***CERF Fellow Report***

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*Research Title and Abstract:*

**Unique Assets, Quality Uncertainty and Noisy Prices**

This projects estimates real estate asset uniqueness along previously not quantifiable dimensions, including shape, size, architecture, perceived beauty, maintenance or shape similarity. This richer picture of individual buildings and their comparability to other properties will improve any estimates of fundamental value. More interestingly, though, it will reveal distributions of transaction values in relation to fundamental value. Since uniqueness of the assets co-determines the availability of information from comparable sales, I hypothesise that uniqueness is also linked to the absolute deviations of sales prices from fundamental values: If little is know about fundamental value, then sales prices will contain more noise.

*Research findings to Date:*

The new research programme is ongoing and has produced several working papers and two (modestly sized) research grants (CDBB, £25K; ZEW SEEK EUR 75K):

* Working paper *“The Total Return and Risk to Residential Real Estate”* (with Matthijs Korevaar, Piet Eichholtz and Ronan Tallec*.*
	+ Current status: Revise and resubmit.
* New working paper: *"Implications of Irreversibility for the Valuation of Urban Land: Applications to House Price Dynamics and Volatility" (*with John M. Clapp and Jeffrey Cohen)
	+ Current status: Revise and resubmit.
* Working paper *"Machine Learning, Architectural Style and Propery Values"* (with Erik B. Johnson)
	+ Current status: Revise and resubmit
	+ This project has been presented at three relevant conferences in our field
		- Urban Economics Asssociation, Annual Meeting (NYC, Oct. 2018)
		- ASSA, Annual Meeting (Atlanta, Jan. 2019)
		- Weimer School Session, Homer Hoyt Institute (Jan 2019, Singer Island, Florida). This conference is by invitation only and I am honoured to have been selected to participate.
* New working paper *"Towards Accountability in Machine Learning Applications: A System-testing Approach"* (with Wayne Xinwei Wan)
	+ A rapidly expanding universe of technology focused startups is trying to change and improve the way real estate markets operate. The undisputed predictive power of machine learning (ML) models often plays a crucial role in the ‘disruption’ of traditional processes. However, an accountability gap prevails: How do the models arrive at their predictions? Do they do what we hope they do – or are corners cut? Training ML models is a software development process at heart. We suggest following the dedicated software testing framework and verifying that the ML model is performing as intended. Illustratively, we augment an off-the-shelf image classifier with a system testing procedure based on local interpretable model-agnostic explanation (LIME) techniques. Analyzing the classifications sheds light on some of the factors that determine the behavior of the system. We show that cross-validation is simply not good enough when operating in regulated environments.
* *"The Odd One Out: Predicting Price Coarseness"* (with Carolin Schmidt, ZEW Manngheim)
	+ Presented at ASSA 2020
	+ Presented at Weimer School May Session, Homer Hoyt Institute (May 2019, Singer Island, Florida). Conference was on "New data and tools in real estate research"
* *Centre for Digital Built Britain (CDBB)* project *"**Machine Learning and AI in the Built Environment"*
	+ This project improved the foundations for applying tried-and-tested machine learning (ML) approaches to the built environment. This mini project reduced the cost of creating and deploying ML systems by creating versatile and extendable API’s, data management infrastructure and mobile apps. A future version of the API’s might be commercialised in areas like mortgage origination, insurance claim processing or property tax (non-UK, though) estimation
* Research grant (EUR 75K) from *Strengthening Efficiency and Competitiveness in the European Knowledge Economies* (SEEK) at the ZEW – Leibniz Centre for European Economic Research. Joint application with Carolin Schmidt.
	+ Follow-up to the CDBB project to improve ML transfer learning in image recognition, specialised to the the built environment. Real estate research will finally get computer vision models that have been fully retrained with building data instead of general purpose models.
	+ The funding will be used to support a new PhD starting under my supervision in September, IT infrastructure and travel.
* Other working papers (not directly related to CERF project)
	+ *"Exogenous Demand Shocks and Liquidity of Turkish Residential Real Estate"*, with Tuğba Güneş
	+ *“Local market power in residential property markets”*, with Joseph Ooi
	+ *“500 Years of Housing Rents, Quality and Affordability”*, with P. Eichholtz and M. Korevaar (submitted for review) https://www.researchgate.net/publication/328278380\_500\_Years\_of\_Urban\_Rents\_Housing\_Quality\_and\_Affordability

*Links to your research outputs:*

* Working Paper “The Total Return and Risk to Residential Real Estate” (with Matthijs Korevaar, Piet Eichholtz and Ronan Tallec https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=3549278
* Working Paper “Valuing Urban Land with Land Residual and Option Value Methods: Applications to House Price Dynamics and Volatility” (with John M. Clapp and Jeffrey Cohen) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3618293>
* Working Paper “500 Years of Housing Rents, Quality and Affordability” (with Matthijs Korevaar, and Piet Eichholtz)
* Working Paper *"Machine Learning, Architectureal Style and Propery Values"* https://github.com/thies/paper-uk-vintages/blob/master/text/manuscript\_assa.pdf
* *"Machine Learning and AI in the Built Environment",* Final report.<https://www.cdbb.cam.ac.uk/Downloads/ResearchBridgeheadDownloads/CDBBMiniProjectFinalReportThiesLindenthal_edited.pdf>
* *"The Odd One Out: Predicting Price Coarseness"* <https://www.dropbox.com/s/apzo3r4uvqxnxk7/The%20Odd%20One%20Out.pdf?dl=0>

*Publications generated during the CERF fellowship(s)*

* Lindenthal, T. “Beauty in the Eye of the Home-Owner: Aesthetic Zoning and Residential Property Values” (2017). *Real Estate Economics*.
* Lindenthal, T., Eichholtz P. and D. Geltner (2017). “Land Assembly in Amsterdam, 1832-2015”. *Regional Science and Urban Economics*.
* Lindenthal, T. (2017). “Estimating Supply Elasticities for Residential Real Estate in the UK“, in: Huang, B., Cao K. and E. Silva (Eds.) *Comprehensive Geographic Information Systems: Socio-economic applications*. Elsevier.

*Seminars, conference presentations (since Aug. 2016)*

* UCL conference: "The Case of Affordable Housing: a global perspective on financing and institutional ownership", presented *“500 Years of Urban Rents, Housing Quality and Affordability”*
* Weimer School May Session, Homer Hoyt Institute (May 2019, Singer Island, Florida), presented *"The Odd One Out: Predicting Price Coarseness"*
* Weimer School Session, Homer Hoyt Institute (Jan 2019, Singer Island, Florida). Presented “*Machine Learning, Building Vintage and Propery Values*”
* ASSA/American Real Estate and Urban Economics Association (AREUEA) Annual Meeting, Chicago (Jan. 2019). Presented “*Machine Learning, Building Vintage and Propery Values*”
* Urban Economics Asssociation, Annual Meeting (NYC, Oct. 2018). Paper “*Machine Learning, Building Vintage and Propery Values*”
* ReCapNet conference. Presented “Local market power in residential property markets”. (Nov 2018, Mannheim)
* Participated in CERF Cavalcade (23.5.2018) with “Unique Assets, Quality Uncertainty and Noisy Prices”
* ASSA/American Real Estate and Urban Economics Association (AREUEA) Annual Meeting, Chicago (Jan. 2017). Presented research paper titled “Beauty in the Eye of the Home-Owner: Aesthetic Zoning and Residential Property Values”

*Press releases and other academic activities*

* I am the initiator of the Virtual Real Estate Seminar ([https://seminar.re](https://seminar.re/)), the largest real estate seminar, as far as I know. In recent sessions, we had up to 140 participants.
* I am co-organiser of the *Cambridge/NUS/Florida Real Estate Finance and Investment Symposium* which was held at the University of Cambridge, on Sep. 26-27th, 2019. This symposium is linked to a special issue at the *Journal of Real Estate Finance and Economics*. I am an editor for this special issue.
* I initiated a session on “Machine Learning and Real Estate” at the ASSA meeting in San Diego, which I will chair. Also, one of my papers (“The odd one out”) will be on the conference programme.

*Comments*

* Working full time with a 2.5 year old and limited nursery sipport remains a challenge. My research time is basically reduced to a few tired hours in the evening. Administrative duties and teaching remained unchanged. I am teaching with a webcam mounted above my daughter’s nappy changing station (students cannot see that, of course).
* I have currently three papers with R&R status on my desk and I struggle to find time to do the work needed. I hope I can meet some of the deadlines.