TECHNISCHE UNIVERSITÄT DRESDEN

DRESDEN concept

Fakultät Wirtschaftswissenschaften **Lehrstuhl für Energiewirtschaft**

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Opponent's Report on Dissertation Thesis

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Author:	**PhDr. Petra Luňáčková**
Advisor:	prof. Ing. Karel Janda M.A., Dr., Ph.D.
Title of the Thesis:	Three Essays on Electricity Markets
Type of Defense:	**PRE-DEFENSE**
Opponent:	**Prof. Dr. Dominik Möst**

Gladly, I evaluate Mrs. Luňáčková's thesis. Therefore, I take the questions mentioned in your evaluation sheet as orientation and have structured the oppontent's report accordingly. First of all, I have to confirm that I have no familiar and personel interrelationship as well as no professional contact (e.g. no common publications or projects) with Mrs. Petra Luňáčková. Consequently, I act as independent opponent.

a) Can you recognize an original contribution of the author?
Mrs. Luňáčková's thesis is based on three published research articles as well as a short introduction at the beginning:

1. Krištoufek, Ladislav and Luňáčková, Petra Long-term memory in electricity prices: Czech market evidence, Journal of Economics and Finance, 2013
2. Krištoufek, Ladislav and Luňáčková, Petra: Rockets and feathers meet Joseph: Reinvestigating the oil-gasoline asymmetry on the international markets, Energy Economics, 2015
3. Luňáčková, Petra; Průša, Jan and Janda Karel: The Merit Order Effect of Czech Photovoltaic Plants, Energy Policy, 2017

The first paper focuses on the properties of electricity spot prices, in particular with regard to the long-term development. Therefore, the authors base their analysis on hourly electricity day-ahead spot prices in the Czech Republic between 2009 and 2012. Data is sufficient for the analysis. However, the term "long-term memory" is not defined in the article. From the reviewer's understanding, long-term in electricity markets is more than (let's say) 10 years as infrastructure developments will influence

price developments. In the considered time horizon, infrastructure changes can hardly be considered. From my understanding of the authors, long-term means in the article a shorter time interval, e.g. less than 3 years.
With the applied methods, the authors can show that Czech prices follow similar patterns observed for other electricity prices, mainly intraday, daily and monthly seasonality in both prices and volume. Therefore, the authors use the detrended fluctuation analysis and are able to separate the above mentioned cyclical properties from the long-term memory. Based on that the authors conclude that "*the results are in hand with majority of the relevant literature as we show that the electricity prices are non-stationary but mean-reverting so that their behavior is partly predictable.*"
In general the paper is well-written and the analysis is well-founded. Also it is a new application to the Czech electricity market, which has to my knowledge not been performed before. In total it can be recognized as an original contribution of the authors. Nevertheless, it has to be mentioned that the question arise between "rigour and relevance". In general, the methods used are quite complex and rigour, but what is the new and innovative conclusion out of the paper, which corresponds to the relevance of the analysis. From an energy economic point of view, it is clear that electricity prices should have the described behavior as prices result from a "technical" electricity system with different technologies. The electricity systems can in general be described with standard micro-economics demand and supply models resulting in the mentioned cycles as especially the inflexible demand show similar patterns. This statement should not lower the value of the work of Mrs. Luňáčková in this article, but should instead help for motivating further research.

The second paper with the title "Rockets and feathers meet Joseph: Reinvestigating the oil-gasoline asymmetry on the international markets" is published in the Journal of Energy Economics, a well-known journal with an excellent reputation. Thereby, the authors analyses the popular belief that oil prices rise at rocket pace but fall slowly like feathers. Therefore, the authors introduce new tests based on the mean reversion behavior and as they state that "*that due to the strong memory of the time series, error correction models are not suitable for analysis of the relationship between oil and gasoline prices.*" With the two tests - they call the first one "wave test" and the second rescaled range ratio" - they come to the conclusion that there is no statistically significant asymmetry with regard to price adjustment. Furthermore, the authors see their article as a starting point for "*treating the asymmetric equilibrium adjustment of the error-correction term in a different, statistically and econometrically convenient, way*".
The paper is well-written and the analysis is well-founded. The authors introduce step by step their new tests, so that the article is well comprehensible. The authors also take the relevant literature into account and start their article with a sufficient and good literature review. From the point of energy economic, it would have been interesting what the conclusions out of the identified price behavior are, independent whether the behavior of rockets and feathers is true. It would be interesting, if the authors would have additionally stated what policy maker or decision maker in energy industry can learn from the analysis? Independent from that comment, the article shows a high quality or research.

A smaller remark concerns the sentence in the introduction: "*The second paper is devoted to the gas and oil prices, which usually determine the price of electricity during the peak times, as their reaction is quick but marginal costs high.*" With regard to "*their reaction*", it is unclear on what it refers. From the understanding of the reviewer, it should better be formulated by: (…) as the reaction of power plants using these types of fuels is quick but marginal costs high.

The third paper named "The Merit Order Effect of Czech Photovoltaic Plants" is published in Energy Policy, also a well-known and high-quality international journal. The authors analyze the merit order effect, in particular the merit order effect of solar power plants. Taking the standard micro-economic model of supply and demand, a further supplier sorted at the beginning of the supply curve due to the low marginal costs will lead to a price decrease. Or in other words, pushing capacity with subsidy instruments in the market will lead to decreasing prices. This effect is called merit order effect and is well-known in energy economics. The authors aim to quantify the merit order effect using Czech market data. Therefore, the authors estimate the merit order effect as elasticity of electricity spot price with respect to the change in supply of electricity from the renewable sources. The authors state that they "*...find no merit order effect for solar plants and small MOE for other renewable sources*". From the view of the reviewer, this result is astonishing. In general, it is well-known that the merit order effect is higher for peak load. This is due to the fact as the supply curve is in general steeper, when capacity is scarce. As the feed-in of PV strongly correlates with the day, especially midday, and load also correlates with the day, highest at noon, the merit order effect should be highest for PV (as it is also the case in other markets). From the paper and its conclusions it was not finally clear to me, whether the not observed merit order effect only holds for daily data or also hourly data. Furthermore, the conclusion "*Our results clearly show that MOE effect does not hold for every type of renewable energy sources which implies green policy consequences because sources that bring savings should be preferred to those that does not.*" could and should not be drawn with this strong statement, as this this evaluation criteria is to simple to evaluate the success of a technology.
Independent from this critical comments, the article is well-written and well-founded. The reviewer liked this article most, especially as significant policy conclusions are drawn, although the reviewer don't agree with all of them.

In total, Mrs. Luňáčková has presented three interesting and good quality papers in her thesis, did extensive literature reviews in their articles, used a proper methodology and derived comprehensible conclusions, so that I can recommend the thesis for defense.

b) Is the thesis based on relevant references?
All three articles are based on relevant references. At the beginning of each article, the authors have a chapter titled with literature review, where they take the relevant articles into account and developed their research gap on the basis of the literature.

c) Is the thesis defendable at your home institution or another respected institution where you gave lectures?

The thesis of Mrs. Luňáčková is based on three well-written and well-founded scientific articles. All articles have a high scientific quality and are rigor in a scientific sense. Hence, I conclude that the thesis is defendable.

With regard to the exact formulation of the question, whether the work is defendable at my home institution, I see two formal challenges remaining. For a cumulative dissertation at my home faculty, following rules (beside others) have to be considered:

- for a cumulative PhD at the Faculty of Business & Economics at TU Dresden, one article has to be **single authorship**, which is not the case here.
- for each article with several authors within a Phd thesis, a declaration for each article of all authors is necessary, which shows what type of work has been done by whom (differentiated by: design of article, structure, modelling, writing, proof-reading etc.)
- furthermore, the PhD candidate also has to mention in his introduction, what of the work can be attributed to him.

In general, it is difficult to attribute what kind of work has been done by whom and I assume that Mrs. Luňáčková was enganged in all articles with an own and significant contribution, meaning more than 30% input and work load in all articles. An overview and a declaration about the single contribution of the author to the article would additonally help for the evaluation of the performance of the candidate.

d) Do the results of the thesis allow their publication in a respected economic journal?

All three articles are published in well-known, established and high-quality international journals. Hence, the question can be definitely be answered with yes, as all articles are already published in respected economic journals.

e) Are there any additional major comments on what should be improved?

There are no major comments for improvement.

However, there are some smaller comments with regard to the introduction:

- With regard to the first article, it is stated: "*It is a natural starting point of this dissertation as at the beginning we were interested in electricity prices as such and thus our first analysis focuses on electricity spot prices properties, in particular on their long term memory.*" The term long term memory is not defined in this introduction and short definition or what the authors mean by that would help the reader (see also comment above).
- A smaller remark concerns the sentence in the introduction: "*The second paper is devoted to the gas and oil prices, which usually determine the price of electricity during the peak times, as their reaction is quick but marginal costs high.*" With regard to "their reaction", it is unclear on what it refers. From the understanding of the reviewer, it should better be formulated by: (...) as the reaction of power plants using these types of fuels is quick but marginal costs high.

f) What is your overall assessment of the thesis? (a) I recommend the thesis for defense without substantial changes, (b) the thesis can be defended after revision indicated in my comments, (c) not-defendable in this form.

As the work of Mrs. Luňáčková (and her co-authors) is very precise and well-founded as well as published in well-known and good-ranked international journals, I recommend the thesis without substantial changes.

Answers from Mrs. Lunackova on the report

Report of Opponent Prof. Dominik Möst

- *Comment 1 regards "long-term memory definition".*
- *Response:* Long-term memory is defined in Chapter 2.3.1, even though it is called "long", which we often (together with memory) associate with time, it is not defined in terms of units of time. Instead, it is defined by the specific decay of auto-correlation function, regardless the time dimension of the time series. There is specific vanishing pattern rather than time. The time ambiguity of long-term memory is now explained also in the thesis, please see General Introduction and extended Chapter 2.3.1.
- *Comment 2 concerns the innovative conclusion of the first paper "Long-term memory in electricity prices: Czech market evidence".*
- *Response:* The first paper was a natural starting point, initial step for the second and third article. At the beginning, it was logical to look first at the electricity prices, analyze them and later on, equipped with this knowledge, use it in more complex analysis. That is also why, the second and third paper are published in journals ranked higher that the first one.
- *Comment 3 asks for the conclusion out of the identified price behavior, what can be learned from the analysis?*
- *Response:* Given that we have found no statistically significant asymmetry with regard to price adjustment, we suggest policy makers do not interfere. We did not identify any market failure, hence we believe there is no need for interventions. Our suggestion is now included also in the Chapter 3.6.
- *Comment 4: The sentence in the General Introduction "The second paper is devoted to..." was reformulated as suggested by the opponent.*
- *Comment 5 regards the not observed solar MOE for hourly and daily data.*
- *Response:* The analysis was performed on hourly data, as well as on daily and weekly averages. For hourly data the solar MOE is close to zero but still non-negative, moreover, is not statistically significant (Table 4.8). For daily and weekly data solar MOE is statistically significant, however, still non-negative. The final results relate to weekly data, which is now made more clear in the concluding Chapter 4.8.

Table A.1: Overview of the Contribution of Petra Lunackova

	Idea	Literature	Analysis and interpretation	Writing and final touch
Essay no.1 "Long memory... "	50%	80%	40%	50%
Essay no.2 "Rockets... "	50%	90%	40%	50%
Essay no.3 "MOE... "	80%	100%	90%	90%

- *Comment 6: We followed the suggestion of the opponent and the final conclusion of the third paper regarding green policy consequences is now less strong, admitting that the issue cannot be so simplified. Please see General Introduction.*
- *Comment 7: For the overview of the author's contribution please see Table A.1.*

All comments and questions from my side have been answered sufficiently by Mrs. Luňáčková. Hence, I can recommend the defense of her work.
Summarizing, Mrs. Luňáčková (and her co-authors) has provided a very good Phd-thesis with interesting articles published in well-known and recognized journals.

Date:	25.01.2018
Opponent's Signature:	[redacted]
Opponent's Affiliation:	Prof. Dr. Dominik Möst, TU Dresden