method and its theoretical underpinnings, we provide an illustrative example for a wage regression with German data.

## 2 Method

Let  $K = \{1, \dots, j, \dots, k\}$  denote the set of explanatory variables or—in the language of game theory—the set of players. With the interpretation mentioned in the introduction, we may group the variables and obtain the partition  $\mathcal{G} = \{G_1, \dots, G_\ell, \dots, G_\gamma\}$ . Estimation of the full OLS model

$$y = \beta_0 + \underbrace{\beta_1 x_1 + \dots + \dots}_{G_1} + \dots + \underbrace{\dots + \beta_j x_j + \dots + \dots}_{G_\ell} + \dots + \underbrace{\dots + \beta_k x_k}_{G_\gamma} + \varepsilon$$

gives the  $R^2(K)$  to be distributed. To this end, running a regression for every combination of variables  $T \subseteq K$  and the resulting  $R^2(T)$  will be considered. Since a regression without any variable but the intercept yields zero explained variance, we face a so-called cooperative game with transferable utility and a coalition structure (CS-game) with player set  $K$ , coalition function  $R^2 : \mathbf{2}^K \rightarrow \mathbb{R}$ ,  $R^2(\emptyset) = 0$ , where  $\mathbf{2}^K$  denotes the power set of  $K$ , and coalition structure  $\mathcal{G}$ .

A solution concept  $\phi$  prescribes for any given  $(K, R^2, \mathcal{G})$  the variables' payoffs, i.e. it assigns to every CS-game a vector  $\phi(K, R^2, \mathcal{G}) \in \mathbb{R}^K$  where  $\phi_j(K, R^2, \mathcal{G})$  is interpreted as variable  $j$ 's payoffs. Note, a solution  $\phi$  does not attribute a value to the group; however, summing up the variables' payoffs in a group,  $\sum_{j \in G_\ell} \phi_j(K, R^2, \mathcal{G})$ , can describe the group's payoff.

A CS-game  $(K, R^2, \mathcal{G})$  induces a game played between the groups. It is called the external game and is denoted by  $(\mathcal{G}, R_{\mathcal{G}}^2)$ , where the coalition function assigns to every set of groups  $\Upsilon \subseteq \mathcal{G}$  its worth via  $R_{\mathcal{G}}^2(\Upsilon) = R^2(\cup_{G_\ell \in \Upsilon} G_\ell)$ , i.e.  $R_{\mathcal{G}}^2(\Upsilon)$  is the  $R^2$  obtained from estimation of the OLS model

$$y = \beta_0 + \sum_{G_\ell \in \Upsilon} \sum_{j \in G_\ell} \beta_j x_j + \varepsilon.$$

### 2.1 Owen value $R^2$ decomposition

The Owen value is well-suited for a decomposition of  $R^2(K)$  of the full model because of its characteristic properties and because it is the consistent extension of the Shapley value.

#### 2.1.1 Axiomatic argument for the Owen value $R^2$ decomposition

Allocation of  $R^2$  to (groups of) variables has to involve certain assumptions. In the following, we impose four assumptions that we regard as plausible.

**Efficiency:** The full model  $R^2$  is decomposed among the variables, i.e.  $\sum_{j \in K} \phi_j(K, R^2, \mathcal{G}) = R^2(K)$ .

**Symmetry within groups:** If  $j'$  and  $j''$  are substitutes according to their explanatory power and belong to the same group, they obtain equal value, i.e.,

$$R^2(T \cup \{j'\}) = R^2(T \cup \{j''\}) \text{ for all } T \subseteq K \setminus \{j', j''\}$$

and  $j', j'' \in G_\ell$  implies  $\varphi_{j'}(K, R^2, \mathcal{G}) = \varphi_{j''}(K, R^2, \mathcal{G})$ .

Note that this symmetry condition ensures that symmetric players cannot be distinguished on the grounds of their group affiliation.

**Symmetry between groups:** If  $G_{\ell'}$  and  $G_{\ell''}$  are substitutes according to their explanatory power, they obtain equal valuation, i.e.,

$$R_{\mathcal{G}}^2(\Upsilon \cup \{G_{\ell'}\}) = R_{\mathcal{G}}^2(\Upsilon \cup \{G_{\ell''}\}) \text{ for all } \Upsilon \subseteq K \setminus \{G_{\ell'}, G_{\ell''}\}$$

implies  $\sum_{j' \in G'} \varphi_{j'}(K, R^2, \mathcal{G}) = \sum_{j'' \in G''} \varphi_{j''}(K, R^2, \mathcal{G})$ .

That is to say that one abstracts from the number of variables in a group and raises groups on an equal level. If, e.g., a long list of grouped dummy variables has the same predictive power as a single variable group, the dummies in total receive the same share as the single variable.

**Monotonicity:** A change of the observations that leads to new coefficients of determination  $\tilde{R}^2$  such that variable  $j$  exhibits higher marginal contributions, must not decrease the explanatory value attributed to variable  $j$ , i.e.,

$$\tilde{R}^2(T \cup \{j\}) - \tilde{R}^2(T \cup \{j\}) \geq R^2(T \cup \{j\}) - R^2(T \cup \{j\}) \text{ for all } T \subseteq K \setminus \{j\}$$

implies  $\phi_j(K, \tilde{R}^2, \mathcal{G}) \geq \phi_j(K, R^2, \mathcal{G})$ .

For practical purposes, this condition introduces a kind of merit principle: variables with higher marginal contributions receive a higher payoff.

**Theorem 1 (Khmelnitskaya and Yanovskaya, 2007)** *The Owen value satisfies efficiency, symmetry within groups, symmetry between groups, and monotonicity.*<sup>1</sup>

The theorem employs axioms that refer to the abstract groups only for symmetry conditions. In contrast, the powerful monotonicity condition refers directly to the variables.

### 2.1.2 Relation to the axioms characterizing the Shapley value

The Shapley value is promoted in the literature to be applied for decomposing the  $R^2$  if the variables are ungrouped. Indeed, the model and the characterization above

<sup>1</sup>In the more general class of CS-games, the Owen value is actually the only value that satisfies these conditions.

generalize the Shapley value  $R^2$  decomposition in the sense that if  $\mathcal{G}$  is the atomistic partition or consists of only one group—i.e. if the variables cannot be distinguished with respect to  $\mathcal{G}$ —, the framework above captures the ungrouped situation. Moreover, in this case the Owen value  $R^2$  decomposition equals the Shapley value  $R^2$  decomposition. To see this, adapt the efficiency and monotonicity properties above to the case where no coalition structure  $\mathcal{G}$  exists. Further, the symmetry conditions above must be replaced by the following property, and the previous theorem unfolds as a generalization of the well-known result of Young (1985).

**Symmetry:** If variables  $j'$  and  $j''$  are substitutes according to their explanatory power, they obtain equal value, i.e.,

$$R^2 (T \cup \{j'\}) = R^2 (T \cup \{j''\}) \text{ for all } T \subseteq K \setminus \{j', j''\}$$

implies  $\phi_{j'} (K, R^2) = \phi_{j''} (K, R^2)$ .

**Corollary 2** *The Shapley value satisfies efficiency, symmetry, and monotonicity.*

## 2.2 Formulas for the Shapley value and the Owen value

In addition to the theorem above, it is useful to develop an intuition about what drives the solutions. We therefore provide both, intuitive formulas referring to marginal contributions and those used for computation.

### 2.2.1 Calculation of the Shapley value

We want to consider permutations of  $K$ , i.e. bijective mappings  $\pi : K \rightarrow \{1, \dots, |K|\}$  where  $\pi(j)$  is interpreted as the position of player  $j$  in  $\pi$ . The set of all  $k!$  permutations on  $K$  is referred to by  $\Pi(K)$ . For a given  $\pi$ , the predecessors of player  $j$  form a set denoted by  $P_j^\pi = \{j' \mid \pi(j') < \pi(j)\}$ . A player  $j$ 's marginal contribution (if players are ordered according to  $\pi \in \Pi(K)$ ) is given by  $R^2 (P_j^\pi \cup \{j\}) - R^2 (P_j^\pi)$ , and the Shapley value can be calculated from

$$Sh_j (K, R^2) = \frac{1}{k!} \sum_{\pi \in \Pi(K)} R^2 (P_j^\pi \cup \{j\}) - R^2 (P_j^\pi) .$$

Note that the Shapley value does not account for a partition. Further, if player  $j$  is a Null player, i.e. if  $R^2 (T \cup \{j\}) - R^2 (T) = 0$  for all  $T \subseteq K \setminus \{j\}$ , we have  $Sh_j (K, R^2) = 0$ .

For the actual computation we use the so-called potential function (Hart and Mas-Colell, 1989), defined recursively by  $f(T) = R^2(T) / |T| + \sum_{j \in T} f(T \setminus \{j\}) / |T|$  and  $f(\emptyset) = 0$  since  $f(K) - f(K \setminus \{j\}) = Sh_j(K, R^2)$ . Calculation of the Shapley value this way avoids employing  $k!$  permutations. For faster computation, we obtain  $R^2(T)$  from

the covariance matrix of the data rather than from the original observations (Grömping, 2006, p. 13).

### 2.2.2 Groups, the Owen value, and the Shapley value

We present two approaches to the Owen value, the first of which applies permutations. We say that a permutation  $\pi$  is compatible with respect to the partition  $\mathcal{G}$  if each group's members appear contiguously in the permutation with no player from another group in between, i.e. for  $j, l \in G_\ell \in \mathcal{G}$  we have  $\pi(j) \leq \pi(k) \leq \pi(l)$  implies  $k \in G_\ell$ . Let  $\Pi(K, \mathcal{G})$  denote the set of all permutations on  $K$  that are compatible with  $\mathcal{G}$ . The Owen value can be obtained from

$$Ow_j(K, R^2, \mathcal{G}) = \frac{1}{|\Pi(K, \mathcal{G})|} \sum_{\pi \in \Pi(K, \mathcal{G})} R^2(P_j^\pi) - R^2(P_j^\pi \setminus \{j\}).$$

In words, variable  $j$ 's marginal contribution to explanatory value does only count if the groups to which  $j$  does not belong to are either completely present or completely absent.

Second, departing from the Shapley value, one may derive the Owen value as follows. If all variables constitute groups of their own such that  $\mathcal{G} = \{\{1\}, \dots, \{j\}, \dots, \{k\}\}$ , then each group should be treated as if it were a variable. In general, the distribution of  $R^2(K)$  among the groups by using the Shapley value on the external game  $(\mathcal{G}, R_{\mathcal{G}}^2)$  suggests itself (one may ignore the partition whenever applying the Shapley value). It remains to allocate group  $G_\ell$ 's payoff  $Sh_{G_\ell}(\mathcal{G}, R_{\mathcal{G}}^2)$  among the variables in  $G_\ell$ .

Consider the case when all variables belong to one group,  $G_\ell = K$  and  $\mathcal{G} = \{G_\ell\}$ . It is desirable to have the same procedure within  $G_\ell$  as if there was no grouping. For that, denote for every subgroup  $C \subseteq G_\ell$  the value of that subgroup by  $r^2(C)$ . Then apply the Shapley value on the resulting internal game  $(G_\ell, r^2)$ . If all variables are in  $G_\ell$ , we have  $r^2(C) = R^2(C)$  and observe  $Sh_j(G_\ell, r^2) = Sh_j(K, R^2)$ .

Finally, if  $G_\ell$  consists of some but not all variables, a consistent definition of the internal game  $(G_\ell, r^2)$  calls for a reasonable prescription of the worth  $r^2(C)$ . This can be achieved as follows: Let  $C$  participate in the game between groups instead of  $G_\ell$  and determine its Shapley value, i.e. with  $\mathcal{G}' = (\mathcal{G} \setminus \{G_\ell\}) \cup \{C\}$  we have  $r^2(C) = Sh_C(\mathcal{G}', R_{\mathcal{G}'}^2)$ . Application of the Shapley value on the resulting internal game yields the Owen value, i.e. for  $j \in G_\ell$  we have

$$Ow_j(K, R^2, \mathcal{G}) = Sh_j(G_\ell, r^2).$$

Note that as a consequence of this setup, the payoffs of the variables of a particular group sum up to the Shapley value from the external game of the respective group, i.e. we have  $\sum_{j \in G_\ell} Ow_j(K, R^2, \mathcal{G}) = Sh_{G_\ell}(\mathcal{G}, R_{\mathcal{G}}^2)$ .

### 3 Application to German wage data

As an illustration of the method we estimate an augmented Mincer regression model for male workers in Germany. Our focus is on the importance of human capital measures on wages. We use data from the 2006 wave of the German Socio-Economic Panel (GSOEP), which features a symbol-digit correspondence test (SCT) for those participants who took the CAPI interview (Wagner et al., 2007; Lang, 2005).<sup>2</sup> The outcome of this test reflects, to a certain degree, innate cognitive abilities, and these could be regarded as important for an individual’s work productivity. To simplify interpretation, we rescale SCT such that it varies between 0 (lowest score) and 1 (highest score). The other human capital variables we consider are years of schooling (EDUC), actual years of work experience (EXPER), and years of employment at the current firm (TENURE).<sup>3</sup> Apart from human capital, we consider whether a man is married (yes/no), the size of the firm (4 categories), industry codes (7 categories), and regions within Germany (15 categories).<sup>4</sup> The dependent variable is the natural logarithm of hourly earnings. We restrict the sample to male German citizens, aged 20–64 years, who worked for at least 10 hours per week, were not self-employed, and not disabled. This leaves us with 850 observations with valid data.

The overall  $R^2$  of our model is 0.497 (Table 1). More than half (55.9%) of this result—or 28% of the entire variation in log wages—can be attributed to the human capital variables in the model, whereas the second-largest group, regional disparity, accounts for only one sixth of the explained variance. Further decomposition of the  $R^2$  share of human capital reveals that the main effect of EDUC is the single most “important” variable, with a 22% share of the overall  $R^2$ . A similar magnitude is achieved by the labor market and firm experience variables, though, if we sum up their respective Owen value shares (22.8%). Despite its “large” coefficient and statistical significance, the main effect of cognitive ability does not turn out to be very important in terms of explanatory power. Its interaction term with EDUC, however, contributes 8.1% of the model’s  $R^2$ . The coefficients imply that up to about 16 years of schooling, greater cognitive abilities result in higher earnings.<sup>5</sup>

Calculating confidence intervals for our results is a computationally tedious task, since we rely on the bootstrap method. Figure 1 presents confidence intervals for the absolute group or Owen values (without standardizing by  $R^2$ ), on the basis of 2000

---

<sup>2</sup>See Anger and Heineck (2010) for a more detailed analysis of wages and SCT based on the GSOEP and Isreali (2007) for a decomposition analysis for a wage regression model.

<sup>3</sup>EDUC is measured as years of schooling that would be necessary to achieve the person’s highest school or college degree, irrespective of how long it actually took.

<sup>4</sup>The regions are equivalent to German *Laender* (NUTS 1) with the exception of Rhineland-Palatinate and Saarland, which are one region in the GSOEP.

<sup>5</sup>Measurement error in our indicator of cognitive ability could be responsible for relatively low predictive power. Suffice to say, measurement error is a general problem in empirical work, not only when decomposing goodness of fit.



Table 1: Wage regression results

Group / regressor	Coef.	$R^2$ decomposition (%)	
		Group	Owen
Human capital	(6 variables)**	55.9	
SCT	0.783*		3.0
SCT $\times$ EDUC	-0.050*		8.1
EDUC	0.104**		22.0
EXPER	0.031**		8.1
(EXPER) <sup>2</sup> /100	-0.053**		4.9
TENURE	0.008**		9.8
Married	0.083**	6.1	
Firm size	(3 dummies)**	15.7	
Industry	(6 dummies)**	5.8	
Region	(14 dummies)**	16.6	
Intercept	0.527*		
Observations	850		
Overall $R^2$	0.497		

*Remarks:* \*/\*\* denotes statistical significance at the 10% / 5% level for individual variables (t-test) or groups of dummy variables (F-test), based on the heteroscedasticity-robust covariance matrix.

bootstrap replications.<sup>6</sup> With 90% confidence we find that between one quarter and about one third of the entire variation in log wages can be attributed to human capital.

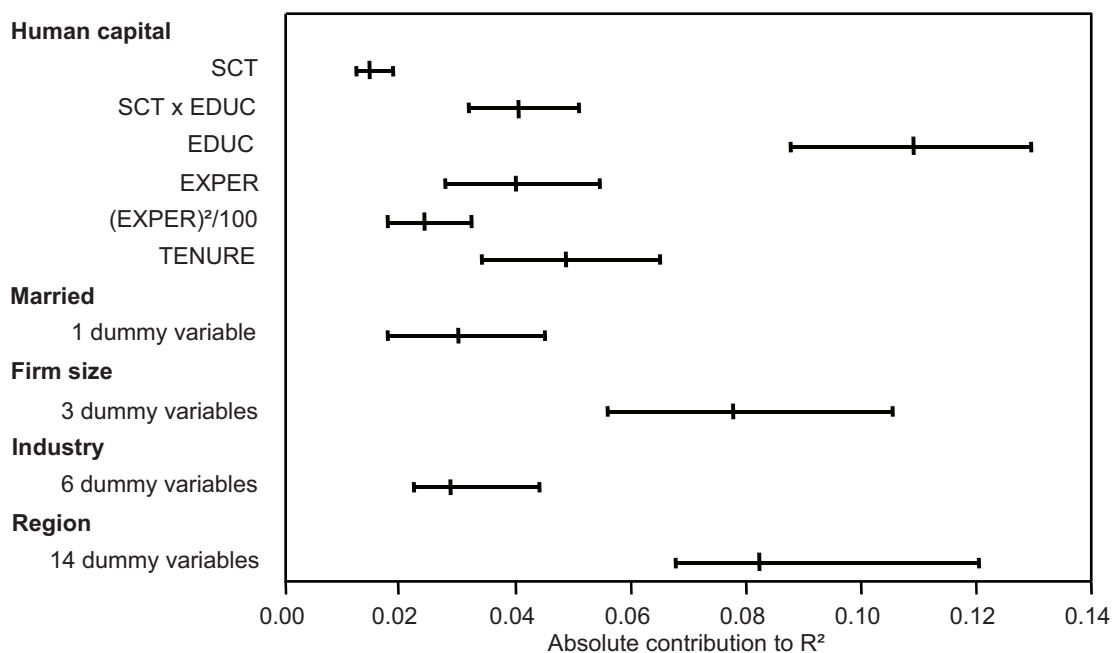
## 4 Concluding remarks

Decomposition of goodness-of-fit can be an attractive diagnostic tool for the identification of important (groups of) explanatory variables in a given model. Unlike statistical significance,  $R^2$  is not a function of the number of observations. Another practical application could consist in the judgment of the value of control variables in the context of survey design, if preliminary data already exist and if data collection is costly.

Both the Shapley and the Owen value reflect average marginal contribution to  $R^2$ . As such, a non-zero value may be assigned even to a variable that exhibits a zero coefficient in the full model. Compared to calculation of the Shapley value for each variable, decomposition based on the Owen value comes at lower computational cost if prior knowledge on the grouping of regressors can be exploited.

<sup>6</sup>Using the software Stata 11.2 (StataCorp, 2009), this bootstrap exercise required about 7<sup>1</sup>/<sub>2</sub> minutes on a desktop PC, whereas estimation of the values in Table 1 only took <sup>1</sup>/<sub>4</sub> second. A user-written program and a syntax file to replicate the results is available upon request from the authors.

Figure 1: Decomposition results with 90% bootstrap confidence intervals



Remarks: Based on 2000 bootstrap replications. Confidence interval for “human capital” group: [0.246; 0.313].

While the present procedure is confined to the case of linear models with independent observations and simple partitions, several extensions can be conceived. First, groups could be further disaggregated, giving rise to level structures (Winter, 1989). For instance, labor market experience and its squared term could form an intermediate group in our application. Second, the model could allow for unit-specific fixed effects that control for time-invariant unobserved heterogeneity, so that only the “within- $R^2$ ” is decomposed. Third, the method could be applied to non-linear models estimated by the maximum likelihood method, admittedly at a much higher computational burden. In this case the likelihood ratio test statistic could be allocated across explanatory entities.

## Acknowledgments

We thank André Casajus and Bastian Gawellek for helpful comments on an earlier version of the paper.

## References

Anger, S. and Heineck, G. (2010). Cognitive abilities and earnings—first evidence for Germany. *Applied Economics Letters*, 17(7):699–702.

- Chevan, A. and Sutherland, M. (1991). Hierarchical partitioning. *American Statistician*, 45(2):90–96.
- Grömping, U. (2006). Relative importance for linear regression in R: The package relaimpo. *Journal of Statistical Software*, 17(1):1–27.
- Hart, S. and Mas-Colell, A. (1989). Potential, value, and consistency. *Econometrica*, 57(3):589–614.
- Isreali, O. (2007). A Shapley-based decomposition of the R-square of a linear regression. *Journal of Economic Inequality*, 5:199–212.
- Johnson, J. and LeBreton, J. (2004). History and use of relative importance indices in organizational research. *Organizational Research Methods*, 7(3):238.
- Khmelnitskaya, A. B. and Yanovskaya, E. B. (2007). Owen coalitional value without additivity axiom. *Mathematical Methods of Operations Research*, 66(2):255–261.
- Lang, F. (2005). Erfassung des kognitiven Leistungspotenzials und der ‘Big Five’ mit Computer-Assisted-Personal-Interviewing (CAPI): Zur Reliabilität und Validität zweier ultrakurzer Tests und des BFI-S. Research note, DIW Berlin.
- Owen, G. (1977). Values of games with a priori unions. In Henn, R. and Moeschlin, O., editors, *Essays in Mathematical Economics & Game Theory*, pages 76–88. Springer, Berlin et al.
- Shapley, L. S. (1953). A value for  $n$ -person games. In Kuhn, H. and Tucker, A., editors, *Contributions to the Theory of Games*, volume II, pages 307–317. Princeton University Press, Princeton.
- Shorrocks, A. (1999). Decomposition procedures for distributional analysis: a unified framework based on the Shapley value. Mimeo, University of Essex.
- StataCorp (2009). *Stata Statistical Software: Release 11*. College Station, TX: StataCorp LP.
- Wagner, G., Frick, J., and Schupp, J. (2007). The German socio-economic panel study (SOEP)—scope, evolution and enhancements. *Schmollers Jahrbuch*, 127:139–170.
- Winter, E. (1989). A value for cooperative games with levels structure of cooperation. *International Journal of Game Theory*, 18(2):227–240.
- Young, H. P. (1985). Monotonic solutions of cooperative games. *International Journal of Game Theory*, 14(2):65–72.

# Universität Leipzig

## Wirtschaftswissenschaftliche Fakultät

Nr. 1	Wolfgang Bernhardt	Stock Options wegen oder gegen Shareholder Value? Vergütungsmodelle für Vorstände und Führungskräfte 04/1998
Nr. 2	Thomas Lenk / Volkmar Teichmann	Bei der Reform der Finanzverfassung die neuen Bundesländer nicht vergessen! 10/1998
Nr. 3	Wolfgang Bernhardt	Gedanken über Führen – Dienen – Verantworten 11/1998
Nr. 4	Kristin Wellner	Möglichkeiten und Grenzen kooperativer Standortgestaltung zur Revitalisierung von Innenstädten 12/1998
Nr. 5	Gerhardt Wolff	Brauchen wir eine weitere Internationalisierung der Betriebswirtschaftslehre? 01/1999
Nr. 6	Thomas Lenk / Friedrich Schneider	Zurück zu mehr Föderalismus: Ein Vorschlag zur Neugestaltung des Finanzausgleichs in der Bundesrepublik Deutschland unter besonderer Berücksichtigung der neuen Bundesländer 12/1998
Nr. 7	Thomas Lenk	Kooperativer Föderalismus – Wettbewerbsorientierter Föderalismus 03/1999
Nr. 8	Thomas Lenk / Andreas Mathes	EU – Osterweiterung – Finanzierbar? 03/1999
Nr. 9	Thomas Lenk / Volkmar Teichmann	Die fiskalischen Wirkungen verschiedener Forderungen zur Neugestaltung des Länderfinanzausgleichs in der Bundesrepublik Deutschland: Eine empirische Analyse unter Einbeziehung der Normenkontrollanträge der Länder Baden-Württemberg, Bayern und Hessen sowie der Stellungnahmen verschiedener Bundesländer 09/1999
Nr. 10	Kai-Uwe Graw	Gedanken zur Entwicklung der Strukturen im Bereich der Wasserversorgung unter besonderer Berücksichtigung kleiner und mittlerer Unternehmen 10/1999
Nr. 11	Adolf Wagner	Materialien zur Konjunkturforschung 12/1999
Nr. 12	Anja Birke	Die Übertragung westdeutscher Institutionen auf die ostdeutsche Wirklichkeit – ein erfolg-versprechendes Zusammenspiel oder Aufdeckung systematischer Mängel? Ein empirischer Bericht für den kommunalen Finanzausgleich am Beispiel Sachsen 02/2000
Nr. 13	Rolf H. Hasse	Internationaler Kapitalverkehr in den letzten 40 Jahren – Wohlstandsmotor oder Krisenursache? 03/2000
Nr. 14	Wolfgang Bernhardt	Unternehmensführung (Corporate Governance) und Hauptversammlung 04/2000
Nr. 15	Adolf Wagner	Materialien zur Wachstumsforschung 03/2000
Nr. 16	Thomas Lenk / Anja Birke	Determinanten des kommunalen Gebührenaufkommens unter besonderer Berücksichtigung der neuen Bundesländer 04/2000
Nr. 17	Thomas Lenk	Finanzwirtschaftliche Auswirkungen des Bundesverfassungsgerichtsurteils zum Länderfinanzausgleich vom 11.11.1999 04/2000
Nr. 18	Dirk Büttel	Continuous linear utility for preferences on convex sets in normal real vector spaces 05/2000
Nr. 19	Stefan Dierkes / Stephanie Hanrath	Steuerung dezentraler Investitionsentscheidungen bei nutzungsabhängigem und nutzungsunabhängigem Verschleiß des Anlagenvermögens 06/2000
Nr. 20	Thomas Lenk / Andreas Mathes / Olaf Hirschfeld	Zur Trennung von Bundes- und Landeskompetenzen in der Finanzverfassung Deutschlands 07/2000
Nr. 21	Stefan Dierkes	Marktwerte, Kapitalkosten und Betafaktoren bei wertabhängiger Finanzierung 10/2000
Nr. 22	Thomas Lenk	Intergovernmental Fiscal Relationships in Germany: Requirement for New Regulations? 03/2001
Nr. 23	Wolfgang Bernhardt	Stock Options – Aktuelle Fragen Besteuerung, Bewertung, Offenlegung 03/2001

Nr. 24	Thomas Lenk	Die „kleine Reform“ des Länderfinanzausgleichs als Nukleus für die „große Finanzverfassungs-reform“? 10/2001
Nr. 25	Wolfgang Bernhardt	Biotechnologie im Spannungsfeld von Menschenwürde, Forschung, Markt und Moral Wirtschaftsethik zwischen Beredsamkeit und Schweigen 11/2001
Nr. 26	Thomas Lenk	Finanzwirtschaftliche Bedeutung der Neuregelung des bundestaatlichen Finanzausgleichs – Eine allokoative und distributive Wirkungsanalyse für das Jahr 2005 11/2001
Nr. 27	Sören Bär	Grundzüge eines Tourismusmarketing, untersucht für den Südraum Leipzig 05/2002
Nr. 28	Wolfgang Bernhardt	Der Deutsche Corporate Governance Kodex: Zuwahl (comply) oder Abwahl (explain)? 06/2002
Nr. 29	Adolf Wagner	Konjunkturtheorie, Globalisierung und Evolutionsökonomik 08/2002
Nr. 30	Adolf Wagner	Zur Profilbildung der Universitäten 08/2002
Nr. 31	Sabine Klinger / Jens Ulrich / Hans-Joachim Rudolph	Konjunktur als Determinante des Erdgasverbrauchs in der ostdeutschen Industrie? 10/2002
Nr. 32	Thomas Lenk / Anja Birke	The Measurement of Expenditure Needs in the Fiscal Equalization at the Local Level Empirical Evidence from German Municipalities 10/2002
Nr. 33	Wolfgang Bernhardt	Die Lust am Fliegen Eine Parabel auf viel Corporate Governance und wenig Unternehmensführung 11/2002
Nr. 34	Udo Hielscher	Wie reich waren die reichsten Amerikaner wirklich? (US-Vermögensbewertungsindex 1800 – 2000) 12/2002
Nr. 35	Uwe Haubold / Michael Nowak	Risikoanalyse für Langfrist-Investments Eine simulationsbasierte Studie 12/2002
Nr. 36	Thomas Lenk	Die Neuregelung des bundesstaatlichen Finanzausgleichs auf Basis der Steuerschätzung Mai 2002 und einer aktualisierten Bevölkerungsstatistik 12/2002
Nr. 37	Uwe Haubold / Michael Nowak	Auswirkungen der Renditeverteilungsannahme auf Anlageentscheidungen Eine simulationsbasierte Studie 02/2003
Nr. 38	Wolfgang Bernhard	Corporate Governance Kodex für den Mittel-Stand? 06/2003
Nr. 39	Hermut Kormann	Familienunternehmen: Grundfragen mit finanzwirtschaftlichen Bezug 10/2003
Nr. 40	Matthias Folk	Launhardt'sche Trichter 11/2003
Nr. 41	Wolfgang Bernhardt	Corporate Governance statt Unternehmensführung 11/2003
Nr. 42	Thomas Lenk / Karolina Kaiser	Das Prämienmodell im Länderfinanzausgleich – Anreiz- und Verteilungsmittlungen 11/2003
Nr. 43	Sabine Klinger	Die Volkswirtschaftliche Gesamtrechnung des Haushaltsektors in einer Matrix 03/2004
Nr. 44	Thomas Lenk / Heide Köpping	Strategien zur Armutsbekämpfung und –vermeidung in Ostdeutschland: 05/2004
Nr. 45	Wolfgang Bernhardt	Sommernachtsfantasien Corporate Governance im Land der Träume. 07/2004
Nr. 46	Thomas Lenk / Karolina Kaiser	The Premium Model in the German Fiscal Equalization System 12/2004
Nr. 47	Thomas Lenk / Christine Falken	Komparative Analyse ausgewählter Indikatoren des Kommunalwirtschaftlichen Gesamt-ergebnisses 05/2005
Nr. 48	Michael Nowak / Stephan Barth	Immobilienanlagen im Portfolio institutioneller Investoren am Beispiel von Versicherungsunternehmen Auswirkungen auf die Risikosituation 08/2005

Nr. 49	Wolfgang Bernhardt	Familiengesellschaften – Quo Vadis? Vorsicht vor zu viel „Professionalisierung“ und Ver-Fremdung 11/2005
Nr. 50	Christian Milow	Der Griff des Staates nach dem Währungsgold 12/2005
Nr. 51	Anja Eichhorst / Karolina Kaiser	The Institutional Design of Bailouts and Its Role in Hardening Budget Constraints in Federations 03/2006
Nr. 52	Ullrich Heilemann / Nancy Beck	Die Mühen der Ebene – Regionale Wirtschaftsförderung in Leipzig 1991 bis 2004 08/2006
Nr. 53	Gunther Schnabl	Die Grenzen der monetären Integration in Europa 08/2006
Nr. 54	Hermut Kormann	Gibt es so etwas wie typisch mittelständige Strategien? 11/2006
Nr. 55	Wolfgang Bernhardt	(Miss-)Stimmung, Bestimmung und Mitbestimmung Zwischen Juristentag und Biedenkopf-Kommission 11/2006
Nr. 56	Ullrich Heilemann / Annika Blaschzik	Indicators and the German Business Cycle A Multivariate Perspective on Indicators of Ifo, OECD, and ZEW 01/2007
Nr. 57	Ullrich Heilemann	“The Soul of a new Machine” zu den Anfängen des RWI-Konjunkturmodells 12/2006
Nr. 58	Ullrich Heilemann / Roland Schuhr / Annika Blaschzik	Zur Evolution des deutschen Konjunkturzyklus 1958 bis 2004 Ergebnisse einer dynamischen Diskriminanzanalyse 01/2007
Nr. 59	Christine Falken / Mario Schmidt	Kameralistik versus Doppik Zur Informationsfunktion des alten und neuen Rechnungswesens der Kommunen Teil I: Einführende und Erläuternde Betrachtungen zum Systemwechsel im kommunalen Rechnungswesen 01/2007
Nr. 60	Christine Falken / Mario Schmidt	Kameralistik versus Doppik Zur Informationsfunktion des alten und neuen Rechnungswesens der Kommunen Teil II Bewertung der Informationsfunktion im Vergleich 01/2007
Nr. 61	Udo Hielscher	Monti della città di firenze Innovative Finanzierungen im Zeitalter Der Medici. Wurzeln der modernen Finanzmärkte 03/2007
Nr. 62	Ullrich Heilemann / Stefan Wappler	Sachsen wächst anders Konjunkturelle, sektorale und regionale Bestimmungsgründe der Entwicklung der Bruttowertschöpfung 1992 bis 2006 07/2007
Nr. 63	Adolf Wagner	Regionalökonomik: Konvergierende oder divergierende Regionalentwicklungen 08/2007
Nr. 64	Ullrich Heilemann / Jens Ulrich	Good bye, Professir Phillips? Zum Wandel der Tariflohndeterminanten in der Bundesrepublik 1952 – 2004 08/2007
Nr. 65	Gunther Schnabl / Franziska Schobert	Monetary Policy Operations of Debtor Central Banks in MENA Countries 10/2007
Nr. 66	Andreas Schäfer / Simone Valente	Habit Formation, Dynastic Altruism, and Population Dynamics 11/2007
Nr. 67	Wolfgang Bernhardt	5 Jahre Deutscher Corporate Governance Kodex Eine Erfolgsgeschichte? 01/2008
Nr. 68	Ullrich Heilemann / Jens Ulrich	Viel Lärm um wenig? Zur Empirie von Lohnformeln in der Bundesrepublik 01/2008
Nr. 69	Christian Groth / Karl-Josef Koch / Thomas M. Steger	When economic growth is less than exponential 02/2008
Nr. 70	Andreas Bohne / Linda Kochmann	Ökonomische Umweltbewertung und endogene Entwicklung peripherer Regionen Synthese einer Methodik und einer Theorie 02/2008
Nr. 71	Andreas Bohne / Linda Kochmann / Jan Slavik / Lenka Slaviková	Deutsch-tschechische Bibliographie Studien der kontingenten Bewertung in Mittel- und Osteuropa 06/2008

Nr. 72	Paul Lehmann / Christoph Schröter-Schlaack	Regulating Land Development with Tradable Permits: What Can We Learn from Air Pollution Control? 08/2008
Nr. 73	Ronald McKinnon / Gunther Schnabl	China's Exchange Rate Impasse and the Weak U.S. Dollar 10/2008
Nr. 74	Wolfgang Bernhardt	Managervergütungen in der Finanz- und Wirtschaftskrise Rückkehr zu (guter) Ordnung, (klugem) Maß und (vernünftigem) Ziel? 12/2008
Nr. 75	Moritz Schularick / Thomas M. Steger	Financial Integration, Investment, and Economic Growth: Evidence From Two Eras of Financial Globalization 12/2008
Nr. 76	Gunther Schnabl / Stephan Freitag	An Asymmetry Matrix in Global Current Accounts 01/2009
Nr. 77	Christina Ziegler	Testing Predictive Ability of Business Cycle Indicators for the Euro Area 01/2009
Nr. 78	Thomas Lenk / Oliver Rottmann / Florian F. Woitek	Public Corporate Governance in Public Enterprises Transparency in the Face of Divergent Positions of Interest 02/2009
Nr. 79	Thomas Steger / Lucas Bretschger	Globalization, the Volatility of Intermediate Goods Prices, and Economic Growth 02/2009
Nr. 80	Marcela Munoz Escobar / Robert Holländer	Institutional Sustainability of Payment for Watershed Ecosystem Services. Enabling conditions of institutional arrangement in watersheds 04/2009
Nr. 81	Robert Holländer / WU Chunyou / DUAN Ning	Sustainable Development of Industrial Parks 07/2009
Nr. 82	Georg Quaas	Realgrößen und Preisindizes im alten und im neuen VGR-System 10/2009
Nr. 83	Ulrich Heilemann / Hagen Findeis	Empirical Determination of Aggregate Demand and Supply Curves: The Example of the RWI Business Cycle Model 12/2009
Nr. 84	Gunther Schnabl / Andreas Hoffmann	The Theory of Optimum Currency Areas and Growth in Emerging Markets 03/2010
Nr. 85	Georg Quaas	Does the macroeconomic policy of the global economy's leader cause the worldwide asymmetry in current accounts? 03/2010
Nr. 86	Volker Grossmann / Thomas M. Steger / Timo Trimborn	Quantifying Optimal Growth Policy 06/2010
Nr. 87	Wolfgang Bernhardt	Corporate Governance Kodex für Familienunternehmen? Eine Widerrede 06/2010
Nr. 88	Philipp Mandel / Bernd Süßmuth	A Re-Examination of the Role of Gender in Determining Digital Piracy Behavior 07/2010
Nr. 89	Philipp Mandel / Bernd Süßmuth	Size Matters. The Relevance and Hicksian Surplus of Agreeable College Class Size 07/2010
Nr. 90	Thomas Kohstall / Bernd Süßmuth	Cyclic Dynamics of Prevention Spending and Occupational Injuries in Germany: 1886-2009 07/2010
Nr. 91	Martina Padmanabhan	Gender and Institutional Analysis. A Feminist Approach to Economic and Social Norms 08/2010
Nr. 92	Gunther Schnabl / Ansgar Belke	Finanzkrise, globale Liquidität und makroökonomischer Exit 09/2010
Nr. 93	Ulrich Heilemann / Roland Schuhr / Heinz Josef Münch	A "perfect storm"? The present crisis and German crisis patterns 12/2010
Nr. 94	Gunther Schnabl / Holger Zemanek	Die Deutsche Wiedervereinigung und die europäische Schuldenkrise im Lichte der Theorie optimaler Währungsräume 06/2011
Nr. 95	Andreas Hoffmann / Gunther Schnabl	Symmetrische Regeln und asymmetrisches Handeln in der Geld- und Finanzpolitik 07/2011
Nr. 96	Andreas Schäfer / Maik T. Schneider	Endogenous Enforcement of Intellectual Property, North-South Trade, and Growth 08/2011
Nr. 97	Volker Grossmann / Thomas M. Steger / Timo Trimborn	Dynamically Optimal R&D Subsidization 08/2011

Nr. 98	Erik Gawel	Political drivers of and barriers to Public-Private Partnerships: The role of political involvement 09/2011
Nr. 99	André Casajus	Collusion, symmetry, and the Banzhaf value 09/2011
Nr. 100	Frank Hüttner / Marco Sunder	Decomposing $R^2$ with the Owen value 10/2011