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Gianfreda, A and Bunn, D W

(2018)

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Operations Research, 66 (5). pp. 1189-1203. ISSN 0030-364X

DOI: https://doi.org/10.1287/opre.2018.1733

INFORMS (Institute for Operations Research and Management Sciences)
https://pubsonline.informs.org/doi/10.1287/opre.20...

A Stochastic Latent Moment Model for Electricity Price Formation

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Abstract

The wide range of models needed to support the various short-term operations for electricity generation demonstrates the importance of accurate specifications for the uncertainty in market prices. This is becoming increasingly challenging, since electricity hourly price densities exhibit a variety of shapes, with their characteristic features changing substantially within the day and over time, and the influx of renewable power, wind and solar in particular, has amplified these effects. A general–purpose, analytically tractable representation of the stochastic price formation process would have considerable value for operations control and trading, but existing empirical approaches or the application of standard density functions are unsatisfactory. We develop a general four parameter stochastic model for hourly prices, in which the four moments of the density function are dynamically estimated as latent state variables and furthermore modelled as functions of several plausible exogenous drivers. This provides a transparent and credible model that is sufficiently flexible to capture the shape–shifting effects, particularly with respect to the wind and solar output variations causing dynamic switches in the upside and downside risks. Extensive testing on German wholesale price data, benchmarked against quantile regression and other models in out-of-sample backtesting, validated the approach and its analytical appeal.

Keywords: Electricity Prices, Density Estimation, Skewness, Quantiles, Risk

1. Introduction

Price formation in wholesale electricity spot markets is known to be a complex function of many fundamental drivers, interactions, time-varying specifications and stochastic shocks. Various factors characterise the idiosyncratic dynamics, and the reasons why the stochastic models for price formation may be challenging to formulate have invited many explanations, see Lucia and Schwartz (2002), Knittel and Roberts (2005), Chen and Bunn (2010), Panagiotelis and Smith (2008), Benth et al. (2013), Aïd et al. (2013) and Weron (2014) among others.

In particular, power markets are local and resource–dependent. In some markets, the production of electricity may be a commodity spread between gas, oil or coal; in others it may be a result of infrastructure investments in nuclear facilities or large reservoirs, whilst elsewhere, and increasingly, it relates to the use of renewable resources such as wind, solar,

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hydro, biomass, geothermal or tidal currents. Furthermore electricity is produced to meet demand instantaneously; it is not easily storable, and in responding to inelastic consumers, the prices are prone to exhibit substantial volatility. And, with liberalised power markets being far from perfectly competitive, often composed of a small oligopoly of generators, at times of scarcity market power effects can result in price spikes substantially above fundamental levels. In contrast and increasingly, with some producers of electricity having inflexible production facilities, eg district heating facilities or nuclear plants, their aversion to shut down/start–up costs may incentivise them to make negative offers to the market during transient periods of oversupply (particularly from wind), resulting in "downspikes".

Thus, to the extent that the underlying commodity properties dominate the price formation and these may be nonstationary, power prices will accordingly follow them as random walks; but if the natural renewables dominate, mean reversion will emerge from the dynamics of weather or transient supply outages. Unsurprisingly, therefore, specification tests on daily power series for mean reversion, unit roots, fractional cointegration or trend stationarity have varied in their indications over time, between locations and according to whether spikes have been trimmed out of the data (eg Haldrup and Nielsen (2006); Escribano et al. (2011); De Vany and Walls (1999); Koopman et al. (2007); Bunn and Gianfreda (2010); Nan et al. (2014)). Furthermore, with many markets being in structural transition, as governments seek to incentivise the replacement of fossil fuels with renewables, price formation will veer between different processes as wind, solar and hydro availabilities fluctuate. Finally, the granularity of power markets is fine and, because of the lack of storage, arbitrage between price formation at different times of the day or year is very restricted; thus we see quite different price distributions at offpeak hours during the night from those in the morning, midday or evening peaks. In the context of all of this, therefore, it is easily understandable why attempts to model the power price processes have led to different models for different times of the day and seasons, with regime switching and time varying specifications, nonlinear formulations as well as skewed and fat–tailed distributions all having been applied.

The complexity and evolutionary nature of these various influences on power price formation is well illustrated by the changing shapes of the German price densities since 2007. The German power market provides the main reference for European prices and, having also been at the forefront with its high penetration of renewable energy, is the most attentively observed in the region. In Figure 1 we display three selected daily time series for hours 3, 12 and 19 in 2007, and contrast these with the same series only four years later in 2011. The 2007 series exhibit the conventional patterns of a fossil fuel dominated power system, mostly coal and some gas at that time, with periods of volatility clustering and positive spikes. In contrast, 2011 shows the situation after some substantial penetration by wind and solar facilities. The price distributions are remarkably different. The predominantly positive skewness has transformed to negative skewness. In the supplementary Appendix 6.1, we display the series for all 24 hours and these fully demonstrate the diversity and rapid evolution in time series properties. The penetration of solar facilities in particular, by residential and commercial end–users, is continuing to diminish the midday need for conventional generation and eroding what used to be a daily peak, see Moody's (2012). Thus, there is complexity in evolution, which materialises annually, as well as the time of day distinctiveness becoming increasingly sensitive to changes in the weather. It is therefore a research question of considerable practical relevance to evaluate if the various hourly price densities can be deter-

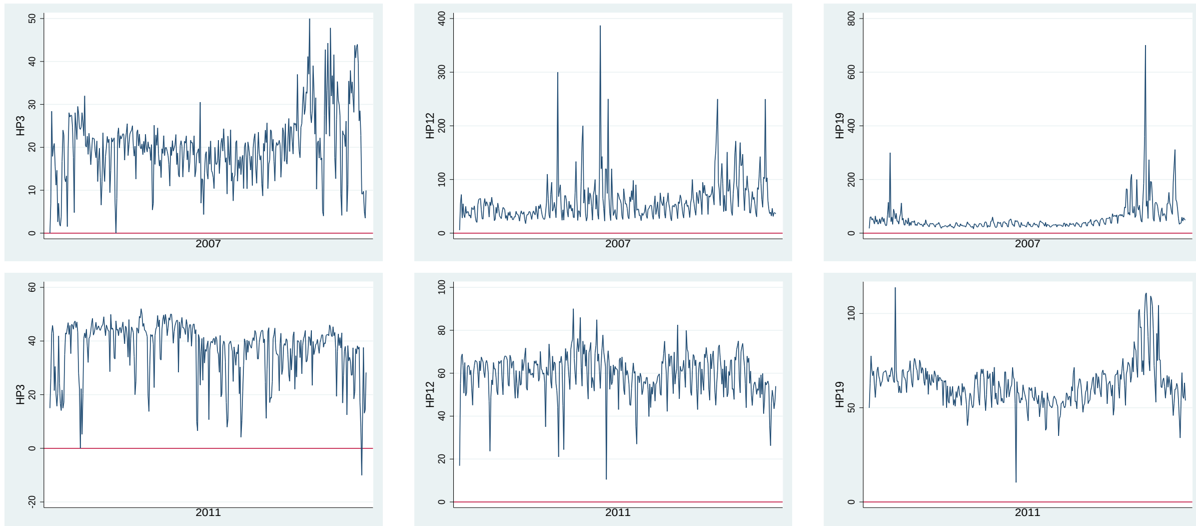


Figure 1: Daily time series for electricity prices (in €/MWh) for hours 3, 12 and 19 in 2007 (first row) and in 2011 (second row). Data source: EPEX (www.epexspot.com)

mined, not apparently as empirical idiosyncracies, but as variations of a general parametric stochastic process, the parameters of which drive the appropriate changes in shape through their dependence upon the evolution of fundamental exogenous factors. That is the aim of this study.

To pursue this, we have searched for a general three or four parameter density specification with special stochastic and analytical features. From a large selection of distribution functions, we identified a few that are sufficiently flexible to provide adequate fit to the wide range of shapes displayed in the German hourly prices over 2006–2016. Furthermore, using generalized linear multivariate estimation for the four moments, sufficient to define the distributions, we were able to relate these moments to several key fundamental dynamic drivers in a plausible way, as well as to an autoregressive representation of the latent estimates to capture behavioural persistence. With respect to the latter feature, the formulation thereby represents to some extent the widely used conditional heteroscedasticity approach for volatility estimation and generalises it to the higher moments as well; the persistence of stochastic skewness being the particular new feature of power prices that we wish to capture. Overall, the latent four moment dynamic modelling within a Skewed t density representation was considered most appropriate on the balance of its empirical performance and closed form analytical properties. Day ahead predictive densities were then recursively estimated out-of-sample and benchmarked successfully against analogous quantile regression and other methods.

In the next section we consider the practical relevance of more accurate hourly price formation modelling for short-term electricity operations and then review some of the related background research on electricity price modelling, forecasting and density estimation. In Section 3, we discuss the case of Germany and present key results from the distributional analysis of power prices and fundamental drivers. The multifactor modelling approach is described in Section 4, with the empirical support and the dependence of higher moments on fundamental drivers in Section 4.1, and the relative performance in forecasting density quantiles compared with other benchmarking techniques in Section 4.2. Finally, we summarise the research contributions in Section 5.

2. Operational Contexts of Power Price Density Modelling

Modelling the day-ahead electricity price formation process at hourly resolution has attracted extensive research (see Weron (2014), for a review) motivated by the practical considerations of a wide range of operational decisions for which these models provide support. Typically, in most wholesale power markets worldwide, the main-marker, day-ahead prices emerge as a vector for all 24 hours of a particular day from auctions held around midday of the previous day. Whilst there are usually some demand and supply responses in the subsequent intra-day trading and real-time balancing, substantial operational commitments in practice need to be planned in advance of the day ahead auction, but with outcomes contingent upon those prices. Forecasts or simulations based upon the price formation models of the day-ahead auction prices are therefore essential to such short-term advance planning.

For example, unit commitment decisions for production facilities are often done days in advance, especially if single or two shift daily schedules are being considered (Hobbs et al., 2001; Tseng and Barz, 2002). From a risk management perspective, Stoft (2002) argues that day ahead hourly price forecasts are crucial for generators making offers to the day ahead auction in a way that recovers start-up costs over their expected dispatched periods. With the relative attractiveness of the intra-day and balancing markets, many generators face the decision problem of how much capacity to offer to the day ahead auction and how much to retain for the intra day and balancing opportunities (Soares et al., 2017; Ding et al., 2017). This will depend upon the relative price risks. The economic operation of gas-fired plants require positive spark spreads and the forecasts of power prices will therefore influence not only the offer strategy to the electricity auctions, but also planning the linked activities in the day ahead gas market, pipeline commitments and/or calls upon any swing option contracts for variable gas off-takes (Eydeland and Wolyniec, 2003; Harris, 2006, Jaillet et al., 2004). Similarly, when trading across interconnectors, transmission capacity may have to be acquired in advance of the day ahead auctions, the value of which will be a real option on the anticipated locational spreads across the day-ahead auction prices (Deng et al., 2001; Carmona and Durrleman, 2003; Bunn and Martoccia, 2010). All of these operational decisions are made in advance of the day-ahead auction prices, often with an element of optionality, and as a consequence, their valuations depend upon the probability densities of the hourly prices. The specifications of the stochastic hourly price-formation in the models that have been presented to support these decisions are often, however, quite simple mean-reverting (Ornstein-Uhlenbeck) or seasonal autoregressive processes, suitable for long-term analysis, but without any conditional dependence upon the exogenous factors such as weather and demand forecasts, as well as fuel prices, that are highly informative in the short term.

We expand on three specific illustrative contexts that are currently being actively researched and where short term conditional models of price formation would appear to be crucial for model adequacy:

- *Optimal Battery Storage and Electric Vehicle Charging Operations:* The operation of an electricity pumped storage facility on a daily cycle, based upon day ahead prices, is a well-established textbook example of optimised operational planning (Sioshansi and Conejo, 2017). Recently the linking of batteries to wind facilities has engaged various researchers in the application of stochastic optimisation techniques (Kim and Powell, 2011, Li et al., 2011, Jiang et al., 2013, Ding et al., 2016, Abdullah et al., 2017). The two stage models of Ding et al. (2016) and Abdullah et al. (2017) make use of the 24 day-ahead forecasts, but these forecasts are derived simply as historical densities. Many papers related to operating electric vehicle charging facilities have similar properties. Typical formulations have been as optimal stopping rules for charging and discharging as a function of mean reverting Gaussian spot prices (Jiang and Powell, 2016). In practice, decision making is likely to be more episodic, as with storage, based upon daily expectations for prices (Sioshansi, 2011). The day-ahead storage optimisation is particularly challenging because valuation depends upon a spread for charging and discharging and the agent has to decide upon both bid and offer hourly quantities for the auction. Accurate price risk modelling is clearly important to operate profitably across these short-term spreads.

- *Risk Management by Renewable Energy Producers:* In the absence of a link to storage, wind or solar producers can face considerable short term revenue risk from both prices and output volumes. This can be managed by means of a financial product that has payoffs to cover low volumes and low prices. Such an option contract is an example of an energy "quanto" option[1], extensively discussed in Caporin et al. (2012), Benth et al. (2015) and Brik and Roncoroni (2016). These are offered as bespoke weather derivative products by the insurance industry (eg Munich Re[2] and Endurance Re[3]. To understand the payoffs from such options, their prices and the optimal design of strikes, a joint stochastic model for the power price and production (Wind or PV) is required. Typically solved by Monte-Carlo methods, not only are stochastic models for wind and prices needed, but also their correlation. In Benth and Ibrahimb (2017) a simple AR(3) model with constant Gaussian noise is assumed for the hourly prices. Other derivative products, specific for particular hours, designed to help with the short term uncertainties for renewable energy producers include the "cap/floor futures" which have been introduced in Germany[4] and Australia[5]. These effectively manage the risk, on an hourly basis, of high and low prices, above and below specified thresholds. Pricing these derivatives evidently requires accurate estimation, particularly regarding the tails, of the density functions involved.

- *Demand-side Engagement:* Operational interest in day-ahead price extremes is also reflected on the demand-side and can be expected to increase with more consumer em-

[1]A long term version of this is sometimes called a *Proxy Revenue Swap*, eg for Capital Power's Bloom Wind Farm (see https://www.environmental-finance.com/content/sections/weather-risk-hub/weather-is-the-new-fuel-risk.html).

[2]https://www.munichre.com/weatherandcommodity/en/group/index.html

[3]https://platts.com/IM.Platts.Content/ProductsServices/ConferenceAndEvents/emea/EU-Power/presentations/Ralph_Renner.pdf

[4]https://www.eex.com/en/products/energiewende-products/german-intraday-cap-futures

[5]https://www.asxenergy.com.au/products/overview_of_the_australian_el

powerment and distributed resources. Exposure to price extremes and their operational remedies can often be quite specific and detailed. For example, in Britain, drawing upon the theory of peak load pricing, the TSO recovers transmission charges from the demand side based upon their consumption in the highest three, non-consecutive trading periods in the winter (the so-called "triads", National Grid, 2015). There is a large incentive to reduce demand in these periods but they are only known ex post, and commercial forecasting services have emerged to provide forecasts[6]. Generally, small distribution-connected turbines are started and run to reduce the net demand of retailers during these periods. But, it has been estimated (Frontier, 2017) that the search cost for these extremes involves targeting over 100 trading periods to ensure coverage of the maximum 3. This is one specific example but, evidently, improved modelling of the extreme price risks has benefits beyond this "triad chasing" to the extent that suppliers can influence demand-side engagement in a more timely and economic manner.

Regarding the need for more accurate price formation models in the above, and other, operational contexts, although there is a large amount of published work on modelling the fundamental drivers of power prices and a growing body of work on the disruptive effects of renewable generation, there is relatively little on the specification of electricity density forecasts. Most of the research on price formation has been in terms of relating their expected values to exogenous factors, such as fuel prices, demand, reserve margin as well as lagged effects, and the model formulations have often justified nonlinear, regime–switching and time–varying specifications (eg Huisman (2008); Karakatsani and Bunn (2008); Chen and Bunn (2010), amongst many). In parallel, stochastic models, often motivated by the need to support derivative pricing, have become increasingly elaborated to take account of non–normality, jumps and mixed processes (eg Benth et al. (2007); Panagiotelis and Smith (2008); Frestad et al. (2010)).

Regarding the particular changes in price formation induced by wind, Gelabert et al. (2011), looking at Spain, demonstrated the negative effects of renewables on price levels. In Texas, similar evidence of negative effects is presented by Baldick (2012), and also by Woo et al. (2011), the latter observing that an increase in wind generation reduces electricity prices but increases the variance and this happens to varying extents throughout the day. The price–wind–demand interrelationship is discussed in the Australian context by Cutler et al. (2011), in which they observe a general lack of correlation between wind and demand, emphasise that demand is the more important driver, but also note periods of low (high) market prices associated with high (low) wind generation at all hours of the day. The additional effects of regional imports and exports, induced by wind variations, have also been investigated by Mulder and Scholtens (2013) in The Netherlands, and by Mauritzen (2013) who identified Nordic hydropower as a natural complement to Danish intermittent wind generation.

From a forecasting perspective, Cruz et al. (2011) compare the predictive accuracy of several univariate, multivariate, linear and nonlinear models for Spanish day–ahead prices, including hourly load and wind generation forecasts as explanatory variables, with results

[6]Npower Triad Warning Service https://www.npower.com/business-solutions/buying-energy/demand-management/triadwarningservice/ and Flexitricity Triad Management https://www.flexitricity.com/en-gb/solutions/triad/

justifying the multivariate specifications. Similarly, Kristiansen (2012) developed a forecasting model for hourly day–ahead prices in Nord Pool based on an autoregressive model with exogenous variables, with the extended specification adding value to the previous work of Weron and Misiorek (2008).

With respect to the evolutionary nature of the model specifications, Paraschiv et al. (2014) considered the effects of both wind and solar generation on the day–ahead price formation in Germany, showing that there has been a continuous electricity price adaption process to market fundamentals, and that price drivers differ across hours with solar and wind generally reducing wholesale electricity prices. They argue that wind effects determine downspikes and even negative prices, whereas solar output balances the high demand during peak hours. Ketterer (2014) also studied the effect of wind in Germany looking at volatility dynamics as well as price levels. She showed that wind power reduces electricity price level but increases its volatility and, through rolling regressions over 3 years, found that the wind effect on mean prices was becoming less negative over time.

Finally, closer to the objectives of this paper, Serinaldi (2011) considered the short–term forecasting of Californian and Italian electricity price densities using the Johnson's S_U distribution, with time varying means and variances, but constant skewness and kurtosis, whilst Panagiotelis and Smith (2008) applied the skew–t distribution in a daily vector autoregressive formulation. Otherwise, rather more researchers have approached the distributional specification through interval forecasts using semiparametric quantile regressions (eg Jónsson et al., 2014; Bunn et al., 2016), also demonstrating the time varying effects of wind, solar and other exogenous variables on particular quantile estimates. The formulation we describe below is an extension of these themes, with a time–varying specification of all four–moments from a parametric density representation of prices, with exogenous drivers and autoregressive latent variable persistence, benchmarked against forecasts from quantile regression and other models, including the simpler specification of Serinaldi (2011).

3. Evolution and Fundamentals of German Prices

In a relatively short period of time, since the turn of this century, the German electricity market has been characterized by a series of radical structural changes: liberalisation, emission trading, a nuclear power phase–out and, most recently, the growth in renewable generation. One consequence of the rapid penetration of wind in particular has been the need to allow negative prices to emerge in the German and coupled spot markets[7]. Negative prices may occur when demand falls and/or wind production is high and they signal an urgent need for generators to reduce output or for consumers to increase demand. However, producers of inflexible plants may prefer to pay for continuing to produce, as this may cost less, or be more practical, than stopping and restarting their plants over a short period of time. Less extreme than negative prices, is negative skewness, and for similar reasons, this is expected to be induced by low demand and/or high wind. Solar could have a similar effect, although being a midday producer, it does not generally coincide with low demand, and so its effect may be more manifest in reducing the otherwise positive skewness in those periods.

[7] Negative pricing has been introduced on the German/Austrian day–ahead market in 2008.

Germany is therefore an appropriate case study to develop and test a stochastic price formulation model in which there is explicit dependence of the shape of the densities on wind, solar and other short-term fundamental drivers. To this aim, we model the individual hourly electricity prices produced by the coupled German/Austrian day-ahead auction market, from January 2006 to December 2016. These 24 hour price vectors are recorded on a 7-day basis, thereby providing 24 hourly time series each containing 4018 observations[8]. In addition and on the same daily horizon, we have considered actual load, forecasted wind and solar PV generation, coal, gas, CO_2 prices all quoted or converted in €/MWh. This data set has been carefully compiled from different sources, namely the EPEXSpot[9] (for hourly day-ahead prices), the four German TSOs websites (for actual and forecasted wind and solar generation aggregated on hourly level), ENTSO-e (for hourly actual loads), and Datastream[10] (for coal ICE API2 CIF ARA, TTF natural gas, and CO_2 daily prices).

Figure 2 shows the evolution of average hourly curves for load, solar and wind production, computed yearly over 2006-2016 together with the 'net load' faced by conventional thermal generators after the feed-in of wind and solar production. The intra-daily load profiles show a slow decline in levels, whereas those for wind and solar show remarkable increases in output over this period. It should be mentioned that the full time series exhibit the usual annual time-varying patterns following calendar seasons, with higher solar PV generation during summer.

Descriptive statistics of price levels are reported in Table 2 in the supplementary Appendix 6.2 for all individual hours, showing the evolution of empirical sample moments across years. Thus, it can be observed that negative skewness, on average, characterized prices densities at times of steep increase and decline in load, ie mid morning and late evening at hours 6, 7, 8,

[8]Regarding the clock changes in spring and autumn, we have excluded from the analysis hour 25, observable at the autumn clock change, and for the spring clock change when the price for hour 3 was missing, we averaged the prices of the previous and following days. Indeed, when the clock is advanced to summer time the data reporting system automatically deletes the values/slots for hour 3 (i.e. from 2.00 am to 3.00 am). Furthermore, in our hour-by-hour approach, the leap year is not awkward as it is simply an extra day influencing the weekly seasonality that we already included in our modelling.

[9]The day-ahead auction DE/AT (Phelix) hourly prices are the reference prices for delivery of electricity on the following day in 24 hour intervals on the German/Austrian TSO zones. The physical deliveries are made within any of the 4 German TSOs zones as well as in the Austrian Power grid. However, EEX is planning to split it into two different zones, and, given our focus on the German market, we limit our analysis on the German TSOs hence considering only actual and forecasted variables (as wind and solar PV) registered in this market by Tennet, 50Herz, Transnet and Amprion. Thus, load and renewable data for Austria are not included.

[10]We have also interpolated Datastream quotations over missing weekends and holidays. The tickers of used series are, respectively: LMCYSPT for the settlement prices of coal Intercontinental Exchange API2 cost, insurance and freight Amsterdam, Rotterdam and Antwerp converted in €/MWh using the USEURSP rates from US$ to Euro (WMR&DS); TRNLTTD for the 1st Future Day settlement prices for the natural gas TTF NL quoted in €/MWh; and finally, EEXEUAS for the EEX-EU CO_2 Emissions E/EUA in €. The four German TSOs used to retrieve wind and solar data are: Tennet (www.tennettso.de), Amprion (www.amprion.net), Transnet BW (www.transnetbw.com) and 50Hertz (www.50hertz.com). Lagged actual load has been used as a proxy for the public unavailability of forecasted load, hence the load observed yesterday is considered the best forecast for today. Through the modelling, we have been attentive to the data that would be available to the market at the time when participants make their bids and offers to the day ahead auction.

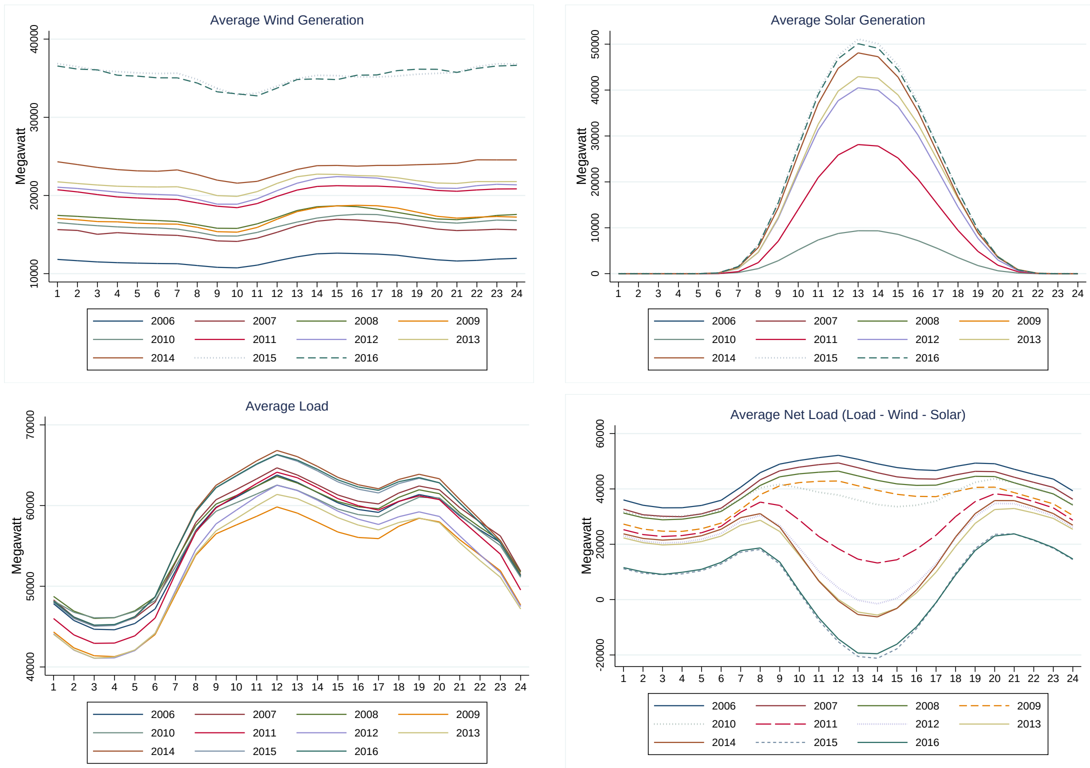


Figure 2: Average Intra–Daily Profiles for Load, Net Load, Wind and Solar Generation. Data sources: Tennet (www.tennettso.de), Amprion (www.amprion.net), Transnet BW (www.transnetbw.com) and 50Hertz (www.50hertz.com) for actual wind and solar generation; and ENTSO-E (www.entsoe.eu) for actual load.

23 and 24, at the beginning of our sample, but after 2010, negative skewness started to occur across the daytime hours as well, when solar generation created a new cycling requirement on the thermal generators. These observations motivated our modelling choice of selecting non-censored distributions with both positive and negative mean and skewness. Thus, to fit the deseasonalised densities of hourly prices, adjusted for holidays, we have considered 3 different classes of distributions with these features and also the capabilities to work within the multivariate formulations we require for estimation in the next section. The first one is a class of 4–parameter distributions, the *Johnson's* S_U (in its original parametrization as in Johnson, 1949 and in its alternative parametrization as in Johnson, 1954; see respectively $JSUo$ and JSU), the *sinh–arcsinh* (as in Jones and Pewsey, 2009; see SHASHo and SHASHo2), the *skew exponential power* (as in Fernadez et al., 1995; see SEP1 and SEP2), the *skew–t* (as in Azzalini, 1986, in Azzalini and Capitanio, 2003 and in Jones and Faddy, 2003; respectively ST1, ST2 and ST5). The second one is a 3–parameter family represented by the *skew–normal* distributions, specifically the skew normal 'type 1' which is a special case of the skew exponential power with $\tau = 2$ (SN1). Thirdly, we selected as a baseline, the 2–parameter *normal* distribution (NO) as this is often used for simplicity in operational models (see previous section).

To identify the best fitting density functions, yearly values of three measures of the goodness-of-fit (the Kolmogorov-Smirnov KS, the Cramer-von Mises CVM, and the Anderson-Darling AD) are reported in Tables 3-10 in Appendix 6.3. According to these measures of fit and accounting for the absolute maximum, the squared and the weighted squared differences (to give more attention on the tails), as well as the AIC criterion to discourage over-parameterisation, we observed the general superiority of the skew student-t distributions (specifically ST1 and ST2). Also recorded in these tables are details of the computational estimation times (for a PC with Intel Core Duo i7-3520M CPU 2.9 GHz and 8GB RAM) which reveal some of the computational difficulties, particulary with the two JSUs. It is also interesting to observe that SN1 and NO emerged to perform well during midday hours which is when, as we observed earlier, the historic positive skewness had been tempered to become more symmetrical through the impact of solar. When we further repeated the analysis on just the deseasonalized prices over the shorter sample 2010-2016 which we use in the multivariate modelling in the next section (shorter because forecast solar data was only available from 2010), we observed that ST2 and JSU were the two best fitting distributions (the former on hours 1-8 & 24, whereas the latter over the hours 9-23; see Table 11 in Appendix 6.3).

On balance, however, we considered the Skewed-t to be most appropriate on the basis of its general fitting and analytical properties. We note that the skewed-t had previously been used for hourly Australian prices in Panagiotelis and Smith (2008) whilst Serinaldi (2011) used the the Johnson's S_U distribution for Californian and Italian electricity price densities. The flexibility of the skew–t distribution to the range of shapes is shown in Figures 3-5, where two forms of the *skew–t* distribution were compared with the JSU, SN1 and NO, for the same motivating sample of hours and years that we displayed in Figure 1. Regarding the skew-t variants, comparing their performances, we decided to focus upon the second skew-t, in which the pdf of the skew–t type 2 distribution, denoted $ST2(\mu, \sigma, \nu, \tau)$, is defined by

$$f_Y(y|\mu, \sigma, \nu, \tau) = \frac{2}{\sigma} f_{Z_1}(z) F_{Z_2}(\omega) \tag{1}$$

for $-\infty < y < +\infty$, where $-\infty < \mu < +\infty$, $\sigma > 0$, $-\infty < \nu < +\infty$ and $\tau > 0$, and where $z = (y - \mu)/\sigma$, $\omega = \nu\lambda^{1/2}z$, $\lambda = (\tau + 1)/(\tau + z^2)$ and f_{Z_1} is the pdf of $Z_1 \sim TF(0, 1, \tau)$ (a t-distribution with $\tau > 0$ degrees of freedom treated as continuous parameter) and F_{Z_2} is the cdf of $Z_2 \sim TF(0, 1, \tau + 1)$. The mean and the variance of Y are given by $E(Y) = \mu + \sigma E(Z)$ and $Var(Y) = \sigma^2 Var(Z)$, where $E(Z) = \nu\tau^{1/2}\Gamma\left(\frac{\tau-1}{2}\right) / \left[\pi^{1/2}(1 + \nu^2)^{1/2}\Gamma\left(\frac{\tau}{2}\right)\right]$ for $\tau > 1$ and $E(Z^2) = \tau/(\tau - 2)$ for $\tau > 2$. This distribution is the univariate case of the multivariate skew-t distribution introduced by Azzalini and Capitanio (2003).

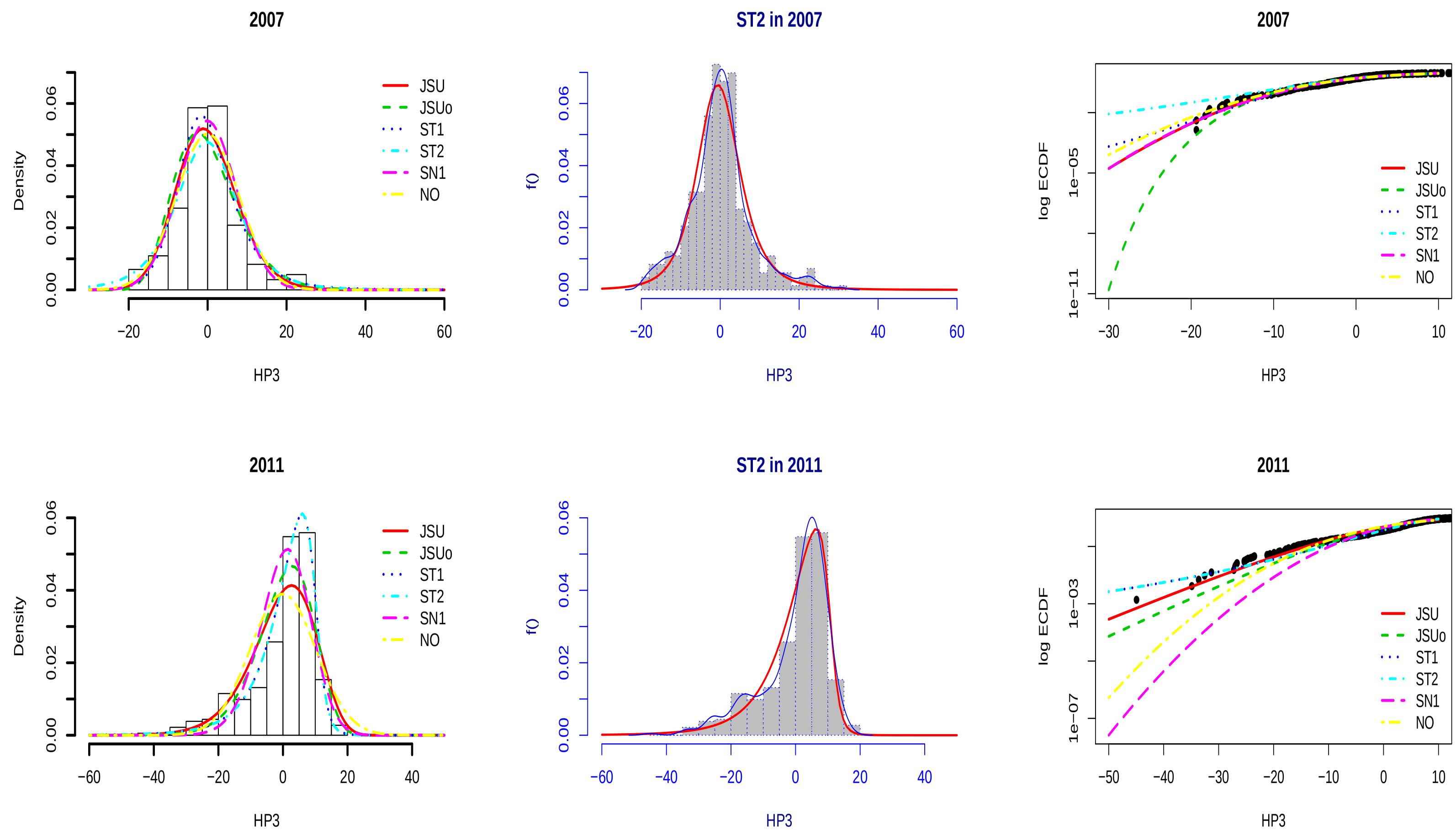


Figure 3: Comparisons of Density Fits (on the first column), the skewed–t fit vs a kernel density (in the middle) and the ECDF with Density in logarithmic scale for hour 3 in 2007 and 2011 (in rows). Descriptive statistics of deseasonalized prices: $\mu = 0.000$, $\sigma = 7.939$, $\nu = 0.546$ and $\tau = 4.487$ in 2007; and $\mu = 0.000$, $\sigma = 10.234$, $\nu = -1.320$ and $\tau = 4.610$ in 2011.

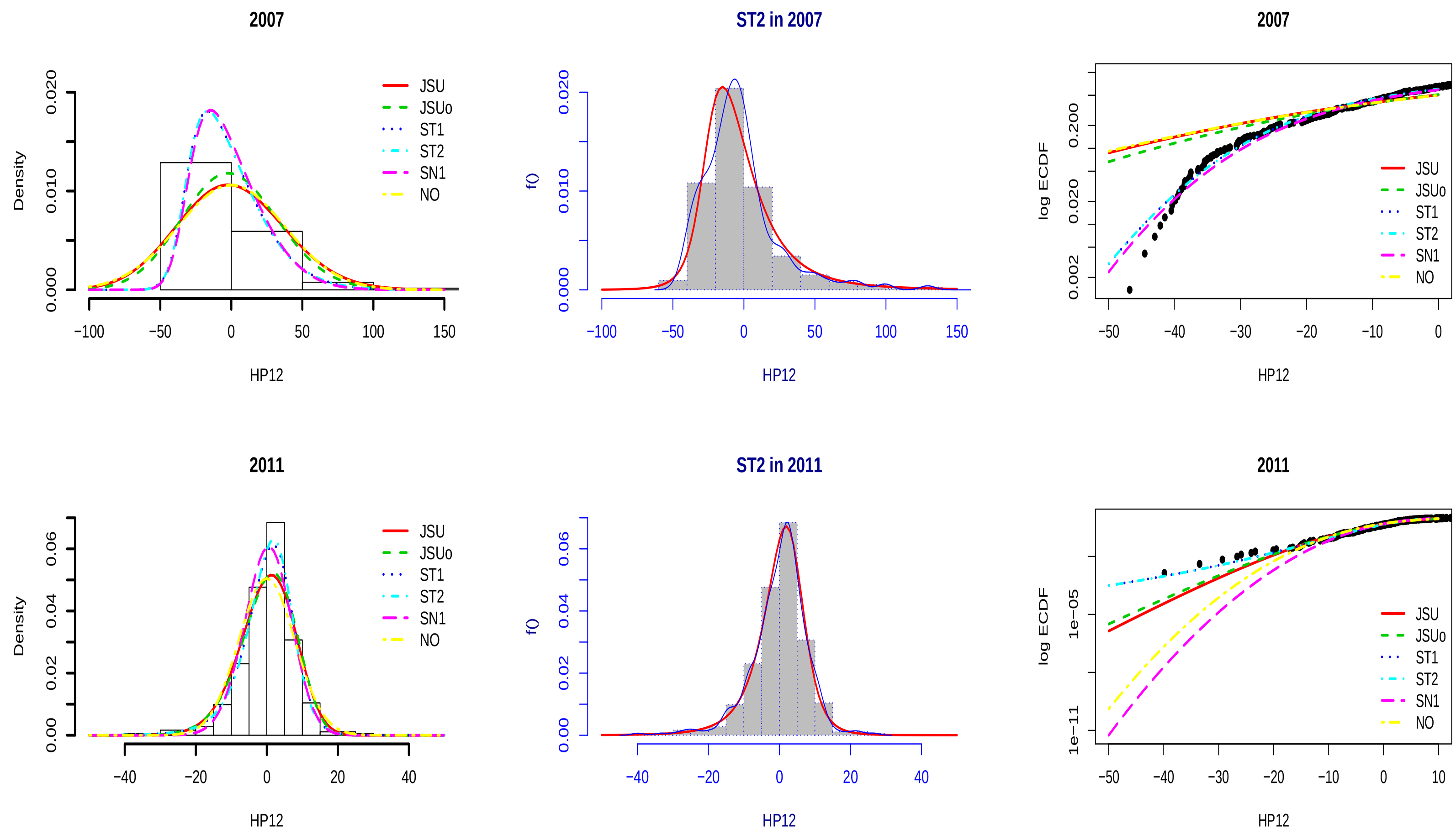


Figure 4: Comparisons of Density Fits (on the first column), the skewed–t fit vs a kernel density (in the middle) and the ECDF with Density in logarithmic scale for hour 12 in 2007 and 2011 (in rows). Descriptive statistics of deseasonalized prices: $\mu = 0.000$, $\sigma = 37.618$, $\nu = 3.642$ and $\tau = 23.575$ in 2007; and $\mu = 0.000$, $\sigma = 7.908$, $\nu = -0.948$ and $\tau = 6.362$ in 2011.

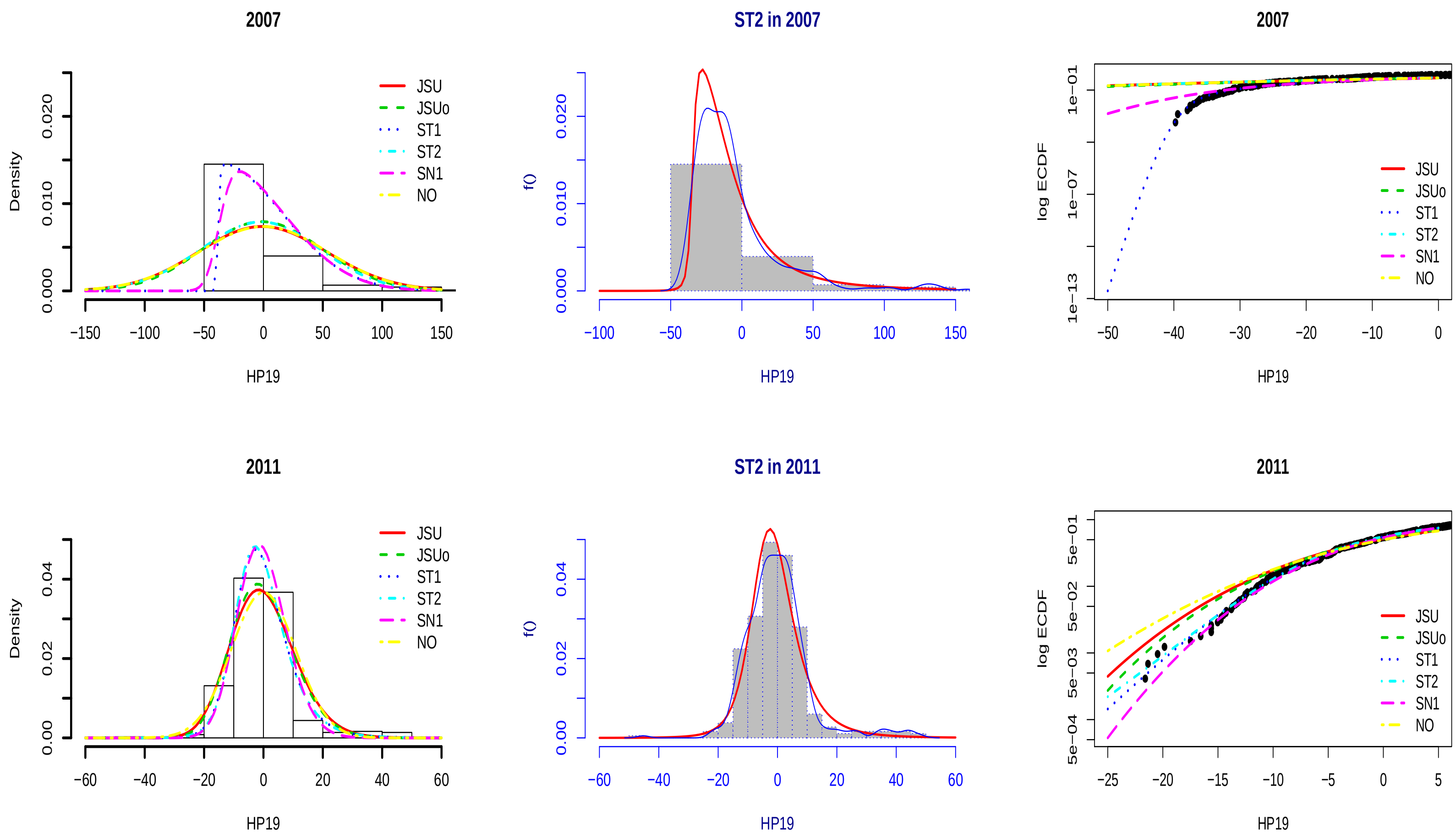


Figure 5: Comparisons of Density Fits (on the first column), the skewed–t fit vs a kernel density (in the middle) and the ECDF with Density in logarithmic scale for hour 19 in 2007 and 2011 (in rows). Descriptive statistics of deseasonalized prices: $\mu = 0.000$, $\sigma = 54.069$, $\nu = 6.172$ and $\tau = 60.714$ in 2007; and $\mu = 0.000$, $\sigma = 10.870$, $\nu = 1.357$ and $\tau = 7.921$ in 2011.

4. Linear Multifactor Dynamic Estimation of the Density Moments

With the attractive flexibility of the four parameter skew–t densities for fitting the various hourly prices, the consequent research question is whether the specification of the first four moments of the skew-t can be well represented in terms of the dynamics of fundamental short term drivers of price formation. To this end, we considered whether these exogenous variables could be formulated and estimated within a generalized model for the first four moments (representing the level μ, the volatility σ, skewness, ν. and kurtosis, τ), resulting from an extension of the Generalized Linear Models in Nelder and Wedderburn (1972); Generalized Additive Models in Hastie and Tibshirani (1986) and Hastie and Tibshirani (1990); and the Generalized Additive Models for Location, Scale and Shape, `gamlss`, as in Rigby and Stasinopoulos (2005) and Stasinopoulos and Rigby (2007). In so doing, we seek to substantially extend the scope of applications undertaken with similar methodology by Serinaldi (2011), Matsumoto et al. (2012) and Scandroglio et al. (2013). Within this framework we formulate the hourly electricity price as a response variable whose distribution function varies according to multiple exogenous factors. From the previous section we choose to represent the response variable (the deseasonalised hourly electricity price) as a the skew–t density with the mean, μ, standard deviation, σ, skewness, ν, and kurtosis, τ modelled as multifactor linear functions as follows.

Let Y be the response variable, it is assumed that independent observations y_i for $i = 1, \ldots, n$ have distribution function $F_Y(y_i; \theta^i)$

with $\theta^i = (\theta^i_1, \ldots, \theta^i_p,)$ a vector of p distribution parameters accounting for position, scale and shape. Generally, p is less than or equal to four, since the 4-parameter families provide enough flexibility.

Given an n length vector of the response variable $\mathbf{y}^T = (y_1, \ldots, y_n)$, let $g_k(\cdot)$ for $k = 1, \ldots, p$ be monotonic link functions relating the distribution parameters to explanatory variables and random stochastic effects to account for extra not explained variability through an additive model given by

$$g_k(\theta_k) = \eta_k = \mathbf{X}_k\beta_k + \sum_{j=1}^{J_k} \mathbf{Z}_{jk}\gamma_{jk} \tag{2}$$

where θ_k and η_k are vectors of length n, e.g. $\theta_k^T = \{\theta_k^1, \ldots, \theta_k^n\}$, $\beta_k^T = \{\beta_{1k}, \ldots, \beta_{J_k k}\}$ is a parameter vector of length J_k, $\mathbf{X}_k$ is a known design matrix of order $n \times J_k$, $\mathbf{Z}_{jk}$ is a fixed known $n \times q_{jk}$ design matrix and γ_{jk} is a q_{jk}-dimensional random variable.

The linear predictors η_k, for $k = 1, \ldots, p$ comprise a parametric component $\mathbf{X}_k\beta_k$ and additive components $\mathbf{Z}_{jk}\gamma_{jk}$; the first term represents a linear function of explanatory variables and the second one represents random effects. For sake of parsimony, we used only linear components in link functions. We assumed identity link functions, $g_1(\cdot)$ and $g_3(\cdot)$, for the expected hourly prices and their skewness; whereas logarithmic link functions were used for $g_2(\cdot)$ and $g_4(\cdot)$ to ensure positivity for standard deviation and kurtosis, obtained by taking the exponential of the filtered log series.

Based upon the conventional considerations of market fundamentals and with regard to the information that would generally be available to market participants by the time they make offers and bids into the day ahead auction, we have expressed the expected hourly price in reduced form as a function of its value observed on the day before (y_{t-1}), as well as on electricity load observed on the day before ($load_{t-1}$, in thousands of MW), forecasts for wind and solar PV generation ($fwind_t$, and $fsolar_t$, also in thousands of MW) available to the market prior to the auction, lagged prices of coal, gas and CO_2 allowances (respectively $coal_{t-1},\ gas_{t-1},\ co_{2t-1}$), together with calendar holidays and weekends in a dummy variable, hol_t, which takes value 1 for weekends and German holidays[11].

Formally, in its basic formulation, this dynamic multi-factor skew t "MFST" model has $g_1(\theta_1) = \eta_1 = E(y_t) = \mu_t$, with a time-varying latent mean

$$\begin{aligned} \mu_t &= \alpha_1 + \gamma_1 y_{t-1} + \beta_{11} hol_t + \beta_{12} load_{t-1} + \beta_{13} fwind_t + \beta_{14} fsolar_t && (3) \\ &\quad + \beta_{15} coal_{t-1} + \beta_{16} gas_{t-1} + \beta_{17} co_{2t-1}. && (4) \end{aligned}$$

We assumed that the dispersion, estimated dynamically as a time varying latent volatility (standard deviation) state variable, is a function of fundamental drivers through $g_2(\theta_2) = \eta_2 = log\left(\sqrt{Var(y_t)}\right) = log(\sigma_t)$, with

$$log(\sigma_t) = \alpha_2 + \beta_{21} hol_t + \beta_{22} load_{t-1} + \beta_{23} fwind_t + \beta_{24} fsolar_t + \beta_{25} coal_{t-1} + \beta_{26} gas_{t-1} + \beta_{27} co_{2t-1}. \quad (5)$$

Distinct from previous formulations (eg Serinaldi, 2011), we extend the scope of dynamic multifactors to the third and fourth moments through the time varying latent parameters, $g_3(\theta_3) = \eta_3 = \nu_t$ and $g_4(\theta_4) = \eta_4 = log(\tau_t)$ as follows

$$\nu_t = \alpha_3 + \gamma_3 hol_t + \beta_{31} load_{t-1} + \beta_{32} fwind_t + \beta_{33} fsolar_t + \beta_{34} coal_{t-1} + \beta_{35} co_{2t-1} + \beta_{36} gas_{t-1} \quad (6)$$

$$log(\tau_t) = \alpha_4 + \gamma_4 hol_t + \beta_{41} load_{t-1} + \beta_{42} fwind_t + \beta_{43} fsolar_t + \beta_{44} coal_{t-1} + \beta_{45} co_{2t-1} + \beta_{46} gas_{t-1}. \quad (7)$$

In order to investigate possible persistence in the latent moments, we also considered a new expanded formulation to include the autoregressive dynamics of the latent moments into the above mean, variance, skewness and kurtosis equations, thus defining an autoregressive multifactor skew-t model, "AR-MFST". In the "AR-MFST" models, the 1-lag autoregressive variables $\mu_{t-1},\ \sigma_{t-1},\ \nu_{t-1}$ and τ_{t-1} are included in each of the corresponding equations 4-7 above. Furthermore, extending this concept to include possible implicit effects between these latent moments, we also considered a vector autoregression version in which the first lags of all four of the latent moments are included in each latent moment equation, 4-7, to give the "VAR-MFST" formulation[12].

[11] To avoid over-parametrization, we have included weekly seasonality together with holidays in one single dummy variable, equal to one over weekends and holidays such as: New Year, Good Friday, Easter Monday, Labour Day, Ascension Day, Whit Monday, German unit day, Christmas Eve, Christmas Day, Boxing day and New Years Eve. Given our focus on the German TSOs market, we have not considered Austrian public holidays nor regional holidays, such as Pentecost, Corpus Christi Assumption of Mary, Reformation day, All Saints day and Repentance Day.

[12] In the former case, μ_{t-1} is replacing lagged prices. And autoregressive terms have been extracted after the estimation of the basic MFST model presented in eqs. 4-7.

All parameters are estimated by maximizing the likelihood function[13], through an adaptation of Cole and Green (1992) algorithm, which uses the first, second and cross derivatives of the likelihood function with respect to the distribution parameters, $\theta(\mu, \sigma, \nu, \tau)$. As the computation of cross derivatives proved to be intractable, we adopted a generalization of the algorithm developed in Rigby and Stasinopoulos (1996a), and Rigby and Stasinopoulos (1996b) for fitting the mean and dispersion additive models which does not require the cross derivatives. Initial values for autoregressive sample parameters have been obtained by fitting the model to the entire sample, then lagged series have been included (and later in the forecasting performance, updated through the rolling iterations).

Optimisation in ML estimations such as this are often sensitive to starting values, leading to local optima, or even singularities with small samples, but with the length of time series in our study, neither of these were problems[14]. Overfitting, on the other hand, was a serious consideration and for that reason we restricted our factor specifications to plausible drivers on the basis of what is known about electricity price formation and we undertook extensive out-of-sample testing in a forecasting context with some challenging benchmark testing.

Whilst it should be recalled that the main objective of this modelling is to elucidate a general–purpose price formation model, flexible enough to accommodate the range of shapes that hourly power prices may take, in a way that relates these shape changes parametrically to fundamental exogenous drivers, the estimation process also derives the time–varying latent estimates of the moments. For several financial engineering applications in particular, such latent estimates of the instantaneous volatility and skewness states are attractive alternatives to historic estimates based upon lagged finite rolling windows. For example, Figure 6 shows the time series of the latent moments for hour 12, whereas similar series are shown for hour 19 in Figure 10 in Appendix 6.1.

[13]The estimation has been carried out using the statistical software R and some of the `"gamlss"` library models (http://www.gamlss.org/).

[14]There are two algorithms to maximize the likelihood function: the first is the CG algorithm, a generalization of the Cole and Green (2002) algorithm which uses first, (expected or approximated) second and cross derivatives of the likelihood function with respect to the distribution parameters; the second one is the RS algorithm, a generalization of the algorithm used by Rigby and Stasinopoulos (1996a) and Rigby and Stasinopoulos (1996b) for fitting the mean and the dispersion of additive models and it does not use cross derivatives. Singularities in the likelihood function similar can potentially occur, especially when the sample size is small as in our yearly analysis. The RS algorithm has an outer cycle which maximizes the penalized likelihood with respect to β_k and γ_{jk} for $j = 1, \ldots, J_k$ in the model successively for each θ_k in turn, for $k = 1, \ldots, p$; and at each calculation in the algorithm, the current updated values of all quantities are used. Roughly, the RS algorithm starts initializing the fitted values θ_k and random effects γ_{jk} in the first outer and inner cycle iterations by regressing partial residuals against a 'weighted' design matrix to obtain updated parameter estimates. Then, the linear predictors η_k are evaluated and updated, and the cycle is repeated until the change in the penalized likelihood is sufficiently small. At this point, convergence is obtained and results produced. On the contrary, in the CG algorithm all weight matrices are evaluated and updated after fitting of all θ_k. Further details on the functioning of algorithms and the maximization of the likelihood can be found in Rigby and Stasinopoulos (2005) and in Stasinopoulos et al. (2008). In all our estimation, we used the RS algorithm and control parameters set to: 0.5 as for the the convergence criterion for the algorithm (*c.crit* and *cc*), and the tolerance level for the backfitting algorithm (*bf.tol*); 1000 for *n.cyc*, for *cyc*, as the number of cycles of the algorithm, and for the number of cycles of the backfitting algorithm (*bf.cyc*). Finally, *Inf* was used for the global deviance tolerance level (*gd.tol*), to allow the algorithm to converge even if the global deviance changes dramatically during the iterations.

Residual analysis for enlarged models is presented in Appendix B.5, Figures 11 and 12, which contain the ACF and PACF of residuals from the main models under consideration; in addition, ACF and PACF for level, squared and cubic residuals are shown in Figures 13 and 14. The PACFs indicated some residual correlations which was expected. We did not include any nonlinear specification in the models, particular with respect to load. Supply functions are known to be nonlinear at low and high levels and whilst we chose a simple linear response as a robust assumption, it will presumably be underspecified. There are also interaction effects. In some of the subsequent modelling we have therefore included AR(7) to capture serial effects of up to a week. For additional insight, Table 17 in Appendix 6.4.3 presents the descriptive statistics of normalized (quantile) residuals for a sample of hours. The *normalized quantile* residuals are given by $\hat{r}_i = \Phi^{-1}(u_i)$ where Φ^{-1} is the inverse cumulative distribution function of a standard normal variate, $u_i = F(y_i|\hat{\theta}^i)$ and $F(y|\theta)$ is the cumulative distribution function with $\theta = (\mu, \sigma, \nu, \tau)$. If the "MFST" models are correctly specified, then the normalized quantile residuals should behave as standard normal ones, see Dunn and Smyth (1996). In our results, these residuals generally exhibit zero mean, unit variance, zero asymmetry and kurtosis equal to three (except for the simpler SN1 and NO distributions) thus indicating model adequacy (the results for other hours are similar and available on request).

4.1. Dependence of Higher Moments on Exogenous Fundamental Drivers

In order to avoid over–elaboration and to justify the multifactor, time–varying representation of the moments, we developed a series of progressively more complex specifications. According to the multifactor formulations of eqs. 4-7, four models were successively estimated:

M1: time-varying mean, but all other moments constant;

M2: time-varying mean and standard deviation, with constant skewness and kurtosis;

M3: time-varying mean, variance and skewness, constant kurtosis;

M4: all four moments time varying.

In all cases, we also specified the models with and without each of the renewable energy drivers (wind and solar) and the results confirmed their incremental impacts (these have not been reported for lack of space, but they are available on request).

Expectations for these factor effects follow from previous work, but as such only inform price levels and variance (eg from Karakatsani and Bunn (2010), Ketterer (2014), Paraschiv et al. (2014), Cló et al. (2015) and Bunn et al, 2016, among others) as this research is the first to consider the higher skewness and kurtosis drivers. Thus, previous research would imply:

1. positive autoregression at lag one in price levels and the higher moments, reflecting some *adaptive behavior and persistence*;
2. positive effect of load (i.e. demand) on the mean power price because of the increasing fundamental marginal cost supply function, and on volatility, reflecting the conventional "inverse leverage" observation that at times of high demand and prices, volatility also increases (in contrast to the usual leverage in equity markets with higher volatility at lower prices);

	Hour 3				Hour 12				Hour 19			
	μ	$log(\sigma)$	ν	$log(\tau)$	μ	$log(\sigma)$	ν	$log(\tau)$	μ	$log(\sigma)$	ν	$log(\tau)$
hol_t	$-$	$+$	$-$	$+$	$-$	$+$	$-$	$-$	$-$	$\pm$	$-$	$+$
y_{t-1}	$+$				$+$				$+$			
μ_{t-1}	$+$	$+$	$-$	$+$	$-$	$-$		$-$	$\pm$	$-$	$-$	$-$
$log(\sigma_{t-1})$	$+$	$+$			$-$	$+$		$-$	$+$	$+$	$-$	$-$
ν_{t-1}		$-$	$+$		$+$	$+$	$-$		$-$	$-$	$-$	$+$
$log(\tau_{t-1})$				$-$		$+$			$+$	$+$		$+$
$load_{t-1}$	$+$	$-$	$+$	$-$	$+$	$-$	$-$	$+$	$+$	$\pm$	$\pm$	$-$
$fwind_t$	$-$	$+$	$-$	$+$	$-$	$+$	$-$	$-$	$-$	$-$	$-$	$+$
$fsolar_t$					$-$	$-$	$-$		$-$	$-$	$-$	$+$
gas_{t-1}	$+$	$+$	$-$	$+$	$+$	$+$	$+$	$-$	$+$	$+$	$+$	$-$
$coal_{t-1}$	$+$	$\pm$	$-$	$-$	$+$	$\pm$	$-$	$\pm$	$+$	$-$	$-$	
co_{2t-1}	$+$	$+$	$-$	$-$	$+$	$+$			$+$	$+$	$+$	$-$

Table 1: High level summary of significant signs for the full model M4 and its AR and VAR variations.

3. fuel prices and CO_2 generally increasing the mean power price because of their input cost;
4. wind (and solar) reducing electricity prices (especially for peak hours as consequence of balancing excess demand), but increasing the volatility.

A high level summary of the significant signs of the full model specifications for the MFST, AR-MFST and VARM-MFST models is shown in Table 1, whereas the full results for estimated coefficients and t-values are in Tables 12-14 in Appendix 6.4.1 for a sample of hours. The entries in Table 1 are for the significant (5%) coefficients and their signs. Where plus and minus signs are overlayed, the indications from all three MFST variations differ. The R-squares (the generalised R-squared in Nagelkerke (1991)), the Global Deviance (defined as a function of the log-likelihood, formally $GD = -2log\mathcal{L}$), and information criteria about the progressive modelling are reported in Tables 15 and 16 in Appendix 6.4.2. These results present a generally coherent interpretation, mostly consistent with expectations but with some new insights. The most important observations are the shape-shifts induced by wind and solar. Both wind and solar production do indeed reduce the skewness of hourly electricity prices and this is more evident at hour 12 when solar is at its maximum level. In addition, both increase the kurtosis of these prices at peak hour 19. The consistency of the results across all of the modelling progressions, with the various inclusions of wind and solar, adds considerably to the robustness of the fundamental specification. The key factor influences are:

1' Lagged price is positive for all four MFST models on price level, indicating adaptive behaviour consistent with expectations. However, for the latent moment autoregressions the results are mixed. Holidays, as expected, reduce business activities and therefore price levels. Latent volatility was positively persistent on itself, as expected and had a positive effect on price levels in periods 3 and 19, but negative in period 12. For the higher moments, some mixed results might suggest over-fitting with the AR MFST and particularly VAR MFST.

2' Load (i.e. demand) has a positive coefficient on the price levels, consistent with conventional expectations and previous research, but negative on price variance for hours 3 and 12. Hour 3 is when more negative price spikes are observed compared to hours 12 and 19 and low load levels over night will therefore manifest higher volatility.

3' Among fuel prices, we find that *natural gas* increases mean and volatility. During the day it increases skewness, whereas it reduces the kurtosis. At night it reduces skewness and increases kurtosis. These effects seem plausible as peaking generation during the day may be associated with positive spikes, whereas its use at night might be counteracting negative price tendencies. *coal* increases mean but it reduces skewness. We also confirm that CO_2 affects price levels and volatility.

4' Wind lowers prices and lowers skewness. Hence the appearance of negative skewness, as noted earlier, can be confirmed as a wind-induced factor. Solar has effects during the day, with negative effects on price levels, volatility and skewness. The wind and solar effects are consistent across all modelling specifications.

It is questionable whether the gains of expanding the dynamic specifications in the model from 3 to 4 parameters,and in extending the specifications to AR and VAR latent moments is worthwhile. In one respect, whilst the interpretations of the kurtosis factor coefficients are generally significant, intuitions regarding their sign are equivocal, and the gains in fit from $M3$ to $M4$ are small. The dynamic three parameter improvement over a two parameter model is substantial, and the skewness story is persuasive; but less so for the kurtosis in going to four parameters. Likewise, the AR and VAR inclusions of the latent estimates produced equivocal estimations and this suggests specification or overfitting problems, despite their conceptual appeal. Thus, in the next section we report results on out–of–sample forecast testing performed on rolling windows of 365 days[15]. The motivation is not primarily to suggest a forecasting method, but to test the robustness of the specifications.

4.2. Forecasting Performance

For robustness and as a check against over-fitting, we test the performance of the MFST, AR-MFST and VAR-MFST models through one period ahead, out-of-sample forecasting, using rolling window estimations and also considering all one-, two-, three- and four-moment specifications. We compare against two benchmarking techniques, one being the well-established semi parametric quantile regression method to derive empirical interval limits and the other being a conventional approach for estimating the conditional means and variances of electricity prices using ARMA–GARCH type models.

Benchmarking against quantile regressions is a challenging test insofar as these estimates of particular points on the density function (eg 5%, 95% intervals) make no distributional assumptions and are purely empirical. The MFST approach will only be as accurate as quantile regression at specific quantiles if its parametric specification is appropriate. More precisely, we compare M1- AR1- and VARM1-MFST versus Quantile Regressions, including an AR(7) structure together with drivers, holidays and seasonality. When the first two moments are considered, an ARX–EGARCHX(1,1), specified with a student-t and a skewed-student-t for the innovations, will estimate volatility persistence and its formulation clearly recalls the $log(\sigma_t)$ in the M2-MFST versions, which will only capture this to the extent that the drivers of heteroscedasticity are in the exogenous multifactor dynamics. But, in the

[15]Not reported here were results based on rolling windows of 730 days and an expanding window of 365 days. These confirmed those found in the rolling approach presented here.

ARMA-GARCH framework, the innovations cannot change density shape as effectively as in the MFST, and then the AR- and VAR-MFST should capture some of the persistence effect through the inclusion of lagged latent moments. In addition, we compare the (AR)M2-MFST (that is specified with two moment equations) with the model formulated in Serinaldi (2011) based on the Johnsons' S_U with daily and hourly dummies, quadratic and cubic loads, and price functionals.

Quantile methods, following Koenker and Bassett (1978), are extensively applied as regression models for expressing specific percentiles of a response variable as a function of exogenous factors. Their main attractive features are firstly their semiparametric formulation of interval estimates of the predictive distribution; and secondly, the fact that they distinguish the impact of explanatory variables to different intervals of the distribution. Thus, in the conventional way, we let $q \in [0,1]$ be a quantile of interest, Y_t be the dependent variable (that is the hourly electricity price levels) and X_t a d–dimensional vector of explanatory variables (e.g. load, forecasted wind and solar generation; gas, coal, and CO_2) with a constant included. The linear conditional quantile function is given by $Q_q(Y_t|X_t) = X_t\beta_q$ and we have used the fundamental drivers as in eq.(4) to forecast and compare selected quantiles:

$$Q_q(y_t) = \alpha^q + \sum_{i=1}^{7} \gamma_i^q y_{t-i} + \beta_1^q hol_t + \beta_2^q load_{t-1} + \beta_3^q fwind_t + \beta_4^q fsolar_t + \beta_5^q coal_{t-1} + \beta_6^q gas_{t-1} + \beta_7^q co_{2t-1} \tag{8}$$

As observed by Chernozhukov and Umantsev (2001), data scarcity may be a problem in estimating the extreme tails of the distribution.

Benchmarking with the ARX–EGARCHX(1,1) model we test both student–t and skew student–t error distributions. Again, we have specified an AR(7) structure with the same factors as eq.8, and in this case with the conditional variance following an EGARCH(1,1) process also driven by the load, wind, solar and lagged fuel drivers. Formally, the conditional mean being as follows

$$y_t = c + \sum_{i=1}^{7} \phi_i y_{t-i} + \lambda_1 hol_t + \lambda_2 load_{t-1} + \lambda_3 fwind_t + \lambda_4 kfsolar_t + \lambda_5 coal_{t-1} + \lambda_6 gas_{t-1} + \lambda_7 co_{2t-1} + \theta\varepsilon_t \tag{9}$$

and the conditional variance as follows

$$\begin{aligned} log(\sigma_t^2) &= \omega + \alpha\ log(\sigma_{t-1}^2) + \beta g(\varepsilon_{t-1}) + \varphi_1 hol_t + \varphi_2 load_{t-1} + \varphi_3 fwind_{t-1} + \varphi_4 fsolar_{t-1} \\ &\quad + \varphi_5 coal_{t-1} + \varphi_6 gas_{t-1} + \varphi_7 co_{2t-1} \end{aligned} \tag{10}$$

with $g(\varepsilon_t) = \theta\varepsilon_t + \varrho[|\varepsilon_t| - E(|\varepsilon_t|)]$ with the conditional density set to be a Student–t, $\varepsilon_t|I_{t-1} \sim t(0, \sigma_t^2)$, or a skew Student–t, $\varepsilon_t|I_{t-1} \sim st(0, \sigma_t^2)$.

We expect that the four parameter, dynamic, multifactor skew-t models ("MFST" and "AR-MFST") to perform better than the ARMAX-GARCHX method, to the extent that the latter is only able to capture mean and variance dynamics. Even if the GARCH element would add the extra responses to conditional volatility and the persistence of shocks, the AR-MFST model is expected to exhibit competitive performance due to the extra flexibility in the density shape and the lagged latent moment persistence.

Having a full dataset of 2557 observations from the beginning of 2010 (because of the solar data not being available before), we perform an in–sample estimation using a rolling window of 365 days. We then forecast the next observation as an out–of–sample test, and recursively advance the process through the time–series[16].

We assess the calibration of the forecast densities by simply using conventional tests, such as Kupiec (1995) unconditional (UC), Christoffersen (1998) conditional coverage (CC) and the Engle and Manganelli (2004) dynamic quantile (DC) tests on yearly basis. In the coverage tests, the null hypothesis is that the calibration frequencies at each quantile are correct. Thus, in the results, a p–value greater than 0.01 indicates that we cannot reject the null hypothesis under a significance test at 1% (hence we are looking for high p values for well calibrated coverage). Tables 18-20, 21-23 and 24-26 in Appendix 6.5 summarise the results for hour 3, 12 and 19, for lower, middle and upper quantiles respectively. Results for a sample of other hours are available in Tables 27, 28, and 29. On this basis, we observe that the this forecasting process on a rolling window of 365 observations provides poor results for *quantile regression*, most likely for the sample size reasons indicated in Chernozhukov and Umantsev (2001).

For hour 3, most practical interest would be in the lower quantiles, for the occurrence of downspikes, and here the MFST and the AR-MFST outperform the quantile regression and the GARCH methodology. For hour 12, practical interest would be in both the high and low quantiles, and here again the MFST and AR-MSFT performances in terms of coverage are better than the two benchmarks especially at lower quantiles (even with the shortest rolling window). For hour 19, most practical interest would be in the high quantiles for the risk of high prices, and we see again that the MFST models outperform the benchmarks. In addition, with the lower quantiles, the flexibility and forecasting ability of MFST models continues to be beneficial with the benchmarks being outperformed. Furthermore, we observe that the ARM3-MFST outperforms the ARM4-MFST in the out-of-sample forecasting testing, and this provides empirical evidence, as suspected, that there is little to be gained through modelling with the fourth moment being dynamic, and potential overfitting can be avoided. Likewise, the VAR representation proved to be less robust than the AR for out-of-sample, and together with the mixed interpretation of the coefficients in Table 1, appears to reflect overspecification.

Finally, to summarise the main comparisons, we show in in Figure 7 the theoretical number of hits (exceedances at particular quantiles) versus the empirical frequencies across the quantiles, for three key models. For illustration we plot the graphs for hour 12 in 2011 and 2015 (similar results for other hours are available on request, showing the same indications). This clearly displays the superiority of the proposed ARM3-MFST, being closest to the theoretical curve, compared to the JSU density model used by Serinaldi (2011) and the EGARCH with skew student t which would perhaps be the most appropriate of the conditional volatility models typically used for Value-at-Risk analysis.

[16]Thus, we start by estimating the models using the first 365 observations, and from this forecast the 1%, 2%, 5%, 25%, 50%, 75%, 95%, 98% and 99% quantiles of the 366^{th} observation. Thereafter, we estimate the models using observation 2 to 366 to forecast quantiles of observation 367 , and so on. The recursive (V)AR-MFST models have been initialized by using the lagged filtered moments obtained from the MSFT estimation on the whole sample; then, the autoregressive terms have been recursively updated by rolling estimations and used into the forecasting procedures.

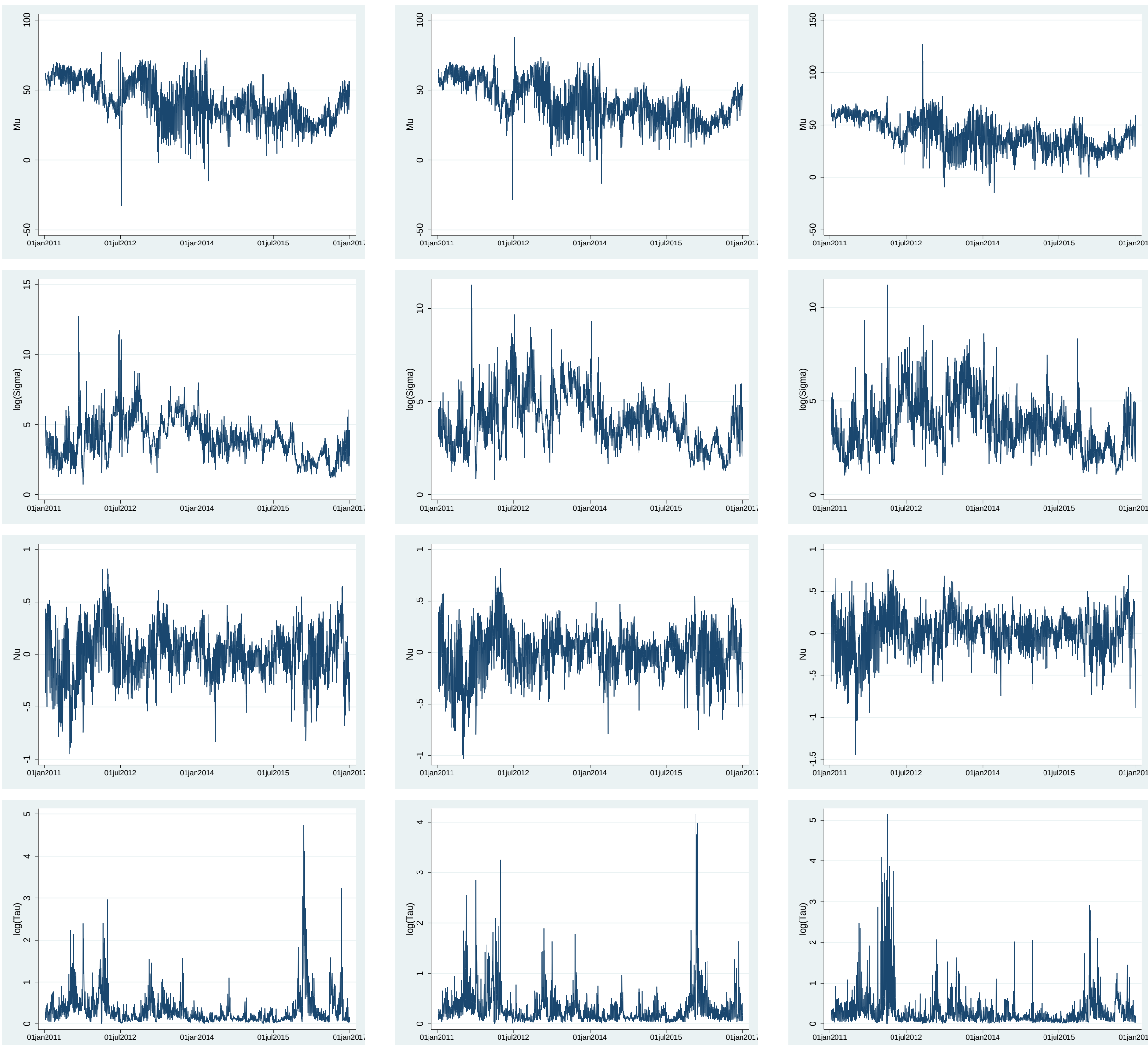
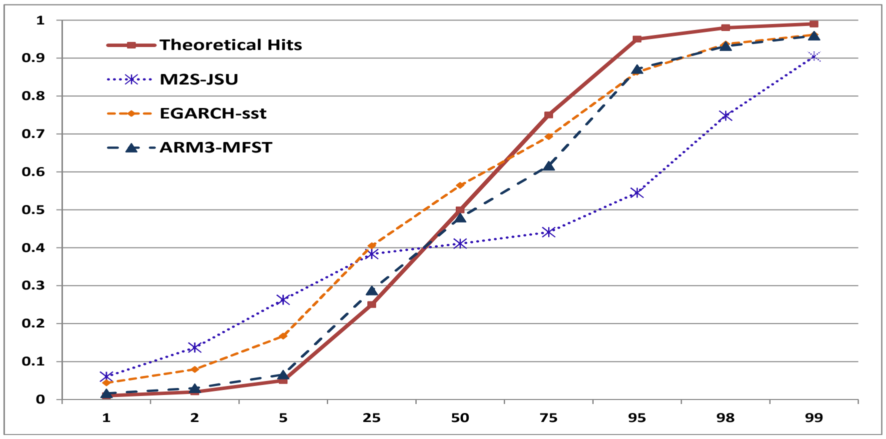


Figure 6: Filtered time series of mean ($\widehat{\mu}_t$) on the first rows, volatility ($log(\widehat{\sigma}_t)$) on the second rows, skewness ($\widehat{\nu}_t$) on the third rows and kurtosis ($log(\widehat{\tau}_t)$) on the last rows, from a skew-t representation of prices at hour 12 based on the MFST (first column), AR-MFST (second) and VAR-MFST models (third column) estimated on a rolling window of 365 days and continuously updated from 2010 towards the end of our sample. Static filtered moments can also be extracted once the model is estimated on the full sample.



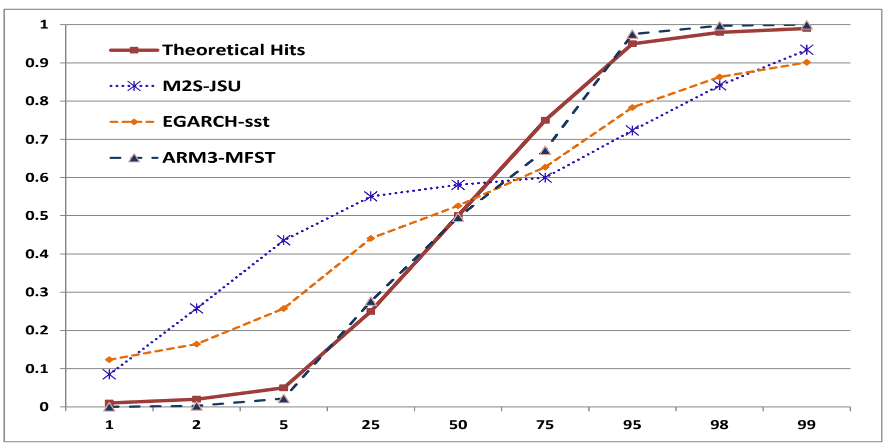


Figure 7: Theoretical versus Empirical Hits of Selected Models across Quantiles for hour 12 in 2011 (first row) and in 2015 (second row). Theoretical Hits are simply 1%, 2%, 5%, 25%, 50%, 75%, 95%, 98%, 99%; M2S-JSU is the model proposed by Serinaldi (2011); EGARCH-sst is the AR(7)X-EGARCH(1,1)-X with a skew student-t distribution as formulated in eqs. 9-10; ARM3-MFST is the 'MFST' model with three moment equations and autoregressive terms included (as formulated in Section 4).

5. Final Comments and Conclusion

The development of an accurate, flexible and analytically tractable representation for electricity price processes has considerable practical value for operations control, risk management and financial products, and the increasing penetration of renewable energy, through solar and wind, is not only adding to the complexity of price formation, but also the greater need for short–term hedging products. Closed form solutions are desirable for hedging, but the choice of an appropriate density function is awkward in power markets because of the rapid shape changes that may occur over time due to intermittent wind and solar output as well as the usual demand and fuel price shocks. The increasing interest in battery storage operations and EV charging logistics is also motivating the use of analytics that require accurate short-term models of the hourly prices. Furthermore, whilst generators have always needed to plan unit commitment several days in advance, retailers are now looking to anticipate demand-side engagement at the day ahead stage, and both generators and retailers are carefully considering their offer quantities to the day ahead auctions in the light of reserving capacities for the profitable intra day and balancing markets.

With this context and methodological need in mind, we have examined the applicability of a stochastic price formation model based upon dynamic latent moments estimated within a skewed–t density to accommodate the range of shapes that hourly power prices exhibit, and furthermore related these shape changes dynamically to a set of exogenous drivers. This is conveniently and transparently achieved through linear multifactor representations of the first four moments of this density, estimated as dynamic latent variables. Benchmarked against quantile regression and ARMAX–GARCHX, the method performed well. In particular, the ability to capture the swings between positive and negative skewness by time of day and according to the amount of renewable energy generation is an appealing feature and could provide a useful ingredient into the daily optimisation of trading positions and operational scheduling. Furthermore, since the evolution of market structure is represented through the exogenous variables, the frequent re–specification that a more empirical approach would require is avoided. The MFST approach therefore offers shape flexibility and stability of specification. Furthermore, introducing lagged latent moments into the model, as AR-MFST, is attractive for interpreting persistence in skewness and volatility, as well as adaptive evolution in the mean, and this was robust to out-of-sample testing.

The approach was not outperformed by the nonparametric quantile regression benchmark, which does not offer analytical solutions, but would have been expected to estimate the percentiles more precisely. In fact our proposed approach was clearly better in terms of out-of-sample performance. This is reassuring for the general functional form of the skew–t and its multifactor drivers. Regarding its comparison to an ARX–EGARCHX, also in this case, the (V)AR-MFST models outperformed, showing that extreme quantiles were better calibrated by the multifactor skew–t models compared to the GARCH model. We observe that the inclusion of conditional volatility and lagged higher moments made the specification more dynamic and superior to the GARCH approach.

It is an open question if the dynamic specification of the fourth moment adds value, with the three moment version performing better out of sample, but for situations where this may be useful, eg portfolio optimisation models that explicitly use the first four moments (Giesecke et al. (2014)), the formulation appears sufficiently robust. As regards, the choice of further exogenous variables, the reserve margin and the flow of imports/exports in the German context would be potentially valuable and may improve accuracy. There is certainly scope for a more comprehensive multifactor modelling of the price formation process, but the main methodological objectives of this research have nevertheless been well supported by the specification, as applied.

Beyond the electricity case which motivated this study, this general approach should have quite wide appeal in capturing the shape–shifting properties in the market price densities not only of a wide range of commodities but also for prices in any market where the key ingredient is a role for significant and time–varying exogenous drivers in determining dynamic shifts in the density shapes.

6. APPENDICES

6.1. Reference Figures

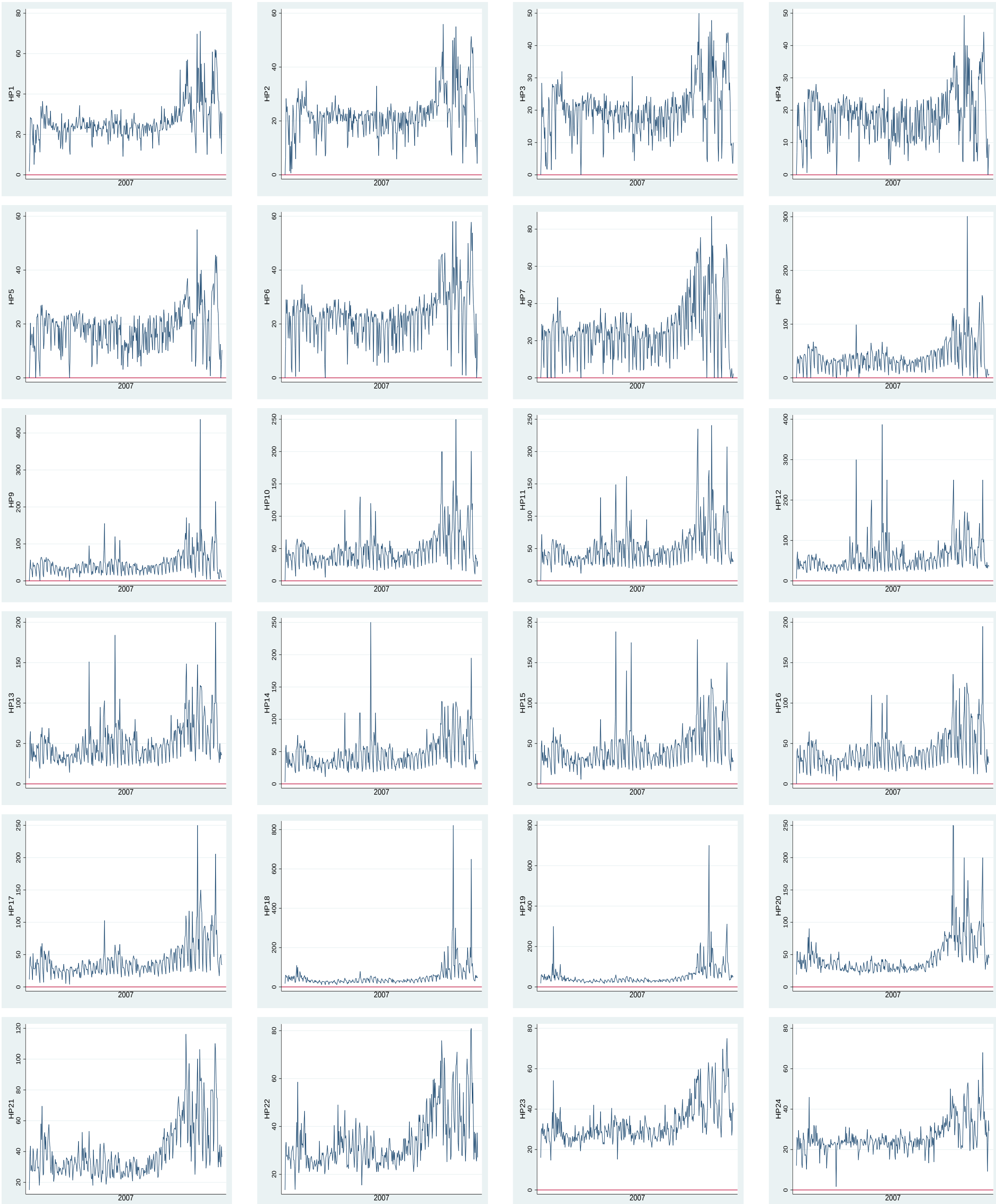


Figure 8: 24 daily time series in 2007, one for each of the separately determined hourly prices.

Figure 9: 24 daily time series in 2011, one for each of the separately determined hourly prices.

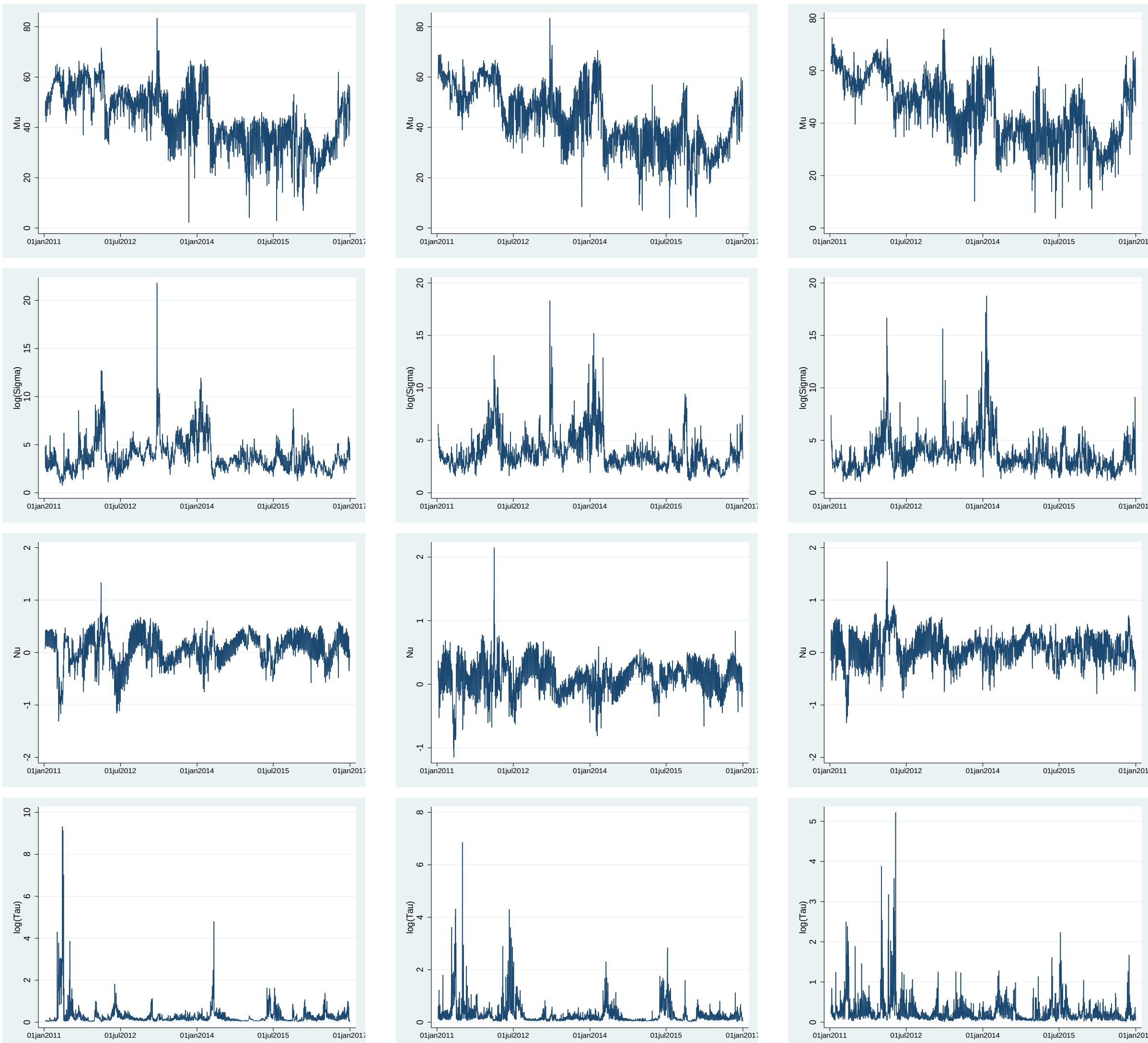


Figure 10: Filtered time series of mean ($\widehat{\mu}_t$) on the first rows, volatility ($log(\widehat{\sigma}_t)$) on the second rows, skewness ($\widehat{\nu}_t$) on the third rows and kurtosis ($log(\widehat{\tau}_t)$) on the last rows, from a skew-t representation of prices at hour 19 based on the M4-MFST (first column), ARM4-MFST (second) and VARM4-MFST models (third column) estimated on a rolling window of 365 days and continuously updated from 2010 towards the end of our sample. Static filtered moments can also be extracted once the model is estimated on the full sample.

Hours	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
						Mean					
1	36.09	26.42	50.23	30.30	37.46	43.28	34.31	28.99	26.10	25.17	23.96
2	31.46	22.59	43.52	25.05	33.77	39.87	30.69	26.25	23.92	23.27	22.30
3	28.07	20.19	38.93	20.85	30.56	36.91	28.38	24.15	22.43	21.90	21.26
4	25.03	18.12	35.41	19.02	27.63	34.85	26.21	23.29	21.14	21.29	20.58
5	25.65	18.13	36.31	19.66	28.01	35.44	26.61	23.74	21.69	21.69	21.00
6	30.90	22.88	43.08	24.45	32.00	39.16	29.74	26.15	23.89	23.81	22.41
7	36.18	25.69	50.70	30.57	38.29	45.49	36.90	34.18	30.55	30.08	27.03
8	52.41	39.21	70.19	41.52	46.19	54.31	46.96	43.60	37.53	36.86	32.95
9	58.50	45.91	75.64	45.00	50.07	57.44	51.38	46.71	39.65	38.85	34.94
10	64.99	49.11	81.77	47.97	52.23	58.32	51.04	45.75	38.53	36.99	34.09
11	69.35	52.44	86.11	50.45	53.28	58.72	49.77	43.84	36.87	34.93	32.28
12	80.78	59.83	93.43	53.56	54.86	59.48	49.50	43.39	36.57	34.21	31.74
13	68.40	50.89	84.96	50.25	52.84	57.92	46.65	40.36	34.19	31.58	29.51
14	64.74	48.06	79.73	46.78	49.94	55.18	44.02	38.10	32.37	30.10	27.96
15	60.94	44.70	75.70	43.25	47.57	52.83	42.05	36.41	31.51	29.42	27.15
16	57.13	41.37	71.04	40.28	45.76	51.29	42.04	36.88	32.08	30.52	28.21
17	54.41	41.38	69.62	40.05	46.00	51.78	43.26	38.50	33.61	32.23	29.74
18	58.27	51.53	76.14	45.53	50.82	57.52	49.87	45.41	38.66	37.78	34.50
19	69.39	53.33	80.78	49.90	54.54	62.55	56.12	50.95	43.37	41.61	36.83
20	58.78	46.39	78.22	48.88	53.52	62.37	56.39	51.29	44.20	42.53	37.19
21	55.07	40.15	74.32	44.98	49.42	58.93	50.98	46.29	39.76	38.70	34.01
22	48.30	34.26	65.82	40.36	45.81	53.63	46.35	41.46	35.61	34.91	30.84
23	46.53	32.90	63.61	40.08	46.23	52.85	45.10	39.14	33.78	33.24	29.36
24	37.57	26.20	52.93	33.78	40.85	46.85	37.97	31.86	28.33	27.35	25.66
						Standard Deviation					
1	10.76	9.23	12.87	11.95	7.28	8.70	14.58	8.20	7.13	9.13	7.74
2	11.20	8.13	14.15	16.98	8.83	9.68	18.63	9.43	7.88	9.33	8.52
3	11.26	7.97	15.24	30.92	10.28	10.34	19.79	11.01	8.24	9.96	9.24
4	11.52	7.70	15.11	17.63	10.60	10.71	20.99	10.78	9.00	9.21	9.14
5	11.02	7.87	14.93	14.86	10.07	10.54	19.04	10.56	8.36	9.18	8.76
6	11.52	9.25	15.17	12.76	10.32	10.11	18.65	9.99	8.29	8.32	8.84
7	16.52	15.03	23.68	20.55	13.40	13.40	22.40	14.09	11.11	11.46	11.11
8	25.05	28.81	30.52	23.94	15.84	15.51	22.01	18.17	14.45	14.20	13.44
9	28.89	34.81	28.59	19.00	14.66	13.83	19.35	18.14	13.81	13.88	13.42
10	40.30	30.07	28.68	16.35	12.28	11.62	16.21	16.30	12.61	12.37	12.20
11	59.40	31.40	29.73	15.43	11.33	10.31	15.19	15.51	11.92	11.84	12.02
12	128.53	41.02	35.17	16.00	11.05	9.99	14.22	15.89	11.77	11.57	11.96
13	49.95	25.73	25.70	13.70	9.97	9.64	13.62	14.80	11.65	11.10	12.82
14	46.54	27.11	25.26	14.25	11.11	10.64	14.04	15.53	13.43	12.33	14.47
15	47.91	25.96	26.43	13.76	11.51	11.09	13.95	17.19	13.74	12.92	15.80
16	42.89	23.66	24.34	12.94	11.74	10.87	13.49	16.69	13.44	12.70	14.44
17	28.21	27.12	22.19	13.41	12.39	10.28	13.57	15.34	12.31	11.82	14.89
18	26.61	64.62	31.94	17.64	15.50	10.73	16.60	17.97	12.61	12.41	15.42
19	131.19	55.41	26.75	19.39	13.40	11.83	20.13	18.06	12.70	12.06	12.08
20	21.96	30.50	23.56	16.72	10.78	9.79	15.85	15.67	11.56	11.39	10.54
21	17.46	18.01	19.63	11.69	7.49	8.42	11.49	12.07	8.30	9.02	8.31
22	13.69	11.72	14.54	7.07	5.39	7.33	9.44	10.28	6.98	8.28	7.11
23	12.53	9.76	11.60	7.10	4.98	6.30	8.30	8.45	6.23	7.99	6.37
24	9.82	7.61	11.28	8.24	5.72	7.70	10.69	7.94	6.86	7.96	7.12
						Skewness					
1	0.56	1.77	-0.88	-5.48	-0.66	-1.84	-7.75	-1.18	-1.86	-1.79	-1.49
2	0.30	0.90	-0.97	-6.09	-1.07	-1.71	-9.04	-1.51	-2.13	-1.94	-1.97
3	0.15	0.50	-2.48	-13.48	-1.07	-1.42	-8.86	-2.53	-2.07	-2.24	-2.66
4	0.14	0.42	-2.33	-4.85	-0.77	-1.10	-8.11	-2.03	-3.09	-1.82	-2.38
5	0.08	0.52	-2.46	-4.13	-0.69	-1.14	-8.17	-1.64	-2.56	-2.21	-2.00
6	-0.29	0.55	-0.89	-4.29	-1.16	-1.67	-8.64	-1.24	-2.87	-1.42	-2.25
7	-0.21	0.93	-0.84	-5.00	-1.27	-1.85	-6.76	-1.11	-1.24	-1.11	-2.32
8	-0.07	3.00	-0.33	-2.66	-0.68	-1.50	-1.71	-0.29	-0.66	-0.68	-1.05
9	1.93	4.88	0.19	-1.22	-0.50	-1.18	1.15	-0.10	-0.35	-0.43	-0.54
10	5.13	2.55	0.64	0.68	-0.23	-1.21	0.61	-0.11	-0.12	-0.24	0.40
11	11.07	2.58	0.81	1.19	-0.04	-1.15	0.61	-0.12	-0.05	-0.15	0.46
12	12.24	3.35	1.55	1.42	0.06	-1.01	0.52	0.30	0.09	-0.03	0.49
13	8.07	1.97	0.83	1.25	0.01	-1.27	0.35	-0.07	-0.31	-0.14	-1.15
14	8.76	2.44	0.47	1.01	-0.35	-1.08	0.19	-0.36	-1.57	-1.32	-1.87
15	10.64	2.16	0.49	0.71	-0.30	-1.03	0.05	-1.81	-1.71	-1.88	-2.82
16	9.64	2.00	0.28	0.57	-0.33	-1.05	-0.05	-1.65	-1.85	-1.34	-0.84
17	3.69	2.91	0.27	0.75	0.10	-0.79	0.43	-0.45	-0.74	-0.30	-0.47
18	2.06	7.55	6.58	1.44	1.48	0.41	1.54	0.75	0.44	0.37	1.38
19	16.47	6.11	2.84	1.73	1.19	1.23	2.90	0.79	0.64	0.41	0.92
20	0.90	3.16	3.02	2.14	0.92	0.20	1.87	0.85	0.67	0.44	0.68
21	0.61	1.67	1.27	1.31	0.77	-0.68	1.01	0.29	-0.03	-0.25	0.00
22	0.68	1.44	0.50	1.12	0.33	-0.39	-0.31	0.14	-0.41	-0.42	-0.91
23	0.85	1.57	0.17	1.32	0.22	-0.85	-0.74	-0.19	-0.89	-0.27	-0.60
24	0.66	1.42	-0.13	-1.95	-0.63	-4.46	-5.38	-1.91	-2.28	-1.08	-1.70
						Kurtosis					
1	3.61	8.22	4.84	71.08	3.32	7.03	89.13	4.67	7.17	8.46	9.36
2	3.44	5.94	5.22	57.11	4.66	6.22	105.79	6.60	9.54	8.03	12.53
3	2.74	4.48	21.84	223.38	4.63	4.79	102.88	15.72	9.82	10.35	18.26
4	2.44	3.90	20.44	41.09	3.47	3.47	86.69	13.98	23.16	7.73	17.27
5	2.49	4.67	21.82	35.88	2.95	3.63	89.33	10.07	18.23	12.46	15.70
6	3.05	5.20	3.78	47.10	3.87	5.65	99.38	6.07	20.83	5.71	18.00
7	2.64	4.59	3.70	50.96	4.19	8.29	66.90	6.20	5.61	5.06	18.50
8	2.51	22.35	2.95	30.85	3.66	6.56	27.15	2.81	3.76	3.42	11.49
9	15.69	47.70	3.43	18.27	3.83	5.10	10.20	3.02	2.82	3.05	8.93
10	46.66	13.01	4.43	6.40	3.96	5.92	7.10	2.95	3.15	3.30	4.83
11	166.68	12.63	4.39	5.34	4.29	5.87	6.61	2.90	3.36	3.32	4.54
12	167.81	20.11	7.27	5.63	3.74	6.36	5.92	5.02	3.28	3.13	4.37
13	88.86	8.92	4.83	5.09	3.82	6.46	4.95	3.40	5.46	3.65	15.65
14	109.26	13.64	3.19	4.93	4.24	5.11	4.36	3.67	13.76	12.44	20.53
15	158.61	9.78	3.14	4.99	4.09	5.17	4.24	14.34	14.04	17.31	30.61
16	136.73	9.38	2.77	5.58	4.59	5.65	4.36	14.38	14.72	11.72	12.65
17	29.62	16.78	2.80	5.77	5.16	6.18	6.00	4.95	7.96	4.06	10.88
18	13.01	78.17	82.38	5.86	7.69	7.21	9.72	4.43	4.11	4.42	6.21
19	293.55	58.69	17.11	7.26	5.90	7.98	18.27	3.82	3.27	3.70	4.89
20	3.45	17.01	24.23	13.67	4.15	6.20	12.79	4.45	3.73	4.40	5.02
21	2.56	5.64	6.73	6.19	3.97	4.52	12.48	2.93	3.42	3.48	5.36
22	2.86	4.95	3.48	6.50	4.27	4.91	6.36	3.36	3.95	3.94	6.05
23	3.19	5.52	2.49	7.66	4.23	7.30	5.86	3.86	5.14	4.10	4.61
24	3.12	7.13	2.55	20.81	4.30	42.67	60.59	11.06	11.52	5.87	10.10

Table 2: Descriptive Statistics for German hourly electricity prices from 01/01/2006 to 31/12/2016.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
HP 1															
2010	sec	1.95	0.88	0.84	0.45	2.94	0.62	0.97	1.22	0.53	0.76	0.08	0.08	0.08	0.10
	KS	0.1043	0.1311	0.1019	0.0999	0.0345	0.0401	0.0261	**0.0252**	0.2004	0.0795	0.0797	0.1533	0.0765	0.1662
	CVM	1.3808	2.1892	1.1370	1.0399	0.0812	0.0954	0.0269	**0.0261**	4.6939	0.5771	0.5852	3.1919	0.6642	3.1808
	AD	9.6540	12.9543	6.3452	5.2505	0.4870	0.5755	**0.3833**	0.3927	30.8319	3.3187	3.3320	20.3288	4.0299	16.3965
	AIC	2560	2571	2518	2503	**2462**	2466	2472	2474	2773	2488	2486	2625	2483	2616
2011	sec	1.90	0.63	0.79	0.39	> 100	0.39	1.16	0.97	0.43	0.69	0.08	0.06	0.06	0.09
	KS		0.5537	0.3347	0.3385	0.1570	0.1279	0.0550	**0.0549**	0.3067	0.0774	0.1696	0.2198	0.1967	0.3663
	CVM		50.9773	17.7589	13.7136	2.5864	1.6536	0.2247	**0.2226**	11.7844	0.6778	3.1368	6.4255	4.2294	16.7820
	AD			105.9948	60.6156	13.7888	10.1099	2.3374	**2.3246**	63.9873	9.2319	17.8803	35.1438	20.3593	77.4224
	AIC		11508	3423	2697	2548	2536	**2461**	**2461**	3046	2580	2616	2742	2541	2994
2012	sec	16.62	51.18	0.81	0.55	17.63	0.48	0.99	1.01	0.60	1.76	0.08	0.08	0.06	er
	KS			0.6393	0.5794	0.2199	0.2114	**0.1392**	0.1394	0.4675	0.0463	0.2209	0.2530	0.2940	0.9816
	CVM			38.5683	42.4846	5.6398	5.0497	**1.6275**	1.6311	26.7599	0.1587	5.6783	10.7433	9.0326	119.2940
	AD				193.3144	30.5878	27.3843	**8.6018**	8.6160	126.4099	1.8496	30.7987	56.9362	44.4275	> 1900
	AIC			>>	3678	2969	2966	**2742**	**2742**	4495	2465	2995	3068	2836	7588
2013	sec	er	er	0.80	0.68	94.60	0.65	1.03	1.22	0.58	0.88	0.08	0.07	0.08	0.08
	KS	0.2128	0.2762	0.1899	0.2105	0.0814	0.0662	**0.0295**	0.0304	0.2564	0.1044	0.1127	0.1906	0.1297	0.2461
	CVM	7.9361	12.6973	3.7454	4.8465	0.6839	0.4256	0.0429	**0.0416**	7.6231	1.2110	1.4358	4.3985	1.7883	7.4900
	AD			17.7897	22.2952	3.6564	2.6397	0.4862	**0.4810**	45.1560	7.6349	8.3450	25.8997	9.3280	36.0136
	AIC	3175	3223	2597	2605	2512	2510	**2489**	**2489**	2916	2567	2566	2700	2531	2792
2014	sec	23.79	er	0.81	0.54	er	0.43	1.13	1.44	0.61	0.98	0.08	0.08	0.06	0.08
	KS		0.6335	0.3497	0.3474	0.1613	0.1420	**0.0704**	0.0707	0.3227	0.0977	0.1739	0.2426	0.2005	0.3985
	CVM		60.6188	19.5052	14.2807	3.0959	2.2901	**0.4359**	0.4391	11.9734	1.0063	3.6671	6.4328	4.5950	19.2615
	AD				63.8955	15.9956	13.2023	**3.7782**	3.7818	64.5449	12.1341	19.9817	34.9132	21.9710	88.2576
	AIC		>>	8851	2513	2352	2341	**2253**	**2253**	2846	2373	2417	2542	2343	2855
2015	sec	4.35	er	0.93	0.38	0.58	0.35	0.94	1.01	0.38	0.61	0.06	0.07	0.07	0.10
	KS			0.2890	0.3161	0.1425	0.1232	**0.0683**	0.0692	0.3132	0.1069	0.1555	0.2033	0.1730	0.3935
	CVM			10.4052	11.8170	2.0225	1.4370	0.4010	**0.3982**	12.9457	1.0474	2.4432	6.0687	3.1722	19.4923
	AD			89.7501	53.9219	10.5565	7.8600	2.6301	**2.5690**	69.1543	7.3633	13.1756	33.4590	16.0647	89.6177
	AIC			6579	2804	2595	2590	2534	**2532**	3151	2634	2645	2769	2599	3115
2016	sec	2.61	3.96	0.87	0.46	1.09	0.42	0.83	0.86	0.47	0.95	0.06	0.08	0.06	0.12
	KS			0.3542	0.3176	0.1086	0.0927	0.0723	**0.0696**	0.3153	0.0910	0.1187	0.1866	0.1490	0.4191
	CVM			20.3441	10.4512	1.0312	0.7630	0.4876	**0.4574**	12.9752	0.5995	1.1565	5.0358	2.0256	22.4516
	AD				48.5671	5.5252	4.1592	2.6349	**2.4987**	69.4496	3.8469	6.4984	28.9854	11.0424	102.4420
	AIC			5892	2740	2502	2500	2471	**2470**	3115	2535	2537	2662	2518	3108
HP 2															
2010	sec	1.46	2.47	0.62	0.44	er	0.57	0.67	0.75	0.49	0.70	0.06	0.08	0.08	0.09
	KS	0.1967	0.2493	0.1563	0.1731	0.0640	0.0555	**0.0429**	0.0457	0.2463	0.0977	0.0985	0.1672	0.0970	0.2235
	CVM	6.0047	9.7827	2.8068	3.5846	0.2902	0.2028	**0.1073**	0.1229	6.9717	0.8188	0.8548	3.6102	1.1048	6.0495
	AD	44.8887		13.5729	17.1491	1.4014	1.0447	**0.7084**	0.8307	42.3148	4.5120	4.7178	22.6638	6.2409	29.2194
	AIC	3274	3316	2644	2659	2574	2573	**2572**	2574	2992	2622	2621	2756	2594	2850
2011	sec	1.63	1.26	0.62	0.45	er	0.39	1.81	2.12	0.53	0.75	0.06	0.08	0.06	0.09
	KS		0.5076	0.3641	0.3177	0.1688	0.1430	**0.0665**	0.0666	0.2965	0.0989	0.1845	0.2187	0.2029	0.3559
	CVM		39.7275	17.3078	11.9079	2.5446	1.7575	0.2871	**0.2844**	10.6147	0.9205	3.2174	6.0129	3.9994	14.5305
	AD			78.8731	52.6372	12.9447	10.1919	2.6181	**2.6078**	58.7266	11.8056	17.6847	33.1361	19.0758	66.9070
	AIC		6232	2740	2746	2620	2609	**2541**	**2541**	3081	2660	2691	2821	2621	3034
2012	sec	9.60	er	27.67	1.19	er	0.46	0.79	0.83	0.47	1.70	0.08	0.08	0.06	er
	KS			0.7787	0.9945	0.2168	0.2117	**0.1605**	**0.1605**	0.4745	0.0463	0.2182	0.2948	0.3057	0.9869
	CVM			59.5991	120.0109	7.2292	6.3019	**2.6126**	2.6134	27.4254	0.1587	7.2688	12.5223	11.5668	119.3412
	AD					39.6691	34.6152	**13.0893**	13.0913	129.0777	1.8496	39.8791	65.4567	57.0516	> 1900
	AIC			>>	>>	3144	3142	**2831**	2832	4703	2465	3170	3232	2984	7736
2013	sec	1.67	0.71	0.81	0.61	> 150	0.47	0.72	0.80	0.64	0.71	0.08	0.07	0.06	0.09
	KS		0.4962	0.4013	0.2482	0.1049	0.0964	**0.0855**	0.0858	0.2939	0.1133	0.1215	0.2067	0.1264	0.3058
	CVM		41.4389	24.0605	8.8667	1.1364	0.9043	**0.3702**	0.3723	9.9905	1.4381	1.6227	4.2936	2.0785	12.9561
	AD				41.8339	5.9565	4.9003	**3.1641**	3.1871	56.3943	9.1054	8.9442	26.2086	11.0885	61.2545
	AIC		>>	>>	2752	2604	2598	**2564**	**2564**	3129	2658	2660	2792	2608	3056
2014	sec	er	er	1.23	0.47	er	0.5	0.93	0.91	0.72	0.72	0.09	0.1	0.08	0.09
	KS		0.7671	0.8333	0.3566	0.1603	0.1401	**0.0653**	**0.0653**	0.3467	0.0847	0.1702	0.2451	0.1987	0.4473
	CVM		78.8824	91.8229	16.6291	2.7307	2.1475	0.2149	**0.2141**	13.6960	0.6803	3.1409	6.1295	4.2783	25.9378
	AD				76.3807	14.5059	11.9148	2.8460	**2.8443**	72.2225	9.1220	17.1070	34.1889	21.1688	124.0623
	AIC		>>	>>	2638	2422	2412	**2305**	**2305**	3017	2423	2480	2601	2398	3077
2015	sec	1.01	0.54	0.72	0.42	0.86	0.44	0.84	0.82	0.41	0.78	0.08	0.07	0.08	0.11
	KS		0.6497	0.6847	0.3330	0.1457	0.1228	**0.0438**	0.0445	0.3245	0.0811	0.1567	0.2169	0.1855	0.3954
	CVM		65.4341	65.9317	14.1985	2.2203	1.5379	**0.2041**	0.2078	12.8114	0.7799	2.6480	6.0242	3.7042	19.8659
	AD				64.2224	11.8988	8.7393	1.9964	**1.9951**	68.6445	7.6692	14.8274	33.6903	18.3982	92.5434
	AIC		>>	>>	2782	2594	2584	**2511**	**2511**	3156	2625	2653	2778	2582	3126
2016	sec	31.18	2.28	0.97	0.47	5.90	0.51	0.78	0.83	0.51	1.10	0.08	0.08	0.08	0.12
	KS			0.9587	0.3712	0.1322	0.1143	**0.0774**	0.0781	0.3438	0.0981	0.1389	0.1966	0.1719	0.5442
	CVM			> 110	15.4599	1.5066	1.0976	0.6328	**0.6098**	15.4381	0.7325	1.6343	5.6916	2.6364	39.9995
	AD				69.9090	8.0036	5.8978	3.4560	**3.3517**	80.0143	4.6192	8.9379	32.1092	13.9219	192.3859
	AIC			>>	2867	2565	2562	2520	**2519**	3276	2596	2603	2723	2567	3461
HP 3															
2010		64.76	11.20	0.66	0.50	1.06	0.35	1.89	2.13	0.65	0.75	0.06	0.06	0.06	0.08
	1	0.1952	0.2497	0.1444	0.1669	0.0732	0.0639	**0.0524**	0.0574	0.2436	0.1085	0.1096	0.1803	0.1043	0.2313
	2	5.5759	8.9326	2.4148	3.4800	0.2943	0.2243	**0.1462**	0.1706	6.7414	0.8837	0.8990	3.5237	1.0822	6.2080
	3	39.3994		11.6616	16.4643	1.4461	1.1831	**0.9683**	1.1397	41.2619	4.9780	5.0567	22.3008	6.1536	29.8188
	4	3283	3320	2749	2765	2683	2683	**2682**	2684	3096	2732	2730	2867	2704	2967
2011	sec	10.15	0.95	0.61	0.44	71.71	0.44	1.31	1.44	0.62	0.70	0.06	0.08	0.08	0.08
	1	0.2863	0.3348	0.2292	0.2524	0.1292	0.1116	**0.0616**	0.0617	0.2741	0.1030	0.1507	0.2116	0.1566	0.2777
	2	12.4922	17.3566	6.4012	7.8142	1.7225	1.2294	0.1802	**0.1793**	8.1497	1.2249	2.5332	4.9095	2.9313	9.2428
	3	76.6459	> 100	28.3154	34.8753	8.5284	7.0082	**1.7975**	1.8017	47.5784	13.9861	13.9165	28.3923	14.4631	43.6821
	4	3202	3257	2712	2739	2661	2654	**2609**	**2609**	3073	2725	2736	2870	2679	2983
2012	sec	er	1.95	26.97	0.84	er	0.78	er	1.31	0.72	er	0.08	0.08	0.08	er
	1			0.7702	0.9918	0.2118	0.2011	0.1544	0.1545	0.4738	**0.0463**	0.2130	0.3025	0.3018	0.9804
	2			58.8355	119.7469	7.3552	6.5116	2.6083	2.6115	27.3934	**0.1587**	7.3926	12.7360	11.8185	119.3518
	3					40.8121	36.4886	13.4274	13.4411	128.9497	**1.8496**	41.0196	66.4242	58.3554	> 2000
	4			>>	>>	3187	3184	2867	2867	4730	**2465**	3214	3275	3026	7882
2013	sec	er	0.73	0.87	0.58	er	0.67	0.56	0.66	1.76	0.75	0.08	0.07	0.08	0.22
	1			0.6541	0.3590	0.0990	0.1028	**0.0777**	0.0779	0.3785	0.0961	0.1057	0.2157	0.1199	0.5551
	2			41.6352	19.3388	1.2196	0.9982	**0.5327**	0.5329	17.0629	0.9204	1.3967	4.8512	2.4580	52.8333
	3				90.1463	7.4434	5.7117	**4.1830**	4.1961	86.9382	6.2943	8.4513	29.8888	14.0135	283.4390
	4			>>	3077	2732	2726	**2657**	**2657**	3605	2752	2773	2892	2699	3897
2014	sec	er	er	1.69	1.04	37.89	1.02	0.98	1.06	1.61	1.12	0.1	0.14	0.11	0.13
	1		0.7653	0.8928	0.3313	0.1390	0.1309	**0.0685**	**0.0685**	0.3520	0.0860	0.1492	0.2290	0.1655	0.4441
	2		83.7038	99.2333	16.1895	2.1493	1.7315	0.2676	**0.2673**	13.8656	0.7722	2.5002	5.5370	3.5586	29.0196
	3				75.0351	11.7859	9.6569	**3.1327**	3.1329	73.0313	8.9729	14.0008	31.8295	18.1992	141.3160
	4		>>	>>	2696	2459	2451	**2357**	**2357**	3095	2469	2512	2634	2436	3189
2015	sec	1.13	1.21	0.78	0.58	19.31	0.78	1.40	1.58	0.78	0.84	0.08	0.08	0.08	0.11
	1		0.8379	0.8812	0.3627	0.1410	0.1342	**0.0499**	0.0500	0.3594	0.0781	0.1499	0.2356	0.1729	0.4806
	2		94.4345	97.0608	18.8198	2.6381	2.0160	**0.2150**	0.2151	15.1682	0.6507	2.9724	6.4279	4.3708	35.0044
	3				85.9112	14.6863	11.6092	2.4395	**2.4370**	78.8421	7.3780	16.9354	35.9120	21.9385	170.8291
	4		>>	>>	2909	2650	2641	**2532**	**2532**	3312	2649	2706	2827	2619	3462
2016	sec	12.07	4.15	0.89	0.68	1.30	0.39	1.39	1.47	0.84	1.12	0.08	0.08	0.06	0.11
	1			0.8086	0.4181	0.1511	0.1380	**0.0893**	0.0900	0.3846	0.1086	0.1571	0.1917	0.1853	0.6871
	2			68.0946	22.1825	2.1411	1.6249	0.8057	**0.7949**	18.6647	0.8727	2.2490	6.4945	3.5210	70.5971
	3				99.2633	11.3852	8.6168	4.4384	**4.3910**	93.5290	5.3951	12.1472	36.1014	18.0515	403.8318
	4			>>	3017	2625	2621	**2556**	**2556**	3491	2643	2663	2776	2601	4066

Table 3: Goodness-of-fit statistics and Computational Time for hours 1-2-3. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. ">" and ">>" mean respectively 'greater' and 'grater than thousands'. "er" means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
HP 4															
2010	sec	9.74	er	0.93	0.88	6.77	0.61	0.87	1.17	0.58	0.76	0.08	0.06	0.07	0.1
	KS	0.1207	0.1509	0.0856	0.1146	**0.0333**	0.0344	0.0394	0.0474	0.2193	0.0866	0.0866	0.1670	0.0719	0.1761
	CVM	1.9020	2.9639	0.7369	1.3779	0.0637	**0.0632**	0.1015	0.1553	4.9719	0.6317	0.6320	3.0000	0.6382	3.7895
	AD	12.5125	17.0817	3.9722	6.5940	0.4469	**0.4321**	0.8183	1.1257	32.5812	3.6354	3.6362	19.8885	4.0828	18.6208
	AIC	2867	2881	2756	2761	**2721**	**2721**	2735	2738	3070	2756	2754	2893	2741	2923
2011	sec	1.59	0.87	0.72	0.59	74.45	0.5	1.05	1.15	1	0.59	0.09	0.08	0.08	0.08
	KS	0.2045	0.2274	0.1734	0.2071	0.1113	0.1004	**0.0598**	0.0601	0.2433	0.1477	0.1441	0.2093	0.1479	0.2390
	CVM	4.9371	6.5266	2.9125	4.4781	1.0009	0.8106	**0.1849**	0.1885	5.6471	2.1763	2.1438	4.1236	2.1761	5.9168
	AD	26.4488	33.4352	12.7205	19.7660	5.0023	4.8065	**1.6121**	1.6406	35.5928	12.4633	12.0514	24.9330	11.1234	29.3874
	AIC	2789	2810	2690	2716	2681	2682	**2666**	**2666**	3030	2763	2761	2900	2717	2924
2012	sec	er	er	30.22	0.61	> 30	0.72	1.47	0.96	0.57	2.3	0.09	0.08	0.13	er
	KS			0.8000	0.6756	0.2046	0.1923	0.1256	0.1256	0.4689	**0.0463**	0.2055	0.3075	0.2954	0.9743
	CVM			64.3944	58.5051	7.0742	6.2841	2.0964	2.0985	26.9361	**0.1587**	7.1161	12.6411	11.5732	118.1021
	AD				283.5335	40.4860	36.5685	12.0376	12.0502	127.1166	**1.8496**	40.7426	66.2035	57.5411	> 700
	AIC			>>	3997	3228	3225	2914	2914	4697	**2465**	3257	3322	3073	7376
2013	sec	er	0.62	0.89	0.55	> 200	0.57	0.57	0.62	1.54	0.72	0.09	0.08	0.06	0.08
	KS		0.8870	0.4113	0.3202	0.0855	0.0904	0.0769	**0.0736**	0.3603	0.1063	0.0930	0.1814	0.0901	0.5797
	CVM		> 100	19.7004	15.7141	0.5893	0.5324	**0.5045**	0.5271	14.9981	0.7890	0.7671	3.6982	1.2739	57.6342
	AD				74.2578	3.5322	**2.9158**	3.3162	3.5938	78.3246	4.3443	4.5371	24.2414	7.9567	> 300
	AIC		>>	>>	3057	2716	2712	**2687**	2688	3543	2747	2750	2877	2704	4008
2014	sec	er	er	0.9	1.03	er	0.7	0.49	0.56	0.7	0.92	0.08	0.06	0.07	er
	KS			0.7923	0.4263	0.1378	0.1356	**0.0888**	**0.0888**	0.4096	0.0909	0.1435	0.2413	0.1653	0.7805
	CVM			62.7834	24.2725	1.9257	1.6512	**0.4388**	0.4390	19.3243	0.7114	2.0834	5.5590	3.4282	88.0624
	AD				111.9962	11.1687	9.3618	**4.3842**	4.3847	95.8934	6.8059	12.0344	32.6887	18.3608	624.5921
	AIC			>>	2978	2539	2535	**2431**	**2431**	3523	2526	2575	2687	2488	4490
2015	sec	0.98	0.67	0.95	0.52	27.81	0.81	er	0.75	0.58	0.59	0.06	0.08	0.08	0.11
	KS		0.6582	0.6307	0.3021	0.1321	0.1213	**0.0652**	0.0653	0.3262	0.0789	0.1442	0.2242	0.1560	0.3750
	CVM		69.0908	50.3467	13.6487	1.8487	1.3801	0.2247	**0.2242**	12.3242	0.8497	2.2599	5.3449	3.1991	21.2121
	AD				62.7400	10.1942	7.9779	2.5013	**2.5003**	66.6485	9.2079	13.0111	30.9201	16.3746	99.7264
	AIC		>>	>>	2784	2589	2581	**2507**	**2507**	3167	2621	2648	2775	2577	3177
2016	sec	1.64	0.65	1.49	0.59	2.66	0.71	0.96	1.13	0.6	1.02	0.08	0.07	0.08	0.11
	KS			0.8017	0.4045	0.1507	0.1397	**0.1001**	0.1010	0.3808	0.1238	0.1575	0.1871	0.1778	0.7141
	CVM			65.6259	21.0197	1.9191	1.5186	0.8714	**0.8563**	18.2593	0.9983	2.0247	6.0170	3.0664	76.6072
	AD				94.6257	9.6661	7.5677	4.5508	**4.4793**	91.8512	5.5836	10.3508	33.5938	15.7217	> 400
	AIC			>>	3022	2619	2616	**2565**	**2565**	3479	2642	2653	2770	2606	4219
HP 5															
2010	sec	er	er	1.43	er	> 100	0.56	0.73	0.7	2.95	0.67	0.11	0.07	0.07	0.08
	KS	0.0944	0.1146	0.0961	0.0764	0.0370	**0.0279**	0.0379	0.0419	0.1989	0.0755	0.0755	0.1701	0.0592	0.1475
	CVM	1.1780	1.6612	0.7643	0.6436	0.0828	**0.0414**	0.0952	0.1488	4.1063	0.5529	0.5535	2.8956	0.5173	2.6604
	AD	7.4178	9.4164	4.8496	3.4398	0.5738	**0.4049**	0.8594	1.1115	28.0520	3.2294	3.2311	19.3156	3.5634	14.1081
	AIC	2736	2744	2723	2704	2679	**2682**	2695	2698	2983	2704	2702	2842	2698	2822
2011	sec	1.78	0.72	0.96	0.46	> 200	0.53	0.68	0.72	1.05	0.69	0.06	0.08	0.07	0.08
	KS	0.2008	0.2320	0.1616	0.1933	0.1012	0.0883	**0.0558**	0.0562	0.2402	0.1408	0.1392	0.1984	0.1372	0.2287
	CVM	5.0548	6.9943	2.7795	4.2929	0.8396	0.6466	**0.1266**	0.1301	5.8866	1.9412	1.9388	4.1271	2.0270	6.0205
	AD	27.6920	36.2844	12.1794	18.8648	4.1508	3.7962	**1.1789**	1.2106	36.7400	11.1488	10.8851	24.8258	10.2650	29.6992
	AIC	2801	2825	2691	2709	2667	2666	**2654**	2655	3021	2742	2740	2878	2698	2910
2012	sec	31.2	74.84	1.01	1.19	er	0.85	0.67	0.72	1.25	1.86	0.1	0.07	0.08	er
	KS			0.7432	0.6797	0.1868	0.1732	0.1022	**0.1021**	0.4682	0.0463	0.1876	0.2926	0.2814	0.9778
	CVM			53.4748	63.6934	5.9456	5.1884	1.2801	**1.2782**	26.9331	0.1587	5.9829	11.6338	10.1940	118.2875
	AD				322.0774	34.9762	31.0550	7.7130	**7.7049**	127.1051	1.8496	35.2018	62.0799	51.6763	> 300
	AIC			>>	4347	3153	3150	**2860**	**2860**	4684	2465	3182	3247	3002	7378
2013	sec	1.47	0.83	1.46	0.74	er	0.76	0.66	0.76	0.93	0.79	0.06	0.08	0.08	0.1
	KS		0.7298	0.8525	0.2747	0.0953	0.0945	0.0735	**0.0684**	0.3259	0.1140	0.1080	0.1776	0.0973	0.4415
	CVM		84.7781	105.2470	11.1016	0.5250	0.4685	**0.4290**	0.4550	12.2342	0.7995	0.7761	3.4898	1.0956	32.5742
	AD				53.7360	2.9419	**2.5454**	2.9308	3.2438	66.4745	4.4272	4.3997	22.9379	6.7880	> 160
	AIC		>>	>>	2950	2691	2688	**2675**	2677	3374	2727	2727	2858	2692	3562
2014	sec	er	er	1.04	0.97	er	0.8	0.64	0.55	0.78	0.92	0.06	0.08	0.08	er
	KS			0.7773	0.3817	0.1322	0.1313	**0.0828**	0.0829	0.3906	0.0843	0.1392	0.2266	0.1524	0.7040
	CVM			60.2882	21.3293	1.7193	1.5044	0.4637	**0.4633**	17.6099	0.8749	1.9229	5.0631	2.9084	77.4100
	AD				99.0188	9.5598	8.1941	**4.8234**	4.8253	88.8364	7.9863	10.6761	30.0715	15.4657	> 500
	AIC			>>	2874	2475	2471	**2393**	**2393**	3363	2484	2512	2630	2438	4167
2015	sec	er	> 170	1	0.39	er	0.58	0.95	0.96	0.61	0.82	0.07	0.07	0.07	0.09
	KS			0.5871	0.3617	0.1196	0.1155	**0.0677**	0.0678	0.3703	0.0724	0.1282	0.2189	0.1495	0.6061
	CVM			34.6601	19.2105	1.7322	1.4146	**0.2740**	**0.2740**	16.0455	0.7163	1.9999	5.2638	3.0257	58.8175
	AD				88.9700	9.7665	8.0192	**3.4736**	3.4765	82.6491	7.4749	11.3890	30.8338	15.7673	> 300
	AIC			>>	2937	2596	2590	**2513**	**2513**	3379	2611	2639	2762	2565	3896
2016	sec	22.86	9.37	1.66	0.59	4.29	0.71	1.17	0.89	0.59	1.09	0.1	0.06	0.09	0.12
	KS			0.6960	0.3935	0.1383	0.1289	**0.1005**	0.1016	0.3710	0.1233	0.1460	0.1894	0.1606	0.7136
	CVM			48.3794	19.0627	1.7331	1.4365	1.0039	**0.9737**	17.6625	1.1272	1.8013	5.6729	2.7295	77.0855
	AD				86.2933	8.5103	7.0486	5.0997	**4.9628**	89.3696	5.9599	8.9804	31.6439	14.1862	> 460
	AIC			>>	2991	2589	2587	2550	**2549**	3425	2614	2618	2738	2596	4212
HP 6															
2010	sec	er	0.67	0.99	er	er	0.42	er	er	0.52	er	0.06	0.08	0.06	0.08
	KS	0.1077	0.1376	0.1486	0.1020	0.0502	0.0586	0.0367	**0.0318**	0.1956	0.0862	0.0860	0.1565	0.0832	0.1721
	CVM	1.2604	2.1135	2.1470	1.3615	0.1923	0.3134	0.0979	**0.0709**	4.9943	0.6266	0.6233	3.4470	0.8025	3.2385
	AD	10.5366	13.9707	11.5335	7.2015	1.1566	1.7720	0.7793	**0.6343**	32.1228	3.6850	3.6750	21.1784	4.7227	17.0167
	AIC	2728	2739	2700	2671	2609	2621	**2614**	2615	2911	2629	2627	2765	2635	2748
2011	sec	49.16	0.86	1.92	0.59	1.26	0.55	0.71	0.75	1	0.59	0.08	0.08	0.06	0.11
	KS		0.3279	0.2092	0.2363	0.1080	0.0840	**0.0357**	**0.0357**	0.2600	0.0902	0.1320	0.2002	0.1475	0.2731
	CVM		17.7462	5.0818	6.8257	1.1659	0.6916	0.0731	**0.0702**	8.3978	0.9994	1.8953	4.9062	2.4319	8.9942
	AD			23.2781	30.7516	6.1273	4.2927	0.8286	**0.8073**	48.7086	8.7793	11.0750	28.2126	12.1981	43.4796
	AIC		3470	2674	2688	2591	2587	**2555**	**2555**	3010	2653	2656	2789	2608	2901
2012	sec	47.04	0.81	1.89	0.48	1.31	0.46	0.75	0.76	1.01	0.57	0.07	0.07	0.08	0.1
	KS			0.7514	0.9918	0.1997	0.1923	0.1320	0.1321	0.4727	**0.0463**	0.2008	0.2884	0.2864	0.9818
	CVM			54.6665	> 60	6.3811	5.6258	1.5891	1.5915	27.3160	**0.1587**	6.4130	12.0373	10.6711	> 60
	AD					36.6110	32.7386	9.1571	9.1667	> 128	**1.8496**	36.8037	63.7086	53.3283	> 120
	AIC			>>	>>	3121	3118	2830	2830	4721	**2465**	3147	3208	2963	7741
2013	sec	er	er	1.5	1.09	er	0.53	0.71	0.79	0.65	0.59	0.06	0.07	0.07	0.08
	KS	0.3249	0.3822	0.1845	0.1917	0.0631	0.0540	**0.0471**	0.0522	0.2688	0.0888	0.0910	0.1656	0.0857	0.2820
	CVM	18.2985	25.0898	5.6268	4.9019	0.1753	0.1202	**0.1028**	0.1341	8.1593	0.5171	0.5396	3.2566	0.7778	10.9845
	AD				24.0365	0.9560	0.7345	**0.8420**	1.0924	48.1203	3.0515	3.1549	21.2538	4.8842	50.9553
	AIC	7999	8088	4254	2743	2605	**2604**	2606	2609	3100	2644	2642	2778	2621	3038
2014	sec	er	er	1.28	0.44	er	0.68	1.13	1.2	0.54	0.97	0.07	0.07	0.08	er
	KS			0.8149	0.4384	0.1317	0.1220	0.0471	**0.0469**	0.4066	0.0699	0.1368	0.2010	0.1773	0.8039
	CVM			68.2371	24.9394	1.9901	1.5636	0.1936	**0.1920**	19.6132	0.4227	2.1376	6.0017	3.4734	92.7449
	AD				> 113	10.8907	8.5451	2.0960	**2.0883**	97.0594	3.8472	11.7420	34.0133	17.6388	> 600
	AIC			>>	2878	2422	2418	**2336**	**2336**	3405	2423	2457	2567	2376	4523
2015	sec	er	0.77	1.03	0.56	86.2	0.84	0.97	1.15	0.56	1.06	0.06	0.06	0.08	0.07
	KS	0.3192	0.3876	0.2758	0.2469	0.0947	0.0749	**0.0499**	0.0510	0.2756	0.0958	0.1171	0.1844	0.1338	0.2923
	CVM	18.9573	26.1015	13.5332	7.0502	0.7957	0.4814	**0.0904**	0.0948	8.8151	1.0199	1.3560	4.2903	1.8179	10.5721
	AD			> 100	32.1171	4.0834	2.8106	**0.9794**	1.0262	50.8976	6.7645	7.6924	25.6845	9.4071	48.8774
	AIC	5308	5393	3530	2592	2470	2465	**2446**	2447	2941	2525	2525	2658	2481	2849
2016	sec	4.01	3.37	1.65	0.54	1.49	0.59	1.28	1.2	0.64	0.93	0.08	0.07	0.08	er
	KS			0.7689	0.4118	0.1257	0.1585	0.0889	**0.0859**	0.3753	0.1006	0.1307	0.1948	0.1563	0.7302
	CVM			62.6362	19.2208	1.5232	2.4094	0.8676	**0.8333**	18.0851	0.9016	1.5511	5.6137	2.5836	77.5127
	AD				86.9352	7.8704	13.0546	4.5122	**4.3553**	91.1485	4.9787	8.1331	31.7364	13.9984	> 400
	AIC			>>	2982	2574	2659	2532	**2531**	3446	2597	2602	2720	2586	4181

Table 4: Goodness-of-fit statistics and Computational Time for hours 4-5-6. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. ">" and ">>" mean respectively 'greater' and 'grater than thousands'. "er" means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
								HP 7							
2010	sec	er	er	2.61	0.56	er	0.68	0.62	0.71	0.63	0.63	0.06	0.07	0.07	0.09
	KS	0.0752	0.0912	0.1924	0.1632	**0.0610**	0.1282	0.0724	0.0698	0.2032	0.0698	0.0698	0.1574	0.1164	0.1570
	CVM	0.5737	0.7299	3.8903	2.8400	**0.4199**	1.6399	0.5261	0.4391	6.1206	0.4902	0.4903	3.7541	1.5716	2.4130
	AD	12.5869		18.8995	14.1395	**2.3583**	9.4350	3.3794	2.8187	37.6391	2.8151	2.8151	22.2702	8.6786	13.1203
	AIC	2978	2980	2727	2707	**2607**	2684	2615	2612	2930	2614	2612	2748	2665	2727
2011	sec	2.25	0.72	2.11	0.54	2.4	0.66	0.92	1.15	0.53	0.91	0.08	0.08	0.08	0.09
	KS		0.7288	0.8001	0.3168	0.0851	0.0678	0.0334	**0.0329**	0.3197	0.0705	0.0958	0.1723	0.1331	0.4383
	CVM		83.1678	95.2119	11.5326	0.6412	0.3403	0.0781	**0.0753**	12.4506	0.3308	0.8548	4.5012	1.6179	28.0037
	AD				53.1121	3.8073	2.2633	0.7338	**0.7281**	67.2618	2.8777	5.3406	26.8478	9.0252	130.9830
	AIC		>>	22737	2929	2685	2681	**2654**	2655	3321	2722	2725	2851	2689	3410
2012	sec	25.06	18.09	0.62	0.44	11.23	0.39	0.91	1.14	0.72	1.36	0.06	0.08	0.08	er
	KS			0.7681	0.6574	0.2375	0.2238	0.1487	0.1488	0.4688	**0.0463**	0.2384	0.2937	0.3282	0.9777
	CVM			60.3252	49.8804	6.2658	5.4580	1.7007	1.7022	26.8757	**0.1587**	6.3057	12.0031	10.3090	117.7743
	AD				> 220	36.3452	32.2419	10.6528	10.6596	126.8747	**1.8496**	36.5996	63.6392	51.3834	> 300
	AIC			>>	3879	3185	3182	2930	2930	4694	**2465**	3214	3278	3038	7216
2013	sec	er	er	0.77	1.68	er	1.03	1.05	0.81	0.99	1.36	0.09	0.08	0.08	0.11
	KS		0.5836	0.4780	0.2744	0.0558	0.0966	0.0507	0.0484	0.3098	**0.0427**	0.0530	0.1658	0.1139	0.3727
	CVM		66.5509	40.5945	7.0983	0.2320	0.7238	0.2587	0.2422	10.9645	**0.1192**	0.1234	3.0961	0.7421	22.5975
	AD				36.3694	1.6609	6.2181	1.7268	1.6661	> 60	**1.0314**	1.2406	21.1882	5.6781	> 108
	AIC		>>	>>	2919	2687	2785	2680	2682	3334	2707	**2706**	2837	2713	3368
2014	sec	27.06	2.75	2.01	1.23	> 100	0.69	0.67	0.74	0.59	0.7	0.06	0.06	0.06	0.08
	KS		0.5365	0.1318	0.2989	0.0854	0.1359	**0.0559**	0.0577	0.3135	0.0560	0.0870	0.1840	0.1441	0.3506
	CVM		56.1613	1.9358	8.7181	0.4091	1.7066	**0.2598**	0.2681	11.1843	0.1977	0.4819	4.1285	1.2977	17.1937
	AD			19.9211	41.3323	3.2375	11.9159	**1.7304**	1.7744	61.5034	2.4080	4.2174	25.5815	8.2111	79.8999
	AIC		>>	3920	2645	2440	2560	**2417**	2419	3038	2476	2476	2601	2452	2963
2015	sec	er	15.89	0.92	0.95	er	1.58	1.14	0.96	0.64	0.83	0.07	0.08	0.06	0.1
	KS	0.2752	0.2932	0.1793	0.1993	**0.0562**	0.0586	0.0587	0.0703	0.2702	0.0769	0.0667	0.1724	0.0950	0.2322
	CVM	12.1973	18.2420	3.4826	4.6419	0.1908	**0.1649**	0.3144	0.4347	7.6377	0.4407	0.4549	3.2894	0.8635	7.8746
	AD		> 160	17.7708	22.9289	1.2946	**1.0443**	1.7031	2.3209	45.7958	3.0922	3.2932	21.7750	5.6913	38.1655
	AIC	4900	4971	2648	2667	2553	**2551**	2554	2558	3042	2599	2597	2732	2568	2907
2016	sec	32.62	1.26	2.21	0.64	46.35	0.86	1.03	1.1	0.72	0.83	0.07	0.1	0.1	0.12
	KS			0.7732	0.4460	0.1102	0.1368	0.0872	**0.0845**	0.3965	0.0854	0.1148	0.1982	0.1544	0.8195
	CVM			61.3611	22.2028	1.4433	2.1732	0.8006	0.7672	19.6343	**0.7643**	1.4376	5.6762	2.6115	95.2370
	AD				99.5174	8.0098	12.3993	4.5409	**4.3802**	97.5620	4.6339	8.0723	32.4566	14.8361	> 600
	AIC			>>	3123	2659	2737	2612	**2611**	3648	2680	2686	2800	2667	4723
								HP 8							
2010	sec	2.26	1.28	0.95	0.95	er	1.06	1.06	1.37	0.64	1.02	0.06	0.06	0.09	0.08
	KS	0.0664	0.0855	0.1979	0.1606	0.0455	0.0801	0.0423	**0.0394**	0.1954	0.0588	0.0587	0.1641	0.1276	0.0839
	CVM	0.4651	0.7973	3.3874	2.0813	0.1821	0.4606	0.1114	**0.0801**	5.0683	0.3420	0.3419	3.1402	2.0481	0.6625
	AD	5.7753		17.9253	11.5070	1.0418	3.2946	1.0645	**0.7876**	32.7814	1.8214	1.8211	20.0594	10.6722	4.9322
	AIC	2891	2894	2839	2810	2715	2750	2724	**2722**	3031	2722	2720	2859	2824	2765
2011	sec	3.83	1.22	0.63	2.51	25.12	0.98	0.8	1.17	0.45	0.73	0.08	0.06	0.07	0.08
	KS			0.7405	0.3138	0.0976	0.0943	0.0526	**0.0502**	0.3286	0.1081	0.1101	0.1855	0.1184	0.4660
	CVM			86.5030	12.7256	0.8444	0.5743	**0.1559**	0.1561	12.8831	0.7243	1.1353	4.4290	1.7502	33.6274
	AD				59.1597	4.7174	3.2507	**1.3487**	1.3864	69.1771	4.6302	6.5663	26.6984	9.6135	> 160
	AIC			>>	2956	2695	2691	**2659**	**2659**	3353	2734	2737	2864	2693	3539
2012	sec	er	er	0.44	0.37	0.7	0.43	1	1.61	0.39	1.5	0.07	0.07	0.11	er
	KS			0.9973	0.4679	0.1479	0.1505	0.1155	0.1101	0.4379	**0.0463**	0.1493	0.2433	0.6423	0.9584
	CVM			> 120	22.8226	3.3136	3.4879	1.9205	1.6004	24.6120	**0.1587**	3.3049	8.8558	58.0876	> 110
	AD				> 100	20.2012	21.1687	12.4271	10.6276	> 110	**1.8496**	20.1758	48.2391		> 120
	AIC			>>	3751	3095	3128	3013	2996	4406	**2465**	3104	3193	4199	6479
2013	sec	er	er	0.47	0.4	9.45	0.63	1.25	1.32	0.76	0.78	0.06	0.08	0.08	0.07
	KS	0.0778	0.0799	0.1285	0.0918	0.0807	0.0979	**0.0678**	0.0886	0.2022	0.0684	0.0685	0.1602	0.0996	0.1017
	CVM	0.6309	0.6153	2.3371	1.0441	0.6979	0.8599	**0.5155**	0.6014	4.3108	0.5276	0.5276	2.6632	0.9936	0.8628
	AD			13.5252	6.5539	3.7773	7.3672	3.8294	4.0120	29.4136	3.0859	**3.0857**	18.9109	7.7148	5.7618
	AIC	2897	2897	2893	2858	2812	2900	2840	2839	3136	2812	**2810**	2950	2916	2845
2014	sec	1.62	0.94	2.37	1.51	er	1.36	0.94	1.07	0.78	0.78	0.06	0.08	0.07	0.06
	KS	0.1691	0.1949	0.3047	0.1645	0.0513	0.1006	0.0562	0.0523	0.2502	**0.0512**	**0.0512**	0.1638	0.1049	0.1797
	CVM	3.8198	7.6138	9.7525	2.3710	0.1224	1.0482	0.1706	0.1743	7.5051	**0.1161**	0.1164	3.1463	0.7353	4.9332
	AD			50.6024	14.8664	1.0810	7.8303	1.3845	1.3462	44.8921	1.1781	**1.1801**	20.7476	5.4684	25.1903
	AIC	6215	6257	2900	2717	2576	2672	**2573**	**2573**	3027	2588	2586	2718	2622	2845
2015	sec	57.6	er	0.49	0.34	er	0.9	1.37	0.92	0.48	0.61	0.06	0.08	0.09	0.08
	KS	0.0893	0.1275	0.0879	0.1049	**0.0254**	0.0278	0.0353	0.0448	0.2153	0.0585	0.0584	0.1614	0.0784	0.1540
	CVM	1.1654	2.2407	1.0259	1.1063	**0.0340**	0.0595	0.0683	0.0984	5.4766	0.2118	0.2113	2.9504	0.4469	3.0405
	AD	11.6563	16.5843	6.6147	6.7323	**0.2536**	0.5250	0.5981	0.7187	35.1751	1.3207	1.3196	19.6718	3.5445	15.7813
	AIC	2962	2976	2703	2702	**2637**	2641	2646	2649	3004	2656	2654	2792	2660	2823
2016	sec	76.41	83.93	0.81	0.41	> 100	0.54	0.79	0.94	0.45	0.98	0.08	0.06	0.1	0.1
	KS			1.0000	0.3740	0.0998	0.1288	**0.0719**	0.0885	0.3601	0.0911	0.1014	0.2035	0.1623	0.7345
	CVM			> 100	14.0426	1.2409	1.6410	**0.6014**	0.9002	17.2711	1.0052	1.1597	5.0421	3.4564	77.3720
	AD				66.7838	7.0025	9.7371	**3.2896**	5.1441	87.7998	5.6934	6.6224	29.4270	18.5967	> 100
	AIC			>>	3160	2752	2806	2714	**2713**	3594	2762	2760	2882	2860	4324
								HP 9							
2010	sec	21.81	24.44	1.7	1.02	34.38	0.92	1.12	1.42	0.95	0.84	0.06	0.08	0.08	0.06
	KS	0.0444	0.0628	0.2039	0.1784	0.0365	0.0793	0.0390	**0.0352**	0.2090	0.0403	0.0402	0.1471	0.1283	0.0902
	CVM	0.2346	0.4484	4.0150	2.8513	0.0606	0.4168	0.0634	**0.0519**	5.5326	0.1234	0.1237	3.0125	1.8859	0.6900
	AD			21.7721	15.7923	0.4075	3.0554	0.8044	**0.6319**	35.3396	0.7723	0.7732	19.7189		5.0112
	AIC	3070	3072	2860	2830	2696	2737	2704	2702	3047	2702	**2700**	2838	2822	2763
2011	sec	er	1.96	1.02	er	1.91	0.46	1.89	1.09	0.66	0.7	0.08	0.08	0.08	0.1
	KS		0.3520	0.2014	0.1942	0.0719	0.0651	0.0404	**0.0378**	0.2668	0.0976	0.0985	0.1726	0.0940	0.2599
	CVM		22.0236	5.3378	5.1628	0.4603	0.3125	0.0911	**0.0831**	8.9039	0.7370	0.8990	4.0979	1.2923	9.3265
	AD			26.3389	25.0870	2.4609	1.7277	0.5293	**0.5005**	51.3074	4.1895	5.0546	24.7419	7.3732	43.8479
	AIC		6969	2768	2771	2631	2630	2613	**2612**	3101	2671	2670	2802	2650	2985
2012	sec	er	er	1.06	0.45	0.93	1.02	0.89	0.86	0.42	0.98	0.06	0.08	0.09	0.06
	KS			0.8803	0.4471	0.1374	0.1236	0.0753	0.1057	0.3881	**0.0463**	0.1422	0.2083	0.7477	0.1797
	CVM			87.5057	23.3667	2.1381	1.5532	0.4766	1.3459	19.6500	**0.1587**	2.2348	6.9667	79.2804	3.4656
	AD					12.7613	9.6104	3.4364	8.8174	97.6158	**1.8496**	13.4382	38.6687		19.1816
	AIC			>>	3372	2949	2945	2871	2917	3884	**2465**	2984	3093	4560	2938
2013	sec	er	> 160	0.56	0.41	46.4	0.84	1.02	1	1.18	0.92	0.06	0.07	0.08	0.06
	KS	0.0886	0.0901	0.0907	0.1006	0.0694	0.0969	0.0751	0.0586	0.2111	**0.0515**	0.0516	0.1595	0.1137	0.1060
	CVM	0.6150	0.6528	0.9858	0.7680	0.4802	0.9991	0.6030	**0.2871**	4.8551	0.2896	0.2895	2.7050	1.6914	0.7588
	AD			5.8372	5.0931	2.6313	7.9739	3.9856	2.4387	32.1433	**1.9438**	1.9450	18.8773		5.1342
	AIC	3045	3047	2890	2891	**2852**	2959	2876	2877	3199	2856	2854	2994	3003	2876
2014	sec	2.09	0.86	1.95	1.08	> 200	1.37	0.62	0.78	0.74	0.73	0.08	0.08	0.08	0.08
	KS	0.0372	0.0371	0.2030	0.1538	0.0363	0.2674	0.0666	0.0539	0.1852	**0.0300**	**0.0300**	0.1385	0.0783	0.0719
	CVM	0.0860	0.0869	4.4658	2.5694	0.0770	10.4644	0.3545	0.2109	3.6894	**0.0449**	**0.0449**	2.5321	0.6891	0.5723
	AD	1.9879	1.9961	21.9041	12.7490	0.4203	> 100	3.7166	1.9791	25.7536	0.3096	**0.3094**	17.4287	5.0062	4.1238
	AIC	2625	2625	2693	2651	2576	3721	2622	2609	2857	2575	**2573**	2711	2636	2628
2015	sec	1.85	1.32	2.17	1.29	> 110	0.84	0.95	1.36	0.56	0.72	0.08	0.07	0.09	0.08
	KS	0.0387	0.0395	0.1602	0.1203	0.0268	0.0829	0.0630	0.0583	0.1845	**0.0226**	**0.0226**	0.1286	0.0749	0.0909
	CVM	0.0998	0.1086	3.1291	1.6187	0.0246	0.7895	0.1806	0.1469	4.1316	**0.0188**	**0.0188**	2.6701	0.6069	0.9182
	AD	2.5384	2.5699	15.8622	8.4410	0.1588	5.2404	1.9186	1.6474	28.1716	**0.1462**	0.1465	18.1224	4.3005	5.8047
	AIC	2764	2764	2774	2743	2679	2750	2706	2708	2978	2680	**2678**	2818	2726	2761
2016	sec	86.89	6.43	1.79	0.77	5.22	1.45	0.89	0.96	0.53	1.02	0.08	0.08	0.11	0.09
	KS	0.5586		0.2752	0.2758	0.1013	0.1084	0.0728	**0.0684**	0.3330	0.1013	0.1013	0.1945	0.2117	0.5145
	CVM	59.2558		10.2381	8.0626	1.0357	1.4622	0.3333	**0.2736**	14.5041	1.0470	1.0466	4.8072	5.2079	38.6514
	AD			48.9451	43.3958	5.8422	8.7762	1.8074	**1.5124**	76.1325	5.9281	5.9272	28.2854	25.8775	182.9803
	AIC	>>		3579	3107	2766	2813	2719	**2706**	3450	2773	2771	2896	2955	3665

Table 5: Goodness-of-fit statistics and Computational Time for hours 7-8-9. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. ">" and ">>" mean respectively 'greater' and 'grater than thousands'. "er" means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without the indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
HP 10															
2010	sec	72.65	1.2	1.45	0.28	> 200	0.83	0.97	1.04	0.84	0.7	0.06	0.07	0.08	0.06
	KS	0.0503	0.0624	0.1972	0.1573	**0.0276**	0.0595	0.0444	0.0397	0.2170	0.0337	0.0337	0.1514	0.1293	0.0772
	CVM	0.2593	0.5877	4.3911	2.8226	**0.0471**	0.4333	0.1050	0.0961	5.9571	0.0850	0.0849	3.1086	2.1320	0.7829
	AD			23.4270	16.0225	**0.4089**	2.9392	0.9735	0.8397	37.4577	0.7282	0.7279	20.1967		5.3250
	AIC	3211	3214	2803	2776	**2635**	2671	2640	2639	3004	2642	2640	2777	2779	2702
2011	sec	69.39	er	5.24	1.64	3.27	0.42	1.5	1.64	0.52	0.94	0.1	0.08	0.08	0.09
	KS		0.4043	0.1124		0.0522	0.0440	**0.0201**	0.0204	0.2755	0.0716	0.0765	0.1750	0.0968	0.2797
	CVM		31.5557	1.7880		0.2612	0.1387	**0.0172**	0.0207	9.4574	0.4059	0.5691	3.8703	1.0218	11.2688
	AD					1.5750	0.8963	**0.1391**	0.1688	53.9736	2.5255	3.4554	23.9321	6.3186	52.3735
	AIC		>>	4662		2565	2564	**2548**	2549	3080	2601	2600	2731	2585	2978
2012	sec	19.29	er	0.89	0.4	7.26	0.92	0.68	1.21	0.46	1.06	0.06	0.08	er	0.08
	KS			0.8253	0.3315	0.1032	0.0879	0.0592	0.0630	0.3324	**0.0463**	0.1069	0.1921	0.4425	0.1476
	CVM			102.1823	11.4260	0.9149	0.6272	0.2528	0.4634	14.3101	**0.1587**	1.0182	5.2631	27.0913	1.9506
	AD				54.1023	5.8183	4.1656	**1.7444**	3.4890	75.2884	1.8496	6.6542	30.6382		11.6370
	AIC			>>	3130	2853	2851	2809	2833	3535	**2465**	2885	3006	3531	2882
2013	sec	er	0.69	0.75	0.49	er	1.07	0.8	0.84	0.73	0.61	0.06	0.08	0.08	0.08
	KS	0.0694	0.0695	0.1314	0.0936	0.0681	0.0784	0.0851	0.0785	0.1802	**0.0574**	0.0575	0.1410	0.0783	0.0812
	CVM	0.2513	0.2500	2.0387	0.7047	0.3248	0.6720	0.2684	0.2479	3.0853	**0.1752**	**0.1752**	2.3456	0.5864	0.5423
	AD	2.1025	2.0998	10.0898	3.3673	1.9644	5.2252	3.0222	2.7309	22.7405	**1.1668**	1.1670	17.0352	4.7692	3.9262
	AIC	2865	2865	2900	2866	2863	2932	2905	2908	3127	2856	**2854**	2996	2925	2885
2014	sec	er	er	18.91	0.87	er	1.04	0.73	0.8	1.04	0.63	0.06	0.08	0.08	0.07
	KS	0.0450	0.0448	0.2035	0.1582	0.0343	0.0638	0.0624	0.0559	0.1987	**0.0321**	**0.0321**	0.1464	0.0911	0.0767
	CVM	0.1297	0.1362	4.5719	2.7480	0.1094	0.4892	0.2474	0.2396	3.6495	0.0597	**0.0596**	2.4997	0.7502	0.4925
	AD	2.4311	2.4801	22.4636	13.9794	0.7751	3.2891	2.3508	2.2261	25.6064	0.6342	**0.6337**	17.4354	5.7328	3.7391
	AIC	2678	2678	2740	2704	2632	2676	2660	2665	2914	2631	**2629**	2767	2696	2679
2015	sec	er	26.88	0.7	0.47	> 140	1.31	0.8	0.84	0.43	0.69	0.06	0.08	0.06	0.06
	KS	0.0485	0.0486	0.1986	0.1642	**0.0275**	0.0824	0.0507	0.0471	0.2003	0.0387	0.0387	0.1389	0.1002	0.0884
	CVM	0.1563	0.1684	4.1766	2.5294	**0.0336**	0.6233	0.1552	0.1262	4.2876	0.0543	0.0542	2.7466	0.9546	0.7306
	AD	3.2949	3.3616	20.2099	12.2884	**0.3132**	4.0804	1.6463	1.4172	28.9195	0.4415	0.4414	18.4196	6.1122	4.7451
	AIC	2777	2777	2788	2756	**2678**	2739	2701	2702	2978	2679	2677	2817	2741	2749
2016	sec	21.41	14.03	5.21	er	93.51	1.26	0.76	0.83	0.54	0.89	0.08	0.08	0.12	0.07
	KS	0.2056	0.2695	0.1228	0.1585	0.0846	0.0748	0.0562	**0.0552**	0.2436	0.1141	0.1137	0.1715	0.2371	0.0999
	CVM	5.6213	10.1727	1.7080	3.4811	0.5761	0.4886	0.2078	**0.1857**	7.9964	1.0380	1.0322	4.1668	6.5916	1.3198
	AD			9.6122	17.7386	2.9205	2.5730	1.0314	**0.9016**	46.9116	5.4246	5.4066	24.6907	31.2461	7.4699
	AIC	4117	4161	2929	2849	2732	2733	2714	**2712**	3141	2763	2761	2895	2993	2757
HP 11															
2010	sec	47.18	70.18	0.47	0.32	1.06	1.28	0.95	1.17	0.95	0.71	0.06	0.06	0.08	0.07
	KS	0.0894	0.1093	0.3459	0.1564	0.0556	0.1190	0.0545	**0.0499**	0.2348	0.0631	0.0632	0.1561	0.1697	0.0970
	CVM	0.7792	1.8038	13.6504	3.2676	0.1747	1.2615	0.2249	0.2082	6.9006	**0.2017**	0.2019	3.3967	3.1287	1.0141
	AD			65.2800	18.7759	1.1430	8.2509	**1.4677**	1.3490	41.9763	1.4909	1.4918	21.5030		6.2869
	AIC	3866	3877	2950	2775	2609	2696	2607	**2606**	3007	2619	2617	2752	2789	2678
2011	sec	> 100	er	0.58	0.38	8.89	0.48	2.34	2.56	0.36	0.86	0.07	0.06	0.08	0.08
	KS		0.3214	0.1144	0.1895	0.0555	0.0454	0.0249	**0.0219**	0.2691	0.0753	0.0790	0.1645	0.0944	0.2563
	CVM		19.9330	1.8311	4.5118	0.3062	0.2003	0.0304	**0.0255**	8.7766	0.5351	0.6834	3.9525	1.0958	8.5834
	AD			11.0602	22.7053	1.7442	1.1878	0.2199	**0.2098**	50.7722	3.1869	4.0066	24.1639	6.5356	40.4594
	AIC		7004	2688	2659	2513	2512	**2495**	**2495**	2985	2549	2547	2679	2535	2850
2012	sec	7.03	56.19	7.05	0.52	0.78	0.84	0.79	1.15	0.52	1.05	0.06	0.08	er	0.06
	KS			0.8211	0.2955	0.0741	0.1257	0.0382	**0.0369**	0.3149	0.0463	0.0806	0.1674	0.4146	0.1221
	CVM			106.2392	9.5626	0.4177	1.6358	0.1578	**0.1451**	12.3665	0.1587	0.4822	4.2711	24.8778	1.2953
	AD					2.8854	10.8206	1.0590	**1.0027**	66.9752	1.8496	3.5701	26.1186		8.1018
	AIC			>>	3085	2837	2947	2811	2811	3478	**2465**	2867	2994	3508	2858
2013	sec	54.18	94.15	0.53	0.42	> 120	0.93	1.24	1.89	0.5	0.61	0.06	0.06	0.07	0.06
	KS	0.0498	0.0498	0.1316	0.0746	0.0658	0.0834	0.0730	0.0924	0.1702	**0.0445**	**0.0445**	0.1402	0.0881	0.0732
	CVM	0.2400	0.2396	2.2357	0.6379	0.4323	0.6550	0.4405	0.3663	2.4872	0.1999	**0.1998**	2.1463	0.4465	0.3824
	AD	1.6247	1.6236	11.2423	2.9485	2.5933	4.8432	4.0809	3.5991	19.4797	1.2646	**1.2644**	16.2537	3.9384	3.3046
	AIC	2857	2857	2910	2862	2876	2928	2923	2934	3115	2862	**2860**	3004	2916	2892
2014	sec	er	er	5.07	1.36	er	1.12	0.67	0.87	1.47	0.67	0.07	0.06	0.08	0.06
	KS	0.0605	0.0615	0.2095	0.1651	0.0491	0.0671	0.0603	0.0547	0.1995	**0.0424**	**0.0424**	0.1450	0.0903	0.0741
	CVM	0.1937	0.2011	4.8993	3.0166	0.1615	0.4814	0.3034	0.3060	3.7196	0.0962	**0.0961**	2.4935	0.7861	0.5029
	AD	2.5966	2.6573	24.2718	15.3131	1.0415	3.1903	2.5853	2.5353	26.0167	0.8269	**0.8264**	17.4978	5.8157	3.7742
	AIC	2688	2688	2758	2718	2635	2680	2663	2669	2924	2635	**2633**	2771	2704	2684
2015	sec	er	0.8	0.64	0.36	er	0.73	1.09	1.07	0.78	0.97	0.07	0.08	0.06	0.08
	KS	0.0543	0.0609	0.1755	0.1448	**0.0379**	0.0727	0.0498	0.0454	0.1960	0.0519	0.0518	0.1447	0.1033	0.0718
	CVM	0.2200	0.2575	3.9107	2.2096	**0.1056**	0.4056	0.1560	0.1609	3.7921	0.1109	0.1107	2.5471	0.8995	0.4659
	AD	2.5256	2.6901	18.9831	10.7169	**0.7231**	3.0729	1.7377	1.6771	26.4623	0.7400	0.7396	17.7572	5.8200	3.6920
	AIC	2729	2730	2774	2739	2680	2738	2706	2709	2970	**2679**	2677	2818	2738	2742
2016	sec	> 100	71.61	1.09	0.97	23.82	1.25	1.09	1.3	0.7	0.9	0.07	0.08	0.12	0.1
	KS	0.1638	0.2209	0.1329	0.1484	0.0707	0.0695	0.0441	**0.0402**	0.2424	0.1030	0.1030	0.1753	0.2182	0.0944
	CVM	3.5903	6.6320	2.3704	2.6339	0.3718	0.3054	0.0879	**0.0743**	6.9919	0.8783	0.8786	3.8793	5.3784	1.0825
	AD			13.0624	13.7835	2.0329	1.8169	0.5479	**0.4707**	42.1953	4.7944	4.7956	23.4516	25.9748	6.4144
	AIC	3382	3413	2845	2842	2747	2749	2735	**2733**	3128	2778	2776	2911	2974	2771
HP 12															
2010	sec	7.06	29.8	0.61	0.42	> 300	0.86	1.19	1.28	0.83	0.71	0.06	0.08	0.08	0.07
	KS	0.0670	0.0692	0.1451	0.1159	0.0532	0.1110	0.0563	0.0612	0.2046	**0.0488**	**0.0488**	0.1475	0.1342	0.0955
	CVM	0.3258	0.4597	2.8225	1.7496	**0.1344**	1.1306	0.2723	0.1531	5.2886	0.1429	0.1428	3.0524	1.7698	0.8221
	AD			15.0941	9.8419	**0.7362**	7.2733	1.9895	1.5929	33.9847	0.9004	0.8999	19.7703	9.9772	5.2670
	AIC	2892	2894	2733	2711	**2623**	2709	2637	2642	2958	2629	2627	2765	2748	2672
2011	sec	> 100	75.94	0.5	0.45	28.16	0.58	0.8	0.81	0.51	0.72	0.06	0.08	0.09	0.08
	KS		0.3147	0.3451	0.1987	0.0651	0.0619	0.0375	**0.0367**	0.2761	0.0756	0.0825	0.1692	0.1022	0.2634
	CVM		18.8497	14.3808	4.5295	0.5151	0.4365	0.1012	**0.0780**	9.6160	0.6346	0.7836	4.3122	1.2447	9.2118
	AD			68.3512	24.3070	3.0084	2.6374	0.5842	**0.4422**	54.5331	3.7518	4.5758	25.6308	7.7005	42.9642
	AIC		>>	2869	2703	2524	2527	2496	**2492**	3002	2549	2547	2678	2564	2861
2012	sec	er	56.41	1.33	18.39	er	0.9	1.08	1.26	0.69	0.9	0.08	0.07	er	0.08
	KS		0.5098	0.3871	0.2507	0.0558	0.1122	0.0519	**0.0363**	0.2957	0.0620	0.0620	0.1595	0.3407	0.1096
	CVM		50.7086	30.1559	6.5372	0.3002	1.2518	0.2313	**0.1055**	10.7040	0.2534	0.2535	3.6732	16.6629	1.0016
	AD				32.8681	1.9743	8.8060	1.4233	**1.1002**	59.7047	2.0533	2.0541	23.3776		6.6201
	AIC		>>	5767	3018	2809	2916	2796	**2806**	3397	2834	2832	2962	3350	2837
2013	sec	er	er	0.73	0.48	0.48	0.82	0.95	0.94	0.72	0.81	0.07	0.06	er	0.06
	KS	0.3164	0.3396	0.0588	0.1736	0.0591	0.1080	0.0653	0.0672	0.2701	**0.0476**	**0.0476**	0.1569	0.2516	0.0848
	CVM	15.3133	21.9481	0.2344	3.0298	0.2041	0.9054	0.2984	0.3192	7.7461	0.1504	**0.1501**	2.5541	11.0060	0.4112
	AD	> 280	> 330			1.3846		2.0601	2.1851	46.4910	1.1773	**1.1758**	18.6477		3.8674
	AIC	>>	>>	3206	3056	**2902**	3019	2909	2914	3427	2916	2914	3051	3371	2929
2014	sec	er	1.25	2.34	1	er	1.25	er	0.84	1	0.68	0.07	0.08	0.06	0.08
	KS	0.0807	0.0818	0.1445	0.0915	0.0631	0.0779	0.0646	0.0651	0.1990	**0.0561**	0.0562	0.1536	0.1001	0.0672
	CVM	0.2900	0.3417	2.6960	0.9652	0.1791	0.3730	0.2867	0.3136	3.6387	**0.1289**	0.1292	2.5369	1.1265	0.4045
	AD	3.2252	3.4898	15.3179	5.9761	1.1275	2.3551	2.3741	2.4284	25.5191	**1.1025**	1.1040	17.6285	7.4376	3.3016
	AIC	2684	2686	2741	2696	**2641**	2668	2666	2673	2924	2643	**2641**	2779	2725	2672
2015	sec	23.63	2.22	0.89	0.36	71.43	0.52	1.04	1.06	0.5	0.72	0.06	0.08	0.06	0.08
	KS	0.0600	0.0625	0.1746	0.1301	0.0537	0.0554	0.0584	0.0521	0.1830	0.0514	**0.0513**	0.1544	0.0898	0.0641
	CVM	0.2723	0.3116	3.9743	2.2171	0.2010	0.3171	0.2128	0.2725	3.2710	0.1850	**0.1847**	2.4401	0.9013	0.2959
	AD	2.2872	2.4563	19.0841	10.5653	1.3087	2.8585	2.1458	2.2495	23.7564	1.2369	**1.2361**	17.4004	5.9572	3.1342
	AIC	2701	2701	2767	2729	2689	2734	2718	2722	2959	2685	**2683**	2825	2743	2731
2016	sec	17.5	49.63	22.19	0.78	10.24	0.75	0.95	1.59	0.78	0.81	0.07	0.08	0.14	0.13
	KS	0.1543	0.2045	0.1259	0.1383	0.0744	0.0643	**0.0460**	0.0491	0.2374	0.1075	0.1076	0.1855	0.2152	0.0997
	CVM	2.9545	5.1808	2.1932	2.1348	0.3749	0.2938	0.0896	**0.0866**	6.4170	0.9372	0.9387	3.7280	4.7585	0.9872
	AD	19.9911		12.8933	11.7297	2.0715	1.8419	0.6408	**0.6272**	39.4774	5.1219	5.1268	22.8906	23.3278	6.0330
	AIC	3147	3170	2867	2852	2759	2765	2748	**2746**	3123	2790	2788	2925	2965	2785

Table 6: Goodness-of-fit statistics and Computational Time for hours 10-11-12. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. “>” and “>>” mean respectively ‘greater’ and ‘grater than thousands’. “er” means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
HP 13															
2010	sec	6.83	88.29	0.84	0.54	40.02	1.82	1.53	0.88	0.5	0.61	0.07	0.07	0.07	0.07
	KS	0.0476	0.0529	0.1691	0.1363	**0.0406**	0.0978	0.0668	0.0520	0.2054	0.0450	0.0450	0.1564	0.1173	0.0909
	CVM	0.1977	0.2704	3.6881	2.4433	**0.1258**	0.9880	0.2815	**0.1176**	5.5504	0.1352	0.1352	3.1596	1.5799	0.9760
	AD			19.4998	13.4850	**0.8423**	6.8207	2.1527	1.2938	35.3496	1.0417	1.0416	20.3154	9.6731	6.2627
	AIC	2907	2908	2696	2671	**2562**	2638	2575	2572	2905	2568	2566	2703	2678	2623
2011	sec	26.29	0.67	0.42	0.34	24.44	0.78	0.89	0.95	0.42	1.04	0.08	0.08	0.06	0.28
	KS		0.3637	0.1109	0.2019	0.0740	0.0681	**0.0468**	0.0517	0.2681	0.0999	0.0985	0.1687	0.0998	0.2384
	CVM		23.2394	1.7751	5.1405	0.3558	0.2308	**0.1344**	0.1446	8.8388	0.6169	0.7356	3.8633	1.1413	8.9291
	AD			11.2706	25.4102	2.0057	1.2905	**0.7077**	0.7943	51.1465	3.5847	4.3753	24.0429	6.8241	42.7804
	AIC		6989	2650	2630	2490	2489	**2475**	**2475**	2979	2532	2531	2663	2508	2847
2012	sec	er	er	6.15	0.7	> 120	0.94	0.67	0.92	1.61	1.04	0.08	0.08	0.11	0.07
	KS	0.2558	0.2929	0.2085	0.1928	0.0729	0.1064	0.0728	**0.0475**	0.2684	0.0483	0.0485	0.1526	0.2367	0.1032
	CVM	11.3868	18.4062	4.1662	3.4001	0.3421	1.1210	0.3927	**0.1758**	8.3866	0.2141	0.2139	3.1945	7.8670	0.8324
	AD			22.2215	19.1792	2.0987	8.5340	2.4539	**1.6086**	49.2535	1.8019	1.8005	21.3379		5.7886
	AIC	>>	>>	2934	2939	2793	2903	**2791**	2799	3294	2811	2809	2944	3155	2821
2013	sec	er	8.99	1.17	0.49	er	0.46	0.47	1.04	0.64	0.66	0.06	0.06	0.11	0.06
	KS	0.0791	0.0797	0.0953	**0.0514**	0.0692	0.0717	0.0796	0.0739	0.1925	0.0573	0.0573	0.1411	0.0799	0.0935
	CVM	0.4537	0.4543	1.1431	0.3268	0.4594	0.5052	0.4448	0.4396	3.4207	**0.2872**	0.2873	2.1734	0.8587	0.4130
	AD			6.5695	2.3493	2.9543		3.8621	3.7299	24.9515	**1.9632**	1.9634	16.8207		3.8236
	AIC	2884	2884	2889	2871	2864	2942	2901	2911	3170	2859	**2857**	2999	2969	2884
2014	sec	er	7.1	0.67	1	5.76	1.51	1.03	0.86	0.64	0.81	0.06	0.06	0.06	0.1
	KS	0.1140	0.1275	0.2818	0.1351	0.0504	0.0962	**0.0466**	0.0472	0.2599	0.0486	0.0485	0.1594	0.1022	0.1607
	CVM	1.1636	2.7071	7.4497	2.1421	0.1529	0.8163	**0.1328**	0.1965	7.0104	0.1577	0.1571	2.8760	1.1280	3.8381
	AD			38.0211	13.9006	1.2298	6.8236	**1.0033**	1.2506	42.6400	1.3162	1.3145	19.5911	7.4999	20.5136
	AIC	5718	5740	2859	2788	2648	2738	2645	**2642**	3088	2654	2652	2786	2718	2912
2015	sec	35.32	73.49	0.59	0.36	71.64	0.68	1.19	1.57	0.56	0.7	0.06	0.06	0.07	0.1
	KS	0.0640	0.0684	0.1535	0.1168	0.0625	0.0823	0.0530	**0.0485**	0.1936	0.0614	0.0614	0.1591	0.0983	0.0802
	CVM	0.3164	0.3635	3.0635	1.7063	0.2423	0.5344	**0.2064**	0.2536	4.0011	0.2493	0.2493	2.6486	0.9956	0.5547
	AD	3.5021	3.6988	14.8345	8.5011	**1.5576**	4.6962	1.9334	1.9543	27.6365	1.6322	1.6322	18.3446	6.4368	4.8200
	AIC	2731	2731	2738	2714	2671	2741	2692	2692	2969	2670	**2668**	2809	2720	2746
2016	sec	er	62.73	1.36	0.76	> 130	0.76	1.59	1.59	0.81	1.11	0.06	0.21	0.11	er
	KS			0.9320	0.3914	0.1009	0.1276	**0.0706**	0.0925	0.3598	0.0998	0.0999	0.2128	0.1590	0.7479
	CVM			> 100	14.0623	1.2878	1.5703	**0.5653**	0.9776	16.9905	1.1696	1.1707	4.8637	3.2644	77.0552
	AD				66.4082	7.4275	9.5616	**3.3455**	5.8965	86.6441	6.8532	6.8593	28.6817	17.8404	441.0596
	AIC			>>	3237	2837	2893	**2800**	2803	3674	2848	2846	2968	2928	4398
HP 14															
2010	sec	11.48	er	2.04	0.92	er	0.67	1.17	1.01	0.94	er	0.07	0.07	0.08	0.07
	KS	0.0469	0.0468	0.3801	0.1736	**0.0322**	0.0654	0.0567	0.0637	0.2290	0.0333	0.0333	0.1501	0.0916	0.1209
	CVM	0.1199	0.1446	15.7608	3.3779	**0.0520**	0.5785	0.1470	0.3438	6.2837	0.0701	0.0701	3.1008	1.1523	1.8297
	AD		7.3046	78.1265	18.7133	**0.5045**	4.2966	1.3726	3.1374	39.0968	0.6773	0.6773	20.2556	7.6918	9.8558
	AIC	3454	3454	3165	2733	**2585**	2633	2593	2604	2970	2592	2590	2726	2677	2728
2011	sec	4.73	58.67	0.43	0.88	> 100	0.73	0.91	0.96	0.47	0.7	0.06	0.08	0.08	0.14
	KS	0.2049	0.2558	0.1652	0.1713	0.0440	**0.0362**	0.0470	0.0541	0.2537	0.0714	0.0758	0.1762	0.0963	0.2174
	CVM	7.3313	12.0170	3.4298	3.6409	0.1472	**0.0870**	0.1050	0.1427	7.3115	0.4936	0.5382	3.4803	0.8922	6.2168
	AD			17.0496	18.1984	0.9203	**0.5755**	0.6029	0.8234	44.0862	3.1063	3.4409	22.3179	5.5917	30.6598
	AIC	3686	3737	2574	2586	2487	2486	**2485**	2487	2932	2530	2529	2663	2506	2779
2012	sec	er	17.58	1.25	2.89	er	0.74	1.08	1.48	2.2	0.98	0.06	0.06	0.13	0.08
	KS	0.2539	0.2638	0.3886	0.1916	0.0636	0.1062	0.0695	0.0691	0.2735	**0.0498**	**0.0498**	0.1591	0.2212	0.1056
	CVM	9.6495	15.8761	17.2357	2.9699	0.3559	1.0810	0.4524	0.4440	8.0048	0.2254	**0.2253**	3.0412	7.3351	0.7577
	AD		> 200	79.3107	17.5300	2.3165	8.5423	2.9240	2.9182	47.5420	2.0137	**2.0128**	20.8042		5.5563
	AIC	8692	8765	3066	2913	**2770**	2882	2771	2776	3267	2788	2786	2921	3124	2799
2013	sec	er	er	0.37	0.44	> 110	0.37	er	0.78	0.57	0.68	0.08	0.08	0.09	0.07
	KS	0.0693	0.0686	0.1388	0.0813	0.0785	0.0918	0.0800	0.0915	0.1974	**0.0658**	**0.0658**	0.1537	0.1011	0.0901
	CVM	0.6348	0.6338	2.7305	0.8834	0.6922	0.5688	0.5931	0.7064	3.4743	**0.4939**	**0.4939**	2.2371	0.5434	0.7698
	AD	3.9993	3.9959	> 16	5.5782	4.1048	4.0564	4.5536	4.9931	> 25	3.0343	**3.0342**	> 17	4.5066	5.8061
	AIC	2886	2886	2968	2908	2870	2941	2907	2915	3180	2864	**2862**	3004	2899	2964
2014	sec	er	er	2.13	0.94	er	1.12	1.39	1.23	0.64	1.01	0.06	0.07	0.06	er
	KS			0.9059	0.3955	0.0880	0.1159	0.0701	0.0700	0.3652	**0.0624**	0.0863	0.1957	0.1442	0.6563
	CVM			> 90	15.1828	0.4071	0.8924	0.3037	0.2940	16.1546	**0.2182**	0.3714	4.0365	1.2405	> 60
	AD				70.6951	3.3690	7.2238	2.1097	2.0460	82.8453	**1.8748**	3.2967	25.8534	8.9085	> 310
	AIC			>>	3088	**2721**	2800	2688	2688	3619	2743	2744	2862	2747	3980
2015	sec	11.87	21.8	0.78	0.43	64.52	0.94	1.27	1.07	0.66	0.99	0.08	0.06	0.06	er
	KS			0.8953	0.3917	0.0824	0.1149	0.0821	0.0807	0.3651	**0.0677**	0.0820	0.1883	0.1359	0.7222
	CVM			98.9341	15.2374	0.4288	0.7811	0.4496	0.4336	15.9531	**0.3262**	0.3646	3.6455	1.1225	73.9154
	AD				70.9565	2.8799	6.1226	2.5599	2.4933	82.3336	**2.0936**	2.6719	23.8690	7.7545	> 420
	AIC			>>	3102	2717	2797	**2696**	2697	3612	2739	2738	2864	2740	4263
2016	sec	er	er	5.37	0.97	1.57	0.63	1.29	1.53	0.78	1.09	0.1	0.07	0.1	er
	KS			0.6742	0.4614	0.1288	0.1557	0.1070	**0.1067**	0.3856	0.1101	0.1304	0.2347	0.1694	0.8533
	CVM			45.0243	19.7031	1.6071	2.0497	1.2583	**1.1885**	19.4454	1.1981	1.5155	5.5892	3.0892	96.0404
	AD				89.0716	9.3613	12.2560	7.3276	**6.9967**	96.7877	7.2012	8.9807	32.1070	17.5176	> 600
	AIC			>>	3372	2908	2971	2870	**2867**	3876	2925	2925	3043	2966	4974
HP 15															
2010	sec	52.89	31.17	1.61	0.76	68.99	0.73	0.89	1.09	0.83	0.72	0.06	0.08	0.06	0.06
	KS	0.0564	0.0567	0.2174	0.1939	**0.0353**	0.0875	0.0615	0.0477	0.2200	0.0386	0.0387	0.1448	0.1193	0.1132
	CVM	0.1792	0.2538	5.6815	4.4362	**0.0859**	0.7697	0.4456	0.0925	6.1645	0.1274	0.1276	3.2576	1.6458	1.2927
	AD			28.4026	22.7725	**0.6604**	4.8326	3.5816	0.9381	38.3672	0.9895	0.9902	20.7571	10.0004	7.3880
	AIC	3236	3237	2772	2750	**2599**	2656	2619	2601	2965	2606	2604	2741	2708	2701
2011	sec	75.21	7.3	0.8	0.39	> 100	1.21	1.12	1.33	0.83	0.66	0.08	0.06	0.06	0.07
	KS	0.1976	0.2416	0.1479	0.1758	0.0337	**0.0301**	0.0392	0.0464	0.2499	0.0634	0.0614	0.1601	0.0901	0.2100
	CVM	6.8444	11.5299	2.2068	3.3791	0.0849	**0.0472**	0.0588	0.0860	7.2931	0.3550	0.4080	3.3775	0.7663	6.4738
	AD	64.6903		11.4984	16.9094	0.5264	**0.3145**	0.3183	0.4711	43.9894	2.2636	2.5808	21.6981	4.9244	31.1894
	AIC	3977	4028	2603	2616	2512	**2511**	2512	2515	2957	2549	2547	2682	2532	2814
2012	sec	59.42	69.15	1.32	0.52	er	0.98	1.31	0.77	0.92	0.85	0.06	0.06	0.13	0.06
	KS	0.2548	0.2693	0.7547	0.1703	0.0507	0.0973	0.0579	0.0580	0.2708	0.0431	**0.0430**	0.1552	0.2338	0.0949
	CVM	9.7255	15.8508	89.0669	2.7775	0.2364	0.9657	0.3395	0.3435	8.0310	0.1577	**0.1575**	2.9643	7.2253	0.6519
	AD				17.0006	1.5853	7.7264	2.2071	2.2572	47.6937	1.4373	**1.4365**	20.4210		4.9597
	AIC	9809	9882	4501	2895	**2742**	2850	**2742**	2746	3244	2758	2756	2891	3096	2777
2013	sec	1.72	0.81	0.64	0.34	> 160	1.62	0.74	0.59	0.55	1.2	0.06	0.06	0.08	er
	KS			0.6641	0.4276	0.0705	0.0986	0.0875	0.0884	0.3937	0.0855	**0.0694**	0.1774	0.1377	0.8026
	CVM			41.6203	19.7371	0.4480	0.7007	0.7650	0.7781	17.5609	0.6594	**0.4499**	3.5286	1.0580	90.4674
	AD				90.9997	3.9302	6.8254	4.5341	4.6183	89.0772	4.1537	**4.0406**	24.6179	8.3402	> 500
	AIC			>>	3361	2922	3004	**2890**	2892	4005	2946	2949	3071	2915	4858
2014	sec	er	er	2.18	0.84	er	0.76	1.02	0.96	0.66	0.86	0.06	0.06	0.07	0.09
	KS			0.9748	0.4005	0.0865	0.1173	0.0564	**0.0550**	0.3702	0.0572	0.0862	0.1921	0.1439	0.6713
	CVM			> 110	16.3190	0.4849	1.1028	0.2842	0.2723	16.6649	**0.2016**	0.4658	4.3273	1.3890	63.6136
	AD				75.1880	3.7924	8.2923	1.9083	1.8499	84.9484	**1.8139**	3.8576	27.0594	9.4335	> 340
	AIC			>>	3102	2727	2808	2690	**2689**	3628	2750	2752	2869	2746	4039
2015	sec	2.77	33.71	0.61	0.36	3.74	0.72	1.46	1.11	0.56	1.16	0.06	0.08	0.06	er
	KS			0.7255	0.4470	0.1015	0.1294	0.0844	0.0839	0.3947	**0.0724**	0.1021	0.2004	0.1552	0.8363
	CVM			52.7423	20.8193	0.5689	0.9988	0.4969	0.4899	18.9449	**0.3846**	0.5415	4.2433	1.4348	96.9696
	AD				> 90	4.0096	7.4179	2.7929	2.7709	> 94	**2.5259**	4.0073	> 26	9.4990	> 600
	AIC			>>	3215	2750	2825	**2713**	**2713**	3805	2771	2774	2893	2756	4889
2016	sec	er	14.88	6.5	4.29	4.43	0.62	1.38	1.61	0.62	1.27	0.08	0.08	0.08	er
	KS			0.7127	0.5159	0.1556	0.1773	**0.1194**	0.1200	0.4195	0.1246	0.1566	0.2492	0.1968	0.9292
	CVM			53.8449	26.3679	2.0623	2.5675	1.5080	1.4620	22.3180	**1.4206**	2.0201	6.4006	3.3930	> 100
	AD				> 110	11.9103	15.0290	8.6400	**8.4414**	> 100	8.5069	11.8024	36.0886	19.1979	> 200
	AIC			>>	3524	2970	3033	2918	**2916**	4136	2985	2992	3101	2994	5885

Table 7: Goodness-of-fit statistics and Computational Time for hours 13-14-15. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. ">" and ">>" mean respectively 'greater' and 'grater than thousands'. "er" means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
HP 16															
2010	sec	26.08	35.24	1.45	0.71	7.05	0.83	1.03	1.12	1.18	0.83	0.07	0.06	0.07	0.09
	KS	0.0668	0.0852	0.3390	0.2125	0.0518	0.0902	0.0446	**0.0399**	0.2298	0.0608	0.0608	0.1451	0.1457	0.1178
	CVM	0.3359	0.5392	13.1291	5.3241	0.1896	0.7842	0.1660	**0.1238**	6.6722	0.2548	0.2546	3.5183	2.2249	1.3379
	AD			64.1514	26.5369	1.1716	4.7793	1.2043	**0.9323**	40.7208	1.6351	1.6346	21.8255	12.4152	7.7766
	AIC	3503	3505	3020	2805	2639	2687	2636	**2632**	3009	2647	2645	2780	2763	2734
2011	sec	> 120	> 260	1.41	0.97	er	0.79	0.9	1.05	0.88	1.06	0.06	0.09	0.06	0.12
	KS	0.2037	0.2469	0.1146	0.1905	0.0459	**0.0407**	0.0409	0.0457	0.2526	0.0460	0.0538	0.1520	0.1054	0.2160
	CVM	8.0548	13.7828	1.0433	3.4378	0.1075	0.0906	**0.0806**	0.0941	7.8142	0.1885	0.2437	3.4422	0.7457	6.9522
	AD			7.0857	17.8594	0.8300	0.7077	**0.5163**	0.5594	46.4573	1.5668	1.9235	21.9901	5.0965	33.6018
	AIC	5375	5436	2711	2638	2515	2515	**2511**	2513	2978	2544	2542	2676	2538	2830
2012	sec	er	er	0.7	1.14	2.87	1.03	0.92	1.06	1.28	0.78	0.08	0.08	0.13	0.08
	KS	0.2294	0.2749	0.5711	0.1748	0.0401	0.0956	0.0420	0.0435	0.2709	**0.0359**	**0.0359**	0.1485	0.2401	0.0871
	CVM	10.4634	16.9921	55.3655	3.0380	0.1188	1.1158	0.1551	0.1478	8.3062	**0.0970**	0.0973	3.1300	8.5582	0.7069
	AD				17.8697	0.8556	7.9771	1.1301	1.0998	48.8683	**0.9010**	0.9028	20.7621		4.9850
	AIC	>>	>>	3540	2875	2712	2817	**2708**	2710	3206	2726	2724	2859	3090	2753
2013	sec	3.08	er	0.6	0.52	er	1.13	0.92	1	0.85	1.47	0.06	0.08	0.08	er
	KS			0.6655	0.4377	0.0705	0.0923	0.0795	0.0793	0.3938	0.0765	**0.0678**	0.1815	0.1366	0.8518
	CVM			> 40	19.8103	0.3563	0.5139	0.5957	0.6008	18.1028	0.5040	**0.3474**	3.3001	0.8419	> 90
	AD				> 90	**3.0675**	5.2609	3.5571	3.6012	91.3107	3.1781	3.0886	23.2975	7.0456	> 700
	AIC			>>	3363	2896	2969	**2868**	2869	4021	2917	2919	3042	2901	5100
2014	sec	er	1.3	1.24	0.95	> 200	1.22	0.81	0.96	0.82	0.83	0.06	0.08	0.06	er
	KS			0.7320	0.4106	0.0837	0.1138	**0.0469**	0.0473	0.3781	0.0506	0.0834	0.1865	0.1423	0.7046
	CVM			> 50	> 10	0.4108	1.0130	0.2446	**0.2429**	17.1868	0.1635	0.4059	4.2448	1.2977	> 70
	AD				> 80	3.5768	8.0281	1.6875	**1.6802**	87.1247	1.6080	3.7069	26.9468	9.1147	> 300
	AIC			>>	3096	2704	2786	**2664**	**2664**	3654	2727	2731	2846	2713	4149
2015	sec	5.18	33.96	1.38	0.92	> 100	0.84	0.95	1.23	0.45	1.33	0.07	0.08	0.08	er
	KS			0.4079	0.3859	0.0778	0.1100	0.0791	0.0788	0.3627	**0.0611**	0.0767	0.1840	0.1336	0.7005
	CVM			16.7883	14.9597	0.3278	0.7756	0.3621	0.3627	15.5394	**0.2560**	0.3000	3.6228	0.9767	> 60
	AD				> 70	2.4809	6.2930	2.1007	2.1132	80.6172	**1.7933**	2.4864	23.8810	7.0573	> 300
	AIC			>>	3100	2724	2808	**2701**	2702	3612	2747	2747	2872	2746	4195
2016	sec	> 100	11.1	1.41	0.86	8.63	0.65	1.07	1	0.62	1.55	0.08	0.08	0.11	er
	KS			0.5527	0.3569	0.1184	0.1473	0.0808	**0.0779**	0.3470	0.1148	0.1148	0.2211	0.1851	0.6564
	CVM			51.6103	11.2212	1.9110	2.1750	0.7449	**0.6605**	15.6888	1.8262	1.8269	5.2714	4.3196	58.3558
	AD				54.5586	10.5503	12.4839	4.9778	**4.6054**	81.1302	10.1560	10.1586	30.1652	22.3122	> 290
	AIC			>>	3264	2914	2969	2868	**2849**	3630	2921	2919	3044	3012	4113
HP 17															
2010	sec	13.73	7.52	1.59	0.71	1.84	0.81	1.26	1.23	1.25	1.03	0.09	0.08	0.08	0.12
	KS	0.1487	0.2127	0.2733	0.1425	0.0800	0.0728	0.0534	**0.0500**	0.2465	0.0976	0.0975	0.1609	0.2290	0.0921
	CVM	2.6714	5.9413	10.1330	3.2979	0.4949	0.6013	0.1751	**0.1397**	7.9830	0.7424	0.7418	4.1570	5.5665	1.2317
	AD			54.0124	18.3030	2.6921	3.3510	0.9089	**0.6989**	46.8011	4.1611	4.1599	24.4887	26.5762	7.3253
	AIC	4534	4561	3133	2875	2722	2736	2703	**2699**	3122	2741	2739	2872	2946	2771
2011	sec	er	27.99	1.33	0.99	52.31	0.58	1.6	0.85	0.92	1.03	0.19	0.08	0.08	0.08
	KS	0.1774	0.2172	0.4432	0.1680	0.0502	0.1067	0.0490	**0.0450**	0.2622	0.0545	0.0545	0.1606	0.0972	0.2235
	CVM	5.9888	11.2401	24.9856	3.4952	0.1413	1.1963	0.1042	**0.0900**	8.7976	0.1645	0.1650	3.5664	1.0741	6.9960
	AD			113.2372	20.8130	1.2370	8.2489	0.9291	**0.7728**	51.0297	1.4799	1.4828	22.5877	7.0623	33.8320
	AIC	>>	>>	2907	2718	2527	2616	2514	**2512**	3014	2539	2537	2669	2598	2844
2012	sec	er	7.16	0.59	0.61	0.45	1.17	0.85	0.94	0.6	0.86	0.09	0.08	0.11	0.06
	KS			0.5393	0.2828	0.0561	0.0420	**0.0304**	0.0337	0.3078	0.0607	0.0607	0.1554	0.4253	0.1070
	CVM			55.5371	9.0858	0.1964	0.0887	**0.0323**	0.0377	11.5214	0.3374	0.3374	3.7053	27.3728	0.9029
	AD					1.2968	0.6282	**0.2198**	0.2623	63.3377	2.2653	2.2651	23.3898		5.8831
	AIC			>>	2989	2745	2744	**2729**	2730	3380	2777	2775	2905	3490	2762
2013	sec	34.92	0.9	1	0.45	er	0.82	1	1.45	1.22	0.67	0.07	0.07	0.08	0.08
	KS	0.1010	0.1436	0.3079	0.1445	0.0555	0.1035	0.0677	0.0734	0.2594	**0.0549**	**0.0549**	0.1730	0.1104	0.1639
	CVM	1.3162	2.6710	11.0200	2.1299	0.2759	0.9063	0.4365	0.4938	6.8500	**0.2530**	**0.2530**	2.7397	0.8524	4.2906
	AD			56.4123	14.4083	1.9581	7.6220	2.8365	3.0893	42.1779	**1.8909**	1.8910	19.3906	6.4900	22.8105
	AIC	5753	5772	3207	3011	**2861**	2959	2866	2868	3320	2867	2865	3002	2932	3148
2014	sec	73.46	er	0.62	0.41	3.74	0.97	1.31	1.32	0.6	1.22	0.06	0.08	0.11	0.08
	KS			0.1127	0.2656	0.0595	0.1068	0.0570	**0.0551**	0.3022	0.0614	0.0615	0.1697	0.1030	0.4321
	CVM			0.8486	6.3936	0.3161	0.8685	0.3069	0.2763	11.2629	**0.2513**	0.2515	3.4009	1.2753	26.7959
	AD				33.7999	2.1153	6.5403	2.1038	1.9170	61.9381	**1.8430**	1.8452	22.0156	8.1080	> 120
	AIC			3950	2924	2672	2750	2659	2657	3292	2682	**2680**	2808	2731	3401
2015	sec	er	er	0.57	0.35	> 250	1.09	1.2	1.28	0.4	0.7	0.07	0.06	0.08	0.08
	KS	0.0723	0.0747	0.1606	0.1210	0.0683	0.0900	0.0731	0.0592	0.2215	0.0571	**0.0570**	0.1608	0.0996	0.1062
	CVM	0.4112	0.4481	3.6488	2.0645	0.2825	0.8188	0.4119	0.3346	5.0950	**0.2145**	**0.2145**	2.6952	0.7090	1.3943
	AD		6.4336	21.0507	12.7069	1.7730	6.7015	3.1175	2.4988	33.4664	**1.5242**	1.5243	18.9287	5.0202	9.0501
	AIC	2995	2996	2848	2812	**2695**	2785	2715	2716	3060	2699	2697	2836	2749	2830
2016	sec	86.35	er	1.51	1.08	3.37	0.79	1.23	1.46	0.96	1.28	0.09	0.08	0.11	er
	KS	0.6111		0.9213	0.3128	0.1332	0.1516	0.0811	**0.0806**	0.3420	0.1337	0.1338	0.2329	0.2151	0.5287
	CVM	69.1100		114.7526	8.3838	2.1091	2.4203	0.5974	**0.5852**	14.3811	2.1343	2.1360	5.5257	5.5208	35.9622
	AD				43.2982	11.7663	13.9244	4.5243	**4.3743**	75.5322	11.9330	11.9378	31.2674	27.5555	165.3423
	AIC	>>		>>	3258	2949	3002	2886	**2867**	3572	2956	2954	3080	3085	3785
HP 18															
2010	sec	30.34	82.29	0.93	0.49	3.62	1.48	1.21	1.25	0.89	0.76	0.07	0.08	0.13	0.08
	KS		0.6075	0.6785	0.3115	0.1159	0.0971	0.0433	0.0433	0.3087	0.0909	0.1291	0.1943	0.3709	0.1564
	CVM		60.9070	72.7608	11.8176	1.4958	0.9832	0.1354	0.1313	11.9370	0.7604	1.9234	5.2619	18.2202	2.7194
	AD				53.7287	7.8142	5.4161	1.3861	1.3636	64.8716	6.3395	10.5619	30.1565		13.6732
	AIC		>>	>>	3111	2923	2916	2869	2869	3483	2966	2977	3104	3446	2919
2011	sec	58.84	18.08	0.89	0.8	1.41	0.53	1	1.36	0.4	0.98	0.07	0.06	er	0.08
	KS			0.7784	0.2254	0.0936	0.0922	0.0520	0.0483	0.2952	0.1026	0.1026	0.1796	0.2985	0.1374
	CVM			94.8822	6.6623	0.6910	0.8427	0.1347	0.1106	11.1984	0.8389	0.8386	4.7271	10.7375	2.4279
	AD				36.4743	4.5096	5.3832	0.9653	0.7940	61.6710	5.5153	5.5145	27.6443		13.7890
	AIC			6012	2938	2646	2665	2604	2597	3177	2663	2661	2788	2999	2796
2012	sec	er	52.25	0.68	0.56	5.79	1.22	1.16	1.48	0.52	0.88	0.06	0.06	0.11	0.08
	KS		0.8508	0.2690		0.1234	0.1053	0.0393	0.0390	0.3558	0.1317	0.1313	0.1894	0.5210	0.1654
	CVM		100.1575	10.7359		1.4898	0.9502	0.1019	0.0999	15.3785	1.7309	1.7232	5.6522	40.3765	2.9302
	AD					8.6239	5.6756	1.2009	1.1968	79.8263	10.2231	10.2004	32.5393		15.2236
	AIC		>>	>>		2939	2933	2870	2871	3667	2988	2986	3106	3848	2917
2013	sec	er	er	0.53	0.29	er	1.25	1	0.95	0.91	0.73	0.08	0.06	0.09	0.08
	KS	0.1937	0.2226	0.1765		0.0599	0.0548	0.0710	0.0854	0.2622	0.0777	0.0776	0.1872	0.2184	0.1185
	CVM	5.6999	9.5769	2.8433		0.2702	0.2374	0.3906	0.5433	6.6811	0.5296	0.5272	3.5252	5.7395	1.0656
	AD			14.4337		1.9906	1.8049	2.2718	2.9301	41.0454	4.4106	4.4017	22.6280	29.3912	6.6990
	AIC	3633	3676	3044		2987	2986	2994	2999	3419	3039	3037	3173	3262	3007
2014	sec	10	42.53	1.37	0.59	1.16	1.32	0.65	0.8	0.81	0.84	0.08	0.06	0.08	0.08
	KS	0.1129	0.1498	0.1103		0.0413	0.0393	0.0458	0.0519	0.2238	0.0768	0.0767	0.1689	0.1685	0.0723
	CVM	1.7153	3.0067	1.2967		0.1219	0.0877	0.0799	0.1034	5.4600	0.5091	0.5078	3.0654	3.5003	0.5636
	AD			8.1955		0.7128	0.6684	0.6319	0.7755	34.8235	2.7845	2.7805	20.0118	17.4372	3.9729
	AIC	2975	2990	2784		2703	2707	2706	2708	3055	2726	2724	2859	2889	2726
2015	sec	er	0.71	0.55	0.27	23.32	1.36	1.03	1.33	0.75	0.89	0.08	0.07	0.11	0.08
	KS	0.1669	0.1869	0.3981		0.0240	0.0380	0.0338	0.0370	0.2483	0.0350	0.0350	0.1407	0.2062	0.0785
	CVM	3.8152	7.0440	18.4412		0.0380	0.0851	0.0857	0.1071	6.8062	0.0735	0.0738	2.7670	5.5806	0.4028
	AD	46.7444	63.8729	86.0282		0.3595	0.6432	0.7999	0.9131	41.8426	0.6098	0.6114	19.1374		3.5136
	AIC	4785	4823	3211		2751	2754	2757	2761	3196	2765	2763	2900	3054	2779
2016	sec	er	65.6	13.58	0.63	0.76	0.98	0.89	1.12	0.65	0.76	0.08	0.07	0.13	0.08
	KS		0.4747	0.4167		0.1454	0.1326	0.0617	0.0624	0.3062	0.1603	0.1602	0.2266	0.3245	0.1691
	CVM		37.5445	29.0261		2.2380	1.6339	0.2985	0.3035	10.6285	2.8532	2.8523	5.6735	13.2296	3.5421
	AD			169.5342		11.4693	9.0596	2.3374	2.3411	58.9355	15.5320	15.5297	31.8629		17.5247
	AIC		6810	3344		2927	2919	2851	2850	3402	2996	2994	3124	3330	2931

Table 8: Goodness-of-fit statistics and Computational Time for hours 16-17-18. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. “>” and “>>” mean respectively ‘greater’ and ‘grater than thousands’. “er” means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
HP 19															
2010	sec	er	4.12	3.29	1.38	> 190	1.22	1.89	1.86	2.06	1.69	0.08	0.11	0.1	0.9
	KS	0.3882	0.4243	0.4364	0.2200	0.0935	0.0913	0.0833	0.0843	0.2798	0.1131	0.1131	0.1890	0.3024	0.1076
	CVM	24.2719	30.8214	32.9072	6.8064	0.8348	0.7045	0.4372	0.4441	8.8725	1.3449	1.3449	3.8118	12.1343	1.5636
	AD					4.1951	3.6783	3.2392	3.3112	51.3539	7.2872	7.2873	23.8887		8.5508
	AIC	7947	8044	4825	2975	2838	2835	2820	2820	3336	2890	2888	3023	3288	2849
2011	sec	33.75	2.77	0.69	0.45	16.69	0.82	1.11	1.4	0.66	1.51	0.08	0.08	0.17	0.12
	KS			0.2055	0.2599	0.1005	0.0881	0.0472	0.0461	0.3094	0.1104	0.1103	0.1911	0.3206	0.1418
	CVM			4.4876	6.9619	0.9103	0.6690	0.1364	0.1315	11.7099	1.1730	1.1712	5.2932	13.5056	1.8172
	AD			25.7360	36.4192	6.4129	5.0856	1.3596	1.3219	63.9166	8.4989	8.4947	30.6685	64.0059	11.1300
	AIC			3106	2989	2747	2747	2692	2689	3291	2782	2780	2904	3146	2798
2012	sec	31.08	er	2.29	4.32	0.37	3.29	0.77	0.8	0.59	0.78	0.08	0.07	er	0.07
	KS			0.8998	0.4726	0.1556	0.1361	0.0445	0.1229	0.4054	0.1582	0.1583	0.2362	0.7415	0.2220
	CVM			92.4132	27.8655	3.1640	2.3213	0.1395	2.2142	20.0709	3.3302	3.3313	7.9301	77.4136	5.6302
	AD					19.0161	14.5728	2.0296	15.0650	99.3397	20.1120	20.1450	43.6178		28.5466
	AIC			>>	3532	3126	3119	2975	3104	4045	3174	3172	3277	4696	3060
2013	sec	6.79	1.27	0.56	0.36	er	1.52	0.82	1.03	0.97	0.86	0.06	0.06	0.08	0.06
	KS	0.1276	0.1580	0.1270	0.1556	0.0422	0.0456	0.0527	0.0689	0.2389	0.0654	0.0653	0.1805	0.1798	0.0993
	CVM	2.8026	4.5604	1.3930	2.4212	0.1277	0.1254	0.2345	0.3897	5.4239	0.5087	0.5066	3.2350	4.2900	0.8501
	AD			7.1119	11.8717	1.0095	1.0586	1.5678	2.2566	34.8530	3.9093	3.9017	21.0950	22.2125	5.4088
	AIC	3240	3262	3034	3055	3006	3006	3024	3029	3386	3057	3055	3193	3234	3030
2014	sec	1.92	1.1	0.69	0.58	> 100	1.13	er	0.86	0.86	0.77	0.06	0.08	0.09	0.06
	KS	0.1198	0.1339	0.0677	0.1031	0.0403	0.0389	0.0547	0.0614	0.1990	0.0933	0.0931	0.1747	0.1661	0.0795
	CVM	1.5650	2.0688	0.4708	0.9853	0.1389	0.1180	0.1408	0.1758	4.0186	0.8240	0.8213	2.9260	2.9526	0.7187
	AD	8.8296	10.9298	2.7455	4.6030	0.9065	0.7461	1.1235	1.3155	27.4226	4.5463	4.5379	19.3902	15.5070	4.3699
	AIC	2767	2775	2731	2729	2716	2716	2734	2737	3016	2752	2750	2888	2871	2736
2015	sec	er	er	0.81	0.86	er	1.52	1.01	1.38	1.2	0.59	0.06	0.06	0.08	0.06
	KS	0.0781	0.0986	0.0809	0.0907	0.0246	0.0421	0.0375	0.0319	0.2060	0.0543	0.0542	0.1394	0.1417	0.0857
	CVM	0.7294	1.2712	0.7042	0.7352	0.0448	0.1037	0.0667	0.0770	4.6561	0.1996	0.1985	2.8368	2.4048	0.4373
	AD			4.0903	4.1841	0.3118	0.6785	0.7851	0.8233	30.9198	1.2457	1.2419	19.0026	12.9506	3.2598
	AIC	2890	2898	2789	2789	2753	2756	2770	2775	3083	2771	2769	2908	2907	2773
2016	sec	8.7	0.74	2.03	1.23	2.4	0.83	0.98	1.1	0.74	0.78	0.07	0.06	0.14	0.08
	KS	0.2441	0.3021	0.1895	0.2103	0.0959	0.0791	0.0420	0.0422	0.2570	0.1248	0.1247	0.1986	0.2589	0.1315
	CVM	9.5332	14.4336	4.1696	5.3512	0.8863	0.6142	0.1297	0.1268	7.8884	1.6238	1.6219	4.3749	7.8199	1.9202
	AD			19.4422	24.5948	4.3899	3.3401	1.0286	1.0078	46.4725	8.8245	8.8187	25.9236	37.1815	9.8985
	AIC	3543	3595	2837	2851	2758	2755	2734	2734	3176	2817	2815	2950	3056	2776
HP 20															
2010	sec	69.87	1.73	0.96	0.49	93.09	1.11	0.86	0.88	0.98	0.81	0.06	0.08	0.08	0.07
	KS	0.1828	0.2138	0.1145	0.1461	0.0817	**0.0772**	0.0856	0.0872	0.2434	0.1199	0.1198	0.1971	0.1977	0.1063
	CVM	4.0056	5.7762	1.6478	2.8323	0.4595	**0.4478**	0.4828	0.5052	5.8084	1.2232	1.2215	3.4325	4.8902	1.2436
	AD	23.3879		8.4136	13.5645	**2.4696**	2.5189	3.1024	3.2309	36.8075	6.9085	6.9029	22.1631	24.3473	7.2449
	AIC	2895	2917	2731	2739	2686	2686	**2683**	**2683**	3067	2742	2740	2879	2927	2710
2011	sec	er	3.77	0.47	0.42	2.14	1.01	1.08	1.23	1.31	0.75	0.07	0.06	er	0.06
	KS	0.1676	0.1931	0.3967	0.1363	0.0404	0.0785	0.0389	0.0385	0.2595	**0.0357**	0.0358	0.1432	0.1945	0.0812
	CVM	3.9768	7.6441	17.2557	3.0070	0.0641	0.7484	0.0859	0.1128	7.9465	**0.0523**	**0.0523**	2.8786	6.1166	0.9816
	AD			83.9392	19.3687	0.5892		0.8609	0.9265	47.2847	**0.5625**	0.5626	19.8404		6.4185
	AIC	>>	>>	3239	2850	2652	2739	2652	**2650**	3145	2659	2657	2793	2984	2740
2012	sec	er	7.25	0.75	0.35	1.08	1	0.72	1.31	0.56	0.91	0.07	0.07	er	0.06
	KS			0.9631	0.3844	0.0883	0.0696	**0.0425**	0.1008	0.3625	0.0677	0.0929	0.2162	0.6144	0.1426
	CVM			114.9456	19.0074	1.1178	0.7090	**0.0964**	0.7514	16.4758	0.3841	1.2849	5.3030	57.8714	2.3829
	AD					7.2443	4.7617	**1.0483**	5.7795	84.5122		8.3364	31.3748		13.5765
	AIC			>>	3297	2949	2945	**2887**	2942	3776	2974	2990	3109	4176	2930
2013	sec	er	er	0.72	0.38	> 220	1.31	1.51	1.39	1.47	1.46	0.09	0.14	0.12	0.13
	KS	0.1729	0.2133	0.1378	0.1668	0.0375	0.0281	0.0405	0.0484	0.2523	0.0530	0.0531	0.1661	0.2009	0.1008
	CVM	5.2932	9.1589	1.6840	2.8958	0.0465	**0.0403**	0.1061	0.1617	6.7756	0.2765	0.2769	3.1420	5.4750	0.6471
	AD			9.3134	14.9140	0.4440	**0.3748**	0.7802	1.0797	41.6062	2.1124	2.1141	20.8635		4.5288
	AIC	3957	4000	2988	3003	**2911**	**2911**	2918	2923	3352	2950	2948	3084	3195	2931
2014	sec	er	er	2.84	1.06	er	1.8	1.22	1.33	0.96	1.22	0.09	0.12	0.13	0.11
	KS	0.1149	0.1424	0.1058	0.0986	0.0453	0.0408	**0.0337**	0.0410	0.2110	0.0835	0.0834	0.1600	0.1712	0.0717
	CVM	1.4037	2.3466	1.1505	1.0860	0.0925	0.0807	0.0595	**0.0728**	4.9523	0.5062	0.5046	3.0883	3.0954	0.6041
	AD			6.9443	6.0291	0.4874	0.5280	**0.4689**	0.5465	32.1657	2.8543	2.8494	19.9418	16.2640	3.9483
	AIC	2801	2814	2716	2703	**2651**	2655	2658	2660	2977	2676	2674	2810	2814	2672
2015	sec	er	1.25	1.37	0.9	14.56	1.48	2.13	1.33	2.14	0.77	0.06	0.19	0.09	0.07
	KS	0.1171	0.1693	0.2106	0.1144	0.0407	0.0384	**0.0301**	0.0368	0.2282	0.0681	0.0682	0.1535	0.2017	0.0689
	CVM	2.0319	4.0674	7.0514	1.7217	0.0767	0.0885	**0.0445**	0.0530	6.4055	0.2875	0.2883	3.0446	4.8772	0.4994
	AD			40.4729	9.8743	0.4408	0.6503	**0.4023**	0.4432	39.6918	1.5293	1.5320	19.9540		3.7765
	AIC	3581	3603	3015	2803	**2705**	2710	2708	2710	3105	2722	2720	2857	2958	2733
2016	sec	> 240	54.74	0.85	0.53	1.23	1.47	1.06	2.53	1.15	0.84	0.06	0.08	0.08	0.08
	KS	0.2052	0.2681	0.2195	0.1738	0.0850	0.0748	0.0389	**0.0370**	0.2498	0.1151	0.1152	0.1935	0.2479	0.1127
	CVM	6.1670	10.5452	6.7896	3.4113	0.5704	0.4381	0.0999	**0.0915**	7.7567	1.1637	1.1643	4.1186	6.7753	1.3008
	AD			37.9025	17.5083	3.0575	2.5033	0.7167	**0.6637**	45.8690	6.3091	6.3109	24.6440	31.8067	7.4461
	AIC	3791	3834	2948	2798	2679	2680	2657	**2655**	3086	2715	2713	2848	2944	2703
HP 21															
2010	sec	1.69	1.48	2.56	0.94	32.41	1.13	1.27	1.4	0.98	0.68	0.07	0.08	0.08	0.08
	KS	0.1409	0.1761	0.1017	0.1288	0.0513	0.0453	**0.0307**	0.0348	0.2219	0.0974	0.0973	0.1713	0.1898	0.0899
	CVM	2.5694	4.1130	1.3465	1.9030	0.1514	0.1136	**0.0393**	0.0533	5.4381	0.8428	0.8415	3.5015	4.2739	0.9634
	AD	17.1928		7.3927	9.2662	0.8880	0.7301	**0.3507**	0.4404	34.6626	5.0373	5.0332	21.8934	21.9939	5.5022
	AIC	2594	2613	2486	2480	2427	**2428**	**2428**	2429	2769	2468	2466	2604	2624	2449
2011	sec	er	1.42	0.97	0.66	er	0.84	1.11	1.18	1.08	0.67	0.06	0.07	0.07	0.08
	KS	0.1112	0.1397	0.0935	0.1129	0.0422	**0.0411**	0.0473	0.0564	0.2259	0.0504	0.0504	0.1511	0.0852	0.1717
	CVM	1.7758	3.2149	0.8078	1.2793	**0.0777**	0.0821	0.1423	0.2005	5.6998	0.1918	0.1921	2.7865	0.4084	3.4385
	AD			5.3866	7.6692	**0.5070**	0.5599	1.0581	1.3470	36.4469	1.2728	1.2746	19.2552	3.4309	17.7223
	AIC	3013	3032	2589	2596	**2528**	2529	2541	2546	2926	2550	2548	2686	2549	2748
2012	sec	2.15	4.42	1.11	0.5	0.69	0.62	1.16	1.46	0.64	0.98	0.06	0.06	er	0.11
	KS			0.4787	0.3638	0.0724	0.1052	**0.0445**	0.0562	0.3515	0.0726	0.0727	0.1789	0.6617	0.1190
	CVM			43.0682	14.4854	0.4566	1.2568	**0.1313**	0.1762	15.9521	0.4859	0.4861	4.4962	65.0816	1.4320
	AD					3.5846		**1.2549**	1.5277	82.3475	3.7475	3.7569	27.4480		9.9287
	AIC			>>	3098	2725	2804	**2691**	2697	3566	2747	2745	2867	4081	2772
2013	sec	er	34.32	0.81	0.64	er	0.89	0.88	1.06	0.98	0.77	0.07	0.07	0.06	0.06
	KS	0.0493	0.0496	0.1405	0.0944	0.0371	0.0719	0.0601	0.0559	0.1749	**0.0304**	**0.0304**	0.1306	0.0886	0.0662
	CVM	0.1517	0.1679	2.2783	0.8516	0.0748	0.4322	0.1975	0.1744	3.5584	**0.0366**	**0.0366**	2.4579	0.9271	0.4083
	AD		2.1537	11.5704	4.3676	0.4986	2.6044	2.0763	1.9048	25.2021	**0.2764**	0.2766	17.2717	5.7172	3.2176
	AIC	2772	2773	2804	2771	2738	2764	2770	2775	3020	2737	**2735**	2876	2819	2770
2014	sec	er	er	0.83	0.45	er	0.68	0.61	0.64	0.9	0.67	0.06	0.08	0.06	0.07
	KS	0.0509	0.0507	0.1921	0.1483	**0.0331**	0.0890	0.0526	0.0465	0.2028	0.0368	0.0368	0.1421	0.0766	0.0983
	CVM	0.1150	0.1325	3.9922	2.3614	**0.0426**	0.8148	0.1822	0.1585	4.5520	0.0476	0.0476	2.7659	0.7135	1.0748
	AD		3.6884	20.7277	12.5361	**0.2857**	5.4448	1.7451	1.5176	30.2135	0.3808	0.3807	18.4401	4.7957	6.7114
	AIC	2553	2553	2534	2498	**2399**	2468	2420	2421	2711	2402	2400	2536	2457	2488
2015	sec	2.11	1.48	0.87	0.58	> 430	1.18	1.14	0.92	0.67	1.01	0.07	0.07	0.07	0.06
	KS	0.0405	0.0449	0.1763	0.1361	**0.0216**	0.0752	0.0480	0.0432	0.1869	0.0315	0.0315	0.1377	0.0752	0.1055
	CVM	0.1578	0.2390	3.4051	1.8646	**0.0224**	0.5019	0.1161	0.0809	4.5669	0.0714	0.0713	2.8874	0.6398	1.3521
	AD	3.8477	4.1623	17.3274	9.8153	**0.1385**	3.1564	1.3187	1.0292	30.2974	0.4200	0.4198	18.9171	4.4488	7.7641
	AIC	2678	2680	2661	2629	**2549**	2585	2567	2568	2855	2552	2550	2689	2598	2642
2016	sec	96.41	43.15	0.84	0.63	1.51	1.15	0.9	1.23	0.61	0.69	0.06	0.08	0.08	0.09
	KS	0.0814	0.1098	0.2363	0.2270	0.0667	0.1033	0.0483	**0.0418**	0.2321	0.0740	0.0744	0.1690	0.1784	0.1319
	CVM	0.6729	1.3078	8.1595	4.9639	0.4513	0.9068	0.1796	**0.1194**	7.6812	0.5828	0.5867	3.9601	3.5836	1.5756
	AD			43.6469	26.1822	2.5368	5.4394	1.1522	**0.7534**	45.4720	3.2604	3.2710	23.6493	17.5572	9.2886
	AIC	4277	4281	2840	2732	2534	2575	2520	**2513**	2925	2544	2542	2677	2692	2633

Table 9: Goodness-of-fit statistics and Computational Time for hours 19-20-21. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. “>” and “>>” mean respectively ‘greater’ and ‘grater than thousands’. “er” means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

		SEP1	SEP2	SHASHo	SHASHo2	JSU	JSUo	ST1	ST2	ST5	SN1	NO	LO	GU	RG
								HP 22							
2010	sec	41.86	19.13	0.86	0.46	> 200	0.64	1.26	1.42	0.63	0.75	0.06	0.08	0.11	0.08
	KS	0.0895	0.1039	0.1228	0.1186	0.0487	0.1217	0.0535	**0.0471**	0.2183	0.0584	0.0585	0.1492	0.1631	0.0899
	CVM	0.6681	1.3726	2.5141	1.5919	0.1991	1.3547	0.2814	**0.1244**	6.0187	0.1865	0.1867	3.2558	2.7250	0.9072
	AD			14.1189	9.0448	**1.1608**	8.8061	1.9714	1.3859	37.5838	1.3050	1.3064	20.6752	14.6565	5.6069
	AIC	2717	2726	2328	2313	**2229**	2329	2237	2243	2589	2239	2237	2374	2398	2265
2011	sec	52.01	15.58	1.08	0.63	11.51	0.67	1.24	1.26	0.56	0.71	0.06	0.06	0.08	0.07
	KS	0.0838	0.1081	0.1267	0.1225	0.0561	0.1036	0.0590	**0.0454**	0.2263	0.0466	0.0464	0.1468	0.0837	0.1692
	CVM	0.8363	1.9940	2.0909	1.8636	0.1655	1.1233	0.2616	**0.0933**	6.7247	0.1497	0.1497	3.1424	0.9517	3.2942
	AD			12.5190	11.2326	0.9689	7.6385	1.9257	**0.8151**	41.2219	0.9483	0.9500	20.4056	6.3103	16.8321
	AIC	3729	3744	2573	2571	**2462**	2558	2470	2465	2866	2470	2468	2604	2511	2676
2012	sec	er	er	1.03	0.67	er	0.49	1.11	1.36	1.06	0.98	0.07	0.08	0.08	0.08
	KS	0.0803	0.1309	0.2288	0.2101	0.0483	0.0907	0.0431	**0.0389**	0.2624	0.0528	0.0527	0.1568	0.1992	0.1530
	CVM	0.6605	2.2344	6.0640	5.1345	0.2387	1.0141	0.1377	**0.1018**	9.0976	0.2736	0.2735	3.7929	4.5710	2.7857
	AD			32.5091	27.9379	1.6748	6.3693	0.9741	**0.7495**	52.3133	1.9642	1.9635	23.3896		15.5156
	AIC	>>	>>	2819	2808	2588	2648	2571	**2565**	3064	2597	2595	2727	2840	2739
2013	sec	er	er	0.53	0.34	> 200	0.53	0.8	0.97	1.56	0.65	0.06	0.08	0.08	0.06
	KS	0.0464	0.0464	0.2051	0.1801	0.0323	0.0752	0.0599	0.0600	0.1916	**0.0321**	**0.0321**	0.1332	0.0830	0.0835
	CVM	0.1322	0.1322	5.4370	3.4538	0.0378	0.6418	0.3171	0.3171	4.3632	**0.0314**	**0.0314**	2.6660	0.7894	0.7740
	AD			27.8823	17.6619	0.2660	4.2548	3.3569	3.3569	29.4440	**0.2359**	**0.2359**	18.2219	5.1283	5.0260
	AIC	2758	2758	2812	2764	2639	2699	2679	2679	2951	2640	**2638**	2778	2712	2708
2014	sec	8.08	1.75	0.98	0.53	er	0.45	0.7	0.9	0.8	0.6	0.07	0.07	0.08	0.07
	KS	0.0824	0.1144	0.1090	0.0978	**0.0269**	0.0391	0.0353	0.0341	0.2107	0.0518	0.0513	0.1450	0.0833	0.1547
	CVM	0.9348	1.9032	1.2057	1.1242	**0.0302**	0.1070	0.0483	0.0551	5.3619	0.1774	0.1866	2.9997	0.5045	2.8042
	AD	10.9022		7.4035	6.8405	**0.2524**	0.8000	0.5166	0.5060	34.3166	1.1735	1.2352	19.5918	3.7535	14.9063
	AIC	2585	2597	2356	2352	**2288**	2294	2295	2297	2636	2305	2303	2437	2312	2456
2015	sec	er	61.39	0.89	0.5	er	0.66	1.27	1.2	0.48	0.93	0.07	0.06	0.11	0.06
	KS	0.0642	0.0902	0.1597	0.1243	**0.0322**	0.0584	0.0393	0.0353	0.2079	0.0503	0.0504	0.1490	0.0745	0.1433
	CVM	0.4459	0.9634	2.8241	1.7470	0.0632	0.3581	0.0784	**0.0572**	5.4298	0.1824	0.1829	3.2113	0.6587	2.3084
	AD	7.7992	10.0479	15.4738	10.1008	**0.4350**	2.2794	0.7558	0.5734	34.6471	1.2217	1.2238	20.3835	4.5647	12.6472
	AIC	2780	2786	2624	2600	**2505**	2529	2510	2510	2839	2515	2513	2651	2548	2638
2016	sec	9.61	21.6	1.32	0.5	> 200	0.74	0.91	1.51	0.65	0.72	0.08	0.06	0.08	0.14
	KS	0.1349	0.2049	0.3879	0.1421	0.0415	0.0517	0.0379	**0.0345**	0.2431	0.0538	0.0564	0.1618	0.0937	0.2067
	CVM	3.7492	7.7812	16.7983	2.7201	0.1608	0.2316	0.0490	**0.0306**	7.8577	0.2600	0.2953	3.6182	0.8334	5.3872
	AD			78.1542	15.8524	1.2447	1.8497	0.5471	**0.3541**	46.5602	1.7655	1.9790	22.5540	6.0479	26.3184
	AIC	5080	5120	2820	2562	2428	2436	2417	**2415**	2863	2444	2442	2576	2468	2685
								HP 23							
2010	sec	10.13	6.24	0.49	0.26	er	0.6	1.28	1.01	0.41	0.62	0.07	0.06	0.08	0.06
	KS	0.0717	0.0829	0.1717	0.1378	0.0735	0.1298	0.0942	**0.0452**	0.2170	0.0787	0.0787	0.1841	0.1535	0.1170
	CVM	0.4030	0.6529	3.4625	2.4252	0.2716	1.3021	0.3954	**0.1348**	6.2837	0.2961	0.2961	3.5252	2.2925	1.3512
	AD			17.5490	12.9825	1.7332	8.3031	2.8787	**1.2903**	38.7752	1.9746	1.9753	21.6879	12.8638	7.9489
	AIC	2752	2755	2320	2306	**2202**	2284	2211	2203	2555	2210	2208	2344	2344	2259
2011	sec	6.52	1.22	0.76	0.53	> 100	0.42	0.96	1.39	0.5	0.97	0.06	0.07	0.07	0.08
	KS	0.3436	0.3982	0.0873	0.2151	0.0506	0.1003	0.0426	**0.0375**	0.2733	0.0436	0.0502	0.1550	0.0968	0.2836
	CVM	23.6223	32.3389	0.3284	4.8234	0.2646	1.3031	0.1415	**0.1061**	10.0699	0.1912	0.2676	3.7548	1.1192	11.6500
	AD				25.8272	1.7193	8.4103	1.0400	**0.8098**	56.7560	1.3135	1.7742	23.3260	7.2841	54.3948
	AIC	>>	>>	8167	2554	2363	2458	2348	**2347**	2897	2379	2378	2508	2405	2795
2012	sec	er	er	0.84	0.39	> 100	0.58	1.27	1.33	0.73	0.84	0.06	0.08	0.06	0.06
	KS	0.1047	0.1543	0.3743	0.2608	0.0463	0.0709	**0.0345**	0.0359	0.2453	0.0557	0.0557	0.1632	0.0937	0.1775
	CVM	1.6273	4.0354	16.5040	8.6630	0.2139	0.4273	0.0549	**0.0446**	7.7297	0.3755	0.3754	3.6958	0.9510	4.3198
	AD			78.7269	41.3853	1.4296	2.8547	0.4128	**0.3200**	45.9347	2.4818	2.4829	22.9550		22.1810
	AIC	4779	4800	2997	2756	2534	2560	2518	**2516**	2957	2551	2549	2683	2607	2743
2013	sec	24.54	er	0.64	0.48	er	0.42	1.45	1.46	0.7	0.98	0.06	0.06	0.08	0.06
	KS	0.0748	0.0744	0.1544	0.1228	0.0435	0.0956	0.0654	0.0621	0.2052	**0.0430**	**0.0430**	0.1499	0.0917	0.1242
	CVM	0.2653	0.3626	2.2901	1.5358	**0.1422**	1.1430	0.3012	0.2404	5.2990	0.1480	0.1481	3.1487	0.9911	1.7299
	AD	8.3111	8.6993	11.5351	8.3462	**1.0371**	7.7056	2.5539	2.1312	33.9628	1.1658	1.1663	20.0905	6.2098	10.3404
	AIC	2788	2790	2610	2602	**2536**	2623	2553	2553	2863	2542	2540	2678	2578	2661
2014	sec	14.76	0.84	0.58	0.52	er	0.98	1.3	1.66	0.57	0.55	0.06	0.07	0.07	0.06
	KS	0.1428	0.2118	0.1651	0.1753	0.0573	0.0516	0.0386	**0.0354**	0.2408	0.0699	0.0756	0.1569	0.1105	0.2122
	CVM	3.8279	7.7029	2.6683	2.8894	0.2422	0.2343	0.0951	**0.0830**	7.2268	0.4040	0.4863	3.7961	1.0074	5.4583
	AD			14.4674	14.9949	1.5365	1.4652	0.5910	**0.5170**	43.1742	2.9494	3.3516	23.0000	6.0309	27.1655
	AIC	3312	3349	2359	2360	2256	2257	**2246**	2247	2652	2284	2282	2413	2280	2492
2015	sec	80.34	> 160	0.46	0.32	87.59	0.43	0.92	1.25	0.69	0.61	0.07	0.06	0.08	0.08
	KS	0.0558	0.0705	0.2381	0.2159	**0.0428**	0.0842	0.0470	0.0413	0.2086	0.0535	0.0535	0.1489	0.0954	0.1317
	CVM	0.3201	0.5682	6.3442	5.0422	0.1408	0.7178	0.1597	**0.1135**	5.7256	0.2330	0.2329	3.4006	1.0204	2.0465
	AD			29.9111	23.9733	**0.8959**	4.2146	1.2471	0.9324	35.9844	1.5330	1.5330	21.0481	6.1835	11.6694
	AIC	2857	2860	2681	2654	**2520**	2563	2524	2522	2851	2527	2525	2662	2588	2630
2016	sec	1.48	27.47	1.62	1.36	er	1.03	0.78	0.83	0.87	0.7	0.07	0.08	0.06	0.11
	KS	0.0874	0.1291	0.1851	0.1487	0.0502	0.0787	0.0353	**0.0314**	0.2210	0.0643	0.0643	0.1540	0.0912	0.1720
	CVM	0.8192	2.0286	3.3427	2.3763	0.1948	0.4491	0.0976	**0.0638**	6.5602	0.3464	0.3466	3.5920	0.9031	3.3125
	AD			18.1965	13.5403	1.2064	2.8294	0.7626	**0.5016**	40.1838	2.1165	2.1186	22.0654	5.9282	17.0635
	AIC	3036	3047	2511	2494	2373	2395	2368	**2366**	2740	2386	2384	2520	2422	2541
								HP 24							
2010	sec	er	er	0.58	0.37	6.84	0.65	0.76	1.05	0.47	0.61	0.07	0.06	0.08	0.08
	KS	0.0816	0.1214	0.3506	0.1192	0.0401	0.0492	0.0326	**0.0355**	0.2299	0.0572	0.0584	0.1522	0.0791	0.1613
	CVM	0.9426	2.0527	13.4918	2.1117	0.1043	0.3094	0.0689	**0.0632**	6.0052	0.2649	0.2794	3.3897	0.6854	3.0646
	AD	12.0347	16.9520	67.3002	12.6406	0.7324	1.9705	0.5351	**0.4746**	37.5152	1.8729	1.9476	21.2942	4.6563	16.1921
	AIC	2722	2733	2755	2406	2285	2307	**2282**	**2282**	2641	2300	2298	2434	2330	2443
2011	sec	1.81	0.74	0.58	0.42	1.59	0.41	1.15	1.36	0.31	1.91	0.06	0.07	0.07	er
	KS			0.6000	0.5144	0.1267	0.1140	**0.0329**	**0.0329**	0.4416	0.0463	0.1287	0.2148	0.1960	0.9386
	CVM			34.2613	31.9053	2.0650	1.6017	**0.0720**	**0.0720**	23.5498	0.1587	2.1352	6.7844	4.0802	115.3783
	AD				> 140	12.7037	9.9654	**1.0755**	1.0756	> 110	1.8496	13.1106	38.6692	21.5923	> 1000
	AIC			>>	3095	2492	2489	**2375**	**2375**	3824	2465	2521	2621	2418	5982
2012	sec	4.21	3.31	0.62	0.34	0.31	0.42	1.05	1.2	0.5	1.66	0.07	0.06	0.08	er
	KS	0.1047	0.1543	0.5683	0.5438	0.1532	0.1414	0.0648	0.0647	0.4538	**0.0557**	0.1543	0.2213	0.2206	0.9609
	CVM	1.6273	4.0354	31.2098	34.6396	2.6187	2.1826	0.3407	**0.3394**	25.0863	0.3755	2.6691	7.4654	4.6596	119.4286
	AD				> 150	15.3051	12.8879	2.7907	2.7831	> 110	**2.4818**	15.6120	41.4685	24.0160	> 1000
	AIC	4779	4800	>>	3392	2721	2718	2598	2598	4201	**2551**	2746	2841	2640	7005
2013	sec	2.1	20	26.84	0.67	er	0.54	0.84	1.5	0.45	0.78	0.06	0.08	0.08	0.1
	KS			0.4256	0.3832	0.1315	0.1095	**0.0628**	**0.0628**	0.3280	0.0793	0.1366	0.2073	0.1817	0.5447
	CVM			29.8012	15.0821	1.4684	0.9625	0.2225	**0.2116**	14.4236	0.5380	1.7172	5.7144	2.6289	38.6227
	AD				67.9933	8.5907	6.1971	2.1465	**2.0522**	75.6948	5.0145	10.3300	32.1215	14.0352	> 180
	AIC			>>	2759	2477	2472	2426	**2424**	3149	2509	2518	2640	2475	3350
2014	sec	1.73	0.67	1.65	0.75	158	0.59	1.12	1.05	0.5	0.72	0.06	0.08	0.06	0.11
	KS		0.8591	0.7940	0.3978	0.1647	0.1496	0.0671	**0.0665**	0.3575	0.0929	0.1739	0.2218	0.2052	0.5431
	CVM		92.1810	67.3253	18.6495	2.8569	2.1167	0.3363	**0.3328**	14.8634	0.6745	3.2235	6.6253	4.4870	38.2423
	AD				83.8510	15.2501	12.1076	3.4182	**3.4089**	77.1606	8.0384	17.7569	36.0628	21.5139	> 180
	AIC		>>	>>	2584	2320	2311	**2222**	**2222**	2954	2328	2373	2491	2291	3177
2015	sec	er	0.85	0.77	0.36	> 220	0.51	1.04	1.31	0.47	0.91	0.07	0.07	0.07	0.09
	KS		0.3426	0.1789	0.2319	0.1230	0.1125	0.0819	**0.0814**	0.2637	0.1328	0.1429	0.1870	0.1499	0.3066
	CVM		16.6971	4.1001	5.2461	1.1832	1.0228	0.4370	**0.4110**	9.6830	1.3520	1.6369	5.1660	2.0433	9.6574
	AD			22.1497	25.8730	6.2410	5.5457	2.3896	**2.2075**	54.4701	7.7019	8.8623	28.7947	10.9466	43.8871
	AIC		7094	2705	2660	2502	2504	2468	**2463**	2933	2533	2532	2662	2533	2807
2016	sec	10.47	6.24	0.78	0.37	56.66	0.67	1.67	1.17	0.49	0.76	0.08	0.08	0.06	0.11
	KS			0.1835	0.3132	0.0931	0.0747	0.0494	**0.0478**	0.3181	0.0672	0.1010	0.1798	0.1438	0.3978
	CVM			6.5368	10.3777	0.7180	0.4292	0.1795	**0.1651**	12.5854	0.3322	0.8835	4.7339	1.7077	21.5034
	AD				48.3511	4.2435	2.7061	1.1752	**1.1121**	67.8392	2.7361	5.4993	27.9198	9.6787	98.6040
	AIC			>>	2660	2428	2425	**2396**	**2396**	3050	2464	2466	2591	2439	3024

Table 10: Goodness-of-fit statistics and Computational Time for hours 22-23-24. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. ">" and ">>" mean respectively 'greater' and 'grater than thousands'. "er" means that an error occurred in the process of fitting the density, then it has been reported in the computational times (in elapsed seconds) of estimated models. The general model formulation (without indication of coefficients and adapted accordingly to the number of moments in used distribution) is: $\mu_t = E(y_t) = y_{t-1} + hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$, $log(\sigma_t) = \nu_t = log(\tau_t) = hol_t + fwind_t + fsolar_t + load_{t-1} + coal_{t-1} + gas_{t-1} + co_{2t-1}$. SN1 used the first three equations, whereas NO, LO, GU and RG used only the first two.

	KS					CVM					AD				
hours	JSU	JSUo	ST1	ST2	ST5	JSU	JSUo	ST1	ST2	ST5	JSU	JSUo	ST1	ST2	ST5
1	0.0603	0.0822	0.0294	**0.0291**	0.4210	1.9100	4.3528	0.5453	**0.5277**	148.5070	12.8945	29.8425	3.9139	**3.8630**	727.8232
2	0.0794	0.0688	0.0260	**0.0259**	0.4584	4.2045	2.9519	0.3020	**0.2985**	176.7370	27.9584	19.9817	3.1511	**3.1483**	841.7994
3	0.0885	0.0620	**0.0255**	**0.0255**	0.4610	5.7829	2.1785	0.2036	**0.2023**	179.0372	38.1926	14.4810	**2.8697**	2.8709	851.0370
4	0.0808	0.0735	0.0184	**0.0182**	0.4619	5.5244	4.2863	0.1258	**0.1224**	180.2509	37.4213	28.9289	1.7491	**1.7386**	855.9105
5	0.0733	0.0639	0.0194	**0.0190**	0.4567	3.8933	2.6782	0.1071	**0.1021**	176.3345	26.8176	18.2258	1.2072	**1.1912**	840.1847
6	0.0645	0.0769	0.0170	**0.0167**	0.4600	2.7978	4.5500	0.1375	**0.1369**	178.3401	21.0471	33.4914	**1.3620**	1.3644	848.2432
7	0.0636	0.0775	0.0205	**0.0203**	0.4549	3.0892	5.1891	0.1415	**0.1403**	175.8737	24.0319	38.7167	1.5832	**1.5664**	838.3356
8	0.0328	0.0464	0.0264	**0.0227**	0.3877	0.5175	2.1116	0.1587	**0.1478**	128.0669	inf	18.8580	inf	**2.0238**	644.3292
9	**0.0261**	0.0832	0.0293	0.0407	0.2952	**0.2976**	6.5921	0.6850	0.7924	72.8623	**3.0777**	inf	5.1236	10.6042	409.4537
10	**0.0343**	0.0648	0.0520	0.0558	0.2121	**0.9334**	2.7193	1.6108	1.1460	33.5401	**6.2472**	inf	14.9900	12.0242	223.8301
11	**0.0467**	0.0621	0.0695	0.0641	0.1910	1.7901	2.7249	**1.7070**	1.8615	25.7141	**11.3990**	inf	17.6122	17.9298	183.3643
12	**0.0566**	0.0632	0.0742	0.0688	0.1897	2.4602	2.9940	**2.2254**	2.4308	24.1867	**15.5861**	inf	21.1385	21.8025	175.5929
13	**0.0513**	0.0642	0.0647	0.0650	0.2146	2.4087	2.8771	2.5482	**1.9983**	32.0021	**15.4343**	19.2628	20.9921	24.5901	217.4465
14	**0.0466**	0.1034	0.0537	0.0557	0.2738	**1.4318**	7.5778	2.1409	2.2748	58.8315	10.4153	65.1354	15.3257	16.2581	346.9655
15	**0.0426**	0.0726	0.0529	0.0540	0.3414	**0.8479**	3.6727	1.7213	1.8447	96.3967	**8.0750**	35.2673	11.0307	11.7799	512.1744
16	**0.0336**	0.0756	0.0454	0.0480	0.3075	**0.7256**	5.0136	1.3505	1.5281	78.6884	**5.9686**	43.0665	8.8552	9.8153	435.6142
17	**0.0327**	0.0593	0.0478	0.0526	0.2545	**0.6182**	2.0496	1.4480	1.3419	51.1149	**4.4347**	inf	10.3259	15.5496	309.8492
18	0.0307	**0.0245**	0.0334	0.0388	0.2623	0.4800	**0.4532**	0.8896	1.1539	53.7730	3.7851	3.1608	5.3925	6.7847	321.4886
19	0.0352	**0.0313**	0.0376	0.0386	0.3264	0.8963	**0.5020**	0.9327	1.1456	85.7751	8.0516	4.4464	5.8537	7.1876	466.0824
20	**0.0170**	0.0217	0.0355	0.0425	0.2643	**0.1570**	0.1950	0.6848	1.0053	55.6637	1.5136	**1.5098**	4.7497	6.7215	331.0547
21	**0.0239**	0.0337	0.0362	0.0338	0.2122	**0.1983**	0.6995	0.3370	0.4910	37.0782	**1.6723**	5.7331	4.9873	5.6475	240.7256
22	**0.0209**	0.0560	0.0509	0.0466	0.1806	**0.2626**	3.2594	0.8717	0.7708	27.8992	**1.4116**	22.7194	10.9785	9.6025	192.3555
23	**0.0472**	0.0612	0.0667	0.0606	0.1679	**1.4743**	4.0055	1.6974	1.6342	22.7213	**7.6127**	29.9739	18.1659	16.5928	165.2484
24	0.0489	0.1069	0.0384	**0.0376**	0.3323	1.3256	7.6553	1.2046	**1.1320**	92.5652	8.2081	53.8549	6.7853	**6.5296**	495.1395

Table 11: Comparing JSU, JSUo, ST1, ST2 and ST5 over the full sample of deseasonalized electricity prices 2010-2016. KS = Kolmogorov-Smirnov, CVM = Cramer-von Mises, and AD = Anderson-Darling statistics; AIC = Bayesian Information Criterion. “Inf” means ‘infinite number’.

6.4. Progressive Modelling

6.4.1. Estimated Coefficients

		Hour 3																					
		M1		M2		M3		M4		AR-M1		AR-M2		AR-M3		AR-M4		VAR-M2		VAR-M3		VAR-M4	
Eq.	drivers		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val
μ_t	const	-5.381	-5.681	-3.811	-4.361	-11.470	-10.682	-10.340	-9.270	-5.223	-5.313	-3.436	-3.877	-11.694	-9.174	-10.041	-7.563	-4.393	-4.474	-9.627	-4.585	-5.445	-1.982
	$load_{t-1}$	0.375	19.663	0.245	14.283	0.215	10.713	0.190	9.130	0.388	18.216	0.234	12.504	0.222	9.749	0.191	7.878	0.247	12.375	0.225	8.590	0.116	2.349
	$coad_{t-1}$	2.266	29.678	2.252	33.302	2.846	24.160	2.790	25.551	2.533	25.075	2.400	25.193	3.067	21.418	2.969	21.193	2.081	15.119	2.739	10.195	2.086	4.550
	gas_{t-1}	0.182	8.748	0.273	14.422	0.429	18.238	0.452	19.583	0.205	9.312	0.291	13.575	0.451	15.744	0.477	15.840	0.222	7.219	0.353	5.749	0.518	3.097
	co_{2t-1}	0.506	16.333	0.618	20.469	0.654	15.258	0.633	15.072	0.610	17.809	0.701	19.259	0.739	14.512	0.701	13.665	0.532	7.988	0.599	7.665	0.765	4.605
	hol_t	-1.271	-6.908	-0.561	-2.924	0.228	0.839	0.369	1.449	-1.216	-6.227	-0.411	-2.091	0.296	0.995	0.472	1.615	-0.448	-2.273	0.107	0.415	0.727	1.159
	$fwind_t$	-0.200	-35.186	-0.146	-23.545	-0.147	-18.077	-0.137	-18.531	-0.211	-30.460	-0.148	-21.178	-0.152	-17.219	-0.140	-16.776	-0.147	-21.022	-0.147	-17.096	-0.126	-13.529
	$fsolar_t$																						
	y_{t-1}	0.092	11.797	0.093	11.721	0.092	12.103	0.091	11.682														
	μ_{t-1}									-0.025	-1.036	0.028	1.038	0.007	0.252	0.009	0.295	0.163	3.224	0.091	1.900	0.105	0.988
	σ_{t-1}																	0.152	2.847	0.015	0.237	0.097	1.225
	ν_{t-1}																			-0.234	-0.928	0.072	0.180
	τ_{t-1}																					-0.017	-0.674
$\log(\sigma_t)$	const	1.772	43.763	2.510	12.691	1.873	8.916	1.810	7.262	1.798	43.964	2.358	11.429	1.695	7.933	1.630	6.426	2.309	10.827	2.859	9.259	3.077	7.344
	$load_{t-1}$			-0.054	-15.200	-0.063	-16.162	-0.069	-14.228			-0.052	-12.871	-0.058	-13.599	-0.063	-11.380	-0.052	-12.610	-0.046	-9.587	-0.058	-6.797
	$coad_{t-1}$			-0.008	-0.484	0.043	2.085	0.057	2.724			-0.011	-0.718	0.042	2.109	0.053	2.520	-0.062	-2.193	-0.154	-3.469	-0.223	-3.316
	gas_{t-1}			0.029	5.976	0.044	8.221	0.061	11.428			0.033	6.807	0.046	8.484	0.063	11.453	0.023	3.591	-0.006	-0.519	0.010	0.775
	co_{2t-1}			0.074	11.727	0.088	11.765	0.066	6.970			0.076	11.403	0.086	11.229	0.059	6.170	0.052	4.349	0.029	2.167	0.010	0.365
	hol_t			0.388	10.995	0.495	11.958	0.556	12.401			0.380	10.782	0.469	11.016	0.526	11.279	0.373	10.454	0.373	8.793	0.488	6.259
	$fwind_t$			0.019	23.080	0.021	22.961	0.023	24.372			0.018	18.944	0.020	19.573	0.021	19.670	0.019	18.659	0.020	18.837	0.023	18.779
	$fsolar_t$																						
	μ_{t-1}																	0.021	2.193	0.026	3.072	0.042	3.755
	σ_{t-1}											0.002	0.444	0.004	0.938	0.003	0.908	0.016	2.251	-0.007	-1.164	0.001	0.211
	ν_{t-1}																			-0.218	-5.275	-0.179	-2.857
	τ_{t-1}																					-0.001	-0.610
ν_t	const	-2.966	-11.181	-2.714	-12.288	5.374	5.064	4.535	4.229	-2.805	-10.837	-2.627	-12.292	5.526	4.739	4.482	3.948	-2.640	-12.409	2.988	1.772	0.161	0.067
	$load_{t-1}$					0.072	3.727	0.096	4.727					0.057	2.313	0.094	3.431			0.034	1.346	0.153	3.511
	$coad_{t-1}$					-0.628	-4.051	-0.603	-4.233					-0.609	-3.772	-0.590	-4.045			-0.221	-0.906	0.173	0.442
	gas_{t-1}					-0.188	-7.093	-0.214	-7.972					-0.174	-5.003	-0.219	-6.162			-0.050	-0.927	-0.260	-2.179
	co_{2t-1}					-0.180	-3.927	-0.156	-3.415					-0.160	-3.176	-0.138	-2.807			-0.004	-0.045	-0.233	-1.518
	hol_t					-1.255	-4.655	-1.399	-5.400					-1.204	-4.328	-1.368	-4.971			-0.832	-3.225	-1.381	-2.330
	$fwind_t$					-0.025	-4.590	-0.030	-5.614					-0.023	-4.135	-0.029	-5.034			-0.026	-4.560	-0.039	-5.580
	$fsolar_t$																						
	μ_{t-1}																			-0.073	-1.690	-0.049	-0.675
	σ_{t-1}																			0.037	0.783	-0.021	-0.292
	ν_{t-1}													0.059	0.504	-0.026	-0.238			0.519	2.424	-0.044	-0.111
	τ_{t-1}																					0.009	0.848
$\log(\tau_t)$	const	1.051	14.531	2.251	12.171	2.023	13.881	1.531	1.030	1.089	14.767	2.263	12.134	2.138	13.562	1.409	0.985	2.283	11.740	2.170	13.391	3.821	1.726
	$load_{t-1}$							-0.045	-1.756							-0.036	-1.392					-0.034	-0.999
	$coad_{t-1}$							-0.017	-0.120							-0.141	-0.948					-0.718	-2.366
	gas_{t-1}							0.173	3.371							0.240	4.373					0.084	0.927
	co_{2t-1}							-0.118	-2.676							-0.157	-3.615					-0.292	-3.440
	hol_t							0.555	1.770							0.509	1.697					0.516	1.409
	$fwind_t$							0.022	2.435							0.022	2.431					0.025	2.371
	$fsolar_t$																						
	μ_{t-1}																					0.155	2.491
	σ_{t-1}																					0.013	0.186
	ν_{t-1}																					-0.203	-0.750
	τ_{t-1}																-0.012	-6.110					0.009	0.205

Table 12: MFST Progressive Modelling for HP3.

		Hour 12																					
		M1		M2		M3		M4		AR-M1		AR-M2		AR-M3		AR-M4		VAR-M2		VAR-M3		VAR-M4	
Eq.	drivers		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val
μ_t	const	16.316	9.428	14.688	7.455	5.768	2.057	9.572	2.803	15.556	7.844	14.017	6.416	4.345	1.657	8.248	2.290	12.536	5.090	18.795	4.941	18.506	3.315
	$load_{t-1}$	0.188	11.188	0.197	9.354	0.294	8.419	0.258	6.240	0.204	8.607	0.215	8.084	0.322	9.457	0.279	6.266	0.222	8.185	0.183	4.428	0.227	3.484
	$coad_{t-1}$	2.306	18.044	2.368	18.780	2.766	16.608	2.691	15.740	2.665	18.779	2.736	19.652	3.175	17.713	3.072	17.310	2.825	17.876	3.266	15.888	2.827	6.041
	gas_{t-1}	0.483	13.707	0.460	9.078	0.383	8.681	0.307	5.460	0.505	13.233	0.471	8.762	0.393	8.823	0.334	6.458	0.398	4.857	0.602	6.364	0.513	3.280
	co_{2t-1}	0.570	11.218	0.572	11.799	0.663	10.393	0.734	11.328	0.685	12.384	0.698	12.966	0.779	11.478	0.841	11.563	0.696	12.902	0.807	11.255	0.777	7.651
	hol_t	-13.118	-46.095	-12.243	-40.472	-7.139	-14.989	-8.197	-12.208	-13.328	-45.764	-12.419	-39.097	-7.059	-15.441	-8.000	-11.770	-12.294	-36.813	-6.868	-14.326	-7.513	-8.800
	$fwind_t$	-0.266	-43.106	-0.249	-39.970	-0.183	-24.245	-0.188	-26.061	-0.272	-38.402	-0.253	-36.525	-0.193	-24.707	-0.191	-24.641	-0.253	-36.568	-0.178	-20.886	-0.187	-17.396
	$fsolar_t$	-0.242	-37.509	-0.233	-35.212	-0.211	-27.675	-0.205	-25.995	-0.242	-33.667	-0.234	-32.471	-0.213	-26.311	-0.207	-25.425	-0.232	-31.325	-0.234	-22.797	-0.224	-22.502
	y_{t-1}	0.115	8.087	0.114	8.277	0.093	8.440	0.088	8.076														
	μ_{t-1}									-0.018	-0.832	-0.023	-1.072	-0.037	-1.430	-0.031	-1.104	-0.027	-1.240	-0.085	-2.204	-0.021	-0.286
	σ_{t-1}																	0.340	1.033	-1.058	-3.285	-1.160	-1.891
	ν_{t-1}																			0.751	3.501	1.227	3.960
	τ_{t-1}																					-0.001	-0.047
$\log(\sigma_t)$	const	1.750	70.752	1.851	8.671	1.760	8.438	1.559	5.731	1.768	70.792	1.597	6.131	1.544	4.733	1.419	4.694	1.601	5.554	2.040	5.694	1.676	4.131
	$load_{t-1}$			-0.009	-3.774	-0.008	-3.664	0.000	-0.074			-0.008	-3.319	-0.006	-1.820	-0.001	-0.172	-0.008	-2.556	-0.012	-3.365	-0.004	-0.972
	$coad_{t-1}$			-0.041	-2.572	-0.032	-1.876	-0.065	-3.169			-0.021	-1.177	-0.023	-1.292	-0.054	-2.379	-0.021	-1.022	-0.024	-1.089	0.088	2.007
	gas_{t-1}			0.040	8.753	0.041	8.840	0.047	8.235			0.025	2.685	0.035	4.429	0.039	4.266	0.025	2.646	0.035	3.610	-0.005	-0.336
	co_{2t-1}			0.004	0.580	0.004	0.533	0.001	0.073			0.002	0.262	0.003	0.416	0.003	0.385	0.002	0.237	0.000	0.055	0.020	1.740
	hol_t			-0.044	-1.055	0.212	4.299	-0.006	-0.079			-0.054	-1.240	0.203	4.137	0.040	0.551	-0.058	-1.318	0.191	3.852	0.013	0.182
	$fwind_t$			0.000	-0.200	0.002	2.443	-0.002	-1.414			0.000	-0.524	0.001	1.348	-0.001	-1.046	0.000	-0.396	0.002	1.819	-0.001	-0.770
	$fsolar_t$			-0.002	-2.291	-0.002	-2.240	-0.003	-3.101			-0.002	-1.622	-0.002	-1.848	-0.003	-2.324	-0.002	-1.533	-0.002	-1.567	-0.003	-2.628
	μ_{t-1}																	0.000	0.014	0.002	0.461	-0.020	-2.841
	σ_{t-1}											0.066	1.932	0.026	1.100	0.029	1.172	0.069	1.954	0.007	0.264	0.132	2.958
	ν_{t-1}																			0.031	1.375	0.092	2.353
	τ_{t-1}																					0.003	2.073
ν_t	const	0.085	0.490	0.089	0.455	3.513	4.021	2.169	1.972	0.090	0.510	0.102	0.512	3.021	3.640	1.895	1.777	0.097	0.473	1.415	1.357	1.163	0.983
	$load_{t-1}$					-0.046	-4.511	-0.032	-2.465					-0.041	-4.233	-0.028	-2.195			-0.019	-1.611	-0.024	-1.503
	$coad_{t-1}$					-0.141	-2.485	-0.106	-1.888					-0.172	-3.171	-0.145	-2.669			-0.157	-2.417	-0.049	-0.432
	gas_{t-1}					0.072	4.859	0.084	5.080					0.086	5.799	0.097	5.794			0.095	3.597	0.091	2.541
	co_{2t-1}					-0.017	-0.843	-0.029	-1.422					-0.008	-0.416	-0.022	-1.113			0.012	0.488	0.024	0.821
	hol_t					-2.300	-9.367	-1.720	-5.719					-2.461	-9.456	-1.946	-5.956			-2.731	-9.729	-2.170	-5.932
	$fwind_t$					-0.028	-6.448	-0.026	-5.617					-0.027	-6.644	-0.028	-5.994			-0.032	-7.052	-0.028	-4.511
	$fsolar_t$					-0.011	-4.012	-0.012	-4.275					-0.011	-4.173	-0.012	-4.463			-0.013	-3.717	-0.014	-3.763
	μ_{t-1}																			-0.016	-1.310	-0.029	-1.520
	σ_{t-1}																			0.080	1.034	0.116	1.030
	ν_{t-1}													-0.107	-2.151	-0.091	-1.332			-0.251	-3.585	-0.236	-2.071
	τ_{t-1}																					0.004	0.992
$log(\tau_t)$	const	1.877	16.181	2.097	14.946	2.353	14.525	-1.014	-0.759	1.892	16.103	2.137	14.743	2.381	14.168	0.443	0.296	2.135	14.684	2.340	14.502	-4.065	-1.555
	$load_{t-1}$							0.088	4.837							0.055	2.366					0.094	3.316
	$coal_{t-1}$							-0.201	-2.020							-0.225	-2.151					0.801	2.972
	gas_{t-1}							0.038	1.225							0.036	1.135					-0.360	-4.529
	co_{2t-1}							-0.013	-0.297							0.003	0.063					0.119	1.587
	hol_t							-1.092	-3.962							-1.022	-3.752					-0.957	-3.180
	$fwind_t$							-0.020	-4.231							-0.015	-2.856					-0.018	-3.085
	$fsolar_t$							-0.005	-0.934							-0.006	-0.885					-0.002	-0.269
	μ_{t-1}																					-0.134	-2.698
	σ_{t-1}																					1.218	3.973
	ν_{t-1}																					0.273	1.185
	τ_{t-1}																0.034	1.606					0.029	1.571

Table 13: MFST Progressive Modelling for HP12.

		Hour 19																					
		M1		M2		M3		M4		AR-M1		AR-M2		AR-M3		AR-M4		VAR-M2		VAR-M3		VAR-M4	
Eq.	drivers		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val		t-val
μ_t	const	-7.260	-3.934	-7.773	-3.223	-2.389	-0.716	-5.486	-1.598	-12.566	-6.075	-10.374	-4.073	7.210	3.726	6.715	4.684	-13.674	-5.167	-18.040	-4.824	-3.144	-1.260
	$load_{t-1}$	0.396	18.763	0.398	13.111	0.431	9.721	0.476	10.414	0.508	18.293	0.475	13.568	0.182	6.794	0.187	8.698	0.447	12.782	0.260	6.482	0.204	8.577
	$coad_{t-1}$	2.521	18.274	2.735	18.156	3.209	15.406	2.744	14.639	3.298	21.261	3.483	20.354	3.627	17.498	3.192	23.995	3.779	19.666	3.930	16.586	2.614	15.653
	gas_{t-1}	0.666	18.076	0.442	10.697	0.271	3.924	0.476	8.552	0.817	18.825	0.512	10.888	0.457	7.245	0.668	21.243	0.271	4.316	0.278	3.650	-0.292	-4.575
	co_{2t-1}	0.303	5.896	0.369	7.013	-0.425	-5.886	-0.408	-5.899	0.492	9.047	0.535	9.281	0.769	10.602	0.792	18.880	0.534	9.310	1.636	8.256	0.270	2.860
	hol_t	-8.853	-27.940	-8.129	-20.883	-5.886	-14.353	-5.310	-11.527	-9.014	-27.953	-8.266	-20.924	-8.962	-26.983	-8.747	-31.340	-7.992	-21.080	-7.339	-16.866	-7.432	-27.942
	$fwind_t$	-0.245	-34.030	-0.213	-28.883	-0.183	-19.698	-0.167	-14.944	-0.271	-32.515	-0.229	-26.635	-0.213	-28.178	-0.217	-37.435	-0.218	-26.680	-0.179	-20.362	-0.236	-37.828
	$fsolar_t$	-0.477	-25.014	-0.307	-15.231	-0.267	-11.197	-0.285	-13.019	-0.520	-25.103	-0.336	-15.385	-0.117	-5.194	-0.096	-7.154	-0.181	-5.211	-0.023	-0.635	-0.040	-1.405
	y_{t-1}	0.140	8.681	0.140	8.850	0.126	8.900	0.131	9.691														
	μ_{t-1}									-0.160	-6.088	-0.137	-4.795	-0.109	-3.747	-0.112	-4.063	-0.146	-4.541	-0.136	-3.290	0.262	5.783
	σ_{t-1}																	0.826	5.072	1.774	6.723	2.448	10.502
	ν_{t-1}																			-2.208	-4.567	-1.152	-4.443
	τ_{t-1}																					0.000	6.637
$\log(\sigma_t)$	const	2.040	45.050	2.297	8.754	1.818	6.540	2.225	8.199	2.025	43.058	2.005	7.511	1.305	6.043	1.466	6.453	1.201	3.776	0.427	1.263	0.249	0.832
	$load_{t-1}$			-0.005	-1.620	-0.006	-1.601	-0.014	-4.282			-0.004	-1.194	0.009	3.306	0.001	0.214	0.009	2.310	0.018	4.744	0.007	2.231
	$coad_{t-1}$			-0.039	-2.277	-0.044	-2.426	-0.022	-1.410			-0.033	-1.753	-0.071	-4.225	-0.069	-4.574	0.027	1.093	-0.007	-0.280	-0.080	-3.780
	gas_{t-1}			0.037	7.089	0.047	8.426	0.031	6.538			0.032	3.748	0.056	7.024	0.035	5.552	0.042	4.622	0.040	4.643	0.030	3.725
	co_{2t-1}			-0.004	-0.626	0.037	5.319	0.031	4.588			0.001	0.214	0.009	1.047	0.015	2.095	0.020	2.730	0.067	3.629	0.054	4.762
	hol_t			-0.110	-2.335	-0.184	-3.956	0.000	-0.010			-0.106	-2.246	-0.037	-0.941	0.118	3.187	-0.087	-1.850	-0.173	-3.932	0.055	1.624
	$fwind_t$			-0.003	-3.042	-0.003	-4.024	0.003	3.507			-0.003	-3.206	-0.005	-5.834	0.000	0.314	-0.005	-5.326	-0.008	-8.037	-0.002	-2.330
	$fsolar_t$			-0.031	-12.772	-0.034	-13.108	-0.017	-7.079			-0.025	-5.335	-0.030	-6.969	-0.003	-1.089	-0.026	-5.256	-0.030	-6.703	-0.014	-4.186
	μ_{t-1}																	-0.019	-4.834	-0.014	-3.119	0.009	1.597
	σ_{t-1}											0.019	0.976	-0.022	-1.307	0.023	1.192	0.028	1.302	0.074	2.903	0.084	3.119
	ν_{t-1}																			-0.238	-4.875	-0.155	-4.794
	τ_{t-1}																					0.000	5.559
ν_t	const	1.391	8.784	1.514	10.005	0.314	0.307	0.744	0.845	1.240	8.029	1.389	9.285	-5.759	-6.068	-4.724	-7.503	1.324	9.021	-1.058	-0.716	-5.835	-8.558
	$load_{t-1}$					-0.039	-2.881	-0.043	-3.768					0.090	8.760	0.078	12.220			0.095	5.937	0.063	9.140
	$coad_{t-1}$					-0.166	-2.456	-0.068	-1.157					-0.254	-3.604	-0.095	-2.593			-0.179	-1.849	-0.112	-2.545
	gas_{t-1}					0.109	4.952	0.076	4.628					0.160	5.895	0.088	7.326			0.016	0.491	0.249	13.743
	co_{2t-1}					0.421	10.447	0.349	11.126					0.197	3.961	0.111	3.494			-0.009	-0.124	0.306	10.920
	hol_t					-1.281	-8.721	-1.268	-8.878					-0.302	-2.267	-0.320	-3.066			-1.045	-7.030	-0.630	-7.761
	$fwind_t$					-0.011	-3.355	-0.016	-5.290					-0.017	-6.427	-0.017	-8.706			-0.026	-7.087	-0.005	-2.956
	$fsolar_t$					-0.059	-6.659	-0.055	-8.136					-0.160	-10.942	-0.154	-27.569			-0.084	-5.300	-0.090	-12.281
	μ_{t-1}																			0.010	0.612	-0.021	-1.830
	σ_{t-1}																			-0.037	-0.359	-0.259	-4.639
	ν_{t-1}													-0.696	-7.303	-0.572	-7.844			-0.684	-3.575	-0.535	-7.448
	τ_{t-1}																					0.000	-0.049
$log(\tau_t)$	const	1.339	16.857	1.701	15.514	1.723	16.544	4.624	4.026	1.349	17.003	1.725	15.372	1.726	16.698	3.414	3.321	1.696	15.562	2.002	14.542	6.961	3.776
	$load_{t-1}$							-0.046	-3.408							-0.033	-2.962					-0.027	-1.406
	$coal_{t-1}$							0.032	0.356							-0.143	-1.615					0.138	0.979
	gas_{t-1}							-0.074	-2.889							-0.024	-1.318					0.015	0.519
	co_{2t-1}							-0.037	-0.926							0.049	1.294					-0.101	-1.843
	hol_t							1.700	3.666							1.598	9.186					1.904	11.937
	$fwind_t$							0.061	6.253							0.046	14.450					0.050	12.662
	$fsolar_t$							0.557	4.015							0.508	61.192					0.471	28.537
	μ_{t-1}																					-0.074	-2.845
	σ_{t-1}																					-0.268	-1.900
	ν_{t-1}																					0.418	3.107
	τ_{t-1}															0.000	-3.332					0.000	-4.010

Table 14: MFST Progressive Modelling for HP19.

	R-sqr			Global Deviance			AIC			SBC		
	Base	AR	VAR	Base	AR	VAR	Base	AR	VAR	Base	AR	VAR
Hour 1												
M1	0.7996	0.7818		15151	15362		15173	15384		15237	15448	
M2	0.8377	0.8217	0.8223	14613	14848	14838	14647	14884	14878	14746	14989	14995
M3	0.8466	0.8326	0.8360	14469	14686	14634	14515	14736	14696	14649	14882	14878
M4	0.8476	0.8337	0.8378	14451	14670	14606	14509	14734	14694	14679	14921	14951
Hour 2												
M1	0.7684	0.7591		15580	15673		15602	15695		15666	15760	
M2	0.8250	0.8174	0.8185	14866	14967	14952	14900	15003	14992	14999	15109	15109
M3	0.8360	0.8283	0.8330	14700	14810	14739	14746	14860	14801	14880	15006	14982
M4	0.8386	0.8320	0.8398	14659	14755	14633	14717	14819	14721	14887	15006	14978
Hour 3												
M1	0.7405	0.7284		15919	16029		15941	16051		16005	16115	
M2	0.8077	0.7988	0.7995	15153	15264	15255	15187	15300	15295	15287	15405	15411
M3	0.8193	0.8115	0.8152	14996	15098	15047	15042	15148	15109	15176	15294	15290
M4	0.8227	0.8153	0.8186	14946	15046	15000	15004	15110	15088	15173	15297	15345
Hour 4												
M1	0.6922	0.6817		16335	16413		16357	16435		16421	16500	
M2	0.7714	0.7625	0.7632	15576	15667	15659	15610	15703	15699	15709	15808	15816
M3	0.7855	0.7769	0.7811	15414	15508	15460	15460	15558	15522	15594	15704	15703
M4	0.7888	0.7801	0.7864	15374	15470	15397	15432	15534	15485	15601	15721	15742
Hour 5												
M1	0.6987	0.6888		16194	16271		16216	16293		16280	16357	
M2	0.7721	0.7646	0.7651	15483	15558	15554	15517	15594	15594	15616	15700	15711
M3	0.7855	0.7797	0.7867	15328	15390	15307	15374	15440	15369	15508	15586	15551
M4	0.7889	0.7734	0.7898	15287	15462	15270	15345	15526	15358	15514	15713	15615
Hour 6												
M1	0.7668	0.7609		15634	15688		15658	15712		15728	15782	
M2	0.8188	0.8165	0.8165	14990	15014	15013	15028	15054	15057	15139	15171	15186
M3	0.8334	0.8312	0.8325	14776	14801	14781	14828	14857	14849	14980	15021	15047
M4	0.8371	0.8341	0.8368	14719	14757	14716	14785	14829	14812	14978	15039	15092
Hour 7												
M1	0.7729	0.7673		16701	16753		16725	16777		16795	16847	
M2	0.8056	0.8082	0.8092	16304	16259	16246	16342	16299	16290	16453	16416	16419
M3	0.8248	0.8318	0.8344	16039	15925	15886	16091	15981	15954	16243	16144	16152
M4	0.8288	0.8339	0.8374	15981	15893	15838	16047	15965	15934	16240	16176	16215
Hour 8												
M1	0.8045	0.8056		17540	17516		17564	17540		17635	17610	
M2	0.8197	0.8224	0.8228	17334	17285	17278	17372	17325	17322	17483	17442	17451
M3	0.8382	0.8460	0.8525	17058	16922	16812	17110	16978	16880	17262	17142	17078
M4	0.8420	0.8487	0.8577	16997	16877	16720	17063	16949	16816	17256	17159	17097
Hour 9												
M1	0.7957	0.7998		17610	17545		17634	17569		17704	17640	
M2	0.8077	0.8092	0.8106	17455	17423	17404	17493	17463	17448	17604	17580	17577
M3	0.8241	0.8333	0.8427	17227	17079	16930	17279	17135	16998	17431	17299	17197
M4	0.8286	0.8404	0.8485	17162	16969	16835	17228	17041	16931	17421	17251	17212
Hour 10												
M1	0.7901	0.7949		17346	17275		17370	17299		17440	17369	
M2	0.8006	0.8013	0.8048	17215	17195	17150	17253	17235	17194	17364	17351	17322
M3	0.8126	0.8139	0.8349	17057	17028	16722	17109	17084	16790	17261	17248	16989
M4	0.8195	0.8222	0.8401	16961	16911	16640	17027	16983	16736	17220	17193	17017
Hour 11												
M1	0.8039	0.8034		17143	17140		17167	17164		17237	17234	
M2	0.8150	0.8122	0.8176	16995	17023	16948	17033	17063	16992	17144	17179	17121
M3	0.8328	0.8261	0.8450	16737	16827	16533	16789	16883	16601	16941	17047	16800
M4	0.8379	0.8322	0.8443	16658	16736	16545	16724	16808	16641	16917	17018	16921
Hour 12												
M1	0.8132	0.8106		17079	17107		17103	17131		17174	17201	
M2	0.8215	0.8192	0.8241	16965	16988	16918	17003	17028	16962	17114	17145	17091
M3	0.8341	0.8367	0.8432	16778	16729	16626	16830	16785	16694	16981	16949	16892
M4	0.8367	0.8380	0.8428	16736	16708	16633	16802	16780	16729	16995	16990	17009

Table 15: Informative Statistics of Enlarged Models. R-sqr is the "Cox-Snell" or Nagelkerke's R squared, Global Deviance is $GD = -2\mathcal{LL}$, AIC and SBC are the Akaike and Schwarz Bayesian Information Criteria for estimated models, as formulated in eqs 2-7 and described therein.

	R-sqr			Global Deviance			AIC			SBC		
	Base	AR	VAR	Base	AR	VAR	Base	AR	VAR	Base	AR	VAR
Hour 13												
M1	0.8262	0.8222		16825	16876		16849	16900		16919	16970	
M2	0.8345	0.8311	0.8345	16700	16745	16693	16738	16785	16737	16849	16902	16865
M3	0.8510	0.8421	0.8549	16433	16573	16358	16485	16629	16426	16637	16793	16625
M4	0.8526	0.8515	0.8559	16405	16417	16340	16471	16489	16436	16663	16699	16717
Hour 14												
M1	0.8321	0.8282		16845	16896		16869	16920		16939	16990	
M2	0.8381	0.8357	0.8382	16752	16781	16742	16790	16821	16786	16901	16938	16915
M3	0.8590	0.8579	0.8644	16400	16411	16293	16452	16467	16361	16604	16631	16559
M4	0.8639	0.8631	0.8705	16309	16316	16176	16375	16388	16272	16568	16599	16552
Hour 15												
M1	0.8267	0.8227		16870	16920		16894	16944		16964	17014	
M2	0.8328	0.8297	0.8316	16779	16817	16789	16817	16857	16833	16928	16974	16962
M3	0.8541	0.8540	0.8605	16431	16425	16309	16483	16481	16377	16635	16644	16576
M4	0.8608	0.8612	0.8705	16311	16296	16120	16377	16368	16216	16570	16579	16497
Hour 16												
M1	0.8129	0.8111		16826	16843		16850	16867		16920	16937	
M2	0.8200	0.8186	0.8205	16728	16739	16713	16766	16779	16757	16877	16895	16886
M3	0.8365	0.8359	0.8429	16482	16483	16372	16534	16539	16440	16686	16703	16639
M4	0.8463	0.8478	0.8589	16324	16292	16099	16390	16364	16195	16582	16574	16476
Hour 17												
M1	0.7924	0.7919		16972	16971		16996	16995		17066	17066	
M2	0.8017	0.8001	0.8009	16855	16869	16859	16893	16909	16903	17004	17026	17032
M3	0.8176	0.8187	0.8227	16642	16620	16563	16694	16676	16631	16846	16839	16830
M4	0.8214	0.8217	0.8258	16589	16577	16518	16655	16649	16614	16848	16860	16895
Hour 18												
M1	0.7465	0.7442		17881	17898		17905	17922		17975	17992	
M2	0.7683	0.7657	0.7666	17652	17674	17664	17690	17714	17708	17801	17831	17836
M3	0.7858	0.7831	0.8006	17451	17477	17262	17503	17533	17330	17655	17696	17529
M4	0.7990	0.7965	0.8021	17289	17314	17243	17355	17386	17339	17548	17596	17620
Hour 19												
M1	0.7489	0.7417		17829	17895		17853	17919		17923	17989	
M2	0.7714	0.7654	0.7726	17589	17650	17569	17627	17690	17613	17739	17806	17742
M3	0.7915	0.7866	0.7895	17354	17408	17373	17406	17464	17441	17558	17627	17640
M4	0.8040	0.8001	0.8052	17196	17241	17176	17262	17313	17272	17455	17523	17553
Hour 20												
M1	0.7223	0.7156		17585	17640		17609	17664		17679	17734	
M2	0.7457	0.7413	0.7494	17361	17399	17317	17399	17439	17361	17510	17556	17490
M3	0.7695	0.7641	0.7658	17111	17163	17145	17163	17219	17213	17315	17383	17411
M4	0.7784	0.7727	0.7766	17010	17068	17024	17076	17140	17120	17269	17351	17401
Hour 21												
M1	0.7553	0.7494		16424	16478		16448	16502		16518	16572	
M2	0.7712	0.7673	0.7716	16252	16290	16242	16290	16330	16286	16401	16447	16415
M3	0.7805	0.7776	0.7882	16146	16174	16050	16198	16230	16118	16350	16393	16317
M4	0.7878	0.7854	0.7945	16060	16083	15973	16126	16155	16069	16319	16366	16350
Hour 22												
M1	0.7862	0.7732		15464	15608		15486	15630		15550	15695	
M2	0.7996	0.7894	0.7935	15299	15419	15369	15333	15455	15409	15432	15560	15526
M3	0.8138	0.8032	0.8155	15111	15246	15082	15157	15296	15144	15291	15442	15325
M4	0.8177	0.8070	0.8154	15058	15196	15082	15116	15260	15170	15285	15447	15427
Hour 23												
M1	0.8082	0.8013		15032	15118		15054	15140		15119	15204	
M2	0.8182	0.8123	0.8138	14897	14972	14952	14931	15008	14992	15030	15113	15109
M3	0.8335	0.8292	0.8298	14671	14732	14722	14717	14782	14784	14852	14928	14965
M4	0.8330	0.8304	0.8330	14679	14714	14674	14737	14778	14762	14906	14965	15019
Hour 24												
M1	0.8286	0.8191		14656	14788		14678	14810		14743	14874	
M2	0.8438	0.8365	0.8382	14419	14531	14504	14453	14567	14544	14552	14672	14661
M3	0.8556	0.8500	0.8528	14219	14312	14264	14265	14362	14326	14400	14508	14507
M4	0.8548	0.8500	0.8564	14233	14310	14200	14291	14374	14288	14460	14561	14545

Table 16: Informative Statistics of Enlarged Models. R-sqr is the “Cox-Snell” or Nagelkerke’s R squared, Global Deviance is $GD = -2\mathcal{LL}$, AIC and SBC are the Akaike and Schwarz Bayesian Information Criteria for estimated models, as formulated in eqs 2-7 and described therein.

6.4.3. Residuals Analysis

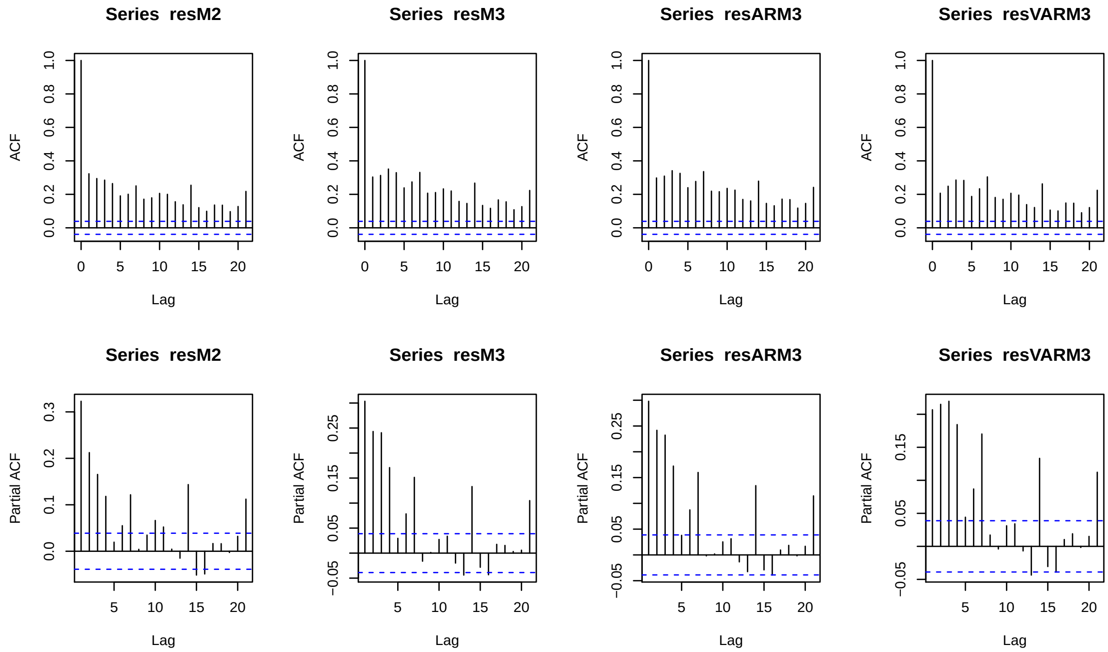


Figure 11: Autocorrelation and Partial autocorrelation Functions for Models M2, M3, ARM3 and VARM3 for hour 3.

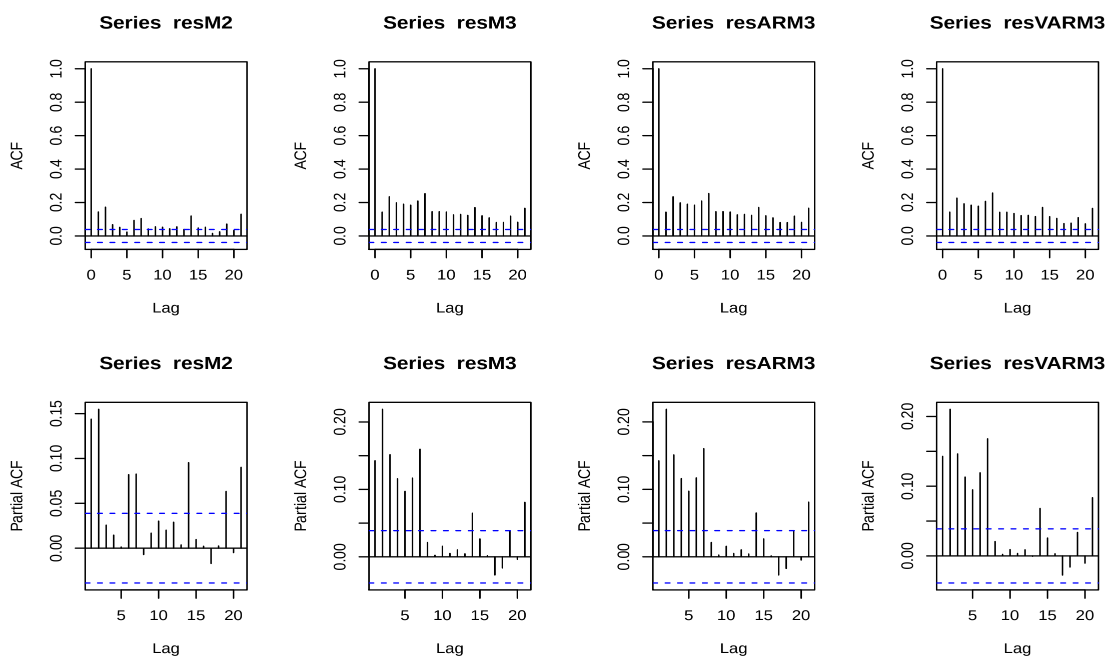


Figure 12: Autocorrelation and Partial autocorrelation Functions for Models M2, M3, ARM3 and VARM3 for hour 12.

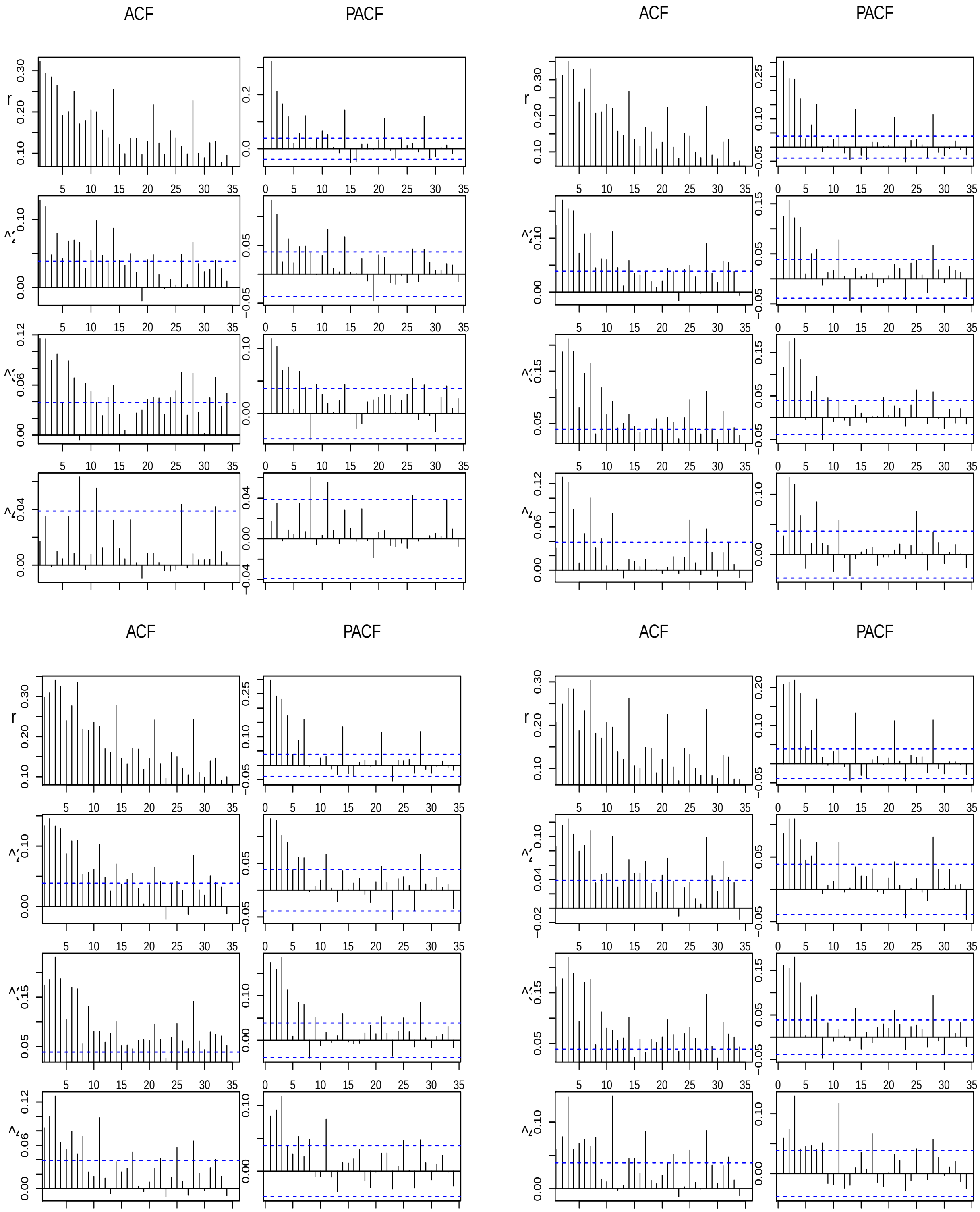


Figure 13: ACF and PACF for Residuals of Models M2 (top-left), M3 (top-right), ARM3 (bottom-left) and VARM3 (bottom-right) for hour 3. Levels of residuals on first rows, r_t^2 on second rows, r_t^3 on third rows and finally r_t^4 on last rows.

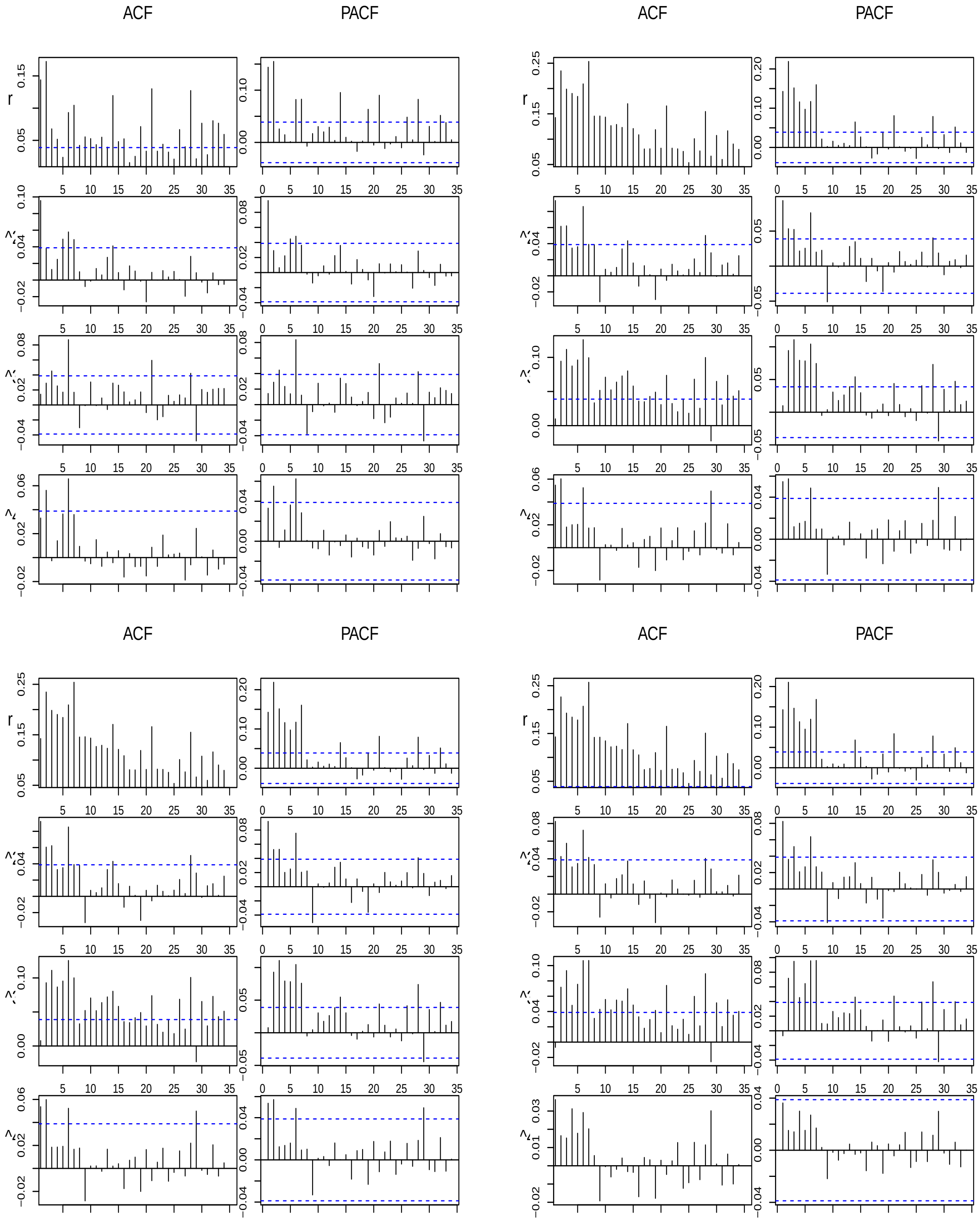


Figure 14: ACF and PACF for Residuals of Models M2 (top-left), M3 (top-right), ARM3 (bottom-left) and VARM3 (bottom-right) for hour 12. Levels of residuals on first rows, r_t^2 on second rows, r_t^3 on third rows and finally r_t^4 on last rows.

		Base				AR				VAR			
		Mean	Var	Skew	Kurt	Mean	Var	Skew	Kurt	Mean	Var	Skew	Kurt
Hour 3													
JSU	M1	-0.004	1.001	-0.061	3.055	-0.002	0.999	-0.075	3.085				
	M2	-0.029	1.007	0.027	2.955	-0.029	1.007	0.025	2.965	-0.028	1.006	0.024	2.963
	M3	-0.029	1.011	0.026	2.941	-0.030	1.010	0.024	2.973	-0.029	1.007	0.025	2.981
	M4	-0.036	0.994	-0.017	3.210	-0.033	0.997	0.007	3.084	-0.029	0.989	-0.034	3.139
JSUo	M1	-0.002	0.998	-0.068	2.994	-0.002	0.998	-0.084	3.020				
	M2	-0.002	0.996	0.033	3.272	-0.002	0.996	0.032	3.325	-0.002	0.995	0.005	3.334
	M3	-0.001	0.997	0.036	2.908	-0.001	0.998	0.050	2.868	-0.001	0.998	0.005	2.889
	M4	-0.002	0.993	0.139	3.505	-0.001	0.996	-0.013	3.411	-0.001	0.994	0.053	3.272
ST1	M1	-0.006	1.001	-0.055	2.835	-0.008	1.000	-0.068	2.830				
	M2	-0.008	0.988	0.113	3.232	-0.009	0.987	0.117	3.255	-0.010	0.986	0.108	3.241
	M3	-0.009	0.974	-0.019	3.226	-0.012	0.971	-0.032	3.279	-0.014	0.958	-0.019	3.378
	M4	-0.009	0.978	-0.033	3.143	-0.016	0.972	-0.026	3.224	-0.027	0.974	-0.055	3.058
ST2	M1	-0.004	0.995	-0.058	2.876	-0.005	0.993	-0.068	2.886				
	M2	-0.009	0.992	0.091	3.189	-0.009	0.990	0.094	3.210	-0.011	0.988	0.088	3.205
	M3	-0.011	0.977	-0.027	3.165	-0.014	0.973	-0.041	3.222	-0.016	0.960	-0.028	3.337
	M4	-0.013	0.976	-0.045	3.125	-0.020	0.967	-0.019	3.223	-0.028	0.964	-0.031	3.092
SN1	M1	0.002	1.068	-10.506	> 240	0.001	1.067	-10.271	> 230				
	M2	-0.001	0.991	-0.068	4.254	-0.003	0.990	-0.052	4.222	-0.004	0.987	-0.054	4.113
	M3	0.007	0.982	-0.258	4.141	0.004	0.977	-0.251	4.035	0.000	0.962	-0.237	4.087
NO	M1	0.000	1.000	-10.527	> 240	0.000	1.000	-10.296	> 230				
	M2	-0.044	0.998	-0.855	5.024	-0.044	0.998	-0.810	4.861	-0.041	0.999	-0.815	4.874
Hour 12													
JSU	M1	0.000	0.999	0.054	3.189	0.001	0.999	0.065	3.199				
	M2	0.001	0.999	0.040	3.144	-0.003	0.999	0.043	3.136	0.004	0.999	0.049	3.131
	M3	-0.001	1.002	0.017	3.104	-0.004	1.002	0.016	3.085	0.000	1.004	0.027	3.094
	M4	0.006	0.973	0.014	3.287	-0.005	0.973	0.018	3.188	-0.003	1.007	0.003	3.050
JSUo	M1	0.000	1.000	0.054	3.093	0.000	1.000	0.067	3.100				
	M2	0.000	1.000	0.037	3.032	0.000	1.000	0.067	3.031	0.000	1.000	0.022	3.028
	M3	0.000	0.997	0.005	3.103	0.001	0.997	-0.002	3.148	0.001	0.996	-0.015	3.205
	M4	0.000	0.997	0.095	3.309	0.000	0.997	0.057	3.356	0.001	0.995	-0.053	3.553
ST1	M1	0.000	1.001	0.008	3.079	0.000	1.001	0.021	3.080				
	M2	0.000	1.002	0.010	3.059	-0.001	1.002	0.028	3.051	0.000	1.002	0.009	3.052
	M3	0.012	0.984	0.127	3.220	0.016	0.980	0.377	3.536	0.024	0.980	0.350	3.527
	M4	0.012	0.973	0.483	3.889	0.004	0.968	0.503	3.860	0.011	0.970	0.395	3.512
ST2	M1	0.001	1.001	0.039	3.085	0.001	1.001	0.056	3.090				
	M2	0.001	1.002	0.035	3.064	0.001	1.002	0.053	3.059	0.001	1.002	0.038	3.063
	M3	0.010	0.985	0.146	3.202	0.016	0.980	0.357	3.492	0.023	0.981	0.337	3.473
	M4	0.000	0.974	0.355	3.619	0.007	0.973	0.482	3.889	0.012	0.970	0.389	3.441
SN1	M1	-0.002	0.968	0.309	5.880			0.250	5.334				
	M2			0.134	4.705			0.100	4.104	0.000	1.003	0.092	5.079
	M3			0.114	3.784	-0.008	0.980	0.328	4.824	0.002	0.991	0.077	4.275
NO	M1	inf				inf							
	M2	inf				inf				inf			
Hour 19													
JSU	M1	0.000	0.997	0.096	3.203	0.000	0.998	0.110	3.227				
	M2	0.012	1.002	0.027	3.063	0.011	1.002	0.030	3.074	0.010	1.002	0.021	3.031
	M3	0.007	1.006	0.016	3.110	0.005	1.005	0.003	3.167	0.004	1.004	0.000	3.134
	M4	0.013	1.004	0.040	2.909	-0.001	0.991	0.027	2.871	0.005	0.996	0.040	2.907
JSUo	M1	0.001	0.999	0.115	3.136	0.001	0.999	0.130	3.155				
	M2	0.003	0.988	0.097	4.500	0.003	0.989	0.081	4.151	0.002	0.997	-0.087	3.489
	M3	0.002	0.992	0.407	3.831	0.002	0.990	0.380	3.780	0.002	0.993	0.260	3.499
	M4	-0.001	0.992	0.252	3.621	-0.001	0.991	0.256	3.554	-0.001	0.989	0.246	3.714
ST1	M1	0.001	1.003	0.063	2.971	0.001	1.003	0.074	2.976				
	M2	0.005	0.995	-0.086	3.209	0.008	0.991	-0.112	3.282	0.003	0.998	-0.071	3.142
	M3	-0.001	0.969	-0.077	3.325	0.003	0.955	-0.136	3.377	-0.001	0.965	-0.100	3.280
	M4	0.030	0.947	-0.007	3.447	0.014	0.920	0.307	3.647	0.017	0.960	-0.078	3.139
ST2	M1	0.005	0.994	0.086	2.983	0.005	0.993	0.100	2.983				
	M2	0.007	0.995	-0.062	3.152	0.010	0.992	-0.085	3.209	0.005	0.998	-0.050	3.094
	M3	0.033	0.957	0.504	3.624	0.026	0.959	0.484	3.629	0.023	0.959	0.497	3.660
	M4	0.016	0.924	0.352	3.850	0.012	0.922	0.295	3.630	0.013	0.921	0.269	3.728
SN1	M1			1.593	10.244	-0.004	0.940	1.615	10.361				
	M2	0.006	0.987	0.042	4.423	0.010	0.982	-0.004	4.128	0.001	0.996	0.030	4.025
	M3	-0.013	0.973	0.329	4.274	-0.011	0.977	0.351	3.976	-0.006	0.989	0.091	4.143
NO	M1	inf				inf							
	M2	0.023	1.000	0.643	4.870	0.028	1.000	0.533	4.491	0.013	1.000	0.553	4.306

Table 17: Descriptive Statistics of (Randomized Quantile) Residuals for Enlarged Models and selected hours.

6.5. Coverage Tests

The formulated models in Tables 18-26, without parameter indications and under the skew Student-t distribution unless diversely specified, are

- with just the first moment:
  - ≻ M1: $\mu_t = c + \sum_{i=1}^{7} y_{t-i} + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$;
  - ≻ ARM1: $\mu_t = c + \mu_{t-1} + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$ with μ_{t-1} filtered from M1;
  - ≻ QReg: $Q_q(y_t) = \alpha^q + \sum_{i=1}^{7} \gamma_i^q y_{t-i} + \beta_1^q hol_t + \beta_2^q load_{t-1} + \beta_3^q fwind_t + \beta_4^q fsolar_t + \beta_5^q coal_{t-1} + \beta_6^q gas_{t-1} + \beta_7^q co_{2t-1}$;
- with the first two moments:
  - ≻ M2st: μ_t as in M1 and $\log(\sigma_t) = hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$;
  - ≻ M2jsu: as M2 but with the Johnson's S_U distribution;
  - ≻ M2Ser: $\mu_t = c + y_{t-1} + y_{t-2} + y_{t-7} + miny_{t-1} + load_t + load_t^2 + load_t^3 + \sum_{i=1}^{6} d_i$ and $log(\sigma_t) = c + y_{t-1} + abs(y_{t-1} - y_{t-2}) + \sum_{i=1}^{6} d_i$ under the Johnson's S_U;
  - ≻ ARM2: μ_t as in ARM1, and $log(\sigma_t) = c + log(\sigma_{t-1}) + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$ with μ_{t-1} and $log(\sigma_{t-1})$ filtered from M2;
  - ≻ VARM2: $\mu_t = log(\sigma_t) = c + \mu_{t-1} + log(\sigma_{t-1}) + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$, with μ_{t-1} and $log(\sigma_{t-1})$ filtered from M2;
  - ≻ AR-EGARCH-st and -sst: as in eqs. (9) and (10) under the Student-t and the skew Student-t distributions;
- with the three moments:
  - ≻ M3: $\mu_t = c + y_{t-1} + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$, and $log(\sigma_t) = \nu_t = c + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$;
  - ≻ ARM3: μ_t and $log(\sigma_t)$ as in ARM1 and ARM2, $\nu_t = c + \nu_{t-1} + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$ with μ_{t-1}, $log(\sigma_{t-1})$ and ν_{t-1} filtered from M3;
  - ≻ VARM3: $\mu_t = log(\sigma_t) = \nu_t = c + \mu_{t-1} + log(\sigma_{t-1}) + \nu_{t-1} + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$, with μ_{t-1}, $log(\sigma_{t-1})$ and ν_{t-1} filtered from M3;
- with four moments:
  - ≻ M4: μ_t, $log(\sigma_t)$, and ν_t as in M3, and with $log(\tau_t) = c + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$;
  - ≻ ARM4: μ_t, $log(\sigma_t)$ and ν_t as in ARM3, $log(\tau_t) = c + \tau_{t-1} + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$ with μ_{t-1}, $log(\sigma_{t-1})$, ν_{t-1} and $log(\tau_{t-1})$ filtered from M4;
  - ≻ VARM4: $\mu_t = log(\sigma_t) = \nu_t = log(\tau_t) = c + \mu_{t-1} + log(\sigma_{t-1}) + \nu_{t-1} + log(\tau_{t-1}) + hol_t + load_{t-1} + fwind_t + fsolar_t + coal_{t-1} + gas_{t-1} + co_{2t-1}$, with μ_{t-1}, $log(\sigma_{t-1})$, ν_{t-1} and $log(\tau_{t-1})$ filtered from M4.

Years	Models	Q_1			Q_2			Q_5		
		UC	CC	DC	UC	CC	DC	UC	CC	DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000006	0.000002	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.042737	0.047887	0.000000	0.021708	0.000301	0.000000	0.063088	0.000001	0.000000
	ARM3	0.238900	0.107340	0.000000	0.003907	0.000000	0.000000	0.038200	0.000000	0.000000
	VARM3	0.005059	0.001559	0.000000	0.001519	0.000014	0.000000	0.000213	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000008	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000008	0.000000	0.000000	0.000029	0.000000	0.000000	0.000005	0.000000	0.000000
	M2st	0.001823	0.000003	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.117696	0.000001	0.000000	0.197757	0.000190	0.000000	0.000153	0.000015	0.000000
	ARM3	0.117696	0.000001	0.000000	0.338885	0.000109	0.000000	0.000013	0.000000	0.000000
	VARM3	0.117696	0.000001	0.000000	0.338885	0.000109	0.000000	0.000013	0.000001	0.000000
	M4	0.000002	0.000000	0.000000	0.000000	0.000000	0.000000	0.000030	0.000000	0.000000
	ARM4	0.000008	0.000000	0.000000	0.000009	0.000000	0.000000	0.000153	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000000	0.000000
2015	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000008	0.000039	0.000000	0.001938	0.003929	0.000000	0.857958	0.208593	0.128320
	M2st	0.006756	0.025518	0.934814	0.068612	0.008689	0.010138	0.000000	0.000000	0.000000
	M2jsu	0.117696	0.004890	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.098483	0.254687	0.988059	0.539538	0.373329	0.000914	0.000000	0.000000	0.000000
	VARM2	0.098483	0.254687	0.988316	0.539538	0.373329	0.000906	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000178	0.000828	0.138134
	ARM3	0.006756	0.025518	0.934814	0.003122	0.012651	0.786306	0.060904	0.019116	0.039357
	VARM3	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.005822	0.008170	0.344486
	M4	0.501312	0.743997	0.021828	0.539538	0.659422	0.745787	0.382296	0.576701	0.928168
	ARM4	0.117696	0.083839	0.001082	0.107486	0.191873	0.360920	0.518500	0.269329	0.332937
	VARM4	0.117696	0.256373	0.078650	0.025949	0.047842	0.090188	0.272025	0.500320	0.802992
2016	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.006054	0.017444	0.000102	0.001997	0.000159	0.000000	0.050582	0.057404	0.000000
	M2st	0.097586	0.252834	0.991500	0.067621	0.183640	0.967964	0.000000	0.000000	0.000000
	M2jsu	0.006054	0.012375	0.000184	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000008	0.000041	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.860310	0.941947	0.004213	0.011879	0.013910	0.000476	0.000000	0.000000	0.000000
	VARM2	0.860310	0.941947	0.004471	0.055625	0.032678	0.000119	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.006681	0.025263	0.934247	0.175408	0.381984	0.148638	0.000718	0.000001	0.000000
	ARM3	0.006681	0.025263	0.934247	0.175408	0.381984	0.148473	0.000718	0.000001	0.000000
	VARM3	0.006681	0.025263	0.934247	0.611055	0.794848	0.565671	0.000345	0.000000	0.000000
	M4	0.018014	0.048560	0.000474	0.342897	0.481181	0.308151	0.414556	0.641707	0.967434
	ARM4	0.018014	0.027413	0.001663	0.055625	0.032678	0.000211	0.942492	0.161620	0.097266
	VARM4	0.000034	0.000049	0.000000	0.005012	0.007823	0.000007	0.081539	0.022825	0.000658

Table 18: Coverage tests for Lower Quantiles of HP3. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_{25}			Q_{50}			Q_{75}		
		UC	CC	DC	UC	CC	DC	UC	CC	DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.830988	0.000003	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.413151	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000002	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000009	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.156623	0.000000	0.000000	0.002501	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000043	0.000000	0.000000	0.000010	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.001210	0.000000	0.000000	0.000063	0.000000	0.000000
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000003	0.000000	0.000000
	M4	0.830988	0.000000	0.000000	0.000006	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.975616	0.000000	0.000000	0.000004	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.194493	0.000000	0.000000	0.000249	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.309641	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000036	0.000000	0.000000	0.250018	0.000000	0.000000	0.002743	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.003358	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000542	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.116647	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000039	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000000	0.000000
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000898	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.209497	0.000000	0.000000	0.021231	0.000004	0.000000
	ARM4	0.000000	0.000000	0.000000	0.143112	0.000000	0.000000	0.038290	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.143112	0.000000	0.000000	0.085083	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.832815	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.002464	0.000000	0.000000	0.066744	0.000001	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.228484	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000646	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.157394	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000011	0.000000	0.000000	0.958256	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000082	0.000000	0.000000	0.793540	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000031	0.000000	0.000000	0.564744	0.000002	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.002464	0.000000	0.000000	0.714061	0.000135	0.000000	0.000319	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000082	0.000001	0.000003	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.001968	0.001453	0.000009	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.373476	0.000000	0.000000	0.000001	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000004	0.000000	0.000006
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000077	0.000000	0.000000
	M4	0.061428	0.000005	0.000000	0.228484	0.000087	0.000010	0.000031	0.000003	0.000000
	ARM4	0.026430	0.000000	0.000000	0.228484	0.000206	0.000011	0.000011	0.000001	0.000000
	VARM4	0.035416	0.000000	0.000000	0.157394	0.003323	0.000098	0.000031	0.000003	0.000000
2015	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000007	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.032857	0.009650	0.006893	0.000052	0.000000	0.000003	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000011	0.000000	0.000000	0.000002	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.007499	0.027198	0.001099	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000001	0.000000	0.000000	0.271553	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.101772	0.000000	0.000000	0.228484	0.000000	0.000000	0.522952	0.000000	0.000000
	ARM3	0.000082	0.000000	0.000000	0.003923	0.000000	0.000000	0.132440	0.000000	0.000000
	VARM3	0.000007	0.000000	0.000000	0.104463	0.000000	0.000000	0.418237	0.000000	0.000000
	M4	0.376452	0.006855	0.010467	0.041022	0.000010	0.000005	0.000492	0.000000	0.000000
	ARM4	0.975884	0.000066	0.000059	0.104463	0.000001	0.000001	0.005143	0.000000	0.000000
	VARM4	0.785058	0.001305	0.001375	0.041022	0.000010	0.000031	0.000031	0.000000	0.000000
2016	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.509491	0.000807	0.000005	1.000000	0.061992	0.000010	0.108524	0.239567	0.022321
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.065951	0.000255	0.000481	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.834382	0.829907	0.013538	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000002	0.000000	0.000000	0.673945	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.008854	0.000000	0.000000	0.108524	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.011984	0.000000	0.000000	0.038290	0.000000	0.000000
	VARM3	0.000000	0.000000	0.000000	0.295710	0.000000	0.000000	0.003971	0.000000	0.000000
	M4	0.369477	0.000836	0.000018	0.601155	0.111012	0.002769	0.005683	0.003815	0.003118
	ARM4	0.951900	0.023730	0.008274	0.250018	0.046772	0.005665	0.000149	0.000002	0.000001
	VARM4	0.136865	0.034958	0.003335	1.000000	0.004233	0.000448	0.003971	0.000004	0.000000

Table 19: Coverage tests for Middle Quantiles of HP3. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_{95} UC	Q_{95} CC	Q_{95} DC	Q_{98} UC	Q_{98} CC	Q_{98} DC	Q_{99} UC	Q_{99} CC	Q_{99} DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000420	0.001309	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.030591	0.000146	0.000737	0.622249	0.007389	0.027654	0.939256
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.030591	0.000146	0.000737	0.622249	0.007389	0.027654	0.939256
	VARM2	0.000000	0.000000	0.030591	0.000146	0.000737	0.622249	0.007389	0.027654	0.939256
	EGARCHst	0.001886	0.000005	0.000000	0.021708	0.000001	0.000000	0.473190	0.113910	0.000000
	M3	0.000000	0.000001	0.055849	0.000146	0.000737	0.622249	0.007389	0.027654	0.939256
	ARM3	0.000000	0.000001	0.055789	0.000146	0.000737	0.622249	0.007389	0.027654	0.939256
	VARM3	0.000244	0.000176	0.018630	0.000146	0.000737	0.622249	0.007389	0.027654	0.939256
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.026103	0.000120	0.000615	0.603163	0.006681	0.025263	0.934247
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.050591	0.003063	0.012432	0.783078	0.097586	0.252834	0.988034
	VARM2	0.000001	0.000005	0.088280	0.000120	0.000615	0.603163	0.006681	0.025263	0.934247
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000171	0.000798	0.022039	0.003063	0.012432	0.793918	0.006681	0.025263	0.934247
	ARM3	0.000037	0.000193	0.004777	0.003063	0.012432	0.789655	0.006681	0.025263	0.934247
	VARM3	0.002044	0.007509	0.050295	0.000120	0.000615	0.603163	0.006681	0.025263	0.934247
	M4	0.000002	0.000000	0.000000	0.000092	0.000000	0.000000	0.000008	0.000003	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.026569	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.026569	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	VARM2	0.000000	0.000000	0.048856	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000667	0.000000	0.000000	0.068612	0.008689	0.000000	0.724226	0.042852	0.000000
	ARM3	0.014147	0.000003	0.000000	0.068612	0.008689	0.000000	0.342459	0.630242	0.000000
	VARM3	0.000007	0.000002	0.000067	0.019025	0.063250	0.000121	0.342459	0.630242	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	M1	0.952019	0.000001	0.000000	0.054567	0.000000	0.000000	0.257954	0.110944	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.026569	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.117696	0.256373	0.000000
	ARM2	0.000000	0.000000	0.026569	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	VARM2	0.000000	0.000000	0.026569	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.051774	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	ARM3	0.000001	0.000005	0.084953	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	VARM3	0.000007	0.000038	0.125103	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000033	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2015	M1	0.079311	0.000998	0.000000	0.910088	0.866199	0.000000	0.724226	0.916521	0.000141
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.001381	0.000478	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.051908	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.856117	0.940933	0.814626
	ARM2	0.000000	0.000000	0.051899	0.003122	0.012651	0.796703	0.006756	0.025518	0.934814
	VARM2	0.000000	0.000000	0.051923	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000007	0.000038	0.157226	0.003122	0.012651	0.797083	0.006756	0.025518	0.934814
	ARM3	0.000007	0.000038	0.157750	0.003122	0.012651	0.796869	0.098483	0.254687	0.992637
	VARM3	0.005822	0.000670	0.003326	0.003122	0.012651	0.797131	0.006756	0.025518	0.934814
	M4	0.000683	0.000086	0.000000	0.011592	0.002554	0.000000	0.048057	0.004252	0.000000
	ARM4	0.002710	0.000167	0.000000	0.000088	0.000029	0.000000	0.000033	0.000007	0.000000
	VARM4	0.000013	0.000001	0.000000	0.000003	0.000000	0.000000	0.000000	0.000000	0.000000
2016	M1	0.180970	0.008472	0.000004	0.175408	0.386258	0.013229	0.097586	0.252834	0.981391
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.026103	0.000120	0.000615	0.603163	0.006681	0.025263	0.934247
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.005012	0.009360	0.000000	0.860310	0.941947	0.095691
	ARM2	0.000006	0.000002	0.000324	0.003063	0.012432	0.781960	0.097586	0.252834	0.988763
	VARM2	0.000006	0.000002	0.000330	0.003063	0.012432	0.789155	0.097586	0.252834	0.991279
	EGARCHst	0.000001	0.000000	0.000000	0.000009	0.000019	0.000000	0.000139	0.000144	0.000000
	M3	0.005637	0.007916	0.231153	0.003063	0.012432	0.778046	0.097586	0.252834	0.976308
	ARM3	0.029983	0.050783	0.506537	0.003063	0.012432	0.779610	0.097586	0.252834	0.978651
	VARM3	0.059399	0.104759	0.517833	0.003063	0.012432	0.782689	0.097586	0.252834	0.983390
	M4	0.000718	0.000107	0.000000	0.000092	0.000338	0.000005	0.000529	0.001638	0.000000
	ARM4	0.000161	0.000053	0.000000	0.000030	0.000054	0.000000	0.000034	0.000049	0.000000
	VARM4	0.000001	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Table 20: Coverage tests for Upper Quantiles of HP3. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-st.

		Q_1			Q_2			Q_5		
Years	Models	UC	CC	DC	UC	CC	DC	UC	CC	DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.362478	0.653153	0.999860	0.077043	0.204213	0.982854	0.131899	0.228489	0.747415
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.755217	0.928583	0.000151	0.046625	0.029370	0.001323	0.100637	0.000106	0.000000
	VARM2	0.755217	0.928583	0.000153	0.176038	0.046094	0.004131	0.038200	0.000166	0.000000
	EGARCHst	0.000001	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.822449	0.088426	0.002268	0.176038	0.003981	0.000002	0.100637	0.000814	0.000002
	ARM3	0.238900	0.107340	0.040831	0.176038	0.003981	0.000002	0.154972	0.000648	0.000000
	VARM3	0.473190	0.113910	0.017902	0.093767	0.039186	0.001123	0.100637	0.000814	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.720414	0.042658	0.000001	0.358469	0.002189	0.000000	0.127009	0.000053	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.720414	0.042658	0.000000	0.802449	0.000608	0.000000	0.017599	0.000000	0.000000
	VARM2	0.720414	0.042658	0.000000	0.342897	0.002194	0.000000	0.005374	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.048753	0.000148	0.000000	0.055625	0.000000	0.000000	0.000073	0.000000	0.000000
	ARM3	0.048753	0.000148	0.000000	0.109291	0.000006	0.000000	0.001447	0.000004	0.000000
	VARM3	0.018014	0.000096	0.000000	0.005012	0.000001	0.000000	0.000006	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.098483	0.254687	0.991249	0.019025	0.063250	0.883629	0.049070	0.001101	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.048057	0.000002	0.000000	0.000729	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.048057	0.000002	0.000000	0.000029	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.001823	0.000072	0.000000	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000515	0.000039	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000135	0.000018	0.000000	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.002117	0.000148	0.000004
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.006756	0.025518	0.934814	0.003122	0.012651	0.717610	0.060904	0.000002	0.000000
	VARM2	0.006756	0.025518	0.934814	0.019025	0.001033	0.000000	0.060904	0.000002	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.342459	0.010290	0.000000	0.068612	0.008689	0.000000	0.678752	0.007428	0.000474
	ARM3	0.342459	0.010290	0.000000	0.068612	0.008689	0.000001	0.761472	0.099267	0.032507
	VARM3	0.342459	0.010290	0.000000	0.068612	0.008689	0.000001	0.857958	0.004694	0.000115
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2015	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000515	0.001687	0.000000	0.001938	0.003608	0.000000	0.382296	0.249397	0.046475
	M2st	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.049059
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000001	0.000005	0.092642
	VARM2	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000001	0.000005	0.092690
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.006756	0.025518	0.934814	0.003122	0.012651	0.794360	0.000667	0.002814	0.126549
	ARM3	0.006756	0.025518	0.934814	0.003122	0.012651	0.794842	0.005822	0.019076	0.113599
	VARM3	0.006756	0.025518	0.934814	0.003122	0.012651	0.794574	0.184689	0.266163	0.255936
	M4	0.117696	0.083839	0.000061	0.054567	0.004209	0.000000	0.029350	0.000897	0.000021
	ARM4	0.017711	0.002318	0.000000	0.000729	0.000079	0.000000	0.009509	0.008970	0.001904
	VARM4	0.000002	0.000001	0.000000	0.000003	0.000000	0.000000	0.000013	0.000001	0.000000
2016	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000001	0.000000	0.000003	0.000001	0.000000	0.009882	0.000807	0.000000
	M2st	0.006681	0.025263	0.934247	0.000120	0.000615	0.603163	0.000006	0.000036	0.155612
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.097586	0.252834	0.992890	0.067621	0.183640	0.968604	0.180970	0.000038	0.000008
	VARM2	0.097586	0.252834	0.992952	0.175408	0.035337	0.005011	0.107839	0.003364	0.011703
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.097586	0.252834	0.989362	0.018707	0.062327	0.912695	0.573304	0.783853	0.013882
	ARM3	0.097586	0.252834	0.990810	0.018707	0.062327	0.914305	0.414556	0.622290	0.120020
	VARM3	0.006681	0.025263	0.934247	0.003063	0.012432	0.785032	0.942492	0.981293	0.000045
	M4	0.048753	0.003191	0.946866	0.342897	0.039009	0.009791	0.687712	0.618925	0.184010
	ARM4	0.006054	0.001414	0.000000	0.200579	0.040330	0.018546	0.191077	0.077298	0.090349
	VARM4	0.006054	0.001414	0.000000	0.026521	0.002827	0.000000	0.526512	0.010649	0.000098

Table 21: Coverage tests for Lower Quantiles of HP12. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

		Q_{25}			Q_{50}			Q_{75}		
Years	Models	UC	CC	DC	UC	CC	DC	UC	CC	DC
2011	M1	0.000000	0.000000	0.000000	0.124615	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.194493	0.000000	0.000000	0.004950	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.371055	0.000001	0.000000	0.022693	0.000000	0.000000	0.000997	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.063756	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.002501	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.830988	0.000000	0.000000	0.006855	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.347979	0.000000	0.000000	0.003537	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.003537	0.002722	0.000000	0.076328	0.095002	0.000000
	M3	0.124688	0.000000	0.000000	0.152811	0.000000	0.000000	0.000001	0.000000	0.000000
	ARM3	0.058685	0.000000	0.000000	0.711017	0.000000	0.000000	0.000001	0.000000	0.000000
	VARM3	0.024857	0.000000	0.000000	0.491384	0.000000	0.000000	0.000069	0.000000	0.000000
	M4	0.003241	0.000000	0.000000	0.368170	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.002214	0.000000	0.000000	0.185609	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000997	0.000000	0.000000	0.266242	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.008854	0.000001	0.000020	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000556	0.000000	0.000000	0.753801	0.000017	0.000000	0.015538	0.000001	0.000000
	M2st	0.015538	0.000022	0.000002	0.006475	0.000000	0.000013	0.000003	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.011984	0.000000	0.000023	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.021296	0.000004	0.000001	0.000000	0.000000	0.000000
	ARM2	0.011241	0.000002	0.000000	0.834382	0.000002	0.000000	0.000036	0.000000	0.000000
	VARM2	0.011241	0.000004	0.000000	0.530459	0.000104	0.000000	0.000036	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.173952	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.002743	0.000001	0.000000	0.008854	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.085083	0.000012	0.000000	0.006475	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.050541	0.000482	0.000000	0.001160	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000022	0.000000	0.000000	0.753801	0.000272	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000008	0.000000	0.000000	0.530459	0.000041	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.916739	0.002957	0.004808	0.000000	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.793540	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.637565	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000019	0.000000	0.000000	0.958256	0.000000	0.000000	0.001676	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.714061	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.793540	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000011	0.000000	0.000000	0.104463	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000001	0.000000	0.000000	0.271553	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.228484	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.002464	0.000000	0.000000	0.000292	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.001676	0.000000	0.000000	0.000193	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000082	0.000000	0.000000	0.005452	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000001	0.000000	0.000000	0.432309	0.000004	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000001	0.000000	0.000000	0.319867	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.496173	0.000011	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000292	0.000001	0.000002	0.000019	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.046912	0.000016	0.000000	0.875223	0.000218	0.000000	0.101772	0.000084	0.000000
	M2st	0.061428	0.000003	0.000000	0.000646	0.000005	0.000036	0.001566	0.000007	0.000211
	M2jsu	0.000000	0.000000	0.000000	0.000126	0.000002	0.000011	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.002793	0.000038	0.000000	0.000000	0.000000	0.000000
	ARM2	0.103177	0.000000	0.000000	0.000013	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.079241	0.000000	0.000000	0.000008	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010249	0.000000	0.000000
	M3	0.489975	0.000008	0.000000	0.000052	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.651793	0.000000	0.000000	0.000052	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.026430	0.000000	0.000000	0.005452	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.026430	0.000001	0.000000	0.190510	0.000000	0.000000	0.000002	0.000000	0.000000
	ARM4	0.001676	0.000000	0.000000	0.041022	0.000000	0.000000	0.000004	0.000000	0.000000
	VARM4	0.001676	0.000000	0.000000	0.319867	0.000000	0.000000	0.000002	0.000000	0.000000
2015	M1	0.000000	0.000000	0.000000	0.157394	0.008526	0.001411	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.489975	0.018289	0.000399	0.714061	0.717797	0.012691	0.003580	0.006926	0.000003
	M2st	0.000007	0.000035	0.002290	0.052583	0.042368	0.001929	0.785058	0.753309	0.000176
	M2jsu	0.000000	0.000000	0.000000	0.083902	0.058584	0.000400	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.001968	0.008298	0.013985	0.000000	0.000000	0.000000
	ARM2	0.446381	0.079471	0.024716	0.958256	0.054159	0.000097	0.376452	0.002840	0.000055
	VARM2	0.693254	0.492014	0.024584	0.373476	0.023611	0.000007	0.522952	0.008893	0.000466
	EGARCHst	0.000000	0.000000	0.000000	0.319867	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.353223	0.033368	0.000082	0.190510	0.000005	0.000000	0.002464	0.000000	0.000000
	ARM3	0.243885	0.001565	0.000000	0.875223	0.000000	0.000000	0.000749	0.000000	0.000000
	VARM3	0.000031	0.000000	0.000000	0.496173	0.000000	0.000000	0.002464	0.000000	0.000000
	M4	0.832815	0.205723	0.175900	0.958256	0.289652	0.042589	0.019498	0.000129	0.000002
	ARM4	0.651793	0.018469	0.050663	0.373476	0.146708	0.009501	0.005143	0.000031	0.000001
	VARM4	0.243885	0.001194	0.000195	0.637565	0.000133	0.000042	0.019498	0.000073	0.000000
2016	M1	0.000002	0.000000	0.000000	0.016056	0.000062	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.762107	0.005903	0.000034	0.094183	0.000000	0.000000	0.000556	0.000010	0.000000
	M2st	0.000340	0.000000	0.000000	0.016056	0.000273	0.000000	0.136865	0.001989	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.059663	0.001201	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.003358	0.004402	0.008863	0.000000	0.000000	0.000000
	ARM2	0.198896	0.000007	0.000000	0.001160	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.125125	0.000015	0.000001	0.000542	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000542	0.000000	0.000000	0.005683	0.000000	0.000000
	M3	0.210474	0.000950	0.000000	0.250018	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.050541	0.000015	0.000000	0.173952	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000149	0.000000	0.000000	0.916739	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.856050	0.043434	0.000402	0.003358	0.000005	0.000000	0.000234	0.000001	0.000000
	ARM4	0.671323	0.000015	0.000004	0.003358	0.000011	0.000000	0.008039	0.000000	0.000000
	VARM4	0.762107	0.000324	0.000010	0.003358	0.000000	0.000000	0.000362	0.000001	0.000000

Table 22: Coverage tests for Middle Quantiles of HP12. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_{95} UC	Q_{95} CC	Q_{95} DC	Q_{98} UC	Q_{98} CC	Q_{98} DC	Q_{99} UC	Q_{99} CC	Q_{99} DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.131899	0.228489	0.189578	0.003639	0.014543	0.811099	0.007389	0.027654	0.939256
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000213	0.000001	0.000000	0.176038	0.000000	0.000000	0.238900	0.107340	0.000000
	VARM2	0.000213	0.000000	0.000000	0.093767	0.000000	0.000000	0.238900	0.107340	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.009491	0.018702	0.000000	0.238900	0.450950	0.000008
	M3	0.000018	0.000000	0.000000	0.000195	0.000001	0.000000	0.015421	0.042117	0.000000
	ARM3	0.000008	0.000000	0.000000	0.001519	0.000000	0.000000	0.106849	0.079249	0.000000
	VARM3	0.000939	0.000000	0.000000	0.009491	0.000260	0.000000	0.001520	0.000755	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.867459	0.006110	0.000071	0.358469	0.002189	0.000000	0.720414	0.042658	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.002832	0.000001	0.000000	0.109291	0.000269	0.000000	0.119098	0.000001	0.000000
	VARM2	0.009882	0.000005	0.000000	0.342897	0.000109	0.000000	0.119098	0.000001	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.277538	0.000461	0.000000	0.904210	0.016419	0.000000	0.504858	0.002671	0.000000
	ARM3	0.389106	0.000299	0.000000	0.904210	0.016419	0.000000	0.860310	0.001019	0.000000
	VARM3	0.000161	0.000004	0.000000	0.802449	0.000016	0.000000	0.504858	0.002671	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.049070	0.000176	0.000000	0.362159	0.615798	0.938763	0.342459	0.630242	0.966196
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.011592	0.000287	0.000000	0.257954	0.110944	0.000009
	VARM2	0.000000	0.000000	0.000000	0.001938	0.000001	0.000000	0.017711	0.002973	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.001938	0.000001	0.000000	0.048057	0.004252	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000729	0.000001	0.000000	0.017711	0.000145	0.000000
	VARM3	0.000000	0.000000	0.000000	0.000729	0.000001	0.000000	0.017711	0.002973	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000069	0.000289	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000178	0.000828	0.134085	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.184689	0.085040	0.003581	0.003122	0.012651	0.740891	0.006756	0.025518	0.934814
	VARM2	0.030817	0.052103	0.033297	0.003122	0.012651	0.792868	0.006756	0.025518	0.934814
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.005157	0.000812	0.000001	0.068612	0.185837	0.004056	0.006756	0.025518	0.934814
	ARM3	0.001381	0.000478	0.000000	0.177586	0.385466	0.034533	0.006756	0.025518	0.934814
	VARM3	0.000683	0.000104	0.000000	0.019025	0.063250	0.833024	0.006756	0.025518	0.934814
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000001	0.000003	0.000000	0.000000	0.000000	0.000000	0.000002	0.000004	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2015	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000013	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000007	0.000038	0.143988	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000039	0.000201	0.245507	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	VARM2	0.000039	0.000201	0.245598	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.014147	0.039241	0.518372	0.003122	0.012651	0.796835	0.006756	0.025518	0.934814
	ARM3	0.014147	0.039241	0.518013	0.003122	0.012651	0.797138	0.006756	0.025518	0.934814
	VARM3	0.000667	0.002767	0.214394	0.000123	0.000627	0.605281	0.006756	0.025518	0.934814
	M4	0.000013	0.000004	0.000000	0.000001	0.000003	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000005	0.000000	0.000000	0.000029	0.000052	0.000000	0.000000	0.000002	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000000
2016	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000345	0.001066	0.000000	0.000092	0.000338	0.000000	0.000034	0.000106	0.000000
	M2st	0.000171	0.000798	0.047675	0.000120	0.000615	0.603163	0.006681	0.025263	0.934247
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000008	0.000015	0.000000
	ARM2	0.414556	0.236078	0.020227	0.175408	0.381984	0.995920	0.006681	0.025263	0.934247
	VARM2	0.180970	0.083389	0.006599	0.175408	0.381984	0.995911	0.006681	0.025263	0.934247
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.030336	0.017291	0.000011	0.003063	0.012432	0.794777	0.006681	0.025263	0.934247
	ARM3	0.030336	0.005067	0.000001	0.003063	0.012432	0.794100	0.097586	0.252834	0.992455
	VARM3	0.127009	0.023772	0.000907	0.018707	0.062327	0.919986	0.006681	0.025263	0.934247
	M4	0.000073	0.000171	0.000000	0.000753	0.001767	0.000001	0.006054	0.011359	0.000426
	ARM4	0.000073	0.000171	0.000000	0.001997	0.000870	0.000000	0.006054	0.011359	0.000264
	VARM4	0.000000	0.000000	0.000000	0.000009	0.000045	0.000000	0.000139	0.000545	0.000000

Table 23: Coverage tests for Upper Quantiles of HP12. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_1 UC	Q_1 CC	Q_1 DC	Q_2 UC	Q_2 CC	Q_2 DC	Q_5 UC	Q_5 CC	Q_5 DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.105957	0.269935	0.993641	0.003639	0.014543	0.811919	0.007528	0.010491	0.337196
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000420	0.000318	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.105957	0.269935	0.992711	0.195891	0.414024	0.061076	0.017930	0.027863	0.045510
	VARM2	0.105957	0.269935	0.992861	0.195891	0.414024	0.054235	0.216771	0.013229	0.001150
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.362478	0.653153	0.999797	0.077043	0.204213	0.978866	0.074224	0.023396	0.002994
	ARM3	0.822449	0.088426	0.000000	0.957655	0.290410	0.000011	0.216771	0.099144	0.016069
	VARM3	0.755217	0.928583	0.999995	0.657748	0.817914	0.999631	0.970981	0.572167	0.507888
	M4	0.000000	0.000000	1.000000	0.000000	0.000000	1.000000	0.000000	0.000000	1.000000
	ARM4	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.340027	0.627392	0.660684	0.904210	0.000004	0.000000	0.942492	0.000001	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.006681	0.025263	0.934247	0.067621	0.000035	0.000000	0.000643	0.000000	0.000006
	VARM2	0.006681	0.025263	0.934247	0.018707	0.001015	0.000000	0.005637	0.000022	0.000089
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.260387	0.000059	0.000000	0.904210	0.000004	0.000000	0.526512	0.001788	0.000001
	ARM3	0.720414	0.000174	0.000000	0.175408	0.000413	0.000000	0.191077	0.000650	0.000000
	VARM3	0.720414	0.000174	0.000000	0.611055	0.007128	0.000028	0.277538	0.000333	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.006756	0.025518	0.934814	0.019025	0.063250	0.903307	0.110310	0.000274	0.000163
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.006756	0.025518	0.934814	0.003122	0.012651	0.795806	0.184689	0.011080	0.000180
	VARM2	0.006756	0.025518	0.934814	0.003122	0.012651	0.794222	0.421216	0.005021	0.000782
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.342459	0.630242	0.999735	0.910088	0.016521	0.000432	0.952019	0.000308	0.000002
	ARM3	0.098483	0.254687	0.992894	0.177586	0.385466	0.991246	0.421216	0.005021	0.001317
	VARM3	0.098483	0.254687	0.993119	0.362159	0.095224	0.313273	0.761472	0.018236	0.000042
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.050568
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.026569
	VARM2	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.051838
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.006756	0.025518	0.934814	0.003122	0.012651	0.744981	0.000667	0.000644	0.076085
	ARM3	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000667	0.000025	0.003962
	VARM3	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.005822	0.008170	0.100350
	M4	0.000135	0.000506	0.000000	0.000260	0.000757	0.000039	0.000069	0.000000	0.000000
	ARM4	0.000033	0.000152	0.000000	0.000088	0.000123	0.000000	0.000069	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000009	0.000043	0.000000	0.000013	0.000000	0.000000
2015	M1	0.017711	0.047812	0.000008	0.000729	0.003300	0.000033	0.000005	0.000023	0.000001
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000029	0.000052	0.000000	0.005157	0.000812	0.000000
	M2st	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.026569
	M2jsu	0.000033	0.000152	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.026569
	VARM2	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.000000	0.000000	0.026569
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.001381	0.000006	0.000000
	ARM3	0.006756	0.025518	0.934814	0.003122	0.012651	0.772641	0.000000	0.000000	0.000000
	VARM3	0.006756	0.025518	0.934814	0.000123	0.000627	0.605281	0.123862	0.000001	0.000000
	M4	0.048057	0.118387	0.000007	0.338885	0.477187	0.066598	0.678752	0.913119	0.000021
	ARM4	0.005937	0.017125	0.000029	0.107486	0.181850	0.001892	0.952019	0.391156	0.001540
	VARM4	0.001823	0.004809	0.000000	0.011592	0.037040	0.000000	0.123862	0.019919	0.000001
2016	M1	0.000002	0.000000	0.000000	0.000001	0.000000	0.000000	0.000032	0.000007	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000345	0.000001	0.000000
	M2st	0.006681	0.025263	0.934247	0.000120	0.000615	0.603163	0.000001	0.000005	0.092709
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.097586	0.252834	0.992478	0.003063	0.012432	0.795178	0.000006	0.000002	0.012444
	VARM2	0.097586	0.252834	0.992716	0.003063	0.012432	0.795202	0.000001	0.000005	0.092210
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.006681	0.025263	0.934247	0.000120	0.000615	0.603163	0.000001	0.000005	0.088045
	ARM3	0.006681	0.025263	0.934247	0.000120	0.000615	0.603163	0.000643	0.000620	0.192393
	VARM3	0.006681	0.025263	0.934247	0.000120	0.000615	0.603163	0.000037	0.000193	0.055334
	M4	0.504858	0.746917	0.757009	0.904210	0.865782	0.470460	0.277538	0.077067	0.000008
	ARM4	0.048753	0.119886	0.019862	0.544678	0.662973	0.228152	0.127009	0.072384	0.000159
	VARM4	0.000139	0.000545	0.000000	0.000270	0.001313	0.000000	0.000718	0.000348	0.000000

Table 24: Coverage tests for Lower Quantiles of HP19. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_{25}			Q_{50}			Q_{75}		
		UC	CC	DC	UC	CC	DC	UC	CC	DC
2011	M1	0.033491	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.018233	0.000000	0.000000	0.223334	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.003312	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.560413	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.001210	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.057060	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000189	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.371055	0.000003	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000276	0.000000	0.000000	0.633821	0.000000	0.000000	0.000001	0.000000	0.000000
	ARM4	0.098125	0.000000	0.000000	0.957791	0.000000	0.000000	0.000042	0.000000	0.000000
	VARM4	0.058685	0.000000	0.000000	0.185609	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000149	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.008039	0.000000	0.000000	0.530459	0.000000	0.000000	0.021231	0.000000	0.000000
	M2st	0.360730	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.402892	0.000002	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.046803	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000003	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.170675	0.000000	0.000000
	M3	0.008039	0.000000	0.000000	0.036356	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.001873	0.000000	0.000000	0.094183	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.000362	0.000000	0.000000	0.173952	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000000	0.000000	0.000000	0.753801	0.000000	0.000000	0.005683	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.916739	0.000001	0.000016	0.001873	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.916739	0.000000	0.000000	0.000058	0.000000	0.000000
2013	M1	0.000000	0.000000	0.000000	0.010209	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000002	0.000000	0.000000	0.432309	0.000006	0.000000	0.000000	0.000000	0.000000
	M2st	0.257869	0.000773	0.001197	0.024238	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.128831	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.958256	0.000013	0.000000	0.000000	0.000000	0.000000
	ARM2	0.522952	0.000005	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.522952	0.000001	0.000000	0.000052	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001127	0.000000	0.000000
	M3	0.001127	0.000000	0.000000	0.190510	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.003580	0.000000	0.000000	0.104463	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.003580	0.000000	0.000000	0.190510	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.000031	0.000000	0.000000	0.319867	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000051	0.000000	0.000000	0.271553	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.001127	0.000000	0.000000	0.128831	0.000002	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000001	0.000000	0.000000	0.003923	0.000000	0.000001	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.079521	0.000000	0.000000	0.793540	0.000000	0.000000	0.295113	0.000000	0.000000
	M2st	0.000992	0.000001	0.000002	0.001968	0.000000	0.000000	0.003580	0.000004	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000033	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.005452	0.015702	0.050337	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002429	0.000000	0.000000
	M3	0.132440	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.376452	0.000000	0.000000	0.000013	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.693254	0.000002	0.000000	0.000033	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.295113	0.000051	0.000001	0.875223	0.001134	0.000000	0.046912	0.000060	0.000007
	ARM4	0.489975	0.001614	0.000000	0.958256	0.000035	0.000000	0.014218	0.000172	0.000000
	VARM4	0.061428	0.000000	0.000000	0.496173	0.000030	0.000000	0.079521	0.000769	0.000001
2015	M1	0.032857	0.061665	0.001351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.353223	0.184293	0.000878	0.496173	0.000189	0.000000	0.522952	0.000398	0.000000
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.958256	0.054159	0.006700	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.010209	0.013732	0.024141	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000005	0.000000	0.000000	0.243885	0.000001	0.000000
	M3	0.035416	0.000000	0.000000	0.000002	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.128779	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.001676	0.000000	0.000000	0.000126	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.023767	0.000335	0.000002	0.000126	0.000003	0.000000	0.000001	0.000000	0.000000
	ARM4	0.167642	0.145795	0.000378	0.000292	0.000042	0.000000	0.000001	0.000000	0.000000
	VARM4	0.879714	0.001767	0.000023	0.000646	0.000661	0.000000	0.000001	0.000000	0.000000
2016	M1	0.056165	0.000185	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.005683	0.000408	0.000002	0.011984	0.000004	0.000000	0.097193	0.000000	0.000011
	M2st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.834382	0.001399	0.000080	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000027	0.000076	0.000876	0.000000	0.000000	0.000011
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM2	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000340	0.000000	0.000000
	M3	0.000022	0.000000	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM3	0.007523	0.002866	0.000004	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M4	0.299639	0.002765	0.000013	0.601155	0.000010	0.000000	0.015538	0.000000	0.000000
	ARM4	0.671323	0.003434	0.000001	0.143112	0.000000	0.000000	0.000556	0.000000	0.000000
	VARM4	0.309641	0.000049	0.000073	0.173952	0.000016	0.000008	0.003971	0.000003	0.000000

Table 25: Coverage tests for Middle Quantiles of HP19. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_{95} UC	Q_{95} CC	Q_{95} DC	Q_{98} UC	Q_{98} CC	Q_{98} DC	Q_{99} UC	Q_{99} CC	Q_{99} DC
2011	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000453	0.000000	0.000000	0.392781	0.102259	0.001235	0.105957	0.269935	0.991296
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001520	0.000000	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000420	0.000000	0.000000
	EGARCHst	0.074224	0.002021	0.000620	0.392781	0.102259	0.001184	0.822449	0.088426	0.001801
	M3	0.003671	0.000001	0.000000	0.957655	0.000409	0.000000	0.473190	0.000019	0.000000
	ARM3	0.000213	0.000016	0.000000	0.749709	0.354551	0.014937	0.362478	0.653153	0.000000
	VARM3	0.000939	0.000109	0.000000	0.093767	0.161552	0.003770	0.473190	0.720013	0.000001
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	0.000000	0.000000	1.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2012	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000073	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000345	0.000000	0.000000	0.011879	0.000001	0.000000	0.001864	0.000000	0.000000
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000753	0.000000	0.000000	0.048753	0.000002	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000092	0.000000	0.000000	0.000139	0.000000	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.017599	0.000000	1.000000	0.802449	0.810113	1.000000	0.097586	0.252834	1.000000
	ARM3	0.001447	0.000001	1.000000	0.611055	0.794848	1.000000	0.097586	0.252834	1.000000
	VARM3	0.000032	0.000000	0.000000	0.200579	0.273041	0.987808	0.504858	0.746917	0.999937
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000002	0.000000	1.000000	0.000000	0.000000	1.000000	0.000000	0.000000	1.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
2013	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.000000	0.000000	0.000000	0.197757	0.048298	0.002166	0.098483	0.254687	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000515	0.000370	0.000000
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000135	0.000018	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005937	0.012184	0.000015
	ARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.048057	0.051865	0.001088
	VARM3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001823	0.000858	0.000000
	M4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2014	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.000005	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2st	0.060904	0.107162	0.047806	0.003122	0.012651	0.772962	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.856117	0.087289	0.000636
	VARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.856117	0.087289	0.000607
	EGARCHst	0.000153	0.000000	0.000000	0.000029	0.000052	0.000000	0.005937	0.012184	0.000000
	M3	0.000005	0.000000	0.000000	0.003122	0.012651	0.796369	0.006756	0.025518	0.934814
	ARM3	0.000153	0.000000	0.000000	0.019025	0.063250	0.918321	0.006756	0.025518	0.934814
	VARM3	0.857958	0.004694	0.000000	0.003122	0.012651	0.796569	0.006756	0.025518	0.934814
	M4	0.000005	0.000003	0.000000	0.000003	0.000003	0.000000	0.000000	0.000000	0.000000
	ARM4	0.000005	0.000007	0.000000	0.000003	0.000001	0.000000	0.000000	0.000000	0.000000
	VARM4	0.000013	0.000012	0.000000	0.000003	0.000014	0.000000	0.000000	0.000000	0.000000
2015	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.005157	0.000037	0.000000	0.000003	0.000001	0.000000	0.000000	0.000000	0.000000
	M2st	0.079311	0.004414	0.000000	0.362159	0.095224	0.002892	0.006756	0.025518	0.934814
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.501312	0.000019	0.000000
	VARM2	0.000000	0.000000	0.000000	0.338885	0.048191	0.000000	0.342459	0.010290	0.000000
	EGARCHst	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000009	0.000000
	M3	0.000000	0.000000	0.000000	0.338885	0.048191	0.000000	0.342459	0.630242	0.976142
	ARM3	0.000000	0.000000	0.000000	0.000260	0.000000	0.000000	0.856117	0.940933	0.001518
	VARM3	0.000153	0.000000	0.000000	0.177586	0.385466	0.027653	0.342459	0.630242	0.991392
	M4	0.000069	0.000001	0.000000	0.000003	0.000000	0.000000	0.000002	0.000000	0.000000
	ARM4	0.000153	0.000015	0.000000	0.000729	0.000542	0.000000	0.000008	0.000003	0.000000
	VARM4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2016	M1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	ARM1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	QReg	0.526512	0.061445	0.000726	0.000753	0.000555	0.000000	0.000139	0.000019	0.000000
	M2st	0.414556	0.036122	0.177217	0.611055	0.007128	0.000004	0.006681	0.025263	0.934247
	M2jsu	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M2Ser	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000000
	ARM2	0.000000	0.000000	0.000000	0.026521	0.000327	0.000000	0.720414	0.914928	0.999998
	VARM2	0.389106	0.083226	0.000001	0.904210	0.000377	0.000000	0.860310	0.001019	0.000000
	EGARCHst	0.000032	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	M3	0.191077	0.000073	0.000000	0.067621	0.008562	0.010455	0.006681	0.025263	0.934247
	ARM3	0.000000	0.000000	0.000000	0.904210	0.000377	0.000000	0.097586	0.252834	0.993023
	VARM3	0.127009	0.000000	0.000000	0.018707	0.062327	0.886865	0.006681	0.025263	0.934247
	M4	0.005374	0.000028	0.000000	0.001997	0.000125	0.000000	0.001864	0.000054	0.000000
	ARM4	0.000345	0.000065	0.000000	0.000009	0.000001	0.000000	0.000008	0.000000	0.000000
	VARM4	0.000032	0.000002	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Table 26: Coverage tests for Upper Quantiles of HP19. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests. Only EGARCH-st have been reported since they provided the same values as those of EGARCH-sst.

Years	Models	Q_1			Q_2			Q_5			Q_{25}			Q_{50}			Q_{75}			Q_{95}			Q_{98}			Q_{99}		
		UC	CC	DC	UC	CC	DC	UC	CC	DC	UC	CC	DC	UC	CC	DC	UC	CC	DC	UC	CC	DC	UC	CC	DC	UC	CC	DC
2011	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.11	0.27	0.99	0.39	0.65	0.17	0.78	0.05	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.14	0.00	0.00	0.62	0.01	0.03	0.94
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.11	0.27	0.99	0.39	0.65	0.93	0.65	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.00	0.02	0.00	0.00	0.36	0.01	0.00
	VARM2	0.36	0.65	1.00	0.39	0.65	0.91	0.97	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.05	0.00	0.20	0.04	0.00	0.36	0.01	0.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.01	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.01	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.11	0.27	0.99	0.66	0.82	0.00	0.33	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.39	0.10	0.00	0.82	0.09	0.00
	ARM3	0.11	0.27	0.99	0.96	0.29	0.00	0.46	0.00	0.00	0.08	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.96	0.29	0.00	0.82	0.09	0.00
	VARM3	0.11	0.27	0.99	0.66	0.82	0.00	0.23	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.66	0.19	0.04	0.82	0.09	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.67	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.26	0.00	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.44	0.00	0.00	0.30	0.00	0.00	0.26	0.00	0.00	0.53	0.00	0.00	0.54	0.00	0.00	0.50	0.00	0.00
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.12	0.00	0.00	0.20	0.00	0.00	0.19	0.00	0.00	0.86	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.00	0.20	0.00	0.00	0.05	0.00	0.00
	VARM2	0.12	0.00	0.00	0.20	0.00	0.00	0.19	0.00	0.00	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.11	0.00	0.00	0.12	0.00	0.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.06	0.00	0.00	0.05	0.00	0.00
	ARM3	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.00	0.03	0.00	0.00	0.05	0.00	0.00
	VARM3	0.05	0.00	0.00	0.06	0.00	0.00	0.19	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.06	0.00	0.00	0.02	0.00	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.95	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.67	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.72	0.04	0.00	0.20	0.05	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.01	0.00	0.00	0.27	0.26	0.00	0.80	0.03	0.00	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.54	0.04	0.00	0.50	0.12	0.00
	VARM2	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.20	0.00	0.00	0.86	0.09	0.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.11	0.00	0.00	0.02	0.00	0.00
	ARM3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.11	0.00	0.00	0.01	0.00	0.00
	VARM3	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.00	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.10	0.25	0.99	0.07	0.19	0.03	0.01	0.01	0.00	0.03	0.02	0.01	0.05	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.10	0.25	0.99	0.02	0.06	0.92	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.04	0.00	0.07	0.19	0.65	0.01	0.03	0.93
	VARM2	0.34	0.63	1.00	0.02	0.06	0.92	0.00	0.00	0.00	0.42	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.18	0.39	0.47	0.01	0.03	0.93
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.72	0.04	0.00	0.07	0.01	0.01	0.58	0.08	0.12	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.71	0.01	0.03	0.93
	ARM3	0.72	0.04	0.00	0.07	0.01	0.01	0.95	0.03	0.01	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.00	0.01	0.03	0.93
	VARM3	0.10	0.25	0.99	0.02	0.00	0.00	0.95	0.16	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.01	0.03	0.93
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.01	0.23	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.17	0.00	0.52	0.61	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.02	0.01	0.01	0.02	0.09	0.00	0.01	0.80	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	ARM2	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.61	0.01	0.03	0.93
	VARM2	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.09	0.00	0.01	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.61	0.01	0.03	0.93
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.01	0.03	0.93	0.00	0.00	0.61	0.06	0.11	0.64	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.58	0.23	0.00	0.01	0.79	0.01	0.03	0.93
	ARM3	0.01	0.03	0.93	0.00	0.00	0.61	0.01	0.02	0.45	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.01	0.00	0.01	0.78	0.01	0.03	0.93
	VARM3	0.01	0.03	0.93	0.00	0.00	0.61	0.29	0.15	0.05	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.00	0.00	0.00	0.61	0.01	0.03	0.93
	M4	0.26	0.48	0.05	0.20	0.31	0.24	0.52	0.63	0.01	0.69	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.12	0.26	0.00	0.05	0.10	0.29	0.08	0.15	0.02	0.45	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.26	0.48	0.00	0.62	0.80	0.02	0.76	0.93	0.20	0.17	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.02	0.00	0.01	0.00	0.00	0.07	0.02	0.00	0.08	0.07	0.03	0.20	0.00	0.00	0.00	0.00	0.00
	M2st	0.01	0.03	0.93	0.00	0.01	0.59	0.00	0.00	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.07	0.18	0.77	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.01	0.03	0.93	0.02	0.06	0.52	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.01	0.36	0.09	0.14	0.34	0.63	1.00
	VARM2	0.01	0.03	0.93	0.07	0.18	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.36	0.09	0.16	0.34	0.63	1.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	M3	0.01	0.03	0.93	0.00	0.00	0.60	0.03	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.01	0.00	0.00	0.00	0.60	0.01	0.03	0.93
	ARM3	0.01	0.03	0.93	0.00	0.00	0.60	0.11	0.18	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.60	0.01	0.03	0.93
	VARM3	0.01	0.03	0.93	0.02	0.06	0.55	0.57	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.60	0.01	0.03	0.93
	M4	0.00	0.01	0.03	0.01	0.04	0.01	0.00	0.00	0.00	0.86	0.20	0.02	0.60	0.11	0.00	0.67	0.00	0.00	0.08	0.00	0.00	0.20	0.05	0.00	0.26	0.11	0.00
	ARM4	0.00	0.00	0.00	0.03	0.05	0.02	0.03	0.02	0.00	0.67	0.22	0.06	0.75	0.03	0.00	0.14	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.03	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.51	0.08	0.00	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 27: Coverage tests for HP8. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests.

			Q_1			Q_2			Q_5			Q_{25}			Q_{50}			Q_{75}			Q_{95}			Q_{98}			Q_{99}	
2011	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.36	0.65	1.00	0.66	0.19	0.04	0.78	0.00	0.00	0.01	0.00	0.00	0.63	0.00	0.00	0.01	0.00	0.00	0.13	0.01	0.00	0.00	0.00	0.62	0.01	0.03	0.94
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.11	0.27	0.99	0.66	0.19	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.29	0.00	0.00	0.97	0.00	0.00	0.75	0.03	0.00	0.01	0.03	0.94
	VARM2	0.11	0.27	0.99	0.66	0.19	0.02	0.06	0.00	0.00	0.01	0.00	0.00	0.19	0.00	0.00	0.41	0.00	0.00	0.33	0.00	0.00	0.75	0.03	0.00	0.01	0.03	0.94
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.11	0.27	0.99	0.96	0.87	0.00	0.61	0.00	0.00	0.56	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.50	0.00	0.00	0.47	0.72	0.00
	ARM3	0.11	0.27	0.99	0.66	0.82	0.51	0.97	0.00	0.00	0.56	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.50	0.00	0.00	0.82	0.93	0.00
	VARM3	0.11	0.27	0.99	0.20	0.41	0.99	0.33	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.31	0.00	0.00	0.82	0.93	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.86	0.00	0.00	0.90	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.05	0.00	0.00	0.28	0.00	0.01	0.02	0.06	0.00	0.10	0.25	0.99
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.26	0.00	0.00	0.34	0.00	0.00	0.13	0.00	0.00	0.01	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.50	0.00	0.00
	VARM2	0.12	0.00	0.00	0.11	0.00	0.00	0.13	0.00	0.00	0.01	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.20	0.00	0.00	0.50	0.00	0.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.05	0.00	0.10	0.25	0.99
	ARM3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.04	0.00	0.10	0.25	0.99
	VARM3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.05	0.00	0.72	0.04	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.72	0.92	1.00	0.91	0.28	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.08	0.00	0.00	0.19	0.00	0.00	0.18	0.39	0.91	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.50	0.74	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.20	0.00	0.00	0.34	0.63	0.95
	VARM2	0.50	0.74	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.20	0.00	0.00	0.34	0.63	0.92
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.12	0.26	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.50	0.12	0.01
	ARM3	0.05	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.86	0.09	0.00
	VARM3	0.12	0.26	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.05	0.00	0.86	0.94	0.27
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.34	0.63	0.33	0.18	0.39	0.02	0.58	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.61	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.34	0.63	0.72	0.07	0.19	0.92	0.95	0.03	0.00	0.88	0.00	0.00	0.08	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.19	0.00	0.01	0.73	0.01	0.03	0.93
	VARM2	0.72	0.92	0.99	0.07	0.19	0.93	0.27	0.00	0.00	0.93	0.00	0.00	0.04	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.16	0.00	0.01	0.72	0.01	0.03	0.93
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.72	0.92	1.00	0.62	0.19	0.13	0.12	0.01	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.86	0.00	0.00	0.00	0.00	0.61	0.01	0.03	0.93
	ARM3	0.34	0.63	1.00	0.36	0.62	0.32	0.19	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.61	0.01	0.03	0.93
	VARM3	0.34	0.63	1.00	0.18	0.39	0.99	0.05	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.76	0.12	0.00	0.00	0.01	0.75	0.01	0.03	0.93
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.11	0.18	0.14	0.38	0.58	0.09	0.88	0.53	0.00	0.23	0.45	0.02	0.10	0.05	0.03	0.02	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.00
	M2st	0.10	0.25	0.95	0.00	0.01	0.72	0.00	0.00	0.06	0.02	0.06	0.03	0.23	0.08	0.00	0.52	0.12	0.00	0.00	0.00	0.01	0.00	0.00	0.61	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.34	0.63	0.84	0.02	0.06	0.71	0.29	0.15	0.25	0.83	0.97	0.00	0.88	0.14	0.00	0.88	0.05	0.00	0.01	0.01	0.17	0.00	0.01	0.80	0.01	0.03	0.93
	VARM2	0.34	0.63	0.82	0.07	0.19	0.94	0.29	0.15	0.26	0.98	0.99	0.00	0.56	0.25	0.01	0.98	0.02	0.00	0.01	0.00	0.01	0.00	0.01	0.80	0.01	0.03	0.93
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.10	0.25	0.99	0.00	0.01	0.79	0.00	0.00	0.47	0.00	0.00	0.00	0.10	0.00	0.00	0.03	0.00	0.00	0.29	0.02	0.00	0.00	0.01	0.80	0.10	0.25	0.99
	ARM3	0.10	0.25	0.99	0.00	0.01	0.78	0.01	0.04	0.17	0.00	0.00	0.00	0.23	0.00	0.00	0.06	0.00	0.00	0.42	0.04	0.00	0.00	0.01	0.80	0.10	0.25	0.99
	VARM3	0.10	0.25	0.98	0.00	0.01	0.74	0.95	0.03	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.08	0.00	0.00	0.18	0.01	0.00	0.00	0.00	0.61	0.01	0.03	0.93
	M4	0.01	0.01	0.00	0.05	0.12	0.28	0.03	0.04	0.05	0.49	0.79	0.00	0.27	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.20	0.10	0.00	0.16	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.24	0.28	0.01	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.10	0.25	0.90	0.00	0.01	0.68	0.00	0.00	0.16	0.16	0.00	0.00	0.21	0.01	0.00	0.58	0.16	0.00	0.11	0.19	0.02	0.00	0.00	0.60	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	ARM2	0.34	0.63	0.99	0.18	0.38	0.87	0.75	0.12	0.00	0.36	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.87	0.01	0.00	0.61	0.01	0.00	0.10	0.25	0.99
	VARM2	0.34	0.63	0.99	0.61	0.79	0.00	0.94	0.03	0.00	0.43	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.36	0.09	0.23	0.10	0.25	0.99
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.01	0.03	0.93	0.00	0.00	0.60	0.28	0.47	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.53	0.07	0.04	0.07	0.01	0.01	0.10	0.25	0.99
	ARM3	0.01	0.03	0.93	0.00	0.00	0.60	0.28	0.15	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.19	0.02	0.00	0.18	0.04	0.11	0.10	0.25	0.99
	VARM3	0.01	0.03	0.93	0.00	0.01	0.79	0.94	0.55	0.02	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.39	0.08	0.07	0.18	0.38	0.13	0.34	0.63	1.00
	M4	0.34	0.63	1.00	0.61	0.18	0.02	0.69	0.05	0.02	0.13	0.03	0.06	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.86	0.94	0.99	0.80	0.03	0.00	0.94	0.14	0.27	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.12	0.08	0.06	0.80	0.35	0.72	0.94	0.55	0.24	0.30	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 28: Coverage tests for HP16. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests.

			Q_1			Q_2			Q_5			Q_{25}			Q_{50}			Q_{75}			Q_{95}			Q_{98}			Q_{99}	
2011	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.11	0.27	0.99	0.08	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.02	0.01	0.00	0.00	0.62	0.01	0.03	0.94
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.36	0.65	1.00	0.08	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.65	0.53	0.01	0.03	0.94
	VARM2	0.36	0.65	1.00	0.08	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.53	0.06	0.02	0.07	0.91	0.01	0.03	0.94
	EGARCHst	0.24	0.45	0.00	0.31	0.00	0.00	0.78	0.21	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.24	0.45	0.00	0.31	0.00	0.00	0.78	0.21	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.36	0.65	1.00	0.20	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.87	0.38	0.01	0.03	0.94
	ARM3	0.76	0.93	0.00	0.20	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.00	0.76	0.93	0.66
	VARM3	0.76	0.93	0.00	0.20	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.25	0.00	0.76	0.93	0.67
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.72	0.00	0.00	0.36	0.00	0.00	0.11	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.18	0.04	0.00	0.10	0.25	0.99
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.86	0.00	0.00	0.36	0.00	0.00	0.94	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.36	0.09	0.00	0.10	0.25	0.99
	VARM2	0.50	0.00	0.00	0.54	0.00	0.00	0.02	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.36	0.09	0.00	0.10	0.25	0.99
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.26	0.00	0.00	0.54	0.04	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.60	0.01	0.03	0.93
	ARM3	0.50	0.00	0.00	0.34	0.05	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.18	0.01	0.03	0.00	0.01	0.78	0.01	0.03	0.93
	VARM3	0.50	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.02	0.06	0.00	0.10	0.25	0.99
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.10	0.25	0.98	0.07	0.01	0.01	0.06	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.74	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.10	0.25	0.98	0.00	0.01	0.76	0.01	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00
	VARM2	0.10	0.25	0.99	0.18	0.00	0.00	0.18	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.72	0.04	0.00	0.91	0.28	0.66	0.19	0.00	0.00	0.35	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.26	0.00	0.00
	ARM3	0.05	0.00	0.00	0.11	0.00	0.00	0.12	0.00	0.00	0.13	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.11	0.00
	VARM3	0.02	0.00	0.00	0.11	0.00	0.00	0.08	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.48	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	M1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.23	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.01	0.03	0.93	0.00	0.01	0.79	0.00	0.00	0.00	0.08	0.00	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.61	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.01	0.03	0.93	0.00	0.01	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.00	0.86	0.94	0.00
	VARM2	0.01	0.03	0.93	0.00	0.01	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.05	0.00	0.72	0.92	0.00
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.34	0.01	0.00	0.91	0.01	0.00	0.76	0.10	0.05	0.79	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.95	0.56	0.00	0.18	0.39	0.00	0.86	0.94	0.00
	ARM3	0.34	0.01	0.00	0.62	0.00	0.00	0.68	0.05	0.06	0.65	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.68	0.65	0.00	0.36	0.62	0.00	0.72	0.92	0.00
	VARM3	0.86	0.00	0.00	0.62	0.01	0.00	0.86	0.04	0.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.26	0.00	0.36	0.62	0.00	0.34	0.63	0.00
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	M1	0.12	0.07	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.86	0.94	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.02	0.05	0.52	0.27	0.23	0.17	0.15	0.20	0.02	0.02	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2st	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.45	0.02	0.06	0.00	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.14	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM2	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.00	0.00	0.02	0.06	0.00	0.01	0.03	0.93
	VARM2	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.07	0.02	0.06	0.00	0.01	0.03	0.93
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M3	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.06	0.00	0.01	0.03	0.93
	ARM3	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.01	0.00	0.02	0.06	0.00	0.01	0.03	0.93
	VARM3	0.01	0.03	0.93	0.00	0.00	0.61	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.02	0.06	0.00	0.01	0.03	0.93
	M4	0.86	0.94	0.00	0.34	0.34	0.02	0.38	0.02	0.00	0.49	0.28	0.16	0.50	0.07	0.14	0.03	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM4	0.50	0.74	0.00	0.80	0.35	0.03	0.38	0.08	0.00	0.24	0.00	0.02	0.32	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VARM4	0.01	0.01	0.00	0.03	0.02	0.00	0.19	0.08	0.00	0.24	0.00	0.00	0.88	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	M1	0.86	0.94	0.00	0.54	0.00	0.00	0.19	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	ARM1	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	QReg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.68	0.00	0.00	0.86	0.00	0.00	0.08	0.15	0.00	0.06	0.03	0.00	0.00	0.00	0.00
	M2st	0.01	0.03	0.93	0.00	0.00	0.60	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.52	0.00	0.00	0.60	0.01	0.03	0.93
	M2jsu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M2Ser	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.26	0.00
	ARM2	0.01	0.03	0.93	0.02	0.06	0.00	0.06	0.02	0.08	0.67	0.00	0.00	0.68	0.00	0.00	0.51	0.00	0.00	0.18	0.32	0.00	0.02	0.06	0.00	0.01	0.03	0.93
	VARM2	0.01	0.03	0.93	0.00	0.01	0.79	0.00	0.00	0.07	0.67	0.00	0.00	0.83	0.00	0.00	0.76	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.60	0.01	0.03	0.93
	EGARCHst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.01	0.01	0.00
	EGARCHsst	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.01	0.01	0.00
	M3	0.01	0.03	0.93	0.00	0.01	0.79	0.11	0.00	0.04	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.60	0.01	0.03	0.93
	ARM3	0.01	0.03	0.93	0.00	0.01	0.79	0.06	0.02	0.12	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.62	0.28	0.00	0.00	0.60	0.01	0.03	0.93
	VARM3	0.01	0.03	0.93	0.02	0.06	0.92	0.03	0.01	0.06	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.06	0.88	0.01	0.03	0.93
	M4	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.67	0.01	0.05	1.00	0.00	0.00	0.09	0.04	0.00	0.01	0.02	0.00	0.03	0.02	0.00	0.02	0.05	0.10
	ARM4	0.02	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.26	0.02	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00
	VARM4	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.07	0.00	0.00	0.17	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 29: Coverage tests for HP23. P-values of Coverage Tests: UC, CC and DC are respectively Kupiec'c unconditional coverage, Christoffesen's conditional coverage and Engle and Manganelli's Dynamic Quantile tests.

Acknowledgments

The authors are grateful to Dipeng Chen for his help and discussions at the initial stage of this research. In addition, the European financial support under the scheme *Marie Curie Actions, Intra–European Fellowship for Career Development* (FP7–PEOPLE–2011–IEF) is kindly acknowledged by the first author.

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