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The historical development of the Swiss rental market - A new price index

Mihnea Constantinescu and Marc Francke

OFRC Applied Paper No. 2012-02

October 2012

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**The historical development of the Swiss rental market
A new price index**Mihnea Constantinescu^{†,*} and Marc Francke^{‡,*}

OFRC Applied Paper No. 2012-02

October 2012

Ortec Finance Research CenterP.O. Box 4074, 3006 AB Rotterdam, The Netherlands,
www.ortec-finance.com**SUMMARY**

A new data set is employed to construct an index of the Swiss rental residential market starting as early as 1936. Given the data sample at our disposal of slightly less than 1000 paired data points spread across all Switzerland, we focus on using the most efficient type of repeated-measurement index to evaluate the yearly price development of the rental property market. In the process of building the index, an alternative of the SPAR method (Sale Price Appraisal Ratio) is developed and compared against a structural time series model and the Case-Shiller approach. The newly developed ISPAR (Inverse SPAR) method yields qualitatively similar results to the regression based methodology yet is influenced to a lesser extent by the sample size. The structural time series model is the version least influenced by the sample size. An interesting finding in our sample is that despite the large time span between successive price measurements, no notable improvement is obtained in using the 3SLS method of Case-Shiller against the traditional Bailey et al. method.

Keywords: long-run price index, Swiss rental market, structural time series index, thin market, arithmetic average index

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1 Introduction

The evolution of real estate prices is closely monitored both by government agencies and investors alike. Their impact on the macroeconomic policy has been clearly shown in the past years and given the size of this asset class, it will most likely retain its importance in the future.

The main purpose of the paper is to track and analyze the historical development of the prices of rental property in Switzerland. Although this may be of little interest to the consumer of space (the tenant), the financial and economic characteristics of the property as an asset will decide if development will be undertaken and space is added to the existing inventory. This is at times neglected as the focus is on demand-side factors such as the price paid by the consumer (rent) and how it stands in proportion to his/her income. An understanding of what drives the supply side is particularly interesting in this setting as the investment objective of the asset holder may be completely disconnected from the drivers of demand. The level of the rent will clearly be important to the investor (rent influences both demand and offer), but in a market dominated by institutional investors, it will also be the volatility in prices that will weigh heavily on the decision to purchase or develop. The reason for this is the higher regulatory capital charge associated with a higher volatility asset.

Switzerland is a particularly fertile ground for this type of analysis as multi-family rental properties are present in many institutional portfolios. This may be explained by the combination of low vacancy rates coupled with pass-through clauses in rental contracts that allow a good portion of inflationary pressures to be passed on to tenants without a considerable delay. The low volatility in values as compared to other asset types and the attractive cash-flow pattern are thus the two main drivers of supply. This implies that supply-side arguments are very much determined by the financial characteristics of the asset price: historical return and volatility. The extra insight in the determinants of supply should enable us to better understand the equilibrium mechanism in the rental market and the its spill-over effects on the decision buy versus rent.

The contribution of the paper is two-fold: the computation of a new long-run index of rental prices in Switzerland that uncovers several cycles of price development of rental multi-unit housing as well as a new index construction method, with the second contribution being actually the result of the particularity of the data sample at our disposal. We could have benefited from a larger data sample but this was unfortunately not available. The existing data-sample has been gathered at very high costs, many of the transactions being manually registered from the archives of the companies managing the assets. Confidentiality related to the identification of the assets limited our ability to obtain hedonic variables severely reducing the list of possible estimation techniques.

Among the existing indexes tracking multi-family rental, two are of relevance to this paper. The first index is the IAZI Price Index¹. This is an index composed of both residential and commercial property with residential making up roughly a half of the underlying pool used to estimate the index. This index is computed starting from 1988. Although mixing the types of properties increases the sample size and thus decreases the standard error of the index, mixing the various real estate sectors brings the risk of distorting the actual development of the individual sectors. This occurs both in terms of development of the sub-markets as well as in terms of volatility and correlation to other asset classes. Understanding risk (as measured by volatility and correlations) is of utmost importance for investors trying to match the income and risk of real estate with that of its outstanding liabilities. The FINMA (Swiss Financial Market Supervisory Authority) requires any Swiss institutional investor holding rental property in their portfolio to make adequate capital provisions according to the risk of the investment (FINMA (2009)). The index used for the calculation of the risk based capital is the IAZI index. This is done through the computation of the historical volatility of returns and a correlation matrix in which the IAZI index captures the risk of residential property in relation to the other investment opportunities. This index is therefore important not only for the measurement of returns but also for computing the risk based capital needed to keep the investor running in a time of crisis. If the portfolio of the investor has different weights on commercial and residential as compared to those of the index then the risk-based capital might not fully reflect the risk of its investment.

¹ <http://www.iazicifi.ch/de/swx-iaz-i-investment-real-estate-price-index.php>

The second index is a multi-family housing index of the Zürcher Kantonal Bank (ZKB) which is computed from the beginning of 1980 but discontinued after 2000. This index will be used as an appropriate benchmark because the sample composition is very similar to ours.

Our intention is to build an index focused exclusively on multifamily housing starting in the early 1930's which through its sole focus on rental multi-family residential property will hopefully better indicate market trends and correlations to other asset classes over a time frame which more closely matches the holding period for these asset class.

2 Methods of index construction

The existing literature on real estate index construction has been developed initially around the hedonic (Rosen (1974)) and the repeated sale methodology (Bailey et al. (1963)). These methods have been greatly expanded and refined in several directions with indexes specialized for certain market sectors and with applications controlling for a wide range of statistical biases going from sampling error to temporal aggregation (Case and Quigley (1991), Hoag (1980), Clapp and Giacotto (1992), Case et al. (1991), Geltner (1991)). More recently, increasing attention has been paid to the hybrid approach and to special applications for thin markets (Francke (2010), Schwann (1998)). The SPAR (sale-price appraisal ratio) method is also presented in the literature as a less error-prone alternative to the existing regression-based methodologies (De Vries et al. (2009), Bourassa et al. (2006)). As the size and structure of the data sample as well as the availability of alternative data dictated the possible choices of index only those arguments are extracted from the literature which are relevant for the present case. The review of the existing literature is therefore focused on the body of knowledge pertaining to repeated-measurement indexes and the sale-price appraisal ratio method.

2.1 The repeat-sale index

The literature on index construction using the repeated-sales method has grown significantly since its first use by Bailey et al. (1963). The idea of the RS method is that by registering the sales price of a property transacting more than one time, one can determine the increase in the value of that property without having to account for the individual characteristics of the property. The costs associated with gathering all the necessary data for hedonic indexes are greatly reduced. The method saves also the researcher from all the problems related to functional form and coefficient stability present in the hedonic model yet introduces sample selection bias. The composition of the sample of transacted properties at any two points in time may be very different leading so to erroneous conclusions about the overall market situation. If at one point in time a major bank sells most of its distressed properties this will induce a downward bias in the index, giving the impression of a larger drop in price than the average. Lemons and flipping candidates tend to register more frequent transactions with the largest absolute value of price changes.

The repeated-sale method is valid as long as the property doesn't undergo major transformations that significantly change the nature of the asset (such as increasing the surface area or updating the energy efficiency class). Age does change and this has to be accounted for in the measurement as well as the time between two transactions.

If this exercise is performed across many properties and the sample structure is representative for the market one can then register the growth rate common to all properties in the market. This common trend will be captured by a series of time dummies which will represent the market development as reflected by the growth in property value. The procedure's aim is to estimate market growth rates and not actual levels. One way to derive the repeated-sale model is by considering the logarithmic price level at two points in time for the same property (let $P_{i,t}$ and $P_{i,s}$ be the prices of property i at times t and s respectively, with $t > s$) as explained by the hedonic variables of that property (let $X_{i,j}$ be one such variable; let k be the total number of variables). Then the registered price difference for property i may be attributed to the passage of time as tracked by the time-dummies μ_t , with t running over the entire period that the index is to be evaluated. The price dynamic given

in Eq. (2.1) is valid as long as the hedonic characteristics and their coefficients don't change over time.

$$\ln(P_{i,t}) - \ln(P_{i,s}) = \underbrace{\left(\sum_{j=1}^k \beta_j X_{i,j,t} - \sum_{j=1}^k \beta_j X_{i,j,s} \right)}_{\Delta} + \left(\sum_{\tau=t}^T \mu_{\tau} D_{i,\tau} - \sum_{\tau=s}^T \mu_{\tau} D_{i,\tau} \right) + e_{i,t}$$

The above equation reduces to

$$\ln\left(\frac{P_{i,t}}{P_{i,s}}\right) = \sum_{\tau=s}^t \mu_{\tau} D_{i,\tau} + e_{i,t} \quad (2.1)$$

This is the basic econometric specification frequently found in the literature and the one, which along with the Case-Shiller three-stage generalized least squares, will be used in the present analysis. The term $e_{i,t}$ is the random error which is assumed to be i.i.d. normal with constant variance in the Bailey et al. (1963) model, heteroscedastic variance in the Case and Shiller (1987) model or serially correlated normal errors in the specification of Graddy et al. (2011). The coefficient μ_{τ} is the logarithm of the cumulative price index at time τ . Implicit in this derivation is of course the assumption that house characteristics and their coefficients do not change over time, except for age. If this assumption fails and the characteristics of the house do change then the term Δ will no longer be zero rendering the estimated $\mu'_{t,s}$ biased.

A notable improvement of the method is the weighed repeat sales methodology of Case and Shiller (Case and Shiller (1987)). The added value of this application is the observation that heteroscedasticity is present in housing data. The sampling variability of registered changes is assumed to be larger the larger is the time span between the two transactions. Assuming that the underlying house value is a Gaussian diffusion, one can correct for the presence of the price heteroscedasticity after performing a three stage regression in which the time span between transactions is used as the weight in the GLS estimation.

Although this improves the efficiency of the estimates for the U.S. sub-markets it does not produce considerable improvements for our sample. Consistent with the results of Jansen et al. (2008) no notable difference is found between the standard specification given in Eq. (2.1) and the Case-Shiller 3SLS estimates.

The present index will be an alternative of the traditional repeat sale method as what will be used are no longer two transaction prices but the purchase price and the latest valuation. Therefore the index will be a repeat measurement index similar to the one used by Gatzlaff and Ling (1994). The econometric specification will be given as

$$\ln\left(\frac{A_{i,t}}{P_{i,s}}\right) = \sum_{\tau=s}^t \mu_{\tau} D_{i,\tau} + e_{i,t} \quad (2.2)$$

where all variables have the same interpretation as in equation (2.1) with the exception of $A_{i,t}$ which is the appraised value of property i as of time t instead of the actual transaction price. The use of the appraised value instead of the actual transaction price does raise some questions. Given the documented biases present in the appraisal process (Diaz III (1999), Geltner (1991), Geltner (1989b)) isn't this method going to bias the entire index? A certain amount of bias will be present for properties which have been recently acquired and whose valuation occurs within one year from purchase. The further apart the measurements the less this bias is present (the smoothing coefficient becomes a geometric series which decreases towards the date of purchase).

The results in the literature point out that the information present in an appraised value lags actual market developments by up to an year Geltner (1989b). This leads to several authors using some form of unsmoothing procedure to extract the market information out of the appraisal index with Blundell and Ward (1987) and Geltner (1991) among the first applications. The underlying assumption used in the unsmoothing filter is that appraisers form opinions about current values using some mix of current market information and past appraisal values. This leads to specifying an appraisal formation equation which puts some weight on actual market transactions and some on previous appraisals. The valuation is assumed to be formed according to the following equation

$$A_t = \alpha \bar{P}_t + \underbrace{(1 - \alpha)}_{\text{smoothing}} A_{t-1} \quad (2.3)$$

Equation (2.3) can be used to back out the actual expected sales price given that one knows the smoothing coefficient and the previous period appraisal. The expected market price equals

$$\bar{P}_t = \frac{A_t - (1 - \alpha)A_{t-1}}{\alpha} \quad (2.4)$$

The smoothing parameter can be obtained by regressing the returns of the appraised index on its past values (Blundell and Ward (1987)) when the smoothing occurs at only one lag. Several lags may be used if further autocorrelation is still present in the regression residuals.

This adjustment is aimed of eliminating the appraisal bias and subsequently using the expected transaction price (the unsmoothed price) in the index estimation rendering it so closer to the original repeated sale method. This is expected to improve the efficiency of the index construction and bring it closer to the actual market development. Equation 2.2 may now be estimated using the value obtained in equation 2.4:

$$\ln\left(\frac{\bar{P}_{i,t}}{P_{i,s}}\right) = \sum_{\tau=s}^t \mu_{\tau} D_{i,\tau} + e_{i,t} \quad (2.5)$$

Unfortunately this approach was not possible due to two reasons: first of all, the smoothing parameter is obtained by regressing an appraisal return series on a lag of the same series. The only reliable appraisal index for Switzerland is the index provided by IPD which has less than 10 data points for this exercise - the IPD Switzerland is thus too short to yield a reliable estimate of the smoothing parameter. This problem may be mitigated up to some level by using an average smoothing parameter frequently found in the literature (namely 0.5). The insurmountable problem was nevertheless that the data set was collected for a standard repeated measurement index - the data pair comprised thus the purchase price and the latest valuation, not the latest two subsequent valuations as this technique requires. Hopefully this will be remedied in the future when the latest valuations are updated.

Marcato (2005) shows that the repeat measurement method using appraisal values yields similar results when compared to either hedonic or backward looking indices. The technique developed in this paper may improve therefore the efficiency of this index construction procedure which already is found to produce stable results using appraised values.

2.2 The Sale Price Appraisal Ratio index

The Sale Price Appraisal Ratio Index (SPAR) is an arithmetic repeat measurement index which makes use of observations of value of the same property at different points in time. Although similar to the repeat sale in the choice of data, two differences set the SPAR method apart from the standard repeat sale method: this method uses an appraised value as the first measure and a transaction price as the second measure and the index is regression-free being computed as a chained series of ratios. The method has been successfully implemented around the world by Bourassa et al. (2006) in New Zealand and De Vries et al. (2009) in the Netherlands. The method is promoted as a reliable index methodology from the viewpoint of regulatory bodies looking for a proper gauge of the evolution of the property market (Bourassa et al. (2006)). The SPAR therefore has less stringent data requirements as compared to the repeated measurement methodology and is a good choice as far the supervisory requirements are concerned. Using both transaction and appraisal data one may expand considerably the sample size and avoid the various sample biases which plague the repeat sale index. While the repeat sale uses only data from properties that transacted at least twice over the time period under consideration, the SPAR takes in consideration all transactions: being able to use as the first measurement an appraisal value one can then consider all transactions, properties that transact for the first time as well as properties that transacted in the past. The equal-weighted SPAR index number is computed using the formula in equation (2.6)

$$Index_t^{EW} = \frac{(1/n_t) \cdot \sum_{i=1}^{n_t} (S_{it}/A_{i0})}{(1/n_{t-1}) \cdot \sum_{i=1}^{n_{t-1}} (S_{it-1}/A_{i0})} \cdot Index_{t-1}^{EW} \quad (2.6)$$

where $Index_t^{EW}$ is the value of the equal-weighted index at time t , S_{it} is the sale price of property i at time t , A_{i0} is the appraised value of property i at the base period and n_t is the number of transactions at time t . Equation

(2.6) shows that in each period the aggregate value growth is averaged across the existing properties. This aggregate growth is then divided by the average aggregate growth of the previous period giving thus an average period growth rate. This rate is further multiplied with the previous index value to indicate the market development over the existing period. The equally-weighted version is adequate to evaluate the average market growth rate. All properties receive the same weight in the calculation of the index (irrespective of the absolute value of their price) and therefore contribute equally to the price development. A value-weighted version may also be computed if one is interested in evaluating a portfolio or a certain market segment (to compare for example large-value properties against small value ones). As the name indicates, the value-weighted version gives a larger weighted to more expensive properties and small to smaller value ones. A value-weighted version of this index can be computed using equation (2.7)

$$Index_t^{VW} = \frac{\sum_{i=1}^{n_t} S_{it} / \sum_{i=1}^{n_t} A_{i0}}{\sum_{i=1}^{n_{t-1}} S_{it-1} / \sum_{i=1}^{n_{t-1}} A_{i0}} \cdot Index_{t-1}^{VW} \quad (2.7)$$

If larger properties appreciate by a larger average rate than smaller properties then a value-weighted index will post larger price increases as compared to the equally-weighted version.

2.3 Developing an alternative SPAR method

The standard SPAR makes use of the ratio of transaction price (second measurement) to appraised value (first measurement) where all properties in the index have an appraised value in the base period. In our case the data is composed of pairs of purchase prices (first measurement) and latest appraisals (second measurement). This data feature makes the original SPAR method impracticable for our purposes, therefore an alternative SPAR method is developed. The new technique uses the same chained ratio philosophy of the original SPAR yet is adjusted so that it can be used with the available data set. This alternative method is called the inverse SPAR (or ISPAR) due to the inversion in the definition of the base.

The main change comes from recognizing that one can use the latest valuation as the base period and compute the index "going back" in time and not forward as the original SPAR is designed. This inversion has no major impact on the features of the model. It remains a constant-quality index which is easy to construct and is consistent when new data is added to the original sample. The main change is therefore that we set the base at the time of the last observation (in our case 2007) instead of the first observation as it is currently done. One therefore computes the development of the index going back from 2007 towards its initial value which will correspond to the period of the first purchases. The equation describing the equal-weighted index will be now

$$Index_{t-1}^{EW} = \frac{(1/n_{t-1}) \cdot \sum_{i=1}^{n_{t-1}} (S_{i,t-1}/A_{i,0})}{(1/n_t) \cdot \sum_{i=1}^{n_t} (S_{i,t}/A_{i,0})} \cdot Index_t^{EW} \quad (2.8)$$

The same inversion also works for the value-weighted index. The value-weighted ISPAR index can be computed using equation (2.9).

$$Index_{t-1}^{VW} = \frac{\sum_{i=1}^{n_{t-1}} S_{i,t-1} / \sum_{i=1}^{n_{t-1}} A_{i,0}}{\sum_{i=1}^{n_t} S_{i,t} / \sum_{i=1}^{n_t} A_{i,0}} \cdot Index_t^{VW} \quad (2.9)$$

It can be seen from the formulas used to compute the ISPAR that no major changes have occurred in the actual computation of the index. The only notable modification is the "inversion" of the time with the index being computed from the present to the past. This convenient trick allows one to make use of this methodology even when the base is in the present instead of being in the past.

2.4 The local linear trend repeat sales model

In a standard repeat model the estimate of the log price level (change) in a period is very sensitive to transaction noise. This is particularly so when the number of transactions per period is low. An individual outlier can have a tremendous impact on the estimation of the log price level (change).

Different methods have been proposed to reduce the impact of transaction noise on the estimate of log price level (change). One option is to apply smoothing techniques on the estimated price levels of the repeat

sales models, such as locally weighted regression as in for example Cleveland (1979) and Wand and Jones (1995, Chapter 5). Another option is to relate log price levels (changes) to a set of economic and financial explanatory variables such as the model developed by Baroni et al. (2007). Another approach is to replace the dummy variables by a smooth and flexible deterministic function, which depends on a relatively small number of parameters, see for example McMillen and Dombrow (2001) and McMillen and McDonald (2004).

Goetzmann (1992) replaced the dummy variable specification by a stochastic trend specification, provided by a random walk with drift. In contrast to the dummy variable approach, the stochastic trend specification enables the prediction of the price level based on preceding and subsequent information. It implies that even for particular time periods where no observations are available, an estimate of the price level can be provided. The use of a structural time series model results in a more stable price index.

Francke (2010) discusses in more detail the various smoothing methods and generalizes the Goetzmann approach by specifying a more general structural time series model, a local linear trend model. The second generalization concerns the estimation of the signal-to-noise ratio parameters. In this article we adapt this model to deal with pairs of transaction prices and assessed values.

Assessed values are available at time T and transaction prices at time $t = 1, \dots, T$. Let a and s denote respectively the log assessed value and the log transaction price. The log assessed value and the log transaction price can be expressed as a function of the unknown log market value (v) and the log price level μ :

$$a_{iT} = \alpha + \beta v_{iT} + \eta_{iT}, \eta_{iT} \sim N(0, \sigma_\eta^2), \quad (2.10)$$

$$s_{it} = \mu_t + v_{iT} + \varepsilon_{it}, \varepsilon_{it} \sim N(0, \sigma_\varepsilon^2). \quad (2.11)$$

In case $\alpha = 0$ and $\beta = 1$, then the assessed values are unbiased estimates of the unknown true market value; there is no over- or undervaluation of cheap or expensive properties. Eq. (2.11) states that the transaction price at time t is an unbiased estimate of the market value at time T corrected for the difference in price level between t and T ($\mu_T = 0$). By subtracting Eq. (2.10) from Eq. (2.11) we get rid of the unknown market value v_{iT} and get

$$\begin{aligned} s_{it} - a_{iT} &= -\alpha + s_{it}(1 - \beta) - \mu_t\beta + \varepsilon_{it}\beta - \eta_{iT} \\ &= -\alpha + s_{it}(1 - \beta) + \mu_t^* + \omega_{it}. \end{aligned} \quad (2.12)$$

Note that it is not possible to identify both σ_ε^2 and σ_η^2 ; only pairs of observations are available. We will assume that $\omega_{it} = \varepsilon_{it}\beta - \eta_{iT}$ has variance σ_ω^2 . If we treat μ_t^* as fixed unknown parameters, we have the standard repeat sales model, supplemented with two regressors, a constant and the log of the transaction price. It can be estimated by ordinary least squares, and the log price level is μ_t^*/β .

In the local linear trend repeat sales model the fixed unknown parameters for the log price level are replaced by a local linear trend model, given by (for this application in reversed time order)

$$\mu_{t-1}^* = \mu_t^* + \kappa_t + \zeta_t, \zeta_t \sim N(0, \sigma_\zeta^2), \quad (2.13)$$

$$\kappa_{t-1} = \kappa_t + \xi_t, \xi_t \sim N(0, \sigma_\xi^2), \quad (2.14)$$

for $t = T, T-1, \dots, 1$, and $\mu_T^* = 0$. The local linear trend model can be characterized as a linear trend model, where both the constant and the slope vary over time. Unlike a linear trend it can cope with periods of rising and falling prices. It includes several specific models: a linear model ($\zeta_t = \xi_t = 0$); a random walk with drift ($\sigma_\xi = 0$), equivalent to the prior proposed by Goetzmann (1992); a random walk ($\kappa_t = 0$); and fixed unknown parameters ($\sigma_\xi \rightarrow \infty$), the standard repeat sales model.

Following Case and Shiller (1987, 1989) we adjust Eq. (2.12) to reduce the impact of pairs that have a long time span between successive measurements, giving

$$s_{it} - a_{iT} = -\alpha + s_{it}(1 - \beta) + \mu_t^* + \omega_{it} + u_{it}, \quad (2.15)$$

$$u_{it+1} = u_{it} + S_{it}, S_{it} \sim N(0, \sigma_S^2). \quad (2.16)$$

Conditional on $(\sigma_\omega, \sigma_\zeta, \sigma_\xi, \sigma_S)$ the model provided by Eqs. (2.13)–(2.16) can be estimated by generalized least squares. The parameters $(\sigma_\omega, \sigma_\zeta, \sigma_\xi, \sigma_S)$ can be estimated by maximum likelihood. For a detailed description of an efficient estimation procedure, see Francke (2010).

Year	#	Year	#	Year	#	Year	#	Year	#	Year	#
1901	2	1945	2	1958	19	1971	12	1984	16	1997	3
1927	1	1946	16	1959	16	1972	11	1985	8	1998	6
1928	1	1947	15	1960	29	1973	7	1986	13	1999	10
1931	1	1948	13	1961	17	1974	1	1987	8	2000	40
1936	4	1949	24	1962	16	1975	3	1988	6	2001	43
1937	1	1950	31	1963	9	1976	6	1989	9	2002	10
1938	3	1951	23	1964	8	1977	18	1990	9	2003	3
1939	2	1952	21	1965	11	1978	20	1991	7	2004	5
1940	5	1953	14	1966	16	1979	13	1992	12	2005	114
1941	4	1954	17	1967	10	1980	15	1993	7	2006	8
1942	11	1955	18	1968	13	1981	22	1994	7	2007	17
1943	11	1956	9	1969	20	1982	17	1995	5		
1944	2	1957	10	1970	17	1983	16	1996	5		

Table 3.1: Number of purchases prices across time

3 Data

The available sample size is of 994 pairs of purchase prices and 2007 valuations with the corresponding purchase years (the earliest purchase year is 1901 while the latest is 2007). All properties are being held in the portfolio of either one of the institutional investors that contributed data to our pool. The sample selection bias is not vital for our sample as it is for repeated sales data. Samples containing only properties transacting at least two times are prone to sample selection bias as the registered transactions may be in most cases "lemons" or buildings that were redeveloped. A survival bias is nevertheless present in the sample because no data was available on the properties that were sold from the portfolios. These properties may have become less attractive over time either due to inherent market conditions or because they did not correspond to the asset-liability objectives of the investor. It is thus difficult to postulate that the properties were necessarily bad-quality properties or properties in bad markets that would so further imply that the sample is tracking exclusively top-tier properties. Table (3.1) shows the number of available data points for each year starting in 1901.

The data covering the period 1901 - 1936 is not used as too many years lack any observation. Several years have very few transactions such as 1937 to 1939, 1974, 1997 and 2003. We expect the accuracy of the Case-Shiller and of the ISPAR index to be low around these years. Also of interest to us is the year 2005 in which a very large number of transactions was registered. We suspect a large portfolio was acquired by one of the companies supplying data to the data pool as a result of the restructuring of SwissAir. For the time being, only a part of the sample has cash-flow data (either rents and/or maintenance or renovation data) meaning that only a price index can be computed going back to the 1930's. The lack of this data has a much larger impact on the results and efficiency of the repeated measurement index than on the ISPAR index. Repeated appraisals will be a requirement for the index to be quality adjusted. In this case we deal with the latest available appraisal implying that no splicing is needed for our index. Nevertheless cash-flow data is still important in understanding the impact of renovations on values and is a pre-requisite for computing a total return index.

Lack of data on renovations may represent a major drawback as we might estimate a price increase due simply to renovation and not related to the actual market dynamic. We would argue that the indexes still properly indicate the actual market development due to two reasons:

- Functional and economic obsolescence is not accounted for in the sample (estimated at roughly 2% per year), expecting therefore any major renovations to be counterbalanced over large periods of time by the compounded effect of obsolescence, as in Harding et al. (2007).
- We compare our index for the period 1980-2000 with the ZKB multifamily index, an index tracking exclusively the multi-family rental segment. The two indexes have very similar dynamics, leading us to believe that the mix of appraisal and transaction data has useful applications.

3.1 Outliers

An initial model has been used to detect outliers. The model is a simplified version of Eqs. 2.12–2.13 where it is assumed that $\beta = 1$ and $\kappa_t = 0$, so

$$s_{it} - a_{iT} = -\alpha + \mu_t^* + \omega_{it}, \quad \zeta_{it} \sim N(0, \sigma_\omega^2) \quad (3.1)$$

$$\mu_{t-1}^* = \mu_t^* + \zeta_t, \quad \zeta_t \sim N(0, \sigma_\zeta^2). \quad (3.2)$$

The parameter value for σ_ζ is set a priori, equal to 0.075. This implies that the log price change is with a probability of 68% in the interval $(-0.075; 0.075)$ and with a probability of 95% in the interval $(-0.15; 0.15)$. So prices are allowed to adjust over time, but extreme price changes are ruled out. The estimate of σ_ω is about 0.705 with residuals (absolute value) > 1.131 ($= 2 \times \sqrt{2} \times 0.4$) being defined as outliers. The total number of outliers is so 72. The number of transactions actually being used in the estimation of the indexes is 869. That is 87% of the sample starting in 1936.

The presence of a very large number of transactions in year 2005 may raise the concern that the indexes would behave differently if the transactions were eliminated. In order to test the stability of the indexes against this assumption, we compute the LLT and the ISPAR without the data pertaining to 2005 and compared them with the full-sample estimations. The results indicate a very high correlation (0.95 and higher) between the full sample results and the partial sample (excluding all 2005 data) results both for the LLT as well as for the ISPAR. The parameters of the LLT method remain highly significant and stable both for the version in which $\beta = 1$ and the one in which β is estimated from the data.

4 Results

The results are classified according to the family to which the various types of indexes belong, either regression-based (3SLS Case-Shiller, the repeated-measurement index and the LLT) or arithmetic average (EW and VW ISPAR).

The Case-Shiller repeat sales model in Eqs. (2.15)–(2.16) is estimated with the μ_t^* s as fixed coefficients and $\beta = 1$ whereas the Local Linear Trend repeat sales model is given as in Eqs. (2.13)–(2.16). Table 4.1 presents the estimated parameters along with the corresponding standard errors for the regression-based methods. A

	Case-Shiller			Local Linear Trend		
	coef	std. err.	t-value	coef	std. err.	t-value
σ	0.260	0.024	56.157	0.268	0.025	53.051
σ_ς	0.00001	26.759	0.443	0.00004	2.548	3.932
σ_ζ				0.10040	0.208	11.038
σ_ξ				0.00001	2.668	4.327
α	-0.05116	0.111	-0.462	-0.09681	0.088	-1.105
β				0.11521	0.014	8.040
κ				-0.026177	0.012	-2.141
ℓ		-716.86			-724.94	
# par		74			7	
n		869			869	
AIC		1581.7			1463.9	
BIC		1934.5			1497.3	

Table 4.1: The Case-Shiller and the Local Linear Trend at a glance

few remarks are in order at this point.

The parameter α is not significantly different from 0 in either models. $\beta < 1$, being significantly different from 1, implies undervaluation of the expensive properties. The random walk in Eq. (2.16) does not add to the model

(so 3SLS does not provide any notable improvement over the Bailey et al. (1963) for the available sample).

The estimated variance (σ_ξ^2) is almost 0 in both cases (and not significant different from 0 in the Case-Shiller model). The variance of the drift term σ_ξ^2 is almost identical to 0 (although significantly different from 0), implying that the model is essentially a random walk with drift. Overall the trends of the LLT model are smoother. Looking at the log-likelihood of the LLT model one may observe that it is 8 points higher, however it uses fewer parameters: the number of parameters for the Case-Shiller is 71 (year dummies) + 1 (α) + 2 variance parameters for a total of 74 parameters while the Local Linear Trend uses 3 (α, β, κ) + 4 variance parameters adding up to 7 parameters. Using either of the information criteria will show that the LLT indicates a better fit.

The ISPAR indexes, both the equally weighted and the value weighted, are plotted together with the LLT Figure (4.1). The indexes have been computed so as to share a common base in 2007 in order for the graph to convey any meaningful information. The three indexes depict a very similar picture over the long run with the LLT showing considerably more stability over short periods of time. What is noteworthy for our analysis is the greater stability of the LLT index as compared to the other types in periods in which very few transactions are available. The period 1973 to 1975 features currently very few transactions in our database. The CS and the RMI (not depicted) have the largest standard deviation in returns while the ISPAR indicates a more even development. The LLT, as noted previously, is the more stable of all the computed types.

Figure 4.1: The regression based indexes

Summary statistics for the entire 1936-2007 period are provided in Table (4.2). The upper part of the table provides the correlation coefficients between the yearly returns while the lower part indicates the average yearly price change and the standard deviation of change.

As noted previously the LLT has the lowest volatility, followed by the EW ISPAR, the VW ISPAR and the CS. The low correlation coefficient between the CS and the EW ISPAR (0.15) is a reminder of the sensitivity of the results to the selection of the index construction methodology. Although informative per se, these cross-correlation numbers will need to account for any autocorrelation structure in the underlying time-series before a meaningful measure of financial risk can be derived (Constantinescu (2011)).

The three regression indexes and the LLT are plotted in Figure (4.2) against the only external benchmark available at this time (the ZKB Mehrfamilienhaus Index, abbreviated as ZKB MFH). Both the LLT and the

	VW ISPAR	EW ISPAR	LLT	CS
VW ISPAR	1			
EW ISPAR	0.73	1		
LLT	0.30	0.29	1	
CS	0.37	0.15	0.49	1
Average	4.1%	2.9%	3.2%	3.7%
Standard Deviation	23.5%	19.2%	7.0%	33.6%

Table 4.2: Summary Statistics - 1936-2007

ISPAR synchronize well with the market cycle described by the ZKB MFH index. As noted previously, this index was selected as a benchmark due to the similarity of the underlying sample used to compute it. No information is available about the method of computation of the ZKB MFH index, therefore it is impossible at this point to attribute any observed differences to either sample composition or index construction method (or a combination of the two). A portion of the 3SLS Case-Shiller index is plotted together with the LLT and the ZKB MFH index in the upper graph in Figure (4.2). The indexes are calculated with the year 2000 as a common base.

Figure 4.2: Comparing the regression based indexes to the ZKB MFH index

Figure (4.1) is interesting as it also shows the relationship between market liquidity (as tracked by the number of transactions in our database) and general economic activity on the one hand and price development on the other. Many of the cycles' bottoms coincide with a lower number of transactions as compared to the previous peaks.

5 Real Estate and the macroeconomic environment

We begin by examining the period 1950 to 1970. Time-series of growth rates in nominal GDP, levels of the mortgage rate and returns on the ISPAR EW are available in Figure (5.1). The reconstruction efforts following the end of World War II translated into a boom of economic activity all across the continent, Switzerland being no exception. The time frame 1950 - 1970 stands out due to the strong and constant growth in real GDP (an average growth rate of roughly 4.7% in real terms) with inflation doubling in the 60s as compared to the 50s. The response from the Swiss National Bank was an increase in the discount rate which led to an increase in both the key nominal and the real interest rate with a peak around in 1974 (the discount rate increased from an average of 3% over the decade 1960 - 1970 to 5.5% in 1974). The rate increase tamed the growth in GDP and with a lag, led to a softer real estate market. The upper graph in Figure (5.1) plots the change in GDP together with the mortgage rate level and the development of the multi-family market as measured by the returns of the equally-weighted ISPAR index.

These macroeconomic developments are also closely tracked by the number of transactions we observe in our sample: properties were purchased steadily over the two decades starting in 1950 and decrease considerably in volume towards the beginning of 1970 (recall that we only have purchased properties on our sample). The increase in the interest rate diminished leveraged purchases while at the same time, the slower economic growth reduced the attractiveness of property as an investment due to the slower growth rate in rents for the already existing properties.

One interesting observation is that the minimum value in transaction volume (only one purchase was registered for the year 1974) was foreshadowing the negative GDP change for 1975. Transaction volume in institutional portfolios decreases very strongly before any major deceleration in the growth rate of the Gross Domestic Product. This may be seen for the year 1974, which was predicting (or led to) the negative print in GDP for 1975 and also for 1995, which was followed by an almost zero growth year in 1996. Pension plans and insurance companies are major participants in the financing of bank operations through their purchase of corporate bonds. If the decrease in purchased property coincided with fewer funds being allocated to bank financing and a higher discount rate then we obtain a sound explanation for the observed deceleration in GDP growth.

As the employment time-series is very short, we focus on total population and its relation to the real estate market. The bottom graph in Figure (5.1) shows the performance of the rental sector and the development in population, as measured by the percentage change in both variables. As expected, increases in population will put an upward pressure on rents and subsequently on the valuation of the rental asset. One such episode is the stronger than average increase in population during the period 1961 to 1964 followed, with a lag of about two years, by a large increase in the value of rental property. The picture becomes less clear after 1977 because of a structural change in the underlying economic set-up. This can be observed by computing the average and the standard deviation in the growth rates of both GDP and population using a rolling window of 15 years. As of 1977 both the average change and standard deviation of changes decrease. The same results are obtained by analyzing a rolling correlation matrix of GDP, population and inflation. This result should not come as a surprise as both the sample mean and standard deviation are components in the calculation of the correlation coefficient.

As the credit-induced housing boom started towards the end of 70s (the discount rate ranged between 1 to 2%) the real estate investment market saw a strong increase in transactions. The low mortgage rates led to an explosive growth in lending and subsequently in real estate prices around the end of the 80s in most sectors of the market.

We also analyze the interaction between the space market (as described by average rent and number of completed apartments) and the asset market (as described by the returns in our indexes). The bottom chart in Figure (5.2) shows how spikes in rents are followed by increases in the number of completed apartments and subsequently lower real estate returns. One such episode is set in motion by the large growth in rents in 1982 (which also coincides with an increase in population after the contraction years of 1975 and 1976) that triggered development and led to an almost 10% increase in 1984 in the number of completed apartments. For the same year we register a decrease in real estate prices of roughly 2%. Another episode is the constant above average increases in rents between 1990 and 1992 and the steady push in real estate returns from

Figure 5.1: Real estate and the macroeconomic environment

4% to roughly 6.3%. The higher rents and higher asset returns caused the explosive development in the beginning of the 90s, with completions in 1994 being roughly 36% higher than the previous year. All of the new space came into a market that was feeling the reverberations of the housing crash of 1991-1992. The results of this analysis are reinforced by the high and significant values of the cross-correlation between the changes in Construction Investment and both the one year and two year lagged values of LLT and the ISPAR. As expected from the four-quadrant model of DiPasquale and Wheaton (1992), Construction Investment will react to higher asset prices with a lag. The lag represents the time needed to plan the development and obtain the necessary construction authorizations. In our case, the first and second lag of the real estate returns index are strongly associated with increases in Construction Investment, thus increasing asset prices today will positively impact investment over a two years time frame.

The analysis indicates similar developments in the single-family housing market, with prices peaking shortly after the beginning of 1990. The correlation analysis for the period 1977-2007 indicates that the ownership and the rental market do share the financial transmission channel. The correlation coefficient between the rental index and the single-family segment varies between 0.26 and 0.41, depending on the index used. The subsequent crash in the beginning of the 90s led to the failure of several regional lenders (the largest failure being the regional bank Sparkasse Thun) and the consolidation of the entire banking sector in Switzerland. These events may be tracked using either the LLT or the ISPAR.

Some of the investors reentered the market towards the end of the 90s and beginning of 2000. The number of transactions is increasing after this period. The reason for the spike in transactions in 2005 is currently unknown although one anonymous reviewer speculated it might be the liquidation of the properties that belonged to Swissair (the company was reorganized in this period while being taken over by Lufthansa). The 9/11 attacks do not produce any discernable effect in prices although the ensuing economic contraction does translate in a lower number of transactions. All economic shocks are transmitted to the real estate market (through either the consumption or the financing channel) with a considerable lag as shown also in Constantinescu (2010).

Figure 5.2: The Space and Asset Market

We also include in our results the correlation matrix between key variables for the period 1977-2007. The upper table in Figure (5.3) shows the value of the contemporaneous correlation between the yearly changes in GDP, Population, Construction Costs for multi-family housing, Construction Investment, Rent, Number of Completed Apartments and the Volume of Mortgages (both residential and commercial) and yearly changes in the IAZI Private House Index (a hedonic transaction-based index tracking the price of single-family homes), the Value-Weighted and the Equally-Weighted ISPAR, the LLT, the 3SLS Case-Shiller and the KGAST (an appraisal-based index of commercial property). The selection of the time frame is motivated firstly by the observed structural change in the values of the standard deviation of most macro-variables around 1977 and secondly by the length of the various time-series. The correlation numbers are computed for the full period for the VW and EW ISPAR, LLT and CS but only for 1998 to 2007 for the KGAST Index and 1983 to 2007 for IAZI Private House Index, this being the respective maximum available lengths of these two series.

The correlation parameters are consistent with the observed evolution of the economic variables and predictions of the DiPasquale and Wheaton (1992) model. There is a positive correlation between the VW and EW ISPAR as well as the LLT and CS on the one hand and GDP, Population, Construction Investment and Mortgage Volume. The low and negative correlation between the estimated indexes and Rent is due to the nature of our indexes, they are all price indexes. Cash-flows accruing to the investor are not accounted for thus rents will impact the valuation only with a lag as they are incorporated in the pricing model several periods after the positive impulse. This is supported by the positive and significant correlation between lagged values in changes in rents and returns of the LLT index. The index tracking the private house market reacts much stronger to changes in the selected variables (recall this is a transaction-based index) and shows a strong positive correlation to growth in rents. The repeated valuation index has very low correlation values to most macro-variables; this may be explained by the reduced sample used for the calculation.

The bottom table in Figure (5.3) presents the correlation numbers between indexes tracking the price of houses and owned apartments and the price of rental units. The new variable WP represents the Wuest and Partner owner-occupied hedonic transaction-based index. All of the computed indexes are positively related to the existing measures of owner-occupied housing.

	IAZI Private [%]	ISPAR VW [%]	ISPAR EW [%]	LLT [%]	CS [%]	KGAST [%]
GDP [%]	0.57	0.25	0.36	0.32	0.11	0
Population [%]	0.61	0.23	0.4	0.3	0.11	0.15
Construction Costs [%]	-0.17	-0.12	-0.17	-0.37	-0.16	0.18
Construction Invest. [%]	0.51	0.32	0.57	0.56	0.35	-0.21
Rent [%]	0.62	-0.01	-0.05	0.09	0.05	0.16
Completed Apart. [%]	-0.01	0.25	0.23	0.11	0.18	0.12
Mortgage Vol. [%]	0.69	0.27	0.33	0.09	0.05	0.11

	WP [%]	IAZI Private [%]	ISPAR VW [%]	ISPAR EW [%]	LLT [%]	CS [%]	KGAST [%]
WP [%]	1	0.7	0.27	0.36	0.29	0.07	0.1
IAZI Private [%]	0.7	1	0.1	0.26	0.46	0.18	-0.07
ISPAR VW [%]	0.27	0.1	1	0.72	0.37	0.27	0.01
ISPAR EW [%]	0.36	0.26	0.72	1	0.51	0.31	0.11
LLT [%]	0.29	0.46	0.37	0.51	1	0.76	0.31
CS [%]	0.07	0.18	0.27	0.31	0.76	1	0.07
KGAST [%]	0.1	-0.07	0.01	0.11	0.31	0.07	1

Figure 5.3: The contemporaneous correlation between key variables

6 Conclusions

A new data set is used to estimate the dynamic of the Swiss multi-family rental market of the past 80 years. Several measurement alternatives are offered and compared to each other and against a benchmark build on different data. The nature of the data set restricts the choice of index types to regression based repeated measurement indexes (of which we compute a repeated-measurement index, the Case-Shiller 3SLS index and the Local Linear Trend index) and arithmetic averages indexes (the Sale Price Appraisal Ratio index). As the nature of the data prohibits us from using the SPAR in its current form, a new method of computation belonging to the arithmetic average family is developed. Given the way the data is used, we name the new method the Inverse Sale Price Appraisal Ratio (or ISPAR). The methodological modification allows us to use this technique and the LLT with a data sample consisting of roughly 1000 pairs of initial purchase prices and latest valuations (as of 2007) to compute an index going back to 1936.

We compare the various indexes to an external benchmark (the ZKB MFH) which tracks the same sub-market but uses a different data sample than us. The preliminary results are encouraging given the limited sample at our disposal. The history of economic events covered by the indexes also lend credibility to our calculations.

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