Introduction to this Volume: Applying Hedonics in the Swiss Housing Markets

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1. Context and Acknowledgements

On June 27–30, 2007, we organized at the Geneva School of Business Administration an International Symposium entitled "Hedonic Methods in Real Estate". Given the numerous existing applications of hedonics in Switzerland, we decided to devote one day and a half of the Symposium to the Swiss research on and the policy applications of the hedonic model. During the first day, called the "Swiss hedonic day", Swiss researchers from universities, consulting firms and banks discussed the models they use, the topics analysed, data, econometric issues, and results of the hedonic approach applied to the Swiss housing and property markets. During the "Swiss policy day", the participants discussed the major policy issues in the noise context, as well as the main economic implications for noise policies. Then, two days of the Symposium convened leading international scholars in order to present and discuss innovative solutions and practices in assessing the characteristics of rent determination and economic impact of environmental improvements and land use changes, as well as the presence of residential segregation and discrimination in housing markets. Through a careful review and selection of the topics presented during the "International Day", we edited the papers of high quality and published them in "Hedonic Methods in Housing Markets. Pricing Environmental Amenities and Segregation." New York: Springer, 2008. Inspired by the quality and quantity of applications of the hedonic model in the Swiss housing and property markets, we launched the "Swiss network for hedonic

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methods in real estate and housing"[1]. We selected some of the papers that were presented during the Swiss Day, carefully reviewed them and had their authors revise them repeatedly. Those papers are now contained in the present issue of the *Swiss Journal of Economics and Statistics*. Our greatest gratitude is to the authors, who have participated with much enthusiasm to this project and spent a lot of time in writing and revising their papers.

We gratefully acknowledge financial support for the Geneva International Symposium and our own research in the field of hedonics by the Geneva School of Business Administration (HEG Genève); the University of Applied Sciences Western Switzerland (HES-SO); the Research group on the Economics and Management of the Environment (REME) of the Swiss Federal Institute of Technology, Lausanne (EPFL); the Swiss Academy of Humanities and Social Sciences; and the Swiss National Science Foundation, National Research Program 54 "Sustainable development of the built environment". Last, but not least, we would like to thank Professor Klaus Neusser, Editor of the *Swiss Journal of Economics and Statistics*, for his support and faith in this project.

2. The Hedonic Price Model

In the 1920s, agricultural economists started explaining unit land prices by regressing them on property attributes (COLWELL and DILMORE 1999). Well known is FREDERICK WAUGH's (1928) regression of the prices of different types of asparagus on their colour, diameter and homogeneity, with a view to helping farmers produce the quality demanded by the market. More influential was the study by ANDREW COURT (1939), who had been mandated by General Motors to defend the company against Congress' accusations of monopolistic price pushing, after the U.S. Department of Labor Bureau of Labor Statistics price index for cars had grown by 45% between 1925 and 1935. COURT was probably the first to estimate a quality-adjusted price index based on the hedonic price (HP) model. He found that car prices had actually declined by 55% over that period for the same quality.

Quality-adjusted price indices is just one, albeit important and increasingly common application of the HP method for economic policy.[2] The basic form of

1 See: http://campus.hesge.ch/baranzia/NETWORK/welcome.asp

2 Recent surveys of the hedonic approach literature, in particular applied to housing markets, are provided by e.g. SHEPPARD (1999), BATEMAN et al. (2001), DAY (2001), PALMQUIST (1999; 2005), and TAYLOR (2008). For application of hedonic methods to actual economic policy, see PALMQUIST and SMITH (2002).

the HP model is a functional relationship between the price *P* of a heterogeneous good *i* and its quality characteristics represented by a vector x_i:

$$P_i = f(\mathbf{x}_i; ß) + u_i \tag{1}$$

In the context of this collection of papers, the heterogeneous good *i* is a property (or a dwelling) with price (or rent) P_i. The x_i would include structural attributes of size and quality of the property, characteristics of the immediate neighbourhood and indicators of its environment and accessibility. **ß** stands for the vector of coefficients that are estimated. There is always an unexplained part of the price represented by *u*.

After the equation has been estimated, it can be used to predict the price of any property *i* with characteristics x_i:

$$\hat{P}_i = f(\mathbf{x}_i; \hat{ß}) \tag{2}$$

Depending on the functional form of f(.), **ß** is more or less directly related to a concept of unit price for the characteristics, as though the heterogeneous good were a shopping cart and its characteristics were commodities purchased separately. For characteristics measured in discrete quantities, an implicit price for characteristic *k* (p_k) of any property *i* can be computed as follows, where $x_{\{-k\}}$ is the vector of all characteristics but the k^{th}:

$$\hat{p}_k = f(x_k + 1, \mathbf{x}_{\{-k\}}; \hat{ß}) - f(x_k, \mathbf{x}_{\{-k\}}; \hat{ß}) \tag{3}$$

For continuous characteristics, it is common to compute implicit marginal prices by taking the first derivative of (2) with respect to the quantity of the characteristic:

$$\hat{p}_k = \frac{\partial f(\mathbf{x}_i; \hat{ß})}{\partial x_k} \tag{4}$$

Implicit prices generally depend on the level of the characteristic and sometimes even on that of the other characteristics. Intuitively, the implicit price of an open fire place in a house depends on how many fire places it already contains and the number of low-temperature days.

If the data span several periods, one could exploit this additional information by simply adding a time dummy (for a detailed introduction, see Triplett 2006). Consider for instance a log-linear model:

$$\ln P_i = \text{ß}'\mathbf{x}_i + \beta_{Ti} T_i + u_i \tag{5}$$

where T_i is the time dummy for the period of transaction of property *i* and β_{Ti} the coefficient for that period. The adjusted price of a property *i* sold in period T_i satisfies:

$$\ln \hat{P}_i = \hat{\text{ß}}'\mathbf{x}_i + \hat{\beta}_{Ti} T_i \tag{6}$$

If the same property had been sold in the base period for which thus there is no time dummy ($T_i = 0$), its estimated price $\hat{P}_{i0}$ would satisfy:

$$\ln \hat{P}_{i0} = \hat{\text{ß}}'\mathbf{x}_i \tag{7}$$

This allows estimating a price index between the base period and period T_i as $\exp(\hat{\beta}_{Ti})$.
Alternatively, hedonic price indices are computed by allowing the coefficients of the characteristics (i.e. the implicit prices) change every period and aggregating those implicit price changes using a traditional index number formula (Laspeyres, Paasche, Fisher, etc.). In that case, weights must be chosen, which amounts to designing a typical or representative property. The aggregation of the implicit price changes can be done more easily and in an intuitively more appealing fashion by simply computing the adjusted price of the representative property over time. Indexing that property by *i* and periods by *t*, the price index is:

$$\frac{\hat{P}_{it+1}}{\hat{P}_{it}} = \frac{f(\mathbf{x}_i; \hat{\text{ß}}_{t+1})}{f(\mathbf{x}_i; \hat{\text{ß}}_t)} \tag{8}$$

This ratio amounts to estimating the price of the same bundle of characteristics at two different dates. It can of course also be used to compare prices across regions without interference of quality differences. In this volume STEFAN FAHRLÄNDER estimates a HP model in each period and the implicit prices are used to value a representative property. The change in estimated price for that property is the price index. This approach allows for varying relative prices of the property attributes, as opposed to the more standard direct approach, which simply adds period-of-transaction dummies to the HP model. STEVEN BOURASSA, MARTIN HOESLI, DONATO SCOGNAMIGLIO and PHILIPPE SORMANI in this volume adopt an intermediate approach, with time dummies but also coefficients of some property attributes that may change over time.

Also of particular relevance for policy purposes is the use of this HP method for testing whether prices are "fair", i.e. compatible with the market instead of distorted by market imperfections, discrimination or prejudice (e.g. Kiel and Zabel 1996; Zabel, 2008; Hite, 2008). In this volume, Andrea Baranzini, Caroline Schaerer, José Ramirez and Philippe Thalmann apply this approach in order to assess whether there exists discrimination against foreign households, by testing whether the nationality of the tenant contributes to explaining rent differentials just like any quality attribute of the dwellings.

When the HP method is a regression of rents on their characteristics, it can even be used as a reference for rent regulation. Indeed, in Switzerland a simplified version of the HP approach was submitted in 2003 to the popular vote in the context of a revision of rent regulation (see e.g. Geiger, 2006;). The proposal was rejected by the Cantons and the population, but the HP approach is presently again discussed in the context of the next revision of rent regulation, in order to define "abusive" rents on new rental contracts.

In the area of environmental economics, the HP method is used more frequently for estimating the impact of specific environmental amenities or nuisances on property prices.[3] Indeed, many environmental and land use characteristics are not traded in markets and are thus often undervalued. As a result, when assessing public projects and policies, environmental values are often not fully integrated in the discussions or not considered at the same level as e.g. the financial costs related to environmental protection.

Actually, the HP approach is not the only economic valuation technique and the literature proposes various methods for assessing the value of non-marketed goods such as environmental quality (for a survey, see e.g. Mäler and Vincent, 2006; van den Bergh, 1999). The literature developed two families of valuation methods. The first refers to "stated preferences" valuation methods, with the most popular approach being contingent valuation (for an application in the Swiss context, see e.g. Priez and Jeanrenaud, 1999). The HP method belongs to the family of "revealed preferences" valuation approaches. Indeed, if characteristic x_k whose implicit price is computed in equation (3) or (4) is an environmental characteristic, the implicit price measures the impact of that characteristic on property prices. It answers questions such as: What is the loss of wealth

3 The approach is also used to transfer the value of morbidity and mortality risks derived from wages differentials in the labour market to assess environmental risks (see e.g. Viscusi 1993; Baranzini and Ferro Luzzi, 2001, for an application within the Swiss labour market).

for property owners exposed to airport noise? Or: What would rental income be absent a given nuisance? In this volume, three papers apply the HP method in order to value non-marketed goods. Marco Salvi assesses the impact of airport noise on Zurich property prices; Silvia Banfi, Massimo Filippini and Andrea Horehájová identify the impacts on Zurich rents of road traffic noise, air quality and mobile phone antennas; finally, Nils Soguel, Marc-Jean Martin and Alexandre Tangerini use the HP approach to obtain estimates of the impact of a nice view on rents in Swiss Alpine tourist resorts.

The HP approach possesses three main advantages over the other valuation methods. Firstly, the HP is based on households' real willingness-to-pay (WTP) for the dwelling's characteristics as revealed on the market, rather than households' assessment of hypothetical alternatives from which their supposed WTP is deduced (see also Cropper and Oates, 1992). Secondly, it integrates and values environmental quality and the features of the urban neighbourhood of the dwellings in a coherent framework, which also incorporates physical apartment and building quality characteristics. Thirdly, with the recent development of geographic information systems (GIS) (see Cavailhès et al., 2008), statistical treatments and environmental quality measures, the hedonic approach allows to analyze a large portion of the housing/rental market, including thousands of observations, providing thus more reliable indications than, e.g. surveys confined to a few hundred households.

We should however note that the HP method, like all the valuation techniques proposed in the literature, is a partial equilibrium approach, as it assumes that the price of the property would be different without the environmental nuisance and nothing else. Consider a neighbourhood close to a landfill. Comparing prices paid for properties in that neighbourhood with prices paid in other neighbourhoods with the HP method allows identifying the depressing impact on prices due to the landfill. Depending on the size of the market, it might be risky, however, to assume that all those exposed properties would sell at the higher price if the landfill were closed. Indeed, that neighbourhood might precisely be attracting a clientele with low purchasing power and might not find sufficient buyers willing to pay the higher prices. Therefore, as shown by Palmquist (1992), it is only when the externality is "localized" (like e.g. noise) that the hedonic price schedule does not change, and thus the WTP for an environmental change can be determined from the implicit price.

It is even trickier to interpret implicit prices as WTP for protection from the environmental nuisance or for the environmental amenity. To begin with, the marginal WTP is only equal to the marginal implicit price for an individual who is in equilibrium, i.e. who could choose among bundles of characteristics with the same implicit prices until she found the one that maximizes her welfare. The marginal implicit price changes with the level of the corresponding characteristic and, possibly, the levels of other characteristics. So does the individual's marginal WTP, but it unlikely changes in the same fashion as the marginal implicit price. As a result, drawing out the marginal implicit price and integrating does not yield total WTP. It is rather necessary to add structure to preferences, information on occupants and, possibly, the supply side of the market, to be able to estimate WTP in a second stage of the HP method, as shown first by Rosen (1974) and Freeman (1974) and applied by e.g. Bajari and Kahn (2008) and Salvi (2008). The identification problem is much more severe than this brief presentation suggests. However, if it is still possible to extract preferences from the hedonic model, then consumer surpluses can be estimated and be used in cost-benefit analysis or for compensation payments.

Another identification problem plaguing the application of HP method to environmental valuation is that of poor or missing indicators. The size and even the quality and condition of a property are relatively easy to measure. It is much more difficult to measure environmental amenities. Even when technical measures are relatively easy to obtain, such as concentrations of some air pollutant or peak noise levels, it is very hard to be sure that those measures correspond to what tenants and buyers perceive (for a discussion, see Baranzini et al., 2006). Moreover, very often environmental indicators are only available at a relatively aggregate level, e.g. that of the census tract. This might bias estimated coefficients and, more importantly, amplify their standard errors. Spatial econometrics are increasingly used to address this problem, like in the contribution by Silvia Banfi, Massimo Filippini and Andrea Horehájová and Marco Salvi in this volume.

In addition, the HP approach used for environmental assessment faces all the problems of the standard HP method, such as the choice of functional form – for which theory provides very little guidance –, multicolinearity – as many characteristics of properties often go together –, non-standard residuals, segmentation of the data – as multiple housing markets may co-exist with imperfect information and arbitrage (Nelson, 2008). Those problems have relatively little consequence when the goal is to predict quality-adjusted prices as in equation (2), except possibly the market imperfections problem. Thus, the fact that prices depend also on the conditions of the transaction (time on market, bargaining power of buyer and seller) may limit the ability of the HP method to predict prices (see Knight, 2008). Those econometric issues are much more problematic when one is interested in individual marginal prices and even more so when marginal prices are extrapolated to determine WTP.

We emphasize that the HP model can be used not only to estimate the economic consequences of environmental nuisances or to assess the economic value of environmental amenities, but also to consider their distribution among the population. One could argue that local nuisances such as noise and air pollution are compensated by lower housing prices. In that case, a problem arises if that compensation is imperfect, in the sense that some households pay higher rents than other households exposed to similar nuisances. A form of "environmental injustice" can thus result, as discussed by Hite (2008). More in general, when socio-economic or demographic patterns of households are linked to such over-paying, that hints at discrimination, either by landlords or by some feature of housing policy (e.g. rent regulation). This issue is analysed in the paper by Andrea Baranzini, Caroline Schaerer, José Ramirez and Philippe Thalmann in this volume.

3. The Contributions in this Volume

The contributions in this volume cover a large spectrum of the applications of the HP method to the housing and property markets. Indeed, the Swiss research applying the HP approach has been very active and started relatively early by international comparison.

The two opening articles of this volume are devoted to a traditional application of HP, i.e. its use in the construction of housing price indexes.

Steven Bourassa, Martin Hoesli, Donato Scognamiglio and Philippe Sormani compare price indices for single family houses and condominiums based on the HP method with the "official" Swiss property price index, published by the Swiss National Bank, which is based on structured median list prices. They find similar general evolutions between 1981 and 2005, except that the indices based on list prices decline earlier at the end of the 1980s and much more than the HP price index. This is interesting, as list prices are often thought to lag the market when it is bearish because sellers try to delay admitting falling prices. The official index also recovers from its deeper trough earlier and much more strongly at the end of the 1990s. Again, this is not necessarily what one would expect, as bullish markets are precisely those where transaction prices can exceed list prices.

The authors explain their result with the changing composition of traded, and therefore presumably also listed, properties. This is illustrated with the time path of the median surface size of traded houses and condominiums. The story is quite convincing for the latter, which correlates quite closely with the corresponding index based on median list prices. The correlation between median lot size and median list price for single-family houses is less obvious, possibly because lot size is a cruder measure for the quality of a house than living area for a flat.

Nevertheless, this paper shows quite convincingly that the main cause of difference between an index based on median list prices and an index based on the HP model using transaction prices is not so much that the first uses list and the second transaction prices, but rather the fact that the first index does not take quality changes in the data sample into account. If the experience from a full property price cycle can be extrapolated and if we believe that the HP index better reflects true price changes, then the official property price index could serve as a forward indicator of the latter, with a lead of 2 to 3 years.

Stefan Fahrländer's paper demonstrates the feasibility and superiority of the "indirect" approach to computing hedonic property price indices over the "direct" approach. In the indirect approach, a HP model is estimated in each period and the implicit prices are used to value a representative property. The change in the estimated price for that property is the price index. This approach allows for varying relative prices of the property attributes, as opposed to the more standard direct approach, which simply adds period-of-transaction dummies to the HP model. Bourassa, Hoesli, Scognamiglio and Sormani in this volume adopt an intermediate approach, with time dummies but also coefficients on some property attributes that may change over time.

The direct approach is much more parsimonious with the data than the indirect approach, which needs sufficient data to adequately estimate a hedonic equation in each period. Even Stefan Fahrländer's implementation is not purely indirect throughout, because of the lack of enough data for the 1985–1999 period. He thus has to resort to time dummies for that period, particularly as he also differentiates among 40 regions. The regional differentiation is handled through fixed effects, which amounts to assuming that marginal prices are more stable across Swiss regions than across time. That assumption of an unsegmented market deserves testing, particularly as other contributions in this volume suggest market segmentation, see the contribution by Nils Soguel, Marc-Jean Martin and Alexandre Tangerini, but in particular the article by Dragana Djurdjevic and Christine Eugster.

Stefan Fahrländer estimates two time series of HP models, for condominiums and for single-family houses, each one using centred moving samples of six quarters. He shows the index for a particular type of condominium in a particular area. This index went up by 40% between 1985 and 1991, declined by about 27% from that peak to a trough in 1999, and grew from there by about 33% until 2004. Comparing with the index computed by Bourassa, Hoesli, Scognamiglio and Sormani, this pattern of evolution is much more pronounced than their hedonic index for Switzerland. In fact, it looks more like the evolution of the official index based on median list prices. But this is probably due to the fact that Stefan Fahrländer chose to illustrate his index in a region where price movements were particularly strong.

The next four papers deal with the issues of valuing non-marketed goods, market segmentation and spatial correlations. The papers by Marco Salvi and by Silvia Banfi, Massimo Filippini and Andrea Horehájová are concerned, among other issues, by valuing the noise impacts. The application of the HP method to assess and value the impact of noise possesses a longstanding tradition in Switzerland, since the results of HP studies can contribute to a wide range of policy issues. For instance, in Switzerland the noise legislation contains provisions indicating that measures against noise have to be "proportionate" and "economically tolerable", which implies an assessment of the economic efficiency of such measures (see OFEFP, 1998). In addition, HP studies can be used as a basis in order to help determine the monetary compensation for exposure to aircraft noise. As a result, in Switzerland there are a number of studies using the HP approach to value road and aircraft noise, some of the earlier papers being those by Pommerehne (1987) for Basle, Thalmann (1987) for Lausanne, Grosclaude and Soguel (1992) for Neuchâtel, and Iten and Maibach (1992) for Zurich.

Marco Salvi's contribution to this volume is particularly important as he is personally involved in the calculation of the compensations that Zurich airport might have to pay to homeowners for the additional noise generated since the airline routes were changed. This paper is obviously not the first estimate of the incidence of airport noise on property prices, but this contribution is particularly careful from the methodological point of view, by using a very rich dataset and developing interesting variables.

Consider first the data. Salvi managed to collect an exceptional sample by the number of observations, 3 947 transactions, and the richness of the descriptors, further increased by geographical data (GIS) used to describe topography and view. In addition, Salvi can use very precise measurements of noise exposure at each hectare of the canton of Zurich. The quality of these data would already justify an estimation of noise impacts improving considerably existing studies.

To those data, Salvi adds leading edge analysis in the consideration of spatial interactions in the hedonic price model. Testing empirically those interactions is one important contribution of the paper, as important as its estimate of the impact of airport noise. It shows that the spatial correlations are statistically significant, but at the same time they practically do not affect the results. Among the results, it is obviously those which relate to aircraft noise, which are the most interesting. They show that the price of a house drops by about 0.7% per additional dB of average daytime noise (6 am–10 pm), or per additional dB of average peak hour noise or average evening hours noise (9–11 pm). This implies noise discounts in the range of 2 to 8% for the vast majority of properties. In our opinion, this contribution opens interesting doors for further research, in particular concerning the treatment of the temporality of the data. Indeed, the transactions used spread out between 1995 and 2007. The price trend over those 12 years is taken into account through time dummies, and the noise data describe the situation at the time of the transaction. However, the noise levels changed over time. It is a key question for hedonic assessment but also for compensation payments whether prices reflect only the level of noise at the time of the transaction or whether the buyers anticipated the changes. Handling anticipated quality changes in hedonic models is a challenging issue for future research.

Silvia Banfi, Massimo Filippini and Andrea Horehájová carefully estimate a standard HP model for the rental market of Zurich. They place special emphasis on the influence of three environmental variables: particulate matter concentration; road traffic noise level and, quite innovatively, distance to mobile phone antennas. The authors do not spend much time discussing whether tenants are really aware of those objective measures of exposition to more or less dangerous nuisances. Nevertheless, they find that the influence of antennas is most significant when it is measured by a dummy variable that indicates whether or not it stands at less than 200 meters from a dwelling, a distance which lies exactly between the sample median and mean. The authors find that the HP model is improved when the sample is split into dwellings belonging to profit and non-profit landlords. Non-profit landlords generally set their rents based on costs, which are frequently lowered by subsidies, either deliberately or under strict rent control. As a result, the authors find, like previous studies, that dwellings in the non-profit sub-market are about 20% cheaper than those in the profit sector, when quality differences are taken into account. Furthermore, they find, as one would expect, that non-profit rents are less sensitive to dwelling characteristics that have little cost impact (only through land prices), such as precisely the less perceptible environmental variables measuring air pollution and electrosmog (noise lowers non-profit rents actually somewhat more than profit rents). This result confirms nicely Rosen's (1974) model, which explains hedonic prices as the result of demand (preferences) and supply (cost) factors. In the non-profit sector, cost factors predominate, while in the profit sector it is preferences. The extraordinarily and permanently low vacancy rate in the city of Zurich (it counted only 180 vacant dwellings on June 1, 2007, or 0.09% of the stock) allows for the co-existence of the two price models.

Nils Soguel, Marc-Jean Martin and Alexandre Tangerini use the HP model to test for segmentation on the market for flats in Swiss Alpine tourist resorts and to obtain estimates for the impact of a nice view on rents. There is a strong presumption that flats which are let furnished on a weekly basis – which the authors call "tourists' apartments" – command different rents than flats that are let unfurnished on a yearly basis – which they call "residents' apartments" –, even though the determinants of rents, and particularly the impact of a nice view, could be the same in relative terms. It would have been interesting to compare total rental income for both types of flats in order to assess arbitrage on the supply side, but the authors only report the sum of weekly rate for the tourists' apartments in February and March. The average rent paid by the tourists is 5.7 times higher than what residents paid for the same period. The fact that residents pay the same rent throughout the year for unfurnished, uncleaned and typically somewhat smaller flats while tourists occupy their furnished and cleaned flats only seasonally can explain part of this difference. Even if those two segments do not really compete, at least on the demand side (landlords might be more likely to compare rental incomes when choosing how to let their flats), it is still interesting to test whether rents depend similarly on the same characteristics. Therefore, Soguel, Martin and Tangerini regress the two months' rents in the touristic and residential segments on the same set of characteristics, including a sophisticated measure of the quality of the view from each individual flat. They gathered a very rich set of housing attributes but for only 510 flats in six resorts.

Although the rent levels are quite different, the estimated coefficients are comparable due to the log-log format of the estimated HP model. The authors find that some variables have very similar impacts on rents in the two segments in terms of elasticities, in particular the quality-of-view and equipment-of-the-flat variables. On the other hand, the tourist rental is much more responsive to the average length of the ski runs near the resort. The quality of the view can account for as much as 21.6% rent differential between the resort offering the best view (Champéry) and the resort offering the view of least quality (Haute-Nendaz) among the six resorts considered.

Dragana Djurdjevic and Christine Eugster's contribution is in the tradition of testing for market segmentation. Indeed, most of the existing hedonic housing models were estimated in Switzerland for individual urban or cantonal markets. The reason was generally not the belief that markets are segmented, but rather the great geographic variability in the availability and quality of the data. Djurdjevic and Eugster show that it is possible to estimate a model for the whole Swiss market (after all, it counts only 2 million rental dwellings), although data availability forces them to consider only 327 of the 2715 Swiss municipalities and only 8 cantons separated from the other 18, which we shall call "rest of Switzerland" (ROS). This cantonal segmentation has more to do with the geographic coverage of the property owners they drew the information from than with population concentrations.

In the paper, Djurdjevic and Eugster test for segmentation first by including dummies for the 8 cantons in a standard ordinary least squares (OLS) specification of a log-log model, and then by adding interaction terms between the cantonal dummies and the log-surface of the apartments, allowing thus for variable slopes. The first model confirms that rent levels vary significantly between cantons, with a maximum difference of almost 9% between the cheapest (ROS) and the most expensive canton (Basle City). The second model corrects the picture somewhat as six of the eight cantons have negative interaction terms. Only in the half canton of Basle City are rents proportionally even more expensive for larger flats.

Next, Djurdjevic and Eugster estimate a multilevel model, which has the same functional form and explanatory variables as the OLS specifications without the cantonal dummies, but which allows for a richer structure of the residuals. Indeed, the intercept and the slope of the log-surface of the apartments are assumed to vary randomly between the municipalities. Not surprisingly, by accounting for differences between municipalities, this model obtains closer predictions of rents than the models with cantonal segmentation only. The cost is of course that it becomes harder to use the model for prediction, as the computed residuals of the sample have to be used to compute the residuals to add to the fixed part of the model. It is interesting to note that the structural variables obtain very similar coefficients in the three models, indicating that marginal effects are quite robust.

The model is used to draw a map of rents for a typical apartment across Switzerland, with rents for an average apartment varying by a factor of three between the cheapest and the most expensive municipality! Note however that this is not fully attributable to the residuals in the multilevel apartment. The greatest part of the differential is captured by the structural variable describing the municipalities' "macro-situation", which is essentially the average level of listed rents in each municipality.

Finally, Andrea Baranzini, Caroline Schaerer, José Ramirez and Philippe Thalmann estimate HP equations for the rental housing markets of the canton of Geneva and the city of Zurich in order to test whether foreigners pay higher rents than Swiss tenants for the same quality. That would suggest price discrimination, but there are more possible reasons for such a rent premium, related to risks and costs for landlords and to lower market knowledge and elasticity of demand of foreign households. Baranzini, Schaerer, Ramirez and Thalmann find a small but significant rent premium of about 2%. It is substantially larger for foreigners with relatively low education achievement, who pay between 5 and 7% more on average for the same dwelling than low education Swiss.

With the same HP equations, Baranzini, Schaerer, Ramirez and Thalmann also test for prejudice, i.e. the possibility that rents are lower the higher the proportion of foreigners residing in the neighbourhood. Indeed, they find that rents are lower by 0.22% in Geneva and 0.02% in Zurich per percent increase in the proportion of foreigners. Again, there might be more than prejudice behind those coefficients, which might capture unobserved neighbourhood qualities correlated with the proportion of foreigners. Indeed, HP estimates that account crudely for those unobserved qualities through neighbourhood fixed effects yield substantially smaller "prejudice" coefficients. But even with that correction, the "prejudice" coefficients are large when a distinction is made between foreigners with high and low education achievement. Thus, rents are lower by 0.30% in Geneva and 0.25% in Zurich per percent increase in the proportion of low education foreigners. On the converse, they are higher by 0.49% in Geneva and even 0.94% in Zurich per percent increase in the proportion of high education foreigners.

These results show that rents are affected by the nationality of the tenant and the socio-economic composition of the neighbourhood, but there is no strong evidence of discrimination and prejudice against all foreigners. It is interesting to note that omitting those variables from the HP equations hardly modifies the estimates for the implicit prices of the traditional dwelling, building and neighbourhood attributes.

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