

Institution: University of Kent		
Unit of Assessment: 17: Business and Management Studies		
Title of case study: Property Valuation Tool Promoting Fairer Taxation in Greece and Reducing Mortgage Lender Risk		
Period when the underpinning research was undertaken: 2013-2017		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Antonis Alexandridis	Senior Lecturer	2012-2019
Period when the claimed impact occurred: 2016-present		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact (indicative maximum 100 words) <p>Research led by Dr Antonis Alexandridis of Kent Business School in 2016 for Eurobank Property Services (a leading Greek and Romanian mortgage lender) resulted in an automatic mass valuation system for the real estate sector. The new tool was implemented by Eurobank Property Services in relation to its mortgage valuations from 2016 onwards, and helped reduce the risk of non-performing loans (i.e. those with property as collateral). The tool was also used by the Greek Ministry of Finance and the European Commission to objectively define the value of real-estate properties in Greece and to inform the tax rate applied to individual properties. The introduction of the system resulted in a range of efficiencies for the bank and cost savings for its clients.</p>		
2. Underpinning research (indicative maximum 500 words) <p>The need for objective and systematic assessment of real-estate property values has always been important. This need became all the more essential following the Eurozone crisis in 2014, when EU countries started exiting bailout programmes and banks needed extra assurances on the value of properties before issuing mortgages, to help reduce the proportion of non-performing loans. Governments require similar information, before they can set annual property tax rates. As a result, banks, lenders, and government bodies need to find ways to provide fast and accurate real-estate valuations at frequent intervals. However, in countries such as Greece and Romania, property markets are in their infancy. Financial institutions see them as inefficient, non-homogeneous, and governed by a consistent lack of information. This presents significant challenges to the accurate valuation of real-estate property in these national contexts.</p> <p>Alexandridis' expertise lies in the areas of mathematical modelling and forecasting. Together with Professor Zapanis Achilleas of the University of Macedonia, he developed a statistical methodology for modelling real-world problems using wavelet neural networks in the context of financial applications [R1, R2]. This enabled him to address the problem of real-estate valuation in non-homogenous, newly developed markets by developing an automatic mass valuation system (referred to variously as AMVS or AMV in the documentation cited in this case study) [R3, R4]. The model used a large database of historical prices from Greece, Romania, and Serbia to obtain accurate property valuations for these markets. Alexandridis' research applied a non-linear automatic valuation method based on an optimised machine-learning technique or neural network. This method forecasts real-estate prices based on characteristics found in hedonic indexes.</p>		

Alexandridis worked in collaboration with two senior managers of Eurobank Property Services, Dr Dimitrios Papastamos (Head of Research and Analytics Division) and Dimitrios Andritsos (Chief Executive Officer). With their input, Alexandridis built a three-layer neural network – consisting of an ‘input variables’ layer, a ‘hidden units’ layer, and an ‘outputs layer’. The novelty of this method stemmed from the use of a black-box model that was presented with a training and a validation sample. The use of this training-validation combined sample helped Alexandridis to select the appropriate number of hidden units, and to identify the statistically significant variables for real-estate valuation purposes. These regularisation methods fine-tuned the neural network to avoid the over-fitting of the method to a given sample, which would have rendered it invalid for other datasets. The use of these techniques in this project (and across Alexandridis’ previous research) to avoid over-fitting has proven to be an especially innovative approach, which improves the accuracy of real-world predictions and outperforms other standard valuation methods such as MRA or SMV [R1, R2, R3].

The results of Alexandridis’ research with Eurobank Property Services indicated that the proposed method [R3] outperformed the bank’s previous property valuation method by reducing the out-of-sample forecasting Mean Square Error (MSE) from 21% to 15%. Alexandridis and his collaborators also identified the property characteristics that led to large forecasting errors. The results indicated that the forecasting error increases when the area of the residence exceeds 120m², the property is a house as opposed to a flat, or when a large unbuilt land area is included. Similarly, properties built before 1950 lead to larger forecasting errors, as the conservation status of the properties and alterations it may have undergone have effects on the actual value. However, the analysis by Alexandridis and his collaborators at Eurobank Property Services revealed that neural networks are less sensitive to changes in these characteristics than are other methods. The results indicated that the proposed methodology constituted an accurate tool for property valuation in non-homogeneous, newly developed markets. The resulting automatic mass valuation system can be adapted in applications such as mortgage quality control or appraisal review, loss mitigation analysis, portfolio valuation, and appraisal process redesign.

Findings from this project were published in 2018 in the *Journal of the Operational Research Society* [R3], having previously been disseminated at a conference in 2017 [R4].

(Note: Since 2019, Eurobank Property Services (EPS) has been Cerved Property Services S.A.)

3. References to the research (indicative maximum of six references)

[R1] Alexandridis, A. K., Zapranis, A. D. and Achilleas, D. (2014). *Wavelet Neural Networks: With Applications in Financial Engineering, Chaos, and Classification*. New Jersey: John Wiley & Sons, pp. 264. ISBN 978-1-118-59252-6. <https://doi.org/10.1002/9781118596272>

[R2] Alexandridis, A. K., and Zapranis, A. D. (2013). ‘Wavelet neural networks: a practical guide’. *Neural Networks* 42: 1-27. ISSN 0893-6080. <https://doi.org/10.1016/j.neunet.2013.01.008>

[R3] Alexandridis, A. K., Karlis, D., Papastamos, D., and Andritsos, D. (2019). ‘Real estate valuation and forecasting in non-homogeneous markets: a case study in Greece during the financial crisis’. *Journal of the Operational Research Society* 70(10): 1769-1783. ISSN 0160-5682. <https://doi.org/10.1080/01605682.2018.1468864>

[R4] Alexandridis, A., Karlis, D., and Papastamos, D. (2017). Real estate valuation and forecasting in non-homogeneous markets: a case study in Greece during the financial crisis’. In: *7th International Conference of the Financial Engineering and Banking Society*, Glasgow, 1-3 June. <http://kar.kent.ac.uk/63439/>

Grant

[G1] Alexandridis, A. (2016). ‘Automatic Mass Valuation Systems for Real Estate Properties Eurobank Property Services S.A.’. Value: €34,000.

4. Details of the impact (indicative maximum 750 words)

The global financial crisis of 2007, and the following Eurozone crisis of 2009-14, resulted in a significant decline in house prices in Greece and Romania; as a result, mortgage lenders lost large amounts of capital through defaulted mortgage loans and other non-performing loans. Following Dr Alexandridis' consultancy work with Eurobank Property Services in 2016, a new automatic mass valuation system was implemented by financial institutions in Greece and Romania, and also adopted by government departments in Greece and the European Commission to determine taxation thresholds.

Greek Ministry of Finance and European Commission: aiding reform of property taxation in Greece

By 2016, Greek taxpayers were paying seven times more in property tax than in 2009, despite the huge increases in unemployment and drops in living standards following the Eurozone crisis of 2009-14. According to European Commission figures for 2015, the only EU countries with higher property taxes were France and Britain. Within this context, the Greek Ministry of Finance decided in 2018 to revise its unified property tax, using accurate values to determine property taxation rate intervals. To achieve this [a], the Ministry needed accurate data on the current value of each residential property in Greece. In June 2018, the Ministry contracted Eurobank Property Services to conduct a pilot survey of 829 real-estate zones across the country. This was achieved using the automatic mass valuation system developed by Dr Alexandridis to accurately define the market value of real-estate properties in the surveyed zones [b, c].

Following this pilot, Eurobank Property Services won a tender from the European Commission (in July 2018) to objectively define the value of real estate in the country's remaining 10,000 building zones [d, e, f]. Eurobank Property Services (by then operating as Cerved Property Services) continued to use the automatic mass valuation system to carry out annual valuations for the Greek Ministry of Finance and the European Commission to inform the tax rate applied to each property [g].

Greece: improving property valuation processes for Eurobank Property Services

The Eurozone crisis left Greek banks with a high proportion of non-performing loans with real estate as a collateral. This put the financial sector in Greece under considerable strain. Alexandridis' automatic mass valuation system (AMV/AMVS) enabled Eurobank Property Services to better assess the value and risks associated with lending against property and helped reduce running costs through the optimisation of its operations [g].

More specifically, since 2016, Eurobank Property Services (now Cerved Property Services) has used Alexandridis' automatic mass valuation system to:

- Revalue its real-estate portfolio (comprising approximately 4,000 loans with real estate as collateral) twice a year.
- Revalue several non-performing loan portfolios for clients such as Elliott Advisors or Bain Capital. Both organisations used the automatic mass valuation system in 2019 to revalue five non-performing loan portfolios (approximately 50,000 properties in total) owned by three systemic retail banks in Greece.
- In 2019 and 2020, more than 5,000 valuations have been reviewed by external appraisers using the automatic mass valuation system as a substitute for manual reviewing processes [g].

In summary, the automatic mass valuation system has improved the company's forecasting and valuation methods from 2015 onwards. This was achieved through a 6% reduction in forecasting errors (from 21% to 15% [R3]), as well as through reducing the time required to conduct valuations on this scale. [g]. As Cerved Property Services' Head of Research and Analytics Division, explained: 'Every individual (AMV) exercise required the commitment of max 2 FTEs for an average period of 2 weeks. The alternative being desktop valuation reports practically

would be a blocking factor for CPS's valuation division, since will be required 10 FTEs for 6 months to complete the above projects on time.' [g]

Romania: improving the valuation practices of leading mortgage lenders

The successful application of the automatic mass valuation system in Greece led Eurobank (Romania), Eurobank Property Services (Romania), and Bancpost S.A. (Romania) to adopt the same approach from 2015 onwards. Given the specific challenges and characteristics presented by the Romanian housing market, Alexandridis adapted the system accordingly [h].

Introducing a new version of the automatic mass valuation system enabled Eurobank Property Services to perform mass revaluations of very large residential portfolios in a more cost- and time-effective manner. The company carried out four mass revaluation exercises involving approximately 20,000 residential collaterals between 2015 and 2018. Achieving this using the previous manual, desktop approach would have occupied the entire valuation department (seven full-time employees) for 16 months. By using Alexandridis' automatic mass valuation system, each of these exercises occupied just two employees over an average period of three weeks. In addition, using the system reduced the verification time of a valuation report by approximately 0.5 days on average [i]. The system was also deployed in real time to check valuations from professional real-estate valuers and to minimise fraud [i].

Benefiting clients

From the perspective of Eurobank/Cerved Property Services' clients, the utilisation of the automatic mass valuation system has led to significant cost savings. The use of this tool meant that valuations carried out using the automatic mass valuation system (AMV) are, according to standard banking costs fees, five times cheaper than the alternative desktop valuation approach [g]. As the General Manager of Eurobank Property Services in Romania stated: 'From the bank's/client's perspective the utilization of statistical tools – including AMV – has led to a significant cost saving impact. Indicatively we can refer to the 4 [...] exercises of approx. 20,000 collaterals. The cumulative fee for these projects was roughly €130,000 while assuming that the same projects would be performed in a desktop approach and in accordance with the agreed fee lists the overall cost would reach €780,000, roughly 5 times more than the actual fees paid.' [i].

5. Sources to corroborate the impact (indicative maximum of 10 references)

[a] Greek Tax Law 4549/2018, Article 126, amendment of Law 4223/2013 (ENFIA), describing the change in the law that was informed by the Eurobank Property Services pilot study conducted using Alexandridis' AMV (p. 63).

[b] Contract between the Greek Ministry of Finance and Eurobank Property Services (EPS) to show the contractual agreement for the work/pilot survey package.

[c] Evidence of delivery of the work/pilot survey package to Greek Ministry of Finance, to show that the Greek Ministry of Finance received the agreed work packages/pilot survey from Eurobank Property Services (EPS).

[d] Invitation to tender from European Commission to Eurobank Property Services (EPS). Tax policy reforms / property tax base valuation review and Quality Assurance (QA) assessment of current zone values, review of boundaries, and improvement for the future.

[e] Contract signed between European Commission and Eurobank Property Services (EPS) for the tax policy reforms / property tax base valuation review and Quality Assurance (QA) assessment of current zone values, review of boundaries, and improvement for the future.

[f] Correspondence between European Commission and Eurobank Property Services (EPS, Eurobank), confirming the receipt of the contract regarding the tax policy reforms / property tax base valuation review and Quality Assurance (QA) assessment of current zone values review.

[g] Letter from the Head of Research and Analytics Division of Eurobank Property Services (EPS; now Cerved Property Services S.A), describing the impact on Eurobank Property Services (EPS) operations of using the AMVS and confirming the use of AMVS by the European Commission and Ministry of Finance, Greece.

[h] Contract between Dr Alexandridis and Eurobank Property Services (EPS) to show the contractual agreement between the two parties and to describe the AVM system and adaptation.

[i] Letter from the General Manager of Eurobank Property Services Romania, describing the impact that AVM had at Eurobank Property Services in Romania.