

# **Investigation into the supply of information and measurement of transparency in the listed property sector**

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## **Abstract**

This article investigates the information that is available to shareholders and the public by listed property companies in order to make investment decisions. It also mentions the usefulness of this information for purposes of mass valuation of the portfolio of properties that are owned by these entities, or to extrapolate to other non-portfolio properties. The study makes use of a multiple regression analysis with empirical testing of property loan stock (PLS) companies in South Africa. It was found that only six of the PLS companies publish any useful information with regards to their property portfolio and only one provided sufficient information to be of statistical significance. It was also found that the provided information is lacking specific property and portfolio details and is, therefore, of limited use overall as far as investment decision-making is concerned. The method applied is, however, confirmed to be applicable for mass valuation techniques, but limited by the amount of information available.

## **Abstrak**

Die artikel ondersoek die inligting wat aan aandeelhouders en die publiek beskikbaar gestel word deur genoteerde eiendomsfondse om sodoende beleggingsbesluite te neem. Die bruikbaarheid van hierdie inligting vir doeleindes van massawaardasietegnieke van die portfolio of nie-portfolio eiendomme word ook gemeld as 'n sekondere aanwending. Veelvoudige regressie analise word gebruik met empiriese toetse van die eiendomsleningseffekte maatskappye in Suid-Afrika. Die ondersoek het bevind dat slegs ses van die maatskappye enige bruikbare inligting publiseer ten opsigte van hul eiendomsportefeulje en slegs een genoegsame inligting publiseer om statisties beduidend te wees. Dit was ook bevind dat die inligting tekortkom ten opsigte van eiendoms- en portefeulje spesifieke besonderhede om beleggingsbesluite te neem. Die metode wat toegepas is, bevestig egter die gebruik van massawaardasietegnieke, maar dat dit beperk word deur inligting wat beskikbaar is.

## 1. Introduction

When considering the valuation techniques of income-producing property, various types of information should be obtained from the market in order to apply them to the valuation of the property under consideration. This includes the comparison with other properties sold in the market. However, due to the illiquid nature of property, especially those typically owned by institutional investors, such transactions do not take place every day. Therefore, the necessary information is not always readily available, nor of the required quality. Furthermore, the commercial property market is so diverse that the difference in property attributes leaves comparison to a few comparables of questionable level of accuracy. With the increasing requirement for accuracy and speed of valuation due to high volume purposes such as municipal valuations, portfolio valuation for large investment companies, auditing of security of financial institutions, etc., the use of alternative techniques such as Computer Assisted Mass Appraisals (CAMA) and Automated Valuation Models (AVM), where no human intervention is present, have developed. These models are based on various techniques such as neural networks or artificial intelligence, multiple regression or hedonic models and hybrid AVMs with human intervention.

As some of the largest property investors in South Africa, the listed property sector possesses information that might be useful in performing valuations on commercial property. This might exceed the general premises of interpolation and also include extrapolation to valuing other properties not included in the listed sector. The purpose of this article is twofold:

1. To test the use of publicly available information from the listed property sector for application in valuation processes such as multiple regression analysis, and
2. The success with which a valuation process such as multiple regression analysis could be used to perform commercial property valuation.

## 2. Literature review

Downs & Güner (1999: 518) stated that problems associated with observing the value of the underlying asset in real-estate securities are frequently cited by practitioners and academics. Brennan (1990: 727-728) refers to this as a latent-asset problem, i.e., the information acquisition problem of investors when the value of some assets is not observable. This suggests that the value of the assets

in listed property funds could not generally be observed by the investors due to information deficiency in the sector. This questions the information that is being made available to investors by publicly traded listed companies in order to make informed investment decisions. If this information is of a sufficient level to make informed decisions, it would provide the opportunity also to extrapolate to other properties not held in the listed market, which generally suffers from information deficiency for valuation purposes.

## **2.1 Information deficiency in property markets and property valuation**

Webb (1994: 63-64), reported that less than 5% of properties in the appraisal-based index are sold in a given year, indicating that commercial properties transact, on average, once in every 20 years. This leaves valuers with very little information to work with in determining market value at specific times. Booth & Marcato (2004: 147) stated that the provision of performance information on the direct real-estate market suffers from a lack of timeliness and reliability. Rode (2004) also mentioned that valuers have a serious problem in estimating market values, because market data were outdated by the time they became available to market players.

This confirms the need for alternative methods to arrive at accurate market assessment. Hager & Lord (1985: 23) are, however, of the opinion that valuation is an expression of personal opinion and that the success of a valuation relies extensively on personal knowledge and expertise in interpreting the many existing variables.

Boyd & Irons (2001: 6-8) discussed the challenges facing valuation practice and commented that the tasks of valuers extend beyond the traditional role of providing a single point estimate. According to him, the valuers' primary role is that of a property market analyst and, therefore, the valuers should be capable of competently commenting on both macro- and micro-factors that are influencing the market in which they are specialists. His views on the competency of valuers is supported by the fact that the courts have, on many occasions, criticised valuers for differing markedly from the market figure or other valuations. The case of 'Interchase Corporation Ltd v CAN 010087573 Pty Ltd and others was discussed to illustrate this. According to Boyd & Irons (2001: 17), this case demonstrates the importance of accurate data. He mentioned that it is not unusual to find that information provided to the valuer is incomplete and occasionally misleading, but it is the responsibility of the valuer to exercise reasonable care in the acceptance and use of valuation

data. He also stated that the valuer must demonstrate expertise in attempting to obtain the most accurate information available and that the valuers' responsibility extends to an evaluation of the reliability and accuracy of the data within a risk analysis, and the subsequent quantification of the degree of uncertainty in the valuation figure. Boyd & Irons (2001: 17) also mentioned that the accuracy that is achievable in a valuation figure depends, to a large extent, on both the quality of the comparable data provided and the competence of the valuer.

Information deficiency is not only affecting valuers. Downs & Güner (1999: 517) found that information deficiency has a direct impact on price-formation decisions by investors, which also ultimately affect valuers when comparable transactions are investigated. This was confirmed by Boshoff (2012), indicating that listed property companies that provided more transparent information to shareholders received better support from institutional shareholders and had clear evidence of shareholder activism.

The mentioned studies indicate that information availability is a concern not only to valuers, but also in investment decision-making. This brings together two aspects of information availability:

1. The information made available by listed property companies in order to enable prospective investors to make investment decisions, and
2. The possibility to use this information to provide evidence of individual market values, which could also be extrapolated to other non-portfolio properties.

## **2.2 Valuation methods and the use of mass appraisal**

In order to evaluate the usefulness of information that is made available in the listed property sector, it is necessary to consider the information that would generally be required. For this purpose, reference is made to literature on different valuation methods.

Various valuation models have been proposed to determine the market value of any property. According to Hager & Lord (1985: 23-24), two methods are used for the valuation of investment properties, namely the investment method and the comparative method. The approach of the investment method is essentially one of income capitalisation, and is also described as the discounted cash flow (DCF) approach. The latter is stated to have the advantage of sophistication, but, due to the possible margins of error in all the variables, might result in inferior results if it is not applied carefully.

Market capitalisation is used to determine the value of income-producing property. The principle is to take the first year's sustainable income of a property and to capitalise that at a rate generally accepted in the market. In this instance, the income and the capitalisation rate are compared to the market separately. It is accepted that the value of a specific amount of net income will have a certain value to the investor and the ratio of the income and the amount that an investor is prepared to pay for that expected income is determined by the market and measured by comparing the same ratio of other properties that have been sold. The capitalisation rate can also be determined by taking the discount rate and deducting long-term capital or income growth.

Gilbertson & Preston (2005: 127-128) indicated that competition between lending institutions and valuers, in terms of speed and cost of valuation services and the availability of data, is stimulating greater use of technology. Technology assists with the collection, organisation and formatting of data utilised for valuations. This has led to technology-based systems such as Computer Assisted Mass Appraisals (CAMA) and Automated Valuation Models (AVMs), which are used for mass appraisal. According to IAAO (2013: 5), mass appraisal is the process of valuing a group of properties as at a given date, using common data, standardised methods, and statistical testing. Mass appraisal is used for various valuation purposes such as municipal tax, mortgages and portfolio management. Values are determined by utilising valuation equations, tables, and schedules developed through mathematical analysis of market data. In addition, IAAO (2013: 16) defined an AVM as a computer programme for property valuation that analyses data using an automated process. A distinction is made with regards to CAMA, which is a system of valuing property that incorporates computer-supported statistical analyses such as multiple regression analysis and adaptive estimation procedure to assist the valuer in estimating value (IAAO, 2013: 17). IAAO (2011: 14-15) described an AVM as a mathematically based computer software programme that produces an estimate of market value based on analysis of location, market conditions, and real-estate characteristics from information collected, whereas the Collateral Risk Management Consortium (2003: 3) indicated that an AVM can be defined as the generic term for any electronic analytic algorithm, process or model that is intended to estimate the value of an individual property, without human assistance (other than the initial entry of the data). Specific to this report, the term applies to models designed to value residential properties. The distinguishing feature between CAMA and AVM is the

level of human interaction, whereby the former assists in valuation, but a reasonable level of human activity is involved, and the latter is without any human interference after database compilation. Robson & Downie (2007: 31) indicated a further difference between AVMs and CAMA systems as the intended application where CAMA systems are mostly applied for taxation purposes, whereas AVMs are mainly applied for loan purposes.

The first signs of AVMs originate from the 1960s. The last decade saw the use of these models outside of North America, and the models are currently used for security valuations on a global basis (Miller & Markosyan, 2003: 173). The development of AVMs in the private sector was driven by the use of technology to automate the residential lending process. Miller & Markosyan (2003: 180) stated that a prolonged period of low interest rates and related increase in lending activity, along with the Internet, are the key stimulants for the development of AVMs. According to Robson & Downie (2007: 46), AVMs developed in the USA and in the UK and have been used for mortgage valuations for over 20 years, but that the most established users of AVMs are still the USA and Canada (Robson & Downie 2007: 29), although general use is observed in the UK, Australia, New Zealand and South Africa.

AVMs have been developed and their use has been established for residential valuations mainly due to the homogeneous nature of this type of property. AVMs are becoming increasingly important and have a role to play in the marketplace. Predictions are that AVMs will improve as database sizes increase and new approaches develop to predict values in heterogeneous residential areas. However, AVMs are still developing and are not free from criticism (Boshoff & De Kock, 2013: 20).

According to Gilbertson & Preston (2005: 127), commercial property valuations are more complex than residential valuations, as limited comparable data is generally available and requires more inputs. The full automation of valuation models is debated, as specialised and heterogeneous properties will not fit into a standard statistical data model. The income valuation approach requires data analysis and adjustments before the value is calculated. Limited research is available on AVMs for commercial property applications, mainly due to the ongoing development of the models, the financial feasibility of such a venture and the intellectual property, which is viewed as confidential.

Boshoff & De Kock (2013: 5) stated the following advantages and disadvantages of AVMs over traditional valuation methods:

- Advantages: lower cost and time saving; consistency; data management; combat fraud, and valuer bias.
- Disadvantages: data shortages; public opinion; the need to inspect property; financial regulation and risk acceptance, and transparency.

Boshoff & De Kock (2013: 20) established that there is scope for commercial property AVMs, however, on a limited basis. They stated that commercial property AVMs will never replace traditional valuers and that they can be implemented as a useful tool for verification and auditing of values. Although AVMs are already well established for use in residential valuation, the application is still very limited for commercial property. In terms of this study, the application of the principles of AVMs and mass appraisal as auditing tool is emphasised. Such an auditing tool is, however, still reliant on a minimum amount of information in order to be of any use.

### **2.3 Information deficiency in listed property companies**

Downs & Güner (1999: 518) stated that problems associated with observing the value of the underlying asset in real-estate securities are frequently cited by practitioners and academics. Brennan (1990: 727-728) referred to this as a latent-asset problem, i.e., the information-acquisition problem of investors when the value of some assets is not observable. Gillan & Starks, in two separate studies (1999 & 2000), found that the behaviour of listed property share prices is influenced by the involvement of institutional investors, as well as by the amount of information that is available to them when they are making investment decisions. The availability of information, therefore, influences shareholder activism and has a direct impact on monitoring management's activities, so that this monitoring ability of institutional investors could affect a firm's value (Chan, Leung & Wang, 1998: 357).

It is, therefore, evident that information availability to shareholders is important and that the ability for shareholders to have a transparent view of the company's operations would have a positive influence on the shareholder activism and subsequent value of the company. More specific to property and the valuations profession, the National Committee for Property Education (2004: 173) stated that one of the purposes of a good valuation report is to provide sufficient information for the reader to draw his/her own conclusions. This could probably also be applied to the annual reports of listed property companies in that these reports should provide sufficient information that shareholders or prospective shareholders can

arrive at their own interpretation of the value of the assets held and, subsequently, the value of the company.

## **2.4 Summary**

The literature review indicated that there is evidence of information deficiency in order to perform valuations accurately as well as decision-making for investment purposes. The different valuation models indicated that the information required for valuation purposes of commercial property would be the income-producing abilities of property, which could be different for different types of property, location and use. Boshoff (2013: 47) noted in this regard that the factors that are property specific and that differentiate the performance of individual properties or property types are:

- Physical characteristics of property;
- Retail sales and profits;
- Vacancy rates;
- Location;
- Employment, and
- Production levels.

With the difficulties that are experienced with property valuation, mass appraisal techniques have developed that are less time consuming, and can overcome fraud and valuer bias. However, the applicability of these techniques is questionable for purposes of commercial property valuation. The information deficiency that is stated for valuation purposes also applies to investors who are interested in purchasing properties. Investors need to use information in order to form an opinion of their willingness to pay a specific price. This would also apply to investors purchasing shares in listed property companies, who need to form an opinion of the underlying value of the portfolio of assets. Such an investor would typically want to make use of the mentioned mass valuation techniques in order to form an opinion of the portfolio.

## **3. Problem statement**

From the literature reviewed, the question is raised as to whether the observed information deficiency is also evident in the listed property sector, with regards to property-specific information that is provided to shareholders, and whether the provided information can be used for property valuation purposes in order to determine the individual values of property by using mass valuation techniques.



In order to investigate the research problem as stated above, it is necessary to consider the null hypothesis, which could be stated as follows:

$$PV_t \neq \beta_0 + \sum_{j=1}^n \beta_j A_{ij} + \epsilon_i$$

and the alternative hypothesis as:

$$PV_t = \beta_0 + \sum_{j=1}^n \beta_j A_{ij} + \epsilon_i$$

where:

$PV_t$	=	<i>Property value at time t</i>
$\beta_0$	=	<i>Y intercept</i>
$A_{ij}$	=	<i>Property attribute j for observation i</i>
$\epsilon_i$	=	<i>random error in Y for observation in i.</i>

If the null hypothesis could be rejected, the alternative hypothesis could be accepted that the property value at time  $t$  is explained by the sum of individual property attributes as explained by the information that is provided by the listed property companies in their publicly available documentation. It is further accepted that, if the alternative hypothesis could be accepted, the principles could in a similar way be applied to other valuations of property, if similar information is available.

#### 4. Research method

The research design is a theoretical description of the subject matter, leading to a quantitative analysis and statistical regression of historical data and an empirical analysis for hypothesis testing.

This study investigated the listed property sector in South Africa, by considering the property portfolios as published in the public domain. An attempt was made to include the portfolios of all listed PLS companies that are reasonably active, but some companies were excluded due to a lack of information. The study considered data from the listed funds for the specific period from 2001 to 2010. The actual data and treatment are for purposes of consistency explained at the applicable points of testing.

## 5. Analysis

The actual data of PLS companies with regard to their property portfolios will be used to develop a model that can explain the value of an individual property, by considering the information provided by the PLS companies.

Actual data on the location, use, size and value variables were available for only six of the companies; other companies did not publish the information. Different companies also provided different levels of information, with Growthpoint Properties (Ltd) being the only company that provided in-depth information that includes subcategories for each type of property. The data used is cross-sectional data only, consisting of the published portfolio information as per the last financial report. The data that were analysed are summarised in Table 1 and the descriptive statistics are included in Annexures A and B. For this purpose, 730 observations were obtained and tested. The data was transformed using the logs of the raw data in order to cater for the diminishing marginal utility of the extra variables, and then tested in two ways. The first was allowing for a dummy variable for each different type of property use, as well as for each different location in combination with the log-transformed other data (dummy analysis), and the other by using the average value per square meter of each type as well as the average value per square meter for each location as proxies for these two variables also as log-transformed data (proxy analysis). The second option has the difference that the number of variables reduced substantially, as the three different dummy variables for *Type* (offices, retail and industrial) are replaced by one *Type* variable and the same for the location dummies, which are in excess of 100 total variables for each of the different locations analysed, that could be replaced by one *Location* variable. Annexure A provides the results of the regression using proxies instead of dummies.

Table 1: Summary of data

Analysis	Variable	Data type		No. of proxies / dummies used	Number of observations
		Dummy	Proxy		
All property	Size	Ratio	Ratio	1	730
All property	Location	Dummy	Categorical	108	730
All property	Type	Dummy	Categorical	3	730
Growthpoint data	Size	Ratio	Ratio	1	410

Analysis	Variable	Data type		No. of proxies / dummies used	Number of observations
		Dummy	Proxy		
Growthpoint data	Location	Dummy	Categorical	65	410
Growthpoint data	Type	Dummy	Categorical	23	410
Growthpoint data	Depreciation	Ratio	Ratio	1	410

Source: Adapted from annual reports of Acucap, Growthpoint, Hyprop, Pangbourne, Redefine and Resilient

From the analysis using dummy variables to the analysis using proxies, although the adjusted R square reduced slightly from 0.590 to 0.581, the F-value increased from 10.357 to 338.532. In order to compare these two figures, it is considered in relation to the critical F-values at the 0.01 level of significance, which is 1.447 and 26.100, respectively. This indicates that the F-value using dummies exceeded the critical F-value 7.16 times, while the F-value using proxies exceeded the critical F-value 12.97 times.

Testing for multicollinearity also posed a problem with the dummy variable analysis, with the VIF values for the three type variables being 48.41, 40.17 and 32.21. With proxy analysis this also reduced to well within acceptable levels (see Annexure A).

A Goldfeld-Quandt test was performed to test for heteroscedasticity in both regressions. For both the dummy and the proxy analyses, the hypothesis of homoscedasticity was only rejected at the 0.25 level of significance, with the F-values being 1.144 and 1.123, respectively, and the critical F-values 1.089 and 1.086, respectively. This indicated that heteroscedasticity could be proven with a marginally higher probability in the dummy analysis.

The above tests confirmed the proxy analysis to be slightly more credible. Replacing the Betas into the multiple linear regression equation, and solving for each of the data points in the data set that contained the actual properties for the six companies, the observed values regressed against the anti-logs of the calculated values could be plotted, as seen in Figure 1. The blue line represents the 1:1 relationship. It is evident that, although the regression of the log transformed data did not have much evidence of heteroscedasticity, the anti-logs of the regressed data still have strong graphical evidence of heteroscedasticity. It is evident that the

larger the properties' values, the more underestimated it becomes in the regression.

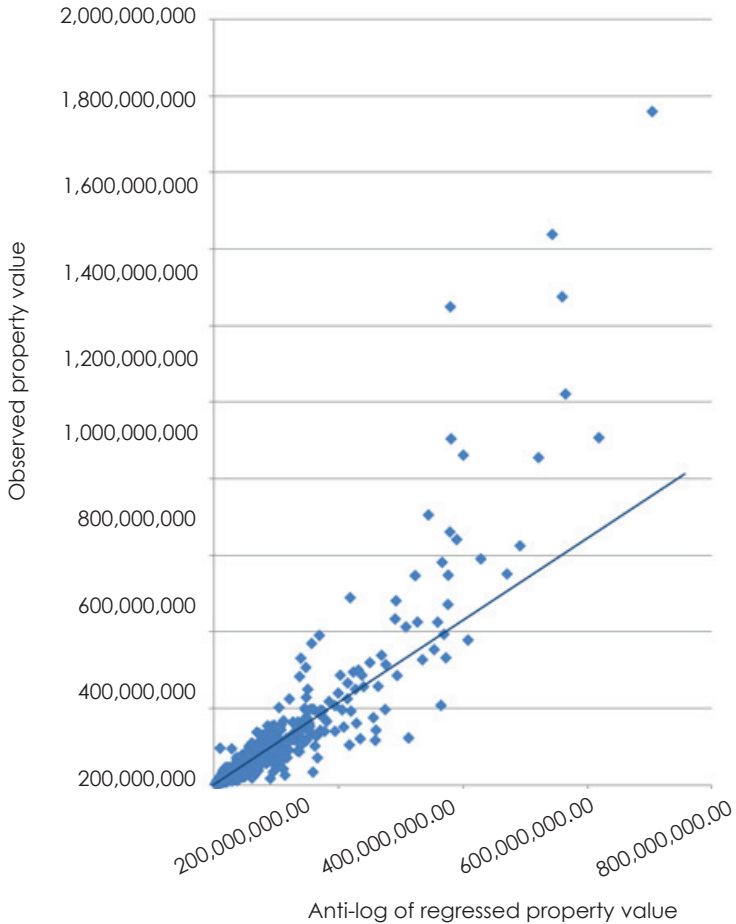


Figure 1: Multiple regression of actual property data

As the largest of the companies with 419 of the 730 properties, as mentioned, Growthpoint publishes its portfolio information in more detail, including subtype use. Each of the three main categories (industrial, offices and retail) is further divided into specific types.

By changing the type variable to include subtypes, the correlation of the calculated values regressed against the actual values strengthened significantly. By having the subtypes available, it was also possible to estimate a depreciation variable, by taking the construction cost, as published by Davis Langdon (2011: 34-35), for each subtype, multiplied by the size of the property, and multiplied by 1,5 to allow for land, professional fees, escalation, etc. The actual value is then divided by the replacement cost to determine the amount of depreciation of each property.

The Growthpoint data is also tested by transforming the data by taking the logs of each variable. The type and location data was also tested, using both dummy variables and proxies.

The R square for the regression of the Growthpoint data strengthened significantly to 0.965 and 0.963 for the dummy analysis and the proxy analysis, respectively. In the case of the dummy analysis, the F-value is 130.146, with the critical F-value at 1.568. This indicates that the F-value exceeds the critical F-value 83.01 times. With the proxy analysis, the F-value is 2,679.902 and the critical F-value 13.5, indicating that the F-value exceeded the critical F-value 198.51 times. This indicates that the addition of the specification information for the Growthpoint data allowed for substantially closer and more significant regression than the general portfolio regression shown in Annexure B. It also confirms the use of proxies rather than dummies in the analysis.

As with the general portfolio regression, multicollinearity posed to be problematic for the dummy analysis, with the VIF values for a number of type dummies indicating severe multicollinearity at values of up to 114.4. It is clear from the regression details in Annexure B that this is not the case for the proxy analysis.

A Goldfeld-Quandt test was also performed on the Growthpoint data in order to test for heteroscedasticity, which indicated that homoscedasticity could be rejected at the 0.25 level for the dummy analysis, with the F-value being 1.240 and the critical F-value at 0.25 being 1.168. For the proxy analysis, homoscedasticity could not be rejected at any level, where the F-value was calculated at 1.018 and the 0.25 level critical F-value 1.120. This indicates not only that it is less probable for heteroscedasticity to be present in the proxy analysis than the dummy analysis, but also that it is less likely for heteroscedasticity to be present in the regression of the Growthpoint data than in the general portfolio data.

As a final test, the Mean Average Percentage Error (MAPE) of the regressions of both the dummy and the proxy analyses was compared. The MAPE analysis is stated by the following equation:

$$MAPE = \sum_{i=1}^N \left| \frac{A_i - R_i}{A_i} \right| \times 1/n \quad (1)$$

where:

MAPE = Mean Absolute Percentage Error

$A_i$  = Actual values

$R_i$  = Regressed values

The results of the MAPE analysis as per equation 1 are shown in Table 2.

Table 2: Results of MAPE analysis

	Dummy analysis	Proxy analysis
All property	29.84%	34.55%
Growthpoint data	24.46%	15.40%

The tests performed on the property data indicated that there is a significant smaller probability of specification errors in the analysis of the Growthpoint data than in the overall property data. Although the results of the MAPE analysis worsened from the dummy analysis to the proxy analysis for the overall property portfolio, both tests have improved for the Growthpoint data and indicated a significant improvement on the proxy analysis. The worsened results for the overall portfolio, moving from dummy analysis to proxy analysis, might be due to the few variables that are available, confirming the specification error in the overall portfolio and indicating that there is a lack of information provided by these companies to their shareholders. The MAPE results for the Growthpoint analysis support this finding in that both MAPE tests delivered more accurate results. The improvement in the MAPE results for using the proxy analysis on the Growthpoint data also confirms the use of the proxy analysis with the increased level of variables used. The graphical presentation of the observed Growthpoint data to the anti-logs of the regressed data is shown in Figure 2.

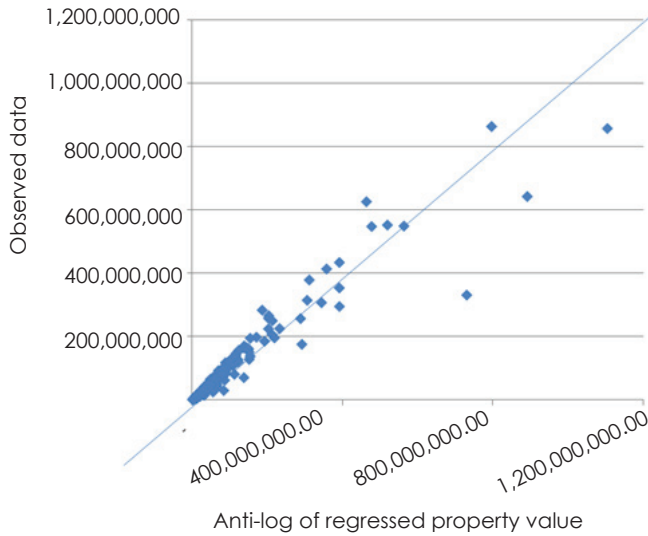


Figure 2: Multiple regression of actual property data – Growthpoint portfolio

The closer regression is evident from Figure 2, but the larger discrepancies in the higher valued properties are still evident, especially in the case of a few outliers. This might be an indication that there are still some specification errors evident, preventing this regression to be a correctly specified hedonic model. Factors not taken into consideration and that might be responsible for this, and should be tested by way of further research, are lease terms, vacancy levels, redevelopment potential, and closer information on actual depreciation and specification levels. In addition, the model did not allow for mixed-use properties, such as industrial and office components to individual properties, which should be further investigated.

## 6. Conclusion

The null hypothesis was partly rejected, as the rejected null hypothesis is only for information supplied by Growthpoint Properties. This indicates that the alternative hypothesis could be accepted in principle, but that the information supplied by all other PLS companies is not sufficient in order for shareholders to make

an informed decision about the assets held by these companies. The importance of this is that the information generally supplied by listed property companies in their annual reports does not equip investors to reach the same conclusions as the directors of these companies in terms of the values of properties that they own. The lack of information limits the extent to which shareholders can make investment decisions and thus hampers shareholder activism and resultant company performance (also refer Boshoff, 2012).

It also shows that it is possible to use listed property information that is publicly available to extrapolate to other properties for which the values are not known, using the properties' attributes to predict the individual value. This would, however, just hold for the value of the property at the same date as the values of the portfolio when it was published, i.e. at year-end, and does not take into consideration the value at any other date in between, or after year-end, for which no published data are yet available.

Apart from the formal hypothesis, a number of findings are worth mentioning:

- Information deficiency was found to be problematic with regards to property-specific variables. Only Growthpoint provides a reasonable accurate level of information that could be used for pricing or valuation purposes and, even then, it still lacks information on lease terms, depreciation or condition of assets, development potential, etc. These are arguably not provided in order to protect competitive advantage, but are to the disadvantage of shareholders who need to make purchase and pricing decisions on shares.
- Discrepancies in property-specific regression were found to be especially problematic in the top-end retail and office properties. The values, as provided by the funds, substantially exceeded the replacement costs, which were estimated using market analysts' information of replacement cost. This could, therefore, indicate that either the properties are overvalued, or the replacement costs for these types of properties are underestimated, indicating that construction cost indexes for these types of properties should be reconsidered.
- Mass valuation techniques such as statistical modelling could be applied successfully, but the data requirement is of utmost importance. A property's value would only be predicted accurately if full details of its condition, quality of built, etc. are also available, which could typically only be determined by an inspection. This supports previous literature that mass



valuation could be used to avoid valuer bias and can be successfully applied for auditing purposes, but has limited application for a full automated valuation process.

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## Annexure A: Multiple regression of actual property data

Descriptive statistics					
	Mean	Standard deviation	N		
Logvalue	7.602617	.5564042	730		
Logsize	3.867066	.5122158	730		
Loglocation	3.8327	.23684	730		
Logtype	3.7874	.24526	730		

Model summary <sup>b</sup>					
Model	R	R square	Adjusted R square	Standard error of the estimate	Durbin-Watson
1	.764 <sup>a</sup>	.583	.581	.3599817	1.380

a. Predictors: (Constant), Logtype, Logsize, Loglocation

b. Dependent variable: Logvalue

ANOVA <sup>a</sup>						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	131.608	3	43.869	338.532	.000 <sup>b</sup>
	Residual	94.080	726	.130		
	Total	225.688	729			

a. Dependent variable: Logvalue

b. Predictors: (Constant), Logtype, Logsize, Loglocation

Coefficients <sup>a</sup>							
Model	B	Unstandardised coefficients		Standardised coefficients	t	Sig.	VIF
		Standard error	Beta				
1	(Constant)	1.030	.265		3.887	.000	
	Logsize	.702	.026	.647	26.627	.000	1.027
	Loglocation	.348	.066	.148	5.268	.000	1.376
	Logtype	.666	.064	.294	10.455	.000	1.374

a. Dependent variable: Logvalue

## Annexure B: Multiple regression of actual property data – Growthpoint portfolio

Descriptive statistics			
	Mean	Standard deviation	N
Logvalue	7.502001	.4717502	410
Logsize	3.840095	.3941955	410
Logdepreciation	-.337096	.2033475	410
Logtype	3.6687	.29457	410
Loglocation	3.8179	.25607	410

Model summary <sup>b</sup>					
Model	R	R square	Adjusted R square	Standard error of the estimate	Durbin-Watson
1	.982 <sup>a</sup>	.964	.963	.0904547	1.932

a. Predictors: (Constant), Loglocation, Logsize, Logdepreciation, Logtype

b. Dependent variable: Logvalue

ANOVA <sup>a</sup>						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	87.708	4	21.927	2679.902	.000 <sup>b</sup>
	Residual	3.314	405	.008		
	Total	91.022	409			

a. Dependent variable: Logvalue

b. Predictors: (Constant), Loglocation, Logsize, Logdepreciation, Logtype

Coefficients <sup>a</sup>							
Model B		Unstandardised coefficients		Standardised coefficients	t	Sig.	VIF
		Standard error	Beta				
1	(Constant)	.545	.085		6.376	.000	
	LogSize	.943	.011	.788	82.074	.000	1.025
	Logdepreciation	-.502	.023	-.216	-22.192	.000	1.057
	Logtype	.785	.019	.490	41.255	.000	1.571
	Loglocation	.075	.022	.041	3.390	.001	1.610

a. Dependent variable: Logvalue