Report on **Bachelor / Master Thesis**

Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague

Student:	**Martin Hrycej**
Advisor:	**Ladislav Kristoufek**
Title of the thesis:	**Volatility spillovers between crude oil and food commodities**

OVERALL ASSESSMENT *(provided in English, Czech, or Slovak):*

Please provide your assessment of each of the following four categories, summary and suggested questions for the discussion. The minimum length of the report is 300 words.

Contribution

This Master Thesis is very much inspired by an influential and higly cited article Vacha and Barunik (2012). Both this Thesis and Vacha and Barunik use wavelets and DCC GARCH. While I am not aware of any important development in DCC GARCH area since 2012, there is some additional development on wavelet side, mainly partial wavelet coherence, taken from Kristoufek et al. (2016) paper. So I do not see anything significantly new on technical side of the paper. On the content side of the paper, the argument taken as „core" [sorry for Czech style of quotation marks] by Mr. Hrycej (relationship between food and fuel prices) is an extension of Pal and Mitra (2017) and all the relevant literature.

Mr. Hrycej considers section 4.4 (wavelet analysis of food commodities and crude oil, pages 39-43) to be „the crux of the thesis" (first sentence in the section 4.4, page 39). I see here a possible avenue for an interesting research topic. Wavelet analysis of Mr. Hrycej shows that over the period covered by data in this Thesis (October 2009 – March 2018) there is not much of a strong evidence of price comovement between considered agricultural commodities (cotton is not really a food) and crude oil. This may be compared to strong line in agricultural commodites research with general idea of biofuels as missing link (Ciaian and Kanc, 2011a,b – papers with about 160 and 60 citations on Google Scholar). The idea is, that prior to biofuels boom there was no comovement among the prices of agricultural commodities and fuel. Biofuels provided the link leading to the comovement among those prices.

Maybe the most recent data show that this comovement is fading, dissappearing. This may be an interesting area of research, driven by the stabilization of biofuels, new trends in fuels prices, new data. Easy feasible first line of approach to this issue would be simple replication and extension of Pal and Mitra (2017) article (wrongly cited as Debdatta and Subrata (2017) in this Master Thesis). Pal and Mitra use wavelets – their data show strong comovement of fuels and food over approximatelly 2001-2012 „During March 1998 to July 2001, there was no correlation between crude oil prices and the world food price index. Starting from August 2001, however, we observed a rapid increase of correlations at around 32 periods of frequency which continued throughout 2006–2008, the period of the food crisis. The correlation was high until October 2012 in the medium to long scale." (Pal and Mitra, 2017). In Pal and Mitra (2017) pictures it looks like the comovements between food and fuels dissapearing recently, so new more recent data would be interesting. The data of Pal and Mitra (2017) are just 6 price indexes. Their data (1990 – February 2016) are publicly available as an attachment to their paper and it should be easy to extend the data series up to now. So first to replicate Pal and Mitra (2017) analysis with updated series and if the conjecture about fading price connection between food/fuels will be confirmed, follow up with different data (like the data in this Master Thesis).

Bright future of biofuels. The reference to Rodionova et al. (2017) on page 2 is not enough to conclude that future of biofuels is bright.

Solar energy: the reference to expensive solar energy on page 2, may be somehow misleading. Currently the future of solar seems quite bright (I may be heavily influenced by my current environment at ANU, with strong policy and technical support of solar energy at ANU and in Australia in general).

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However the development of LCOE (levelized cost of energy) estimates and the literature in general seem to point to solar electricity becoming an economically viable energy source. While LCOE of nuclear energy does not change much, LCOE of solar is noticeably going down over the last 10 years.

The empirical results obtained by wavelet analysis are in general consistent with previous results in many paper by Kristoufek and his co-authors. Low price comovement between ethanol and fuels is consistent with previous results of Kristoufek et al.. Similarly higher correlation between elements of diesel branch of biofuels than for ethanol branch (ethanol connected with agriculture, biodiesel (missing in this thesis) connected with fosil fuels).

On page 42: heating oil and soybeans may be more interesting than crude oil and soybeans.

p. 74 „Cotton unexpectedly deviates from the trio“ What is unexpected here? What was the expectation of Mr. Hrycej?

Methods
Mr. Hrycej showed good understanding of the advanced method of DCC GARCH and wavelet analysis.

I have some concerns about the use of wavelet phase in partial wavelet analysis – see the Questions section. Actually, in the empirical analysis I noticed the real use of wavelet phase (in text, in comments) only on page 29 in the first discussed commodity grouping of fosil fuels and it was not in connection with partial wavelet coherence. In the rest of the Thesis, I noticed wavelet phase being mentioned only on a couple of places – always not related to partial wavelet coherence and generally saying that no clear information about the direction of influence is provided by the phase arrows in the pictures.

The Master Thesis is titled as **Volatility** spillovers between **crude oil** and **food** commodities.
I understand that the title does not have to fully characterize the paper. While DCC GACR is clearly volatility concept, I am missing this clear volatility (versus price levels or returns) characterization in the case of wavelets and Granger causality parts of the paper. It is clearly stated on page 10 that wavelet analysis is done on price levels without any differencing or transformation.
Also the emphasize on crude oil and food both in the title and in a number of parts of the Thesis (talking about the core issue of the empirical analysis) is somehow out of place with some motivations with respect to biofuels. This is connected with an issue, that the paper is mainly reduced form technical paper: It is just a sequence of repetitive rather mechanical applications of Vacha and Barunik (2012) techniques to a set of 11 biofuels related commodities and indexes (plus the funny case of gold not being really used in the paper anyway). The Master Thesis is missing deaper expert insights in the economics of food, fuel, biofuels. To be fair, I have to mention that these economics insights are difficult and it would be unfair to assume that IES Mgr student will be able to master both the techniques (where wavelet technique is not a standard part of econometric curriculum) and the economics of the analysed topic during about 1 year of work devoted (partially) to his Master Thesis.

Data: The data set is rather limited. Why the data prior to 2009 are not used? It would be interesting to have a good description of data set - to clearly identify, why these particular data are used, how they relate to data used in similar papers. Is the considered heating oil really heating oil or is it actually diesel (or material from which diesel is produced)? Good understanding of data both from economic and technological point of view would be a contribution to the biofuels literature. Discussion of missing values is nice, but it could be more clear, so that reader would clearly undertand what Mr. Hrycej did

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with the data and all the manipulations would be easily replicable. For example „the proportion of missing values is over one half" – we need clear identification of out of which base the proportion is taken. We need clear replicable description of data manipulations conducted.
Also some indication why particular data series were considered would be good. In the absence of any theory or other structural framework for the data selection, the approach used in Filip et al. (2016) my be useful here too: first consider a wide set of possible relevant prices and use some data clasification technique to select smaller set of prices used for actuall wavelet (and DCC GACR) analysis.

Pearson correlation coefficient (p.25): Why not to include some measure of statistical significance – for example standard *, **, ***, convention for p-values?

Literature
The literature review covers just about 6+1 very relevant papers.
Let me go over those 6+1 papers mentioned in the Literature review section.

1. Recent paper Filip et al. (2017) is a work of Mr. Hrycej's advisor and it provides a good comprehensive literature review, so it is well placed in the Literature review for this Master Thesis despite different techniques being used there. Given the focus of this Master Thesis on wavelet (plus DCC GARCH + simple Granger causality), I am missing the references to other relevant related papers by Mr. Hrycej's advisor – in particular Nature Energy article Filip et al. (2016), which is higly relevant, recent, using wavelet methodology.
2. Mitchell (2008) paper is definitelly one of the most influential (and consequently higly cited) papers in the discussion about food price crisis of 2007-2008 and the role of biofuels in this crisis. So it deserves to be here.
3. Zhang et al. (2010) is just mentioned here as an motivation paper for more recent Filip et al. (2017)
4. Vacha et al. (2013) is a work of Mr. Hrycej's advisor, which introduces wavelet methodology to biofuels literature for the first time. It definitelly belong here.
5. Vacha and Barunik (2012) very higly cited paper introducing wavelet methodology to energy literature clearly belongs there since this Master Thesis is very much modelled after that paper.
6. Kristoufek et al. (2016) is also well placed here, since it introduced partial wavelet coherence to biofuels literature. The citation is wrong since the journal is GCB Bioenergy. Missing GCB part of title is essential (in the relevant community GCB is a top journal, where its daughter journal GCB Bioenergy supports its standing by connection with CCB in a similar ways as it is the case for Nature and its daughter journals.)
7. Article Pal and Mitra (2017), wrongly cited as Debdatta and Subrata (2017) (Mr. Hrycej confused first names and surnames of the authors, which most likely would not happen if he looked at other relevant publications of these authors - i.e. this is related to my comment that Mr. Hrycej focused just on a vary small set of highly relevant and properly emphasized papers while not paying sufficient attention to other relevant literature). This Pal and Mitra (2017) article is higly relevant since it uses wavelet methodology and it nicely summarizes the literature about relation between the prices of fuel and food over a long horizon.

While the choice of 6 leading articles (+supplementary Zhang et al. (2010) as motivation for Filip et al. (2017)) is well done and the review of those article is well conducted, both the Literature review and the Master Thesis as a whole suffer from omitting many other very relevant references. Starting with missing relevant papers of the advisor and continuing with such important papers like Serra and Zilberman (2013). In particular other wavelet biofuels papers of different authors should be mentioned – there are not so many of them.

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In the Literature Review section, there are consistently placed quotation marks at the end of titles (but not at the beginning of titles) – it is clear systematic mistake during copy-paste process, but its prevalence is anoying and showing unsufficent care devoted to final reading of the paper.

Manuscript form
The Master Thesis is written in a good English. It is well writen, nicely readable with a minimum of English mistakes (Ethanol does not need capital E, Granger needs capital G, p.5). However I am not fully happy with a style of this thesis. In a number of places the writing style does not fully fit into a scholarly work and sometimes the styling could be improved. See for example footnote 6 on page 4 – this is not how the scholarly writing looks like – or intro to wavelet coherence on p. 10, which could be stylistically improved. Or „What is the wavelet itself good for?“ on p. 12. Or footnote 3 on p.1: Oladosu et al. (2018) refer to oil price elasticity of GDP – oil was missing there.

The footnote 4 on page 36 is plainly wrong. Vacha and Barunik (2012) do not deal with ethanol and its feedstocks.

Manuscript structure: Why is Granger chapter 5 sandwiched between wavelet and DCC GACR? Given the simple concept of this Granger chapter, I would prefer to place it before wavelet chapter.

Summary and suggested questions for the discussion during the defense
The Master Thesis contains a lot of work. It is rather on technical side (using the statistical techniques repeatedly for different data). The work with literature could be much better (easy to achieve) and more economic insights would be helpful (difficult to achieve).
I like the suggestion to use Barunik and Vacha (2018).

Questions:
I am surprised by a presence of wavelet phase (the small arrows) in the partial wavelet coherence pictures. Could Mr. Hrycej explain which software, which packages etc. he used for his wavelet analysis? And how it is with wavelet phase in partial wavelet coherence. Comparison of different computer code/packages (for example Matlab, R, ...) would be interesting.

Could Mr. Hrycej clearly explain the concepts of price comovements in the terms of price levels and volatilities (see Serra and Zilberman (2013) and in general the writings of Serra on the topic of biofuels prices commovements in the terms of volatility) and clearly relate it to his Master Thesis?

Data: Is the gasoline before blending with biofuel? (I suppose that heating oil, which seems to be either directly diesel or very close proxy to diesel is before any blending)

Why just DJCI was selected for PWC?

References (sorry for wrong spelling etc. caused by copy-pasting from pdf file of Master Thesis – I am leaving mistakes in original Master Thesis without corrections. I am leaving this ugly copy-paste style in order to visually differentiate original references used in the Master Thesis and my added references not contained in the Master Thesis).

B a r u n ik , J. & L. V a c h a (2018): “Do co-jumps im pact correlations in currency m arkets?” *Journal of Financial M arkets* 37: pp. 97-119.
Ciaian, Pavel & Kancs, d'Artis, 2011a. "**Interdependencies in the energy-bioenergy-food price systems: A cointegration analysis**," Resource and Energy Economics, Elsevier, vol. 33(1), pages 326-348, January.

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Ciaian, Pavel & Kancs, d'Artis, 2011b. "**Food, energy and environment: Is bioenergy the missing link?**," Food Policy, Elsevier, vol. 36(5), pages 571-580, October.

D e b d a t t a , P. & M. K. S u b r a t a (2017): "Time-frequency contained comovement of crude oil and world food prices: A wavelet-based analysis." *Energy Economics* 62: pp. 230-239.

F ilip ,O .,K . J a n d a ,L . K r i s t o u f e k , & D . Z ilb e rm a n (2 0 1 7): "Foodversus fuel: A n updated and expanded evidence." *Energy Economics* A v a ila b le o n lin e 6 N o v e m b e r 2017.

Filip, Ondrej; Janda, Karel; Kristoufek, Ladislav and Zilberman, David."Dynamics and Evolution of the Role of Biofuels in Global Commodityand Financial Markets." Nature Energy, article number 16169, 12(1), December 2016, 9 pages.

K r i s t o u f e k , L., K. J a n d a , & D. Z ilb e r m a n (2016): "Comovements of ethanol-related prices: evidence from Brazil and the USA." *Bioenergy* 8 (2): pp. 346-356.

M i t c h e l l , D. (2008): "A N ote on Rising Food Prices." *T he W orld Bank Policy Research W orking Paper* 4682: pp. 1-20.

O la d o su , G. A., P. N. L e ib y , D. C. B o w m a n , R. URiA-MARTiNEZ, & M. M. J o h n s o n (2018): "Im pacts of oil price shocks on th e U nited States economy: A m eta-analysis of th e oil price elasticity of GDP for n et oil-importing economies." *Energy Policy* 115: pp. 523-544.

Pal and Mitra (2017) – see the wrong reference to D e b d a t t a , P. & M. K. S u b r a t a (2017): R odioN ovA , M. V., R. S. P o u d y A l, I. TiwARi, R. A. V o lo sh iN , S. K. ZhARm ukhA m Edov, H. G. NAm, B. K. ZAyAdAN, B. D. BRucE, H. J. M. H o u , & S. I. A llA k h v E R d iE v (2017): "Biofuel production: Challenges and opportunities." *International Journal of Hydrogen Energy* 4 2 (1 2): pp. 8450-8461.

Biofuel-related price transmission literature: A review

Teresa Serra and David Zilberman Biofuel-related price transmission literature: A review Energy Economics, 2013, vol. 37, issue C, 141-151

VAchA, L. & J. BARuNik (2012): " Co-movement of energy commodities revisited: Evidence from wavelet coherence analysis." *Energy Economics* 34: pp. 241-247.

VAchA, L., K. JANdA, L. K R isT oufE k, & D. ZilbERmAN (2013): "Timefrequency dynamics of biofuel-fuel-food system ." *Energy Economics* 40: pp. 233-241.

ZhANg, Z., L. LohR , C. EscAlANTE, & M. WETZsTEiN (2010): "Food versus fuel: W h at do prices tell us?" *Energy policy* 38: pp. 445-451.

***SUMMARY OF POINTS AWARDED** (for details, see below):*

CATEGORY		POINTS
Contribution	*(max. 30 points)*	20
Methods	*(max. 30 points)*	25
Literature	*(max. 20 points)*	11
Manuscript Form	*(max. 20 points)*	15

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TOTAL POINTS *(max. 100 points)*	**71**
GRADE (A – B – C – D – E – F)	**C**

NAME OF THE REFEREE: Karel Janda

DATE OF EVALUATION: August 23, 2018

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Referee Signature

EXPLANATION OF CATEGORIES AND SCALE:

CONTRIBUTION: *The author presents original ideas on the topic demonstrating critical thinking and ability to draw conclusions based on the knowledge of relevant theory and empirics. There is a distinct value added of the thesis.*

Strong	*Average*	*Weak*
30	*15*	*0*

METHODS: *The tools used are relevant to the research question being investigated, and adequate to the author's level of studies. The thesis topic is comprehensively analyzed.*

Strong	*Average*	*Weak*
30	*15*	*0*

LITERATURE REVIEW: *The thesis demonstrates author's full understanding and command of recent literature. The author quotes relevant literature in a proper way.*

Strong	*Average*	*Weak*
20	*10*	*0*

MANUSCRIPT FORM: *The thesis is well structured. The student uses appropriate language and style, including academic format for graphs and tables. The text effectively refers to graphs and tables and disposes with a complete bibliography.*

Strong	*Average*	*Weak*
20	*10*	*0*

Overall grading:

TOTAL	**GRADE**
91 – 100	**A**
81 - 90	**B**
71 - 80	**C**
61 – 70	**D**
51 – 60	**E**
0 – 50	**F**