

Seasonal Factors and Outlier Effects in Returns on Demand in Australia's National Electricity Market.

Vikash Ramiah

*School of Economics, Finance and Marketing,
RMIT University, Melbourne, Australia*

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Key Literature

- Koopman (1993) document intra-daily and intra-week effects and incorporate them into their demand model using splines.
- Earlier studies considered longer-term load forecasting horizons several months into the future, using daily, weekly or monthly demand data (Engle, Granger and Hallman, 1989).

Key Literature

- Pardo, Meneu and Valor (2002) employ daily data in a study of Spanish electricity demand and emphasise the importance of daily and monthly seasonal structures.
- Smith (2000) and Cottet and Smith (2003) document intra-day patterns in demand in New South Wales and incorporates diurnal variation into a Bayesian regression framework to model intraday electricity load data and obtain short-term load forecasts.

Motivation for Paper

- Many studies recognise seasonalities but fail to incorporate the spike behaviour in demand
- Most studies based on short samples or low-frequency data
- We cover all the regions under NEMMCO

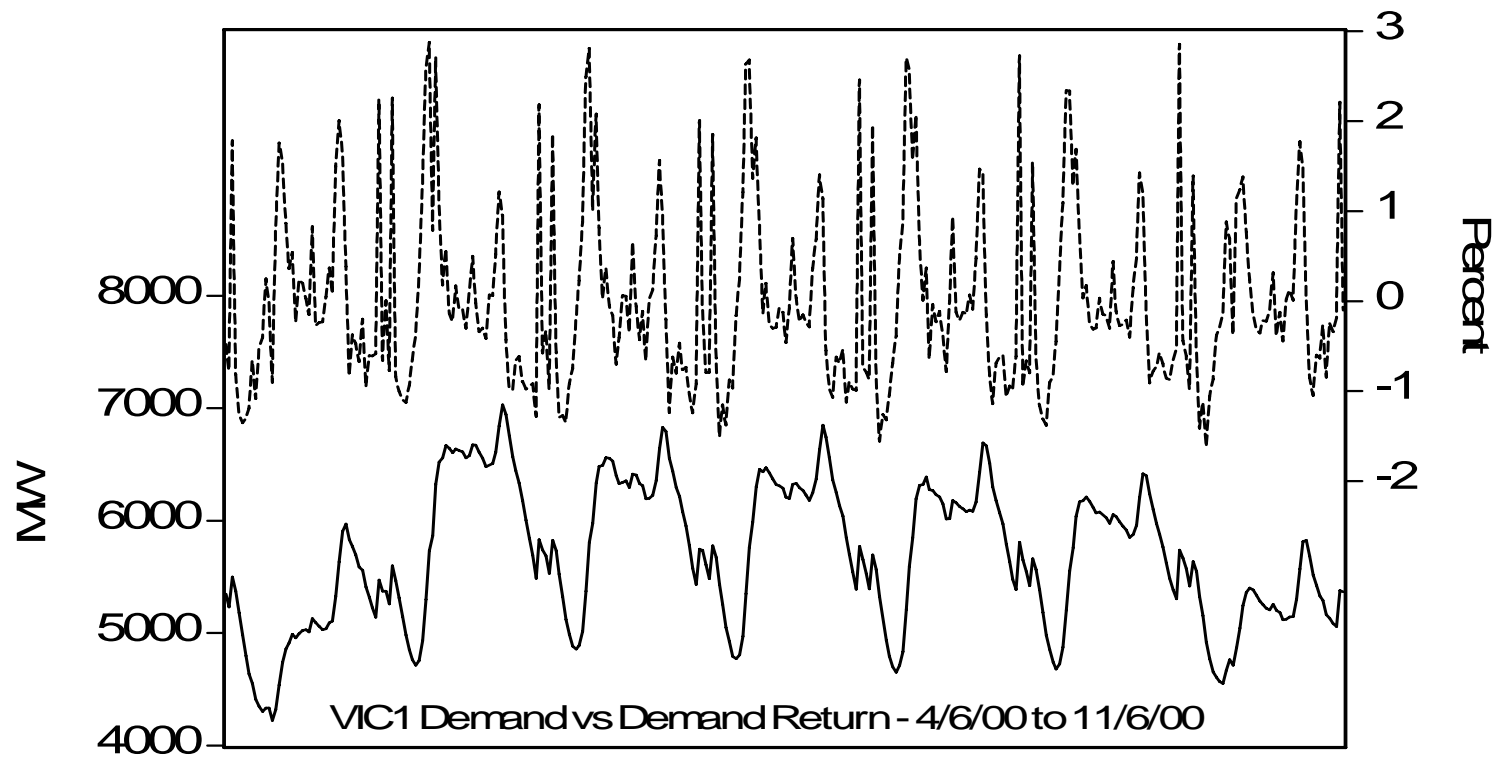
Data Set

- Half-hourly pool price for 12.30am 1/1/1999 to 12.30am 1/2/2006 for 5 NEM regions:
 - VIC1,NSW1,QLD1,SA1,SNOWY1
 - 124,224 obs for each region
- Discrete returns generated as:

$$RD_t = \frac{(D_t - D_{t-1})}{D_{t-1}}$$

- Returns spikes defined as $> \mu + 4\sigma$

VIC Demand Series Snapshot



— Demand - - - - Demand Return

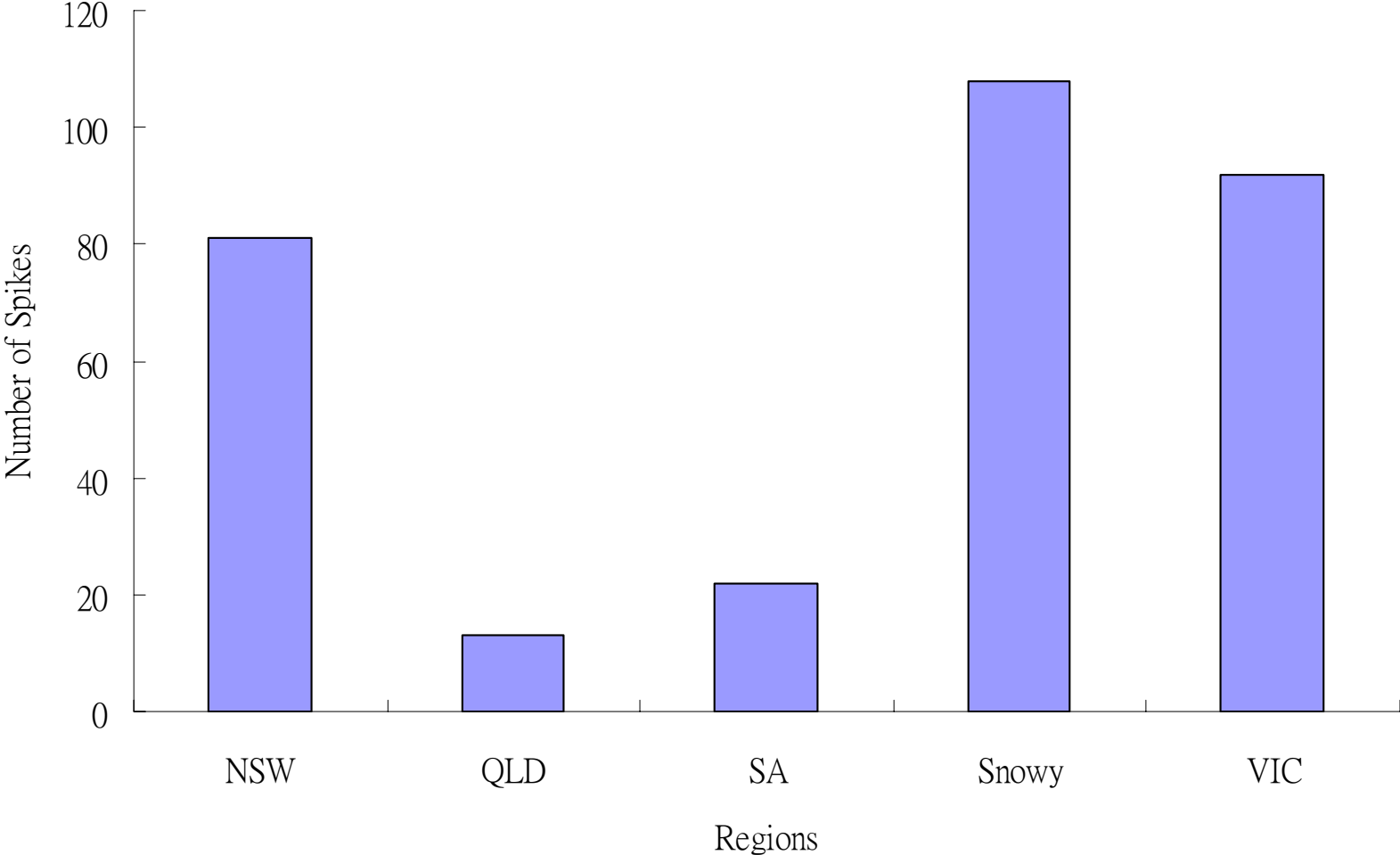
Table 1: Descriptive Statistics for Demand by Region, January 1999 to January 2006

<i>Demand</i>	NSW1	QLD1	SA1	SNOWY1	VIC1
Mean*	8123.89	5197.74	1451.56	32.13	5411.02
S.D.*	1306.02	864.33	264.45	28.77	757.26
Maximum*	12884.15	8231.95	2873.03	736.89	8545.39
Minimum*	4624.03	2945.96	778.00	0.00	2726.88
Skewness	0.03	0.12	0.74	1.20	0.04
Kurtosis	2.64	2.67	4.44	7.34	2.83
JB Stat	700.17	874.81	22026.19	127134.50	175.72
ADF**	-22.83	-17.50	-28.30	-17.01	-24.77
N	124224	124224	124224	124224	124224

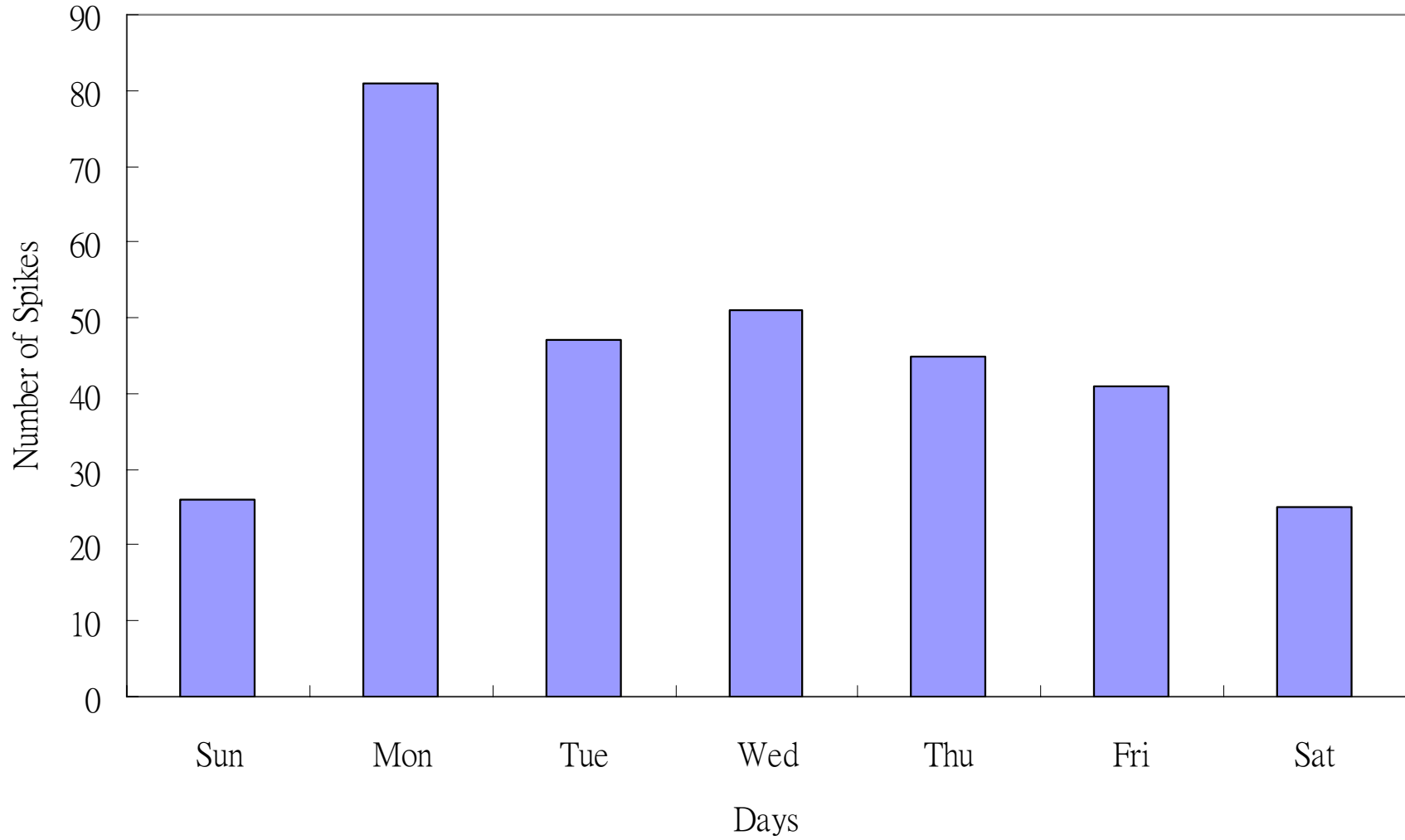
*Mean, Standard Deviation, Maximum and Minimum are expressed in Megawatts (MW).

*Augmented Dickey-Fuller (ADF) Statistic rejects the hypothesis of a Unit Root at the 1% level of confidence

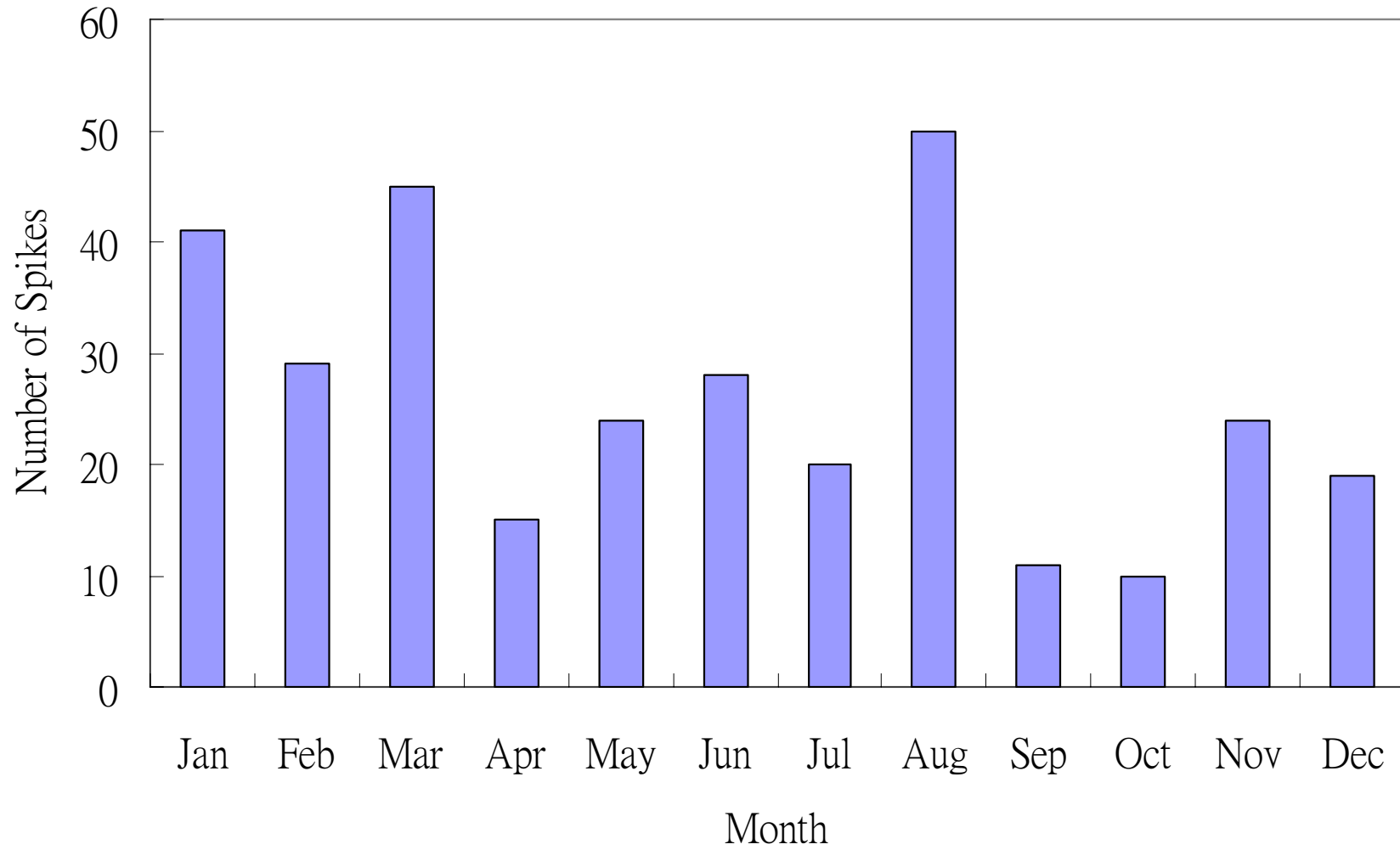
Spike Occurrence- Region



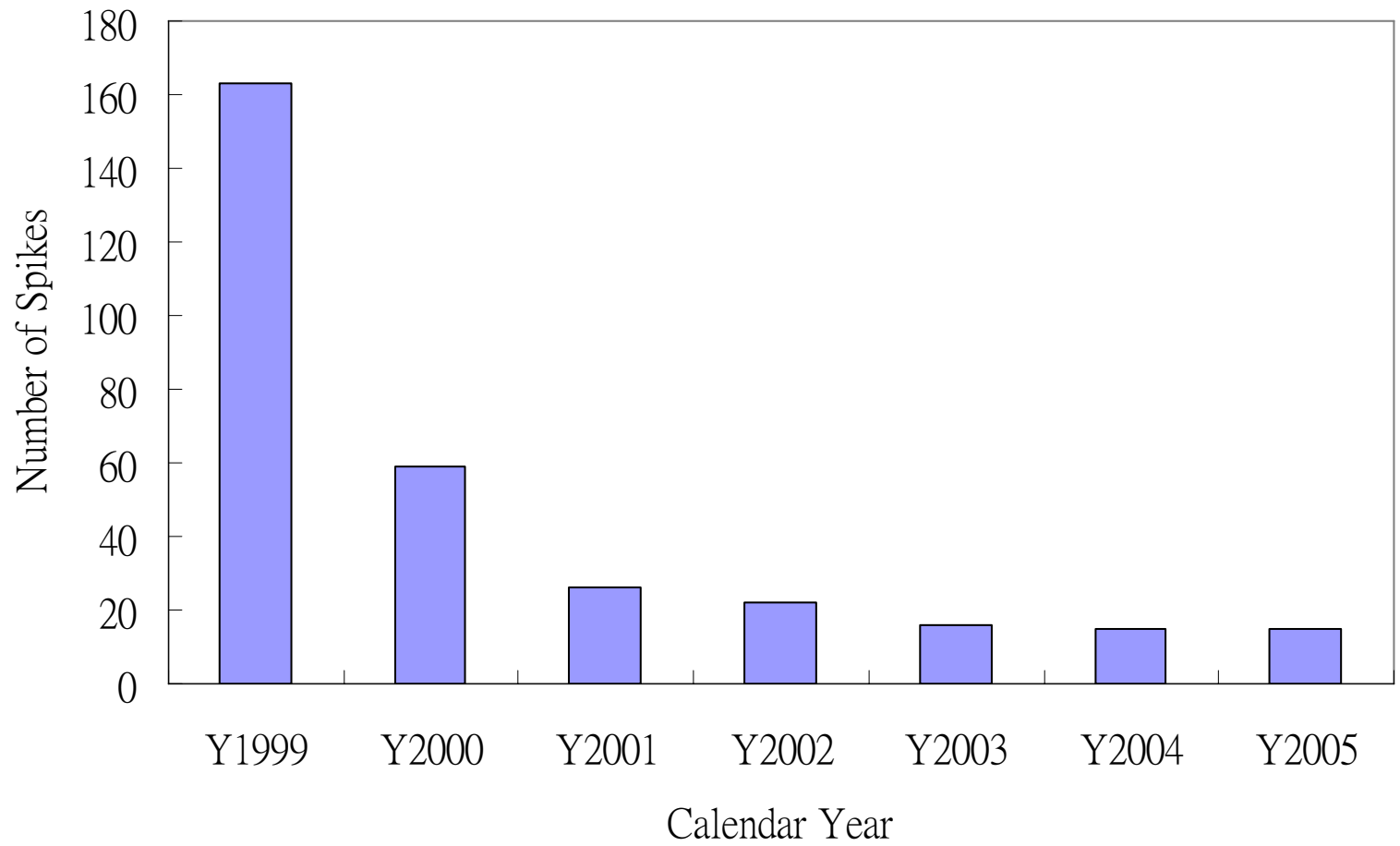
Spike Occurrence- Day of the Week



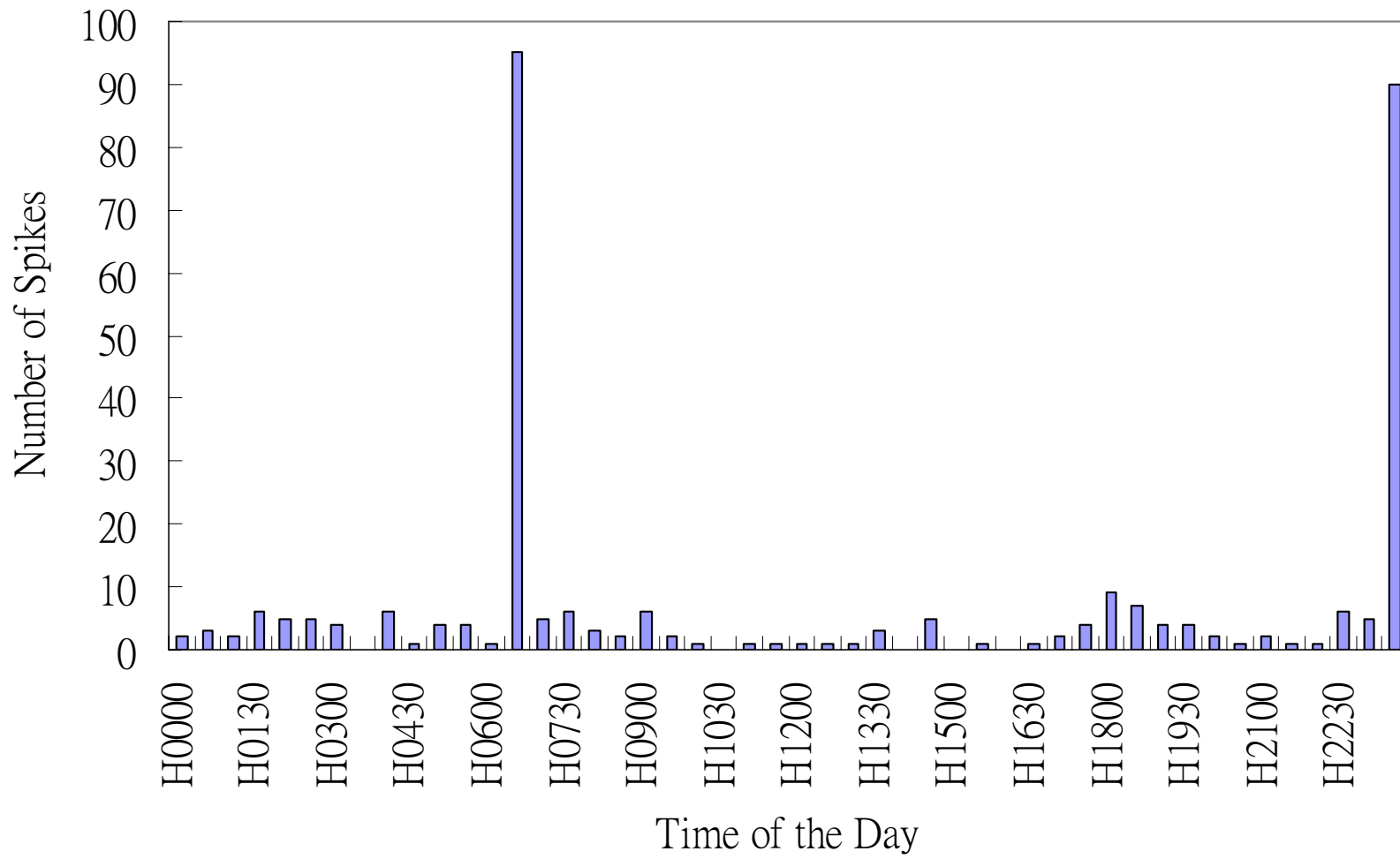
Spike Occurrence- Month



Spike Occurrence- Year



Spike Occurrence



Model

$$RD_{R,t} = \alpha_0 + \sum_{i=1}^1 \beta_{1,i} RD_{R,t-i} + \sum_{j=1}^6 \beta_{2,j} DAY_j + \sum_{k=1, \neq 9}^{12} \beta_{3,k} MTH_k + \sum_{l=1999, \neq 2001}^{2006} \beta_{4,l} YR_l$$
$$+ \sum_{m=1, \neq 24}^{48} \beta_{5,m} HH_m + \sum_{o=1}^{N_{R,S}} \beta_{6,o} SPIKE_{R,o} + \varepsilon_t$$

- The trading interval at 1130hrs, Sunday, September and the year 2001 were incorporated into the constant term

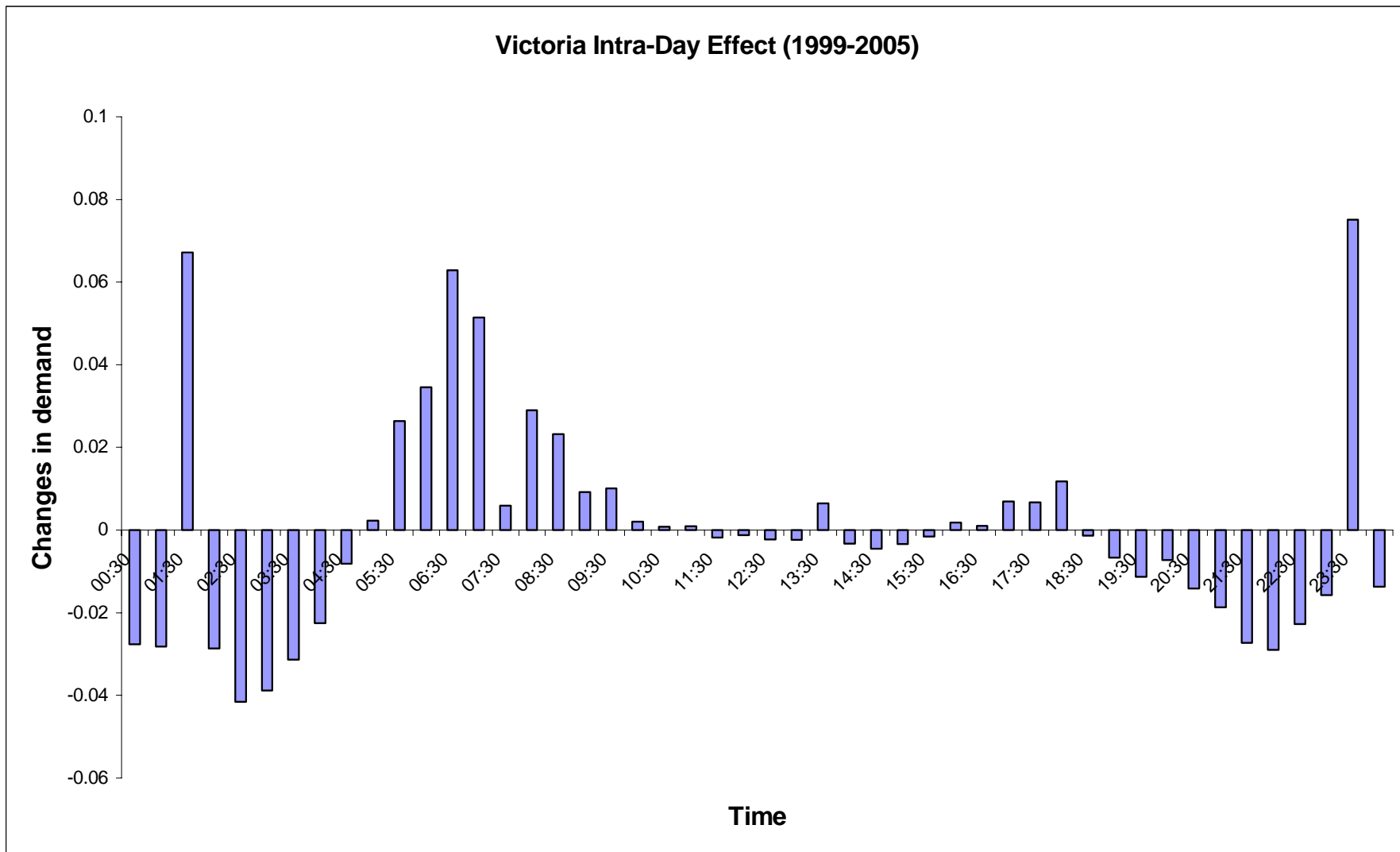
Table 4: Panel (a) - Results Of Regression Analysis For Half-Hourly Demand Return Against Seasonal Dummy Variables, By Region For Day, Month and Year.

	NSW 1		QLD 1		SA 1		SNOWY 1		VIC 1	
	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value
C	-0.00603	0.0000	-0.00170	0.0003	0.00356	0.0001	0.14213	0.0283	-0.00228	0.0000
MON	0.00099	0.0000	0.00084	0.0012	0.00091	0.0000	-0.02728	<i>0.3126</i>	0.00058	0.0000
TUE	0.00014	<i>0.1596</i>	0.00020	<i>0.4257</i>	0.00011	<i>0.4830</i>	0.02017	<i>0.4385</i>	0.00004	<i>0.7635</i>
WED	0.00010	<i>0.3355</i>	0.00014	<i>0.5700</i>	0.00005	<i>0.7354</i>	0.00966	<i>0.7107</i>	0.00006	<i>0.6743</i>
THU	0.00004	<i>0.7633</i>	-0.00020	<i>0.4318</i>	-0.00047	0.0185	-0.00070	<i>0.9795</i>	0.00002	<i>0.8637</i>
FRI	-0.00099	0.0000	-0.00105	0.0001	-0.00092	0.0000	-0.06913	0.0107	-0.00062	0.0000
SAT	-0.00025	<i>0.0608</i>	-0.00033	<i>0.1991</i>	-0.00018	<i>0.3943</i>	-0.07809	0.0039	-0.00021	<i>0.1151</i>
JAN	-0.00018	<i>0.7045</i>	0.00001	<i>0.9731</i>	0.00009	<i>0.9017</i>	0.09671	0.0118	-0.00008	<i>0.6487</i>
FEB	0.00005	<i>0.9211</i>	-0.00005	<i>0.8965</i>	0.00016	<i>0.8192</i>	0.12537	0.0014	-0.00004	<i>0.8384</i>
MAR	0.00003	<i>0.9564</i>	-0.00008	<i>0.8243</i>	0.00006	<i>0.9295</i>	0.01884	<i>0.6234</i>	-0.00018	<i>0.3254</i>
APR	-0.00009	<i>0.8486</i>	-0.00025	<i>0.4936</i>	-0.00014	<i>0.8442</i>	0.05806	<i>0.1333</i>	-0.00011	<i>0.5386</i>
MAY	0.00009	<i>0.8415</i>	0.00009	<i>0.8068</i>	0.00022	<i>0.7549</i>	0.09169	0.0168	0.00004	<i>0.8141</i>
JUN	0.00003	<i>0.9459</i>	0.00010	<i>0.7847</i>	0.00038	<i>0.5890</i>	0.02449	<i>0.5265</i>	0.00003	<i>0.8564</i>
JUL	0.00011	<i>0.8179</i>	0.00012	<i>0.7305</i>	0.00016	<i>0.8166</i>	0.09349	0.0148	0.00002	<i>0.9074</i>
AUG	-0.00003	<i>0.9485</i>	0.00005	<i>0.8984</i>	0.00040	<i>0.5402</i>	0.13220	0.0006	0.00000	<i>0.9990</i>
OCT	0.00000	<i>0.9958</i>	0.00001	<i>0.9848</i>	0.00009	<i>0.8924</i>	-0.00254	<i>0.9471</i>	0.00001	<i>0.9752</i>
NOV	0.00008	<i>0.8591</i>	0.00001	<i>0.9867</i>	0.00013	<i>0.8503</i>	0.06341	<i>0.1011</i>	0.00004	<i>0.8251</i>
DEC	0.00012	<i>0.7934</i>	-0.00010	<i>0.7765</i>	0.00041	<i>0.5580</i>	0.07055	<i>0.0659</i>	0.00000	<i>0.9779</i>
1999	-0.00009	<i>0.8388</i>	-0.00006	<i>0.8125</i>	-0.00019	<i>0.7573</i>	0.46005	0.0000	-0.00031	0.0237
2000	0.00003	<i>0.9510</i>	0.00007	<i>0.8035</i>	0.00002	<i>0.9756</i>	0.46308	0.0000	0.00000	<i>0.9931</i>
2002	-0.00002	<i>0.9638</i>	-0.00001	<i>0.9771</i>	-0.00004	<i>0.9498</i>	-0.01374	<i>0.6404</i>	0.00001	<i>0.9208</i>
2003	0.00001	<i>0.9872</i>	0.00001	<i>0.9737</i>	0.00003	<i>0.9614</i>	-0.03868	<i>0.1884</i>	0.00002	<i>0.8872</i>
2004	-0.00005	<i>0.9083</i>	-0.00001	<i>0.9658</i>	0.00004	<i>0.9459</i>	-0.15811	0.0000	0.00002	<i>0.8831</i>
2005	0.00002	<i>0.9587</i>	0.00001	<i>0.9726</i>	0.00009	<i>0.8793</i>	-0.16240	0.0000	0.00003	<i>0.8539</i>
2006	-0.00013	<i>0.8982</i>	-0.00008	<i>0.9109</i>	-0.00129	<i>0.3875</i>	-0.25318	0.0013	0.00005	<i>0.8807</i>
LR(-1)*	0.43941	0.0000	-0.22674	0.0000	0.16065	0.0486	-0.00069	-1.9700	0.58207	0.0000
R²	0.87		0.83		0.82		0.98		0.82	
Adj R²	0.87		0.83		0.82		0.98		0.82	

* Estimating with higher lag values results in a near singular matrix. Appropriate AR terms were incorporated to correct for autocorrelation.

Table 4, Panel (b): Results of regression analysis for Demand and Return against seasonal dummy variables, by half-hourly trading interval by region, 0000hrs to 2330hrs

	NSW 1		QLD1		SA 1		SNOWY1		VIC1	
	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value
H 0000	-0.01300	0.0000	-0.04000	0.0000	0.04400	0.0000	-0.18700	0.0128	-0.05500	0.0000
H 0030	-0.00800	0.0000	-0.05700	0.0000	-0.01300	0.0000	0.07800	0.2979	-0.01700	0.0000
H 0100	-0.01400	0.0000	-0.04700	0.0000	0.00400	0.0000	0.16600	0.0278	-0.01000	0.0000
H 0130	-0.01400	0.0000	-0.04300	0.0000	-0.06200	0.0000	0.58300	0.0000	0.08600	0.0000
H 0200	-0.02000	0.0000	-0.03600	0.0000	-0.06400	0.0000	-0.12800	0.0897	-0.06600	0.0000
H 0230	-0.01900	0.0000	-0.02900	0.0000	-0.05300	0.0000	0.27200	0.0003	-0.02300	0.0000
H 0300	-0.00900	0.0000	-0.01900	0.0000	-0.04000	0.0000	0.24300	0.0013	-0.01200	0.0000
H 0330	-0.00500	0.0000	-0.01000	0.0000	-0.03100	0.0000	0.24500	0.0012	-0.00600	0.0000
H 0400	0.00500	0.0000	-0.00400	0.0000	-0.02300	0.0000	0.05900	0.4360	-0.00200	0.0000
H 0430	0.01500	0.0000	0.00500	0.0000	-0.01300	0.0000	0.03000	0.6942	0.00700	0.0000
H 0500	0.02000	0.0000	0.01300	0.0000	-0.00400	0.0000	-0.15400	0.0406	0.00900	0.0000
H 0530	0.04800	0.0000	0.03400	0.0000	0.00500	0.0000	-0.07000	0.3541	0.02700	0.0000
H 0600	0.03900	0.0000	0.04500	0.0000	0.02200	0.0000	-0.18700	0.0130	0.02100	0.0000
H 0630	0.04900	0.0000	0.07900	0.0000	0.02800	0.0000	0.03500	0.6466	0.04500	0.0000
H 0700	0.04500	0.0000	0.08400	0.0000	0.05200	0.0000	-0.05000	0.5108	0.01700	0.0000
H 0730	0.01100	0.0000	0.08200	0.0000	0.04100	0.0000	-0.06800	0.3637	-0.02200	0.0000
H 0800	0.03600	0.0000	0.05800	0.0000	0.02300	0.0000	-0.06200	0.4070	0.02800	0.0000
H 0830	0.02000	0.0000	0.03500	0.0000	0.03100	0.0000	-0.09800	0.1937	0.00900	0.0000
H 0900	0.00300	0.0001	0.01800	0.0000	0.01900	0.0000	-0.22300	0.0031	-0.00200	0.0000
H 0930	0.01500	0.0000	0.01400	0.0000	0.00700	0.0000	0.02700	0.7155	0.00700	0.0000
H 1000	0.00100	0.2160	0.00400	0.0000	0.00500	0.0000	-0.09300	0.2183	-0.00100	0.0001
H 1030	0.00200	0.0143	-0.00100	0.1748	-0.00200	0.0008	-0.03000	0.6863	0.00200	0.0000
H 1100	0.00200	0.0025	-0.00200	0.0000	-0.00100	0.3255	-0.07100	0.3401	0.00300	0.0000
H 1200	0.00400	0.0000	-0.00100	0.0000	-0.00100	0.0113	-0.00900	0.9030	0.00200	0.0000
H 1230	0.00300	0.0001	-0.00400	0.0000	0.00200	0.0374	0.14300	0.0573	0.00100	0.0170
H 1300	0.00200	0.0429	-0.00500	0.0000	0.00000	0.8147	-0.06700	0.3708	0.00100	0.0001
H 1330	0.00400	0.0000	-0.00100	0.0012	-0.00200	0.0035	0.29500	0.0001	0.01000	0.0000
H 1400	0.00200	0.0327	-0.00100	0.0039	0.00600	0.0000	-0.06300	0.4030	-0.00500	0.0000
H 1430	0.00500	0.0000	0.00000	0.3733	-0.01000	0.0000	0.01600	0.8270	0.00000	0.5452
H 1500	0.00500	0.0000	-0.00300	0.0000	-0.00600	0.0000	-0.02700	0.7180	0.00200	0.0000
H 1530	0.00700	0.0000	-0.00100	0.0472	-0.01000	0.0000	-0.02400	0.7543	0.00300	0.0000
H 1600	0.01100	0.0000	0.00400	0.0000	-0.00900	0.0000	0.07600	0.3129	0.00500	0.0000
H 1630	0.00800	0.0000	0.00800	0.0000	-0.00400	0.0000	-0.06700	0.3711	0.00200	0.0000
H 1700	0.01900	0.0000	0.01600	0.0000	-0.00300	0.0003	0.10900	0.1476	0.00900	0.0000
H 1730	0.01400	0.0000	0.02100	0.0000	0.00500	0.0000	0.17800	0.0182	0.00500	0.0000
H 1800	0.02700	0.0000	0.02700	0.0000	0.01000	0.0000	0.22000	0.0035	0.01000	0.0000
H 1830	-0.00100	0.2382	0.01300	0.0000	0.01500	0.0000	-0.02000	0.7900	-0.00600	0.0000
H 1900	-0.00100	0.3147	0.00600	0.0000	0.00200	0.0397	-0.07300	0.3341	-0.00400	0.0000
H 1930	-0.00400	0.0000	-0.01000	0.0000	-0.00800	0.0000	0.05600	0.4581	-0.00500	0.0000
H 2000	-0.00200	0.0118	-0.01400	0.0000	-0.01200	0.0000	0.11000	0.1443	0.00200	0.00016
H 2030	-0.01000	0.0000	-0.02300	0.0000	-0.01000	0.0000	0.12200	0.1063	-0.00700	0.0000
H 2100	-0.00800	0.0000	-0.02200	0.0000	-0.01700	0.0000	0.01600	0.8276	-0.00800	0.0000
H 2130	0.00400	0.0000	-0.02100	0.0000	-0.02100	0.0000	0.06500	0.3884	-0.01400	0.0000



Thank you!