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Disparities in Prices and Income across German NUTS 3 Regions

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Abstract

In EU countries, knowledge on spatial disparities in overall price level is extremely scarce. When interregional price disparities are large, however, nominal income measures fail to assess prosperity and the catch-up processes of regions. Despite its importance for regional policy, no official regional price statistic is available as a standard. On account of this gap, this paper deals with the econometric estimation of regional price indices for German NUTS 3 regions. Econometric price models for the consumer price index (CPI) and the housing rent index (HRI) are developed on the ground of utility maximization in a two-goods model. The estimated price indices are used to analyse price disparities in the period 1995 – 2004 across German NUTS 3 regions. Real income comparisons show that the East / West gap is likely to be substantially larger than assessed from incomplete price data in previous studies.

Keywords: Regional price level, econometric price models, price disparities, real income disparities

JEL Classification: C21, R13, R31

1. Introduction

Although disparities in cost of living across space play a crucial role in regional economics and policy (Jüßen, 2005), knowledge on regional price levels is scarce in the EU. National statistical offices do not gather price data area-wide. Collections of price data are usually conducted for constructing the consumer price index (CPI) at the national or state level. Although statistical offices of the states provide

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inflation rates for the sixteen NUTS 1 regions in Germany, the data do not allow for interstate price comparisons. In the United Kingdom the private Reward Group regularly reports cost-of-living indices for the eleven standard (macro-) regions that are used *inter alia* in salary surveys (Johnston et al., 1996). Information on regional price levels at a lower regional level such as for NUTS 2 or NUT 3 regions is not ordinarily available.

On account of this lack of information, regional EU studies must ordinarily rely on nominal indicators. Jüßen (2005) points to the necessity to "analyze convergence of real GDP in order to assess if regional policy is likely to achieve its objective of equalization". In measuring spatial disparities in standard of living, Aten and Heston (2005) estimate regional price levels using spatial-econometric models calibrated with national consumer price indices. The breakdown of country estimations to a regional level is, however, not easy to justify. First, the econometric models built from international studies are primarily demand-orientated and not grounded in economic theory. Second, the calibration with the national consumer price index does not necessarily imply an adequate explanation of regional price levels. Third, there is no *a priori* guarantee that responses of explanatory variables at the national and regional levels are identical.

Roos (2006a) was the first to advance an econometric estimation of regional price levels in Germany. He predicts CPI without housing for all German districts and states for the single year 1993. Blien et al. (2008) apply a different method to provide 1993 estimates of this sub-price index for all West German districts. Using CPI inflations rates of the states Roos (2006a) extrapolates state price levels (without housing) for the period 1994 – 2002. In a follow-up study Roos (2006b) calculates overall CPI at the state level using housing price data from the microcensus survey. On the basis of such aggregated data, West / East comparisons of real income per capita can be shown to result in a too narrow gap when high income regions tend to be high price regions.

Our study extends the works of Roos (2006a, 2006b) in several respects. We predict a consumer price index without housing (CPI-H) and an index of housing rents (HRI) for all German NUTS 3 regions in the period 1995 – 2004. By aggregating both series, a panel data set of overall regional level is obtained. The consumer price index without housing alone does not adequately reflect regional cost of living, as housing rents show considerably larger spatial disparities than prices of other goods and services. Only by employing complete CPI data, real income comparisons can be validly accomplished at the district level. Biases in East / West comparisons of purchasing power are thereby largely avoided.

The price and income comparisons are based on econometric regional price models for the consumer price index without housing (CPI-H) and the housing rent index (HRI). They are derived from utility maximization of consumers in a two-goods model. The CPI model without housing is calibrated using data on the latest price comparison of 50 selected German cities in 1993 (Ströhl, 1994). Data on housing rents are available for all 439 German districts at the current fringe of the sample period from the Federal Office for Building and Regional Planning (BBR). Estimates for CPI without housing, housing rents and overall price level at the NUTS 3 level for the period 1995 – 2004 are obtained from numerical specified econometric price models.

The panel data set allows for spatial price and income comparisons providing enlarged information for regional policy. In particular the rejection of the law of one price for housing rents has severe consequences with regard to convergence of consumer prices. As a side effect, some insights into the development of local housing prices during the transition period after German unification are provided.

The subsequent sections of this paper are organized as follows. Section 2 presents a simple model for the prices of consumer goods and housing. In sector 3, econometric issues are addressed. The data basis of this study is introduced in section 4. Results of econometric estimation of the price equations at the district level are discussed in section 5. A comparison of regional price indices and real income is conducted in section 6. Section 7 concludes.

2. A Price Model of Consumer Goods and Housing

Reduced-form equations for the price of goods (without housing) and housing services can be derived from a system of supply and demand schemes. Consumer theory states that demand for both kinds of goods, X and H, depends on the prices of housing and other goods, p_H and p_X, income, y, as well as a vector of other influences $\mathbf{d} = (d_1 d_2 \ldots d_r)$ (cf. Pollak and Wales, 1981; Goodman, 1990; Hansen et al. 1998). Olsen (1987) derives demand for housing services from a two-goods model of intertemporal choice based on a utility function of the Stone-Geary type. Goodman (1990) addresses the inclusion of demographic factors as explanatory variables on the grounds of tastes or supplements for the lack of knowledge on futures income and prices (cf. Megbolugbe and Cho, 1996; Hansen et al., 1998). He additionally deals with the issue of tenure choice in the demand of housing services.

The model of intertemporal choice allows demand equations for both housing services and all other goods to be derived. For the ease of exposition, we consider housing services from the viewpoint of a renter.[1] Because of a lack of regional disaggregated future data, we restrict the consumer's choice to one period, but include supplementary variables affecting utility in the demand functions (see Olsen, 1987).[2]

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1 Arevalo and Ruiz-Castilo (2006) apply the rental equivalence approach to include non-rental housing services into the consumer price index (see also Crone et al. 2000).

2 The supply and demand functions obtained from one-period optimization are shown to be special cases of intertemporal utility maximization. In the general case, the knowledge of future goods prices is necessary that are particularly missing on the regional level. Moreover, in our simplified approach, consumer's decisions are constraint by income instead of wealth.

The representative consumer maximizes the utility function, $U = U(X,H)$, with respect to the budget constraint $p_H \cdot H + p_X \cdot X = y$, where p_X is the price of all goods without housing, p_H the price of housing services and y income. The usual demand system can be enriched by additional parameters depending on the supplementary variables affecting utility (Pollak and Wales, 1981; Goodman, 1990; Megbolugbe and Cho, 1996). A simple form of enrichment is the so-called translation, where interactions between the original economic and supplemetary variables are precluded.[3] Let a_X and b_H be functions of the consumers' characteristics:

$$a_X = a_X(\mathbf{d}) \quad \text{and} \quad a_H = a_H(\mathbf{d}) \ .$$

Then translation (T) leads to the demand system

$$X_T^D = a_X + X^D(p_X, p_H, y - p_X \cdot a_X - p_H \cdot a_H) \tag{1}$$

and

$$H_T^D = a_H + H^D(p_X, p_H, y - p_X \cdot a_X - p_H \cdot a_H) \ . \tag{2}$$

The parameters a_X and a_H may be interpreted as "subsistence" levels that depend on demographics. The term $y - p_X \cdot a_X - p_H \cdot a_H$ reflects a kind of supernumerary income.

Supply functions for X and H can be derived by profit maximization when the two-product technology is assumed to be separable.[4] Then for all goods excluding housing, the standard supply function

$$X^s = X^s(p_X, w, r) \tag{3}$$

comes from a neo-classical production function with labour L and capital K as input factors. Equation (3) explains goods supply X^s as a function of the goods price, p_X, the wage rate, w, and the interest rate, r.

The supply of housing may, *inter alia*, depend on the price of housing services, construction costs, costs of financing and land supply (Ho and Ganesan, 1998; Ge et al., 2006). Tse et al. (1999) use the change in housing prices as the only influencing factor. With the housing price, p_H, a measure of other influences of profitability i_P and land supply, l, as explanatory variables, the supply function reads

$$H^s = H^s(p_H, i_P, l) \ . \tag{4}$$

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3 Interactions can be included by the method of scaling (see Goodman, 1990; Megbolugbe and Cho, 1996).

4 The two-product technology is said to be separable if inputs can be split up. A part of input is used in production of X and the other part in production of H.

In equilibrium, demand and supply in both markets must match. After aggregating (1) and (3) over all households and firms, respectively, and solving for the goods market price p_X, one obtains the relation

$$p_X = p_X(p_H, Y, w, r, \mathbf{d}) \ , \tag{5}$$

while the price of housing services, p_H, is achieved analogously from equating (2) and (4):

$$p_H = p_H(p_X, Y, i_P, l, \mathbf{d}) \ . \tag{6}$$

Equations (5) and (6) render equilibrium prices in the goods and housing market as functions of the determinants of the respective aggregate supply and demand equations. In both price functions, individual income, is also replaced by aggregate income *Y*.

The price equations (5) and (6) form the frame for econometric models for the sub-price indices CPI-H and HRI. In the context of the econometric modelling we debate the effects of the selected explanatory variables on the price indices. We also discuss endogeneity problems that are possibly arising in real economies.

3. Econometric Issues

In order to establish an econometric model for the consumer price index without housing (CPI-H) and the housing price index (HRI), we refer to equilibrium relationships (5) and (6) of the demand and supply scheme. As prices for both kinds of goods have to be estimated for the whole sample period, they cannot be used as mutual determinants in the price models themselves. Moreover, we have to abstract from the interest rate in virtue of its constancy across regions.[5] Thus, empirically, regional price level of the *X*-goods has to be explained by purchasing power, wage and other factors affecting utility. Purchasing power is usually measured by disposable income (*Y*). In some areas, however, demand from tourists and travellers may additionally affect local prices. On this account, we introduce the hotel overnight stays (HOS) as a measure for the effect of 'foreign' purchasing power on regional price level. Consumers living in densely populated areas may benefit from a wide-ranging choice of products or suffer from congestion and pollution. Thus, we add population density (DENS) as an additional influence factor.

Using these explanatory variables, the econometric model for the consumer price index (without housing), CPI-H, reads

$$\text{CPI-H} = \alpha_0 + \alpha_1 \cdot Y + \alpha_2 \cdot \text{HOS} + \alpha_3 \cdot w + \alpha_4 \cdot \text{DENS} + u \ , \tag{7}$$

5 Regional differentiated investment allowances are not available for the consumption sector of the economy.

where u is an identically normally distributed error term with $E(u) = 0$ and $V(u) = \sigma_u^2$. As rising purchasing power leads to additional demand, Y and HOS are expected to be positively related with the consumer price index (CPI-H). As a cost factor, wages (w) affect regional prices positively. The density variable (DENS) captures agglomeration effects on regional prices. The higher population density, the higher is demand concentrated on given supply thereby putting an upward pressure on CPI-H. Stronger competition among firms in economic centres works in the opposite direction. Thus, the sign of DENS depends on the strength of both effects.

As income and prices are simultaneously determined in real markets, Y cannot be viewed as exogenous in econometric analysis. The well-known price-wage spiral suggests that the same applies to the wage rate (w). Thus, in order to eliminate an endogeneity bias, both Y and w should be instrumented. This can be carried out by two-stage least-squares (TSLS) instead of OLS estimation. Besides hotel overnight stays and population density, population and human capital may serve as additional instruments. Roos (2006a) showed population to have quite the same explanatory power as income. Human capital is often used as a control variable in international econometric price level models (cf. Aten and Heston, 2005).

In explaining housing prices, purchasing power is again measured by regional disposable income (Y). At least in the long run, charges for tourist accommodation may exert an upward pressure on housing rents as usage may become interchangeable. On this account, hotel overnight stay (HOS) can be viewed as a potential influence of profitability. As land prices are highly variable, we measure scarcity of housing space by dwelling capacity (DWELL). We additionally explain prices for H-goods by supplementary variables such as population density (DENS), human capital (HUM) and the growth rate of population (GPOP):

$$(8)\quad \mathrm{HRI} = \beta_0 + \beta_1 \cdot Y + \beta_2 \cdot \mathrm{HOS} + \beta_3 \cdot \mathrm{DWELL} + \beta_4 \cdot \mathrm{DENS} + \beta_5 \cdot \mathrm{HUM} + \beta_6 \cdot \mathrm{GPOP} + v\,.$$

v is an identically normally distributed error term with $E(v) = 0$ and $V(v) = \sigma_v^2$.

Because of demand effects, the regression coefficients of Y and HOS are expected to positively influence the dependent variable of the HRI model. As population is attracted by favourable living and working conditions, population growth (GPOP) will work in the same direction. Given the demand for housing, an increase of living space (DWELL) puts a downward pressure on housing rents. Due to scarcity of land, HRI will be higher in agglomerated areas than in rural regions. This effect is captured by the DENS variable. Finally, a higher share of skilled workers (HUM) will increase demand for higher-valued living space putting an upward pressure on HRI.

In housing price models, Y is usually viewed to be exogenous (cf. Goodman, 1990; Lee et al., 2001; Ge et al., 2006) as housing rents account for only a small part of disposable income. Thus, the HRI model can be estimated without instrumenting Y. An endogeneity bias could arise from introducing population growth

(GPOP) an exploratory variable. An employment shock may have an expectational effect on housing rents and affect population growth at the same time. In this case, GPOP can become correlated with the error term of the HRI model. However, according to large commuting flows between NUTS 3 regions and limited labour mobility in Germany the extent of the possible endogeneity bias is assessed to be very restricted.[6] Moreover, as GPOP is already a non-economic variable, its instrumentation would turn out to be difficult. For both reasons, we refrain from instrumenting population growth.

In some cases, regional characteristics may give rise to outliers. Since outliers may adversely affect regression coefficients, they should be taken into account in the final price models. Not all outliers are, however, harmful. Leverage points will only distort regression coefficients if they come along with large residuals. A useful diagnostic for identifying influential observations is provided by Cook's distance that combines residuals and extreme values in the *x*-space. According to Fox (1991), we consider a data point with a CD value larger than the cut-off value of $4/(n-k)$ as an influential observation.

4. Data

Data of the dependent variables, CPI-H and HRI, of the econometric price models stem from two sources. CPI data without housing used to calibrate an econometric price model for *X*-goods are available from the latest city survey by the German Federal Statistical Office in 1993 (Ströhl, 1994). The price comparison is conducted for 50 selected German cities. Rent data used to estimate a price for *H*-goods are provided by the Federal Office for Building and Regional Planning (BBR) for 439 German districts in 2004. Time series of the independent variables for all 439 German districts are obtained from German regional statistics and the Federal Employment Agency.

A panel data set of the consumer price index without housing (CPI-H) and the housing rent index (HRI) for the period 1995 – 2004 is obtained in three steps:

- First, raw data of CPI-H and HRI are obtained by calculating the predicted values from the numerical specified regression models (7) and (8) using observed values of the explanatory variables.
- Secondly, the regression values of the sub-price indices are adjusted using inflation rates for CPI-H and HRI at the state level.[7]

6 In Germany, more than 50 % of employees bounded to the social security system are commuters who travel to their workplaces across NUTS 3 regions (Kosfeld and Dreger, 2006).

7 For Schleswig-Holstein, Hamburg and Bremen no inflation rates are provided by official statistics. However, we can adjust the regression estimates by common rates for CPI-H and HRI for all three states that can be calculated from the national and state inflation rates.

- Thirdly, the population-weighted sub-price indices CPI-H and HRI are normalized to a value of 100 for the year 2000.

We calculate overall regional price level (CPI) by aggregating CPI-H and HRI using the official weights of the *X*- and *H*-goods in the baskets of commodities (Statistisches Bundesamt, 1998, 2003). Because of different consumer buying habits, the Federal German Statistical Office applies different weight schemes for establishing the consumer price index (CPI) for the western and eastern part of the German economy in the first decade after unification. We make use of this differentiation for calculating regional CPIs in the first half of the sample period:

$$\text{(9a)} \quad \text{CPI} = \begin{cases} .81498 \cdot \text{CPI-H} + 0.18502 \cdot \text{HRI for West German districts} \\ .87895 \cdot \text{CPI-H} + 0.12105 \cdot \text{HRI for East German districts} \end{cases} \quad \text{for } 1995-1999.$$

According to official statistics, the regional CPIs are calculated with uniform weights for the second half of the sample period:

$$\text{(9b)} \qquad \text{CPI} = .78783 \cdot \text{CPI-H} + .21217 \cdot \text{HRI} \quad \text{for } 2000-2004.$$

Since the regression values of the sub-price indices are obtained from regional price determinants, district inflation rates are allowed to differ from the inflation rate of the corresponding state. The approach we adopt here explicitly accounts for intrastate differences of CPI-H and HRI inflation. In particular different development of prices in agglomerations and rural regions are captured. The subsequent adjustment ensures that the population-weighted indices of districts reflect the inflation rates of the states. The normalisation of the indices to 100 in the year 2000 is carried out to facilitate comparisons with CPI and its components of official statistics.

Although a constant weighting scheme is used in official statistics for all regions,[8] consumer buying habits can vary across space. Moreover, environmental conditions may affect utility of consumers besides the prices of goods and services in different areas (Schultze, 2003; Diewert, 2004). As such effects are not accounted for, the regional price indices are not interpretable as "true" cost-of-living indices (COLI). Using national weights in constructing regional price indices rather adopts the Laspeyres approach of a "pure" price comparison (Ströhl, 1994; Neubauer, 1996, 151).

Demand-effective income is preferably operationalised by disposable income. However, complete time series of this variable are not available for all German states on the district level. For Rhineland Palatinate data for the years 1993 and 1994 are missing. For the Saarland and all East German states except Berlin highly disaggregated data on disposable income are only available for the period 1995 –

8 The Federal German Statistical Office makes only a West-East differentiation in consumer baskets of goods in the 1990ies.

2004 ("National Accounts of the States", Statistical Office Baden-Württemberg). As balanced panel data on this income variable is available for 1992 to 2004 at the state level, we use the information on the state growth rates to calculate 1993 data for the CPI-H regression.

Gross domestic product (GDP) is a poorer indicator for demand-effective income. However, GDP data is available for the whole period of investigation, 1995 – 2004, at the district level by the working group "National Accounts of the States" (Statistical Office Baden-Württemberg). All eastern states except Saxony and five western states (BW, BY, HB, HE, NW) additionally report GDP figures for 1993. For the CPI-H regression we estimate GDP in cities of these states by using 1994 district and 1993 state data. We employ GDP data for assessing robustness of estimation results. This can also be done by proxying demand by population, which is available for all years.

Particularly in tourist districts, income and population are expected not to capture whole local demand. Demand for goods does not only come from residents, but also from tourists and travellers. In tourist regions, 'foreign' demand may significantly impact local goods prices. We use hotel overnight stays as a proxy for external demand. Data on this variable are only incompletely available from the "Statistik regional" CD. Gaps are closed by interpolating as well as by using other variables of the tourism statistic.[9]

The supply side of price determination is involved by the costs of the production factor labour. Data on wages on the district level are made available by the Institute for Employment Research (IAB) for the period 1993 – 2004. More specifically, the labour costs are measured by average gross wages and salaries of full-time employees subject to the social security system. They include taxes and payroll deductions of the employees, but no social security contributions of the employers. Wage data is provided for all German districts.

We use population density to capture the impact of agglomeration on goods and housing prices. In particular in the HRI regression, the ratio of population to the floor area of building and open space is preferable to the ratio of population to district area as it captures scarcity more adequately. Attractiveness of living and working conditions on housing rents is proxied by population growth. Higher living claims of skilled workers are measured by the proportion of employees with a university degree or degree from an advanced technical college. Descriptive statistics for all variables are reported in Table 1 for the margins of the period of investigation.

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9 Roos (2006a) approximated external demand by using a dummy variable constructed from hotel beds.

Table 1

Descriptive Statistics

Variable	Year	Mean	Standard deviation	Minimum	Maximum
Consumer price index	1995	89.9	1.2	88.4	97.6
without housing[a]	2004	102.5	1.8	97.8	107.6
Housing rent index (HRI)[a]	1995	79.6	9.9	62.6	111.3
	2004	87.5	8.9	73.1	124.4
Consumer price index (CPI)[a]	1995	88.7	1.9	86.0	97.5
	2004	99.3	2.8	95.4	111.2
Disposable income[b]	1995	11.3	0.7	9.5	14.3
	2004	14.4	0.6	13.0	16.6
Gross domestic product (GDP)[b]	1995	14.3	3.3	10.1	23.7
	2004	18.6	4.4	12.9	35.0
Population[b]	1995	156.4	321.9	45.4	3471.0
	2004	149.2	314.3	44.1	3387.5
Population density[b, c]	1995	3366.8	1818.3	1573.8	10057.5
	2004	3159.1	1400.1	1520.0	9447.6
Wage[d]	1995	52.0	3.8	45.0	70.8
	2004	63.0	5.9	50.9	82.2
Hotel overnight stays[c]	1995	269.5	655.3	9.2	6720.0
	2004	383.8	1131.6	14.4	11504.4
Dwelling capacity[c]	1995	81.9	109.6	16.5	1770.3
	2004	89.7	116.5	17.7	1878.5
Human capital[c]	1995	0.092	0.031	0.047	0.228
	2004	0.094	0.033	0.050	0.250

Sources: [a] Own calculations, [b] National Accounts of the States (*Volkswirtschaftliche Gesamtrechnung der Länder*), State Statistical Office Baden Württemberg, [c] Statistik regional (CD), Federal Statistical Office Germany, [d] Federal Employment Agency, Nuremberg.

5. Estimation Results

Data for the consumer price index without housing (CPI-H) are available from the price comparison across 50 German cities in 1993. In a preliminary step, we aimed at identifying outliers by calculating Cook's distance from OLS estimation of the price model (7). The city of Mainz is a potential outlier as its standardized residual is larger than 2. However, none of the CD values exceed the cut-off value of 0.089. As no influential observation is identified, we calibrate the econometric model for the *X*-goods using the complete sample data set.

Table 2 reports the results of two-stage least-squares estimation (TSLS) of variations of the CPI model (7). In all regression, population, population density, hotel overnight stays, human capital and an east dummy are used as instruments. Hotel overnight stays are measured relative to regional population. Population density is measured by relating population to the living and open space. First, the original model (7) is estimated by instrumenting disposable income and wage. 93.4 % of the CPI variance is explained by the employed explanatory variables. The White test does not point to the presence of heteroscedasticity.

All regression coefficients are significant with the expected signs. The first CPI-H regression model is run with disposable income, which exerts a positive impact on regional price level. Moreover, the higher the population density, the higher is the consumer price index. This effect may result from stronger local demand for consumer goods in densely populated areas. It overcompensates downward pressure on prices due to competition. The positive correlation between CPI and wages can well be explained by the wage-price spiral. The positive response of regional prices on hotel overnight stays is expected to capture the demand of tourists and travellers for local goods. In the second and third CPI-H models, disposable income is substituted by GDP and population, respectively. Both variables show quite the same explanatory power as disposable income.

Table 2

Estimation Results for CPI-H Models

	TSLS of CPI (without housing)		
Instruments	Population, population density, hotel overnight stays, human capital, east		
Const.	82.173 (119.784)	82.470 (110.844)	81.999 (124.208)
Disposable income	0.049 (2.470)		
GDP		0.029 (2.394)	
Population			0.710 (2.515)
Population density	16.537 (2.470)	14.824 (2.079)	16.213 (2.429)
Wage	0.215 (19.158)	0.212 (18.079)	0.218 (20.011)
Hotel overnight stays	0.222 (2.112)	0.196 (1.840)	0.226 (2.166)
R^2	0.934	0.932	0.935
SER	0.931	0.941	0.921
SSR	38.981	39.826	38.210
White (*p*-value)	6.601 (0.949)	7.292 (0.923)	6.985 (0.935)

Notes: t-values for the regression coefficients in parenthesis – R^2: coefficient of determination – SER: Standard error of regression – SSR: Sum of squared TSLS residuals – White: White heteroscedasticity test.

The housing rent model (8) is estimated by employing the complete data set covering 439 German districts. As the Federal Office for Building and Regional Planning (BBR) collects data on housing rents since quite recently, the regressions are carried out for the latest year of investigation 2004. Because no endogeneity bias comparable with the CPI-H model is expected to be present with the housing rent index, it is admissible to estimate the HRI regression models by ordinary least-squares (OLS) or, in case of heteroscedasticity, weighted least-squares (WLS).

In a preliminary step, the HRI model is estimated by OLS for the purpose of outlier detection. With n = 439, the cut-off value of Cook's distance amounts to 0.0093. With this critical value, 29 districts are identified as influential observations. 20 outlying districts are located in West Germany and 9 in East Germany. Their effect on parameter estimation is controlled for by dummy variables in the final model.

Table 3

Estimation Results for HRI Models

	Regression with outliers		Regression with outlier dummies	
Const.	2.517	(5.263)	2.989	(6.906)
Disposable income	0.180	(11.307)	0.130	(8.567)
Population density	0.015	(5.598)	0.015	(6.204)
Population growth rate	13.923	(2.717)	24.044	(4.978)
Dwelling capacity	–4.210	(–5.207)	–3.396	(–4.693)
Hotel overnight stays	0.062	(6.505)	0.049	(5.617)
Human capital	14.180	(14.621)	14.429	(15.571)
R^2	0.718		0.829	
SER	0.576		0.464	
SSR	143.185		86.775	
White (p-value)	93.583 (0.000)		45.746 (0.282)	

Notes: t-values for the regression coefficients in parenthesis – R^2: coefficient of determination – SER: Standard error of regression – SSR: Sum of squared TSLS residuals – White: White heteroscedasticity test.

Although there are some changes in absolute values of the estimated coefficients between the regressions with and without outliers, all signs are as expected. Table 3 shows that the coefficient of determination increases from 71.8 % in the regression model with outliers to 82.9 % in the regression model where outliers are controlled for by dummy variables. As the White test accepts the null of homoscedastictiy in the latter case, the final housing rent model is estimated by OLS.

While the impact of population density on housing rents does not differ in both regressions, the effect of population growth turns out to be considerably stronger when outliers are controlled for. While the positive influence of the former variable is expected to result from stronger local demand, the significant positive coefficient of the latter variable may due to the influx of 'foreign' citizens attracted by regional job opportunities or amenities. The most significant impact on the housing rent index (HRI), however, comes from disposable income, albeit its estimated regression coefficient decreases noticeably in the final model. The latter effect is also observed for hotel overnight stays and dwelling capacity. An increasing number of overnight stays puts upward pressure on rents because of higher opportunity costs.

On the other hand, housing demand relative to housing supply slackens with increasing dwelling capacity thereby reducing pressure on housing rents. The positive regression coefficient of human capital is well in line with the hypothesis that the demand of academics and skilled workers is mainly focused on the high-quality market segment of housing.

6. Regional Price and Income Variation

The consumer price index (CPI) exhibits a considerable spatial variation of regional price level (Figure 1). In 1995, the overall price level in Frankfurt / Main was about 25 % higher than in Stendal. The difference between the highest and lowest CPI districts, Munich and Mittlerer Erzgebirgekreis, enlarged in 2004 to 37.5 %. Without housing, the differences narrow to about 13 % in 1995 and 16.5 % in 2004. This is in line with the tendency to the law of one price for tradable goods. Notice, however, that non-tradable goods, particularly services, in the CPI without housing may preserve perceptible price disparities. Districts like Munich, Frankfurt, Stuttgart and Cologne are found at the top independently whether housing rents are included or not. With the exception of Hamburg, the districts with the ten largest CPI values are concentrated in South Germany, the Main-Rhine area and the Lower Rhine area. By contrast, all districts with the ten lowest CPI values are located in East Germany.

Price dispersion increases during the period of investigation across German districts. While the coefficient of variation of the CPI increases from 4.1 % in 1995 to 5.5 % in 2004, it only rises from 2.5 % to 2.6 % for the CPI without housing. A rise of relative price dispersion is also observed within the West and East German regions. CPI price disparities within East Germany are, however, relatively small compared with those in West Germany. Neither in Germany as a whole nor in the two former German states evidence for σ-convergence is found.

CPI convergence regressions largely corroborate results on σ-convergence.[10] β-divergence is found for West and East Germany with the CPI with and without housing. For Germany as a whole, the coefficient of the lagged CPI is positive with housing and negative without housing. In view of the low speed of convergence of 0.9 % in the latter case, both results imply persistent price disparities. Although Roos (2006a) states that price level differentials cannot exist over a long period across German states, the estimated half-life of about 15 years for the CPI without housing does not give rise for rapid price adjustments. Persistency of regional price levels has also been established for other countries. Cechetti et al. (2002), for instance, found a unit root in US city price levels with an implied half-life of 9 – 10 years over a very long sample period. According to Busetti et al. (2006) three quarters of price levels across Italian regional capitals are not converging. Dayanandan

[10] Estimation output on convergence regressions is available by the authors on request.

and Ralhan (2005) estimate CPI half-lives of 7 – 8 years for Canadian provinces and cities.

Figure 1: Consumer Price Index 1995 and 2004

The disparities in housing rents across German regions are extremely large. In 1995, the Munich HRI exceeds that of Stendal by around 137 %. The gap between the highest and lowest HRI district widens during the period of investigation reaching a value of 284 % in 2004. While all ten regions with the highest housing rents are located in West Germany, the geographic distribution of the ten districts with lowest housing rents is mixed. Figure 2 shows that low-rent regions are situated in both German parts.

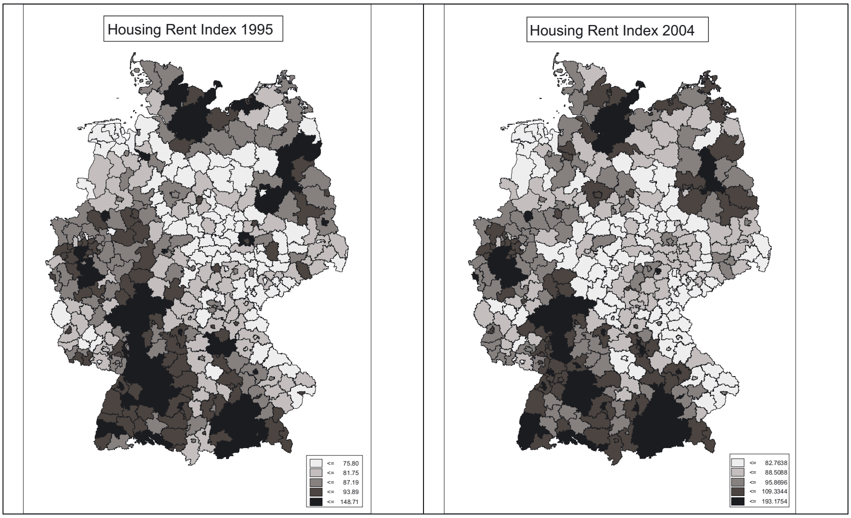

Figure 2: Housing Rent Index 1995 and 2004

The great disparities in the HRI are reflected by large CV values. In both Germany as a whole and West Germany, the coefficient of variation rises from 16.4 % in 1995 to about 20 % in 2004. This tendency clearly indicates σ-divergence of housing rents in both areas. By contrast, the declining CV values during the sample period in East Germany point to σ-convergence. These findings are largely corroborated by convergence regressions. The coefficient of lagged HRI is, however, not significant for Germany as a whole. For East Germany, the rate of HRI convergence is estimated by 6.3 % which implies a half-life of 11 years.

As high-income regions tend to be high-price-level regions as well, disparities in purchasing power are somewhat levelled off. However, real-income gaps between highest and lowest income districts are still large. In 1995, the highest ratio in real income per capita between two districts was 1.9 and in 2004 1.8.

Based on district data, the East / West ratio fell from 0.796 in 1995 to 0.863 in 2004. Thus, the real income gap between East and West Germany is estimated by short 14 % at the fringe of the period of investigation. According to Roos' estimates, the West / East gap with respect to real income per capita is already closed in 2002 (Roos, 2006b). The estimate of an East / West ratio of unity in 2002 could, however, result from aggregation to the regional level. Our finding, based on district data, is close to the finding of the IWH (2003) which reports a real income gap of 0.91 in 2002.

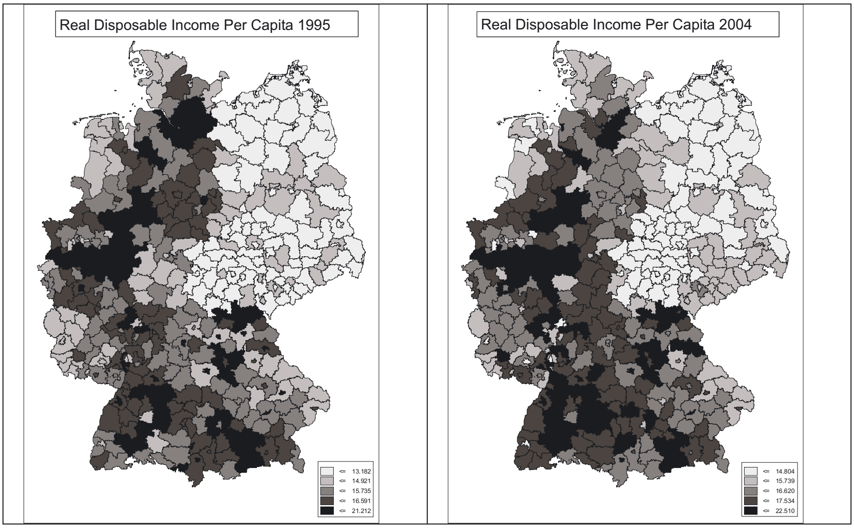

Figure 3: Real Disposable Income 1995 and 2004

σ-convergence of real income per capita can be proved for Germany as a whole as well as within East Germany, while σ-divergence arises for West Germany. Using highly disaggregated data the CV decreases from 0.120 in 1995 to 0.098 in 2004, while it falls off from 0.04 in 1995 to 0.03 in 2002 with state data (Roos, 2006b). The variation is considerably less within both parts of the German economy.

β-convergence is established for Germany as a whole and the Eastern and Western part of the country. Real income convergence across all German districts turns out to be stronger than nominal income convergence. For all German districts the rate of real income convergence increases by the factor 1.6 to a value of 4.1 %. This rate of convergence implies a half-life of about 17 years. In contrast to nominal income, the coefficient of lagged initial income is significant for West Germany. The rate of convergence of 1.8 % implies a half-life of 39 years. Lagging regions within East Germany caught up to wealthier regions relatively quickly during the period 1995 – 2004. On average, the real income gap across East German districts is halved in 8 years.

8. Conclusion

In this paper a model for prices of consumer goods and housing is used for estimating the consumer price index (CPI) with and without housing as well as the housing rent index (HRI) for all 439 German NUTS 3 regions in the period 1995 – 2004. Regional CPIs are calibrated with the aid of a price comparison of 50 German cities by the Federal German Statistical Office in 1993. The HRI model is econometrically estimated using rent data surveyed by the Federal Office for Building and Regional Planning (BBR) in 2004. Both econometric price models are able to explain a high percentage of regional price variation. In particular the goodness of fit of the CPI model without housing proves to be very high. Overall regional price levels are obtained by weighting both sub-indices with the shares of consumer expenditures. As consumption patterns are not available at the district level, regional CPIs are Laspeyres-type indices and not "true" cost-of-living indices (COLI).

The spatial CPI pattern is found to be relatively stable during the period of investigation. Clusters of high-price-level districts are in particular located in South Germany around the cities of Munich and Stuttgart, in the Rhine-Main area, in the Lower Rhine area alongside the centre line Cologne / Düsseldorf and around the city of Hamburg. As expected, most East German districts are low-price-level regions. Districts with low price levels are, however, also found alongside the Czech border in Bavaria and scattered in Rhineland-Palatinate, the Saarland and Hesse. While the CPI without housing converges with an annual rate of 0.9% across all German regions, the total overall price index tends to diverge during the period of investigation. This behaviour is in line with a relatively high rate of convergence of tradable goods which are more strongly weighted in the former price index.

Disparities in housing rents are extremely large. High HRI regions are not only located in West Germany, but also in East Germany – particularly in the surrounding area of Berlin. There is no evidence of HRI convergence across all German districts. However, the development of the HRI is completely different in both former German nations. While HRI disparities have increased in the period 1995–2004 in West Germany, the housing rents tend to converge across East German regions.

Although some NUTS 3 regions with high real income per capita are located in the northern part of the country, for the most part high income districts are situated in Southern Germany. Real income per capita converges faster to the unique steady state than nominal income per capita. The West / East gap is reduced by about 7 percentage points during the period of investigation. Across East German regions, the speed of convergence is extremely high. In real terms, income per capita nearly converges with the "natural rate" of 2 % across West German regions. σ-convergence, however, can only be proved for Germany as a whole and East Germany.

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