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Forecasting of Real Estate Stock Returns on the Stock Exchange of Thailand A State-space Model of Long-Memory Process Approach

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ABSTRACT

This is a study of forecasting as an essential tool for investment on stock markets. Special emphasis is given to the test of the state-space model corresponding to a long memory process on the Stock Exchange of Thailand infiltration of Land and Houses stock returns from 2008 to 2010. The structure of Land and Houses stock returns is estimated by an econometric model, from which the results are used in dynamic simulation. The collected daily data of the stock returns of Land and Houses were confirmed to be stationary and to exhibit a long-memory process. Moreover, the tested results confirmed, based on state-space modeling of long memory processes, that the state-space model is best captured by an ARFIMA model-1. The model predicted that Land and Houses stock returns would show a positive value during the period of October 1 2010 through November 15 2010.

1. Introduction

The long memory process concept was developed by Harold Edwin Hurst in 1906. However, time series with long memory processes have appeared in many areas of research methodology such as financial economics, macroeconomic series, hydrology, cardiac dynamics, traffic networks, meteorology and tourism economics (Mahendran and Pauline 2003, Chu 2008, and Chaiboonsri *et al.* 2006, 2009, and 2010). State-space modeling for long-range dependent data was suggested by Chan and Wilfredo (1998). Subsequently, this topic was studied by a substantial number of researchers such as de Lima and Amazons (2007), and Palma *et al.* (2008). In terms of financial econometrics, however, few studies have focused on state-space modeling for long-range dependent data. Therefore, this paper seeks to both estimate and predict Land and Houses stock returns based upon the state-space model for long-range dependent data. We believe that this approach has not previously been used to both estimate and predict Land and Houses stock returns.

2. Research Aim and Objective

This research aims to predict the stock returns of Land and Houses for the period of 1/10/2010 through 15/11/2010; and to identify the best

model parameters for forecasting Land and Houses stock returns in a specific period.

3. Scope of this research

The scope of this research focuses on the period 2008-2010. The data were mostly secondary, and included daily data on stock returns to Land and Houses. The source of data was the Stock Exchange of Thailand.

4. The research framework and methodology

4.1 The general state-space model

State-space modeling in economics has become increasingly useful for estimation and forecasting. Several textbooks -- such as Durbin and Koopman (2001) and Shumway and Stoffer (2000) -- now present the basics of the state-space model The model consists of the measurement equation (E-1) and the state equation (E-2).

$$Y_t = X_t \beta + Z_t \alpha_t + \varepsilon_t \quad \text{(E-1)}$$

$$\alpha_{t+1} = T_t \alpha_t + \mu_t \quad \text{(E-2)}$$

where:

Y_t = scalar dependent variable

X_t , Z_t = explanatory variable and /or known constants

α_t = containing p states

ε_t = it is i.i.d. $N(0,h^{-1})$

T_t = known constants

μ_t = it is i.i.d. $N(0,H)^{-1}$ as well as ε_t and μ_t are independent of another for all state and time

4.2 The state-space modeling of long-memory processes

The state-space representation of the ARFIMA model has been suggested by Chan and Palma (1998). Moreover, the state-space modeling of long memory processes was extended by several researchers such as de Lima and Amazons (2007) and Palma *et al.* (2008). A finite-dimensional state-space system starts from both equations (E-3) and (E-4).

$$X_{t+1} = FX_t + \varepsilon_t , \quad \text{(E-3)}$$

$$Y_t = GX_t + \eta_t , \quad \text{(E-4)}$$

where:

$Y_t = \in R$ $X_t = \in R^m$

And *m* is the dimension of the state-space representation. The infinite-dimensional state-space representation of an ARFIMA process with long memory parameter $d \neq 0$ can be expressed as equation (E-5).[1]

$$Y_t = \frac{\Theta(B)}{\Phi(B)}(1-B)^{-d}\varepsilon_t = \sum_{j=0}^{\infty}\varphi_j \varepsilon_{t-1}, \quad \text{(E-5)}$$

Furthermore, an infinite-dimensional state-space representation of an ARFIMA process with long memory parameter $d \neq 0$ may be constructed from equation (E-5).[2]

5. Data description

Figure 1 depicts Land and Houses stock returns from 2008 through 2010. The collected daily data are confirmed to be stationary and to exhibit a long-memory process.

Table 1 presents the descriptive statistics on Land and Houses stock returns during 2008-2010.

6. The results of research

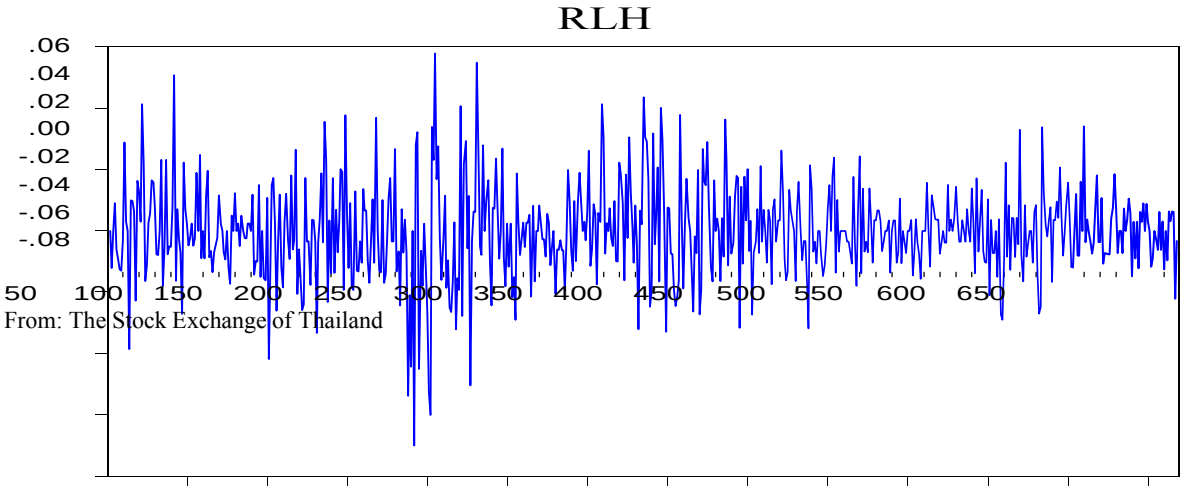
6.1 The results of various tests for unit roots

Table 2 presents the results of two unit root tests: the ADF-unit ("ADF-Test") and the Phillip-Perron ("PP-Test"). Both confirm that Land and Houses stock returns of have no unit root, in other words they constitute a stationary process (see more detail in Table 1).

[1] For greater detail, please see Chan and Palma (1998).

[2] Again, for further details, please see Chan and Palma (1998).

Figure 1: Graphical presentation the Land and Houses' stock returns during period of 2008-2010.



From: The Stock Exchange of Thailand

Table 1: The descriptive statistics of Land and Houses' stock returns during the period 2008-2010.

	RLH
Mean	-0.000156
Median	0.000000
Maximum	0.058000
Minimum	-0.070100
Std. Dev.	0.015238
Skewness	-0.003630
Kurtosis	4.936163
Jarque-Bera	104.4972
Probability	0.000000
Sum	-0.104300
Sum Sq. Dev.	0.155112
Observations	669

Source: The Stock Exchange of Thailand

Table 2: Results of Unit Root tests

Variable	ADF-Test	PP-Test
Stock returns to Land and Houses	-23.53576*** [0.0000] [0.0000] I(0)	-23.47873*** I(0)

Source : From computed

Note: * : significant at 5% level, ** : significant at 1% level

6.2 The results of various tests for Long Memory Process

Table 3 shows the results of various tests for long memory processes based on the R/S, Modified R/S and GPH tests of Land and Houses stock returns during the study period. (All data were collected from the Thailand Stock Exchange)

Table 3: Results of Various Tests for Long Memory based on R/S Test, Modified R/S Test and GPH Test

Variable	R/S Test	Modified R/S Test	GPH Test
Stock returns to Land and Houses	3.684**	2.563**	3.1275**

Source: computed

Note: Null Hypothesis: no long-term dependence or no long memory process.
For GPH test, Null Hypothesis: **d = 0**. , * : significant at 5% level, ** : significant at 1% level

The test results are summarized in Table 3. For each test, the test statistics and its corresponding statistical significance are given. If the statistical value of the R/S test, Modified R/S test and GPH test are significant at the 5% level or better then the null hypothesis of no long-term dependence or memory process in the time series data may be rejected. The results in Table 3 confirm for all three tests that the stock returns on Land and Houses display a long memory (long-term dependence) process. Indeed, the levels of significance are better than 1%.

6.3 The forecasting results of the state-space model represented by ARFIMA models

Table 4 shows forecasting performance accuracy of each of several models based on state-space ARFIMA (p,d,q) formulations to forecast the stock returns to Land and Houses on the Thailand stock exchange during the period of 2008 to 2010.

Table 5 presents the forecasting results of Land and Houses stock returns based on a state-space model represented by an ARFIMA Model-1 for the period October 1, 2010 through Nov 15 2010. Similarly, Table 6 presents the forecasting results for an ARFIMA Model-2 during the same period. Because the state-space model represented in ARFIMA Model-1 achieves a lower value of RMSE (Root Mean Square Error), the ARFIMA Model-1 was selected to be the best model for forecasting Land and Houses stock returns for the specific period under study. This result is supported graphically by figures 2 and 3.

7. The conclusions of research and policy recommendations

This paper has examined the consequences of the configuration of Land and Houses stock returns estimated by the use of the construction of an econometric model. The results are then used in an interesting non-observed model of the general form known as a state-space model to predictg stock market returns. Collected daily data of the stock returns on Land and Houses confirmed a stationary series consistent with a long-memory process. Moreover, the tested results showed that the state-space modeling of long memory process was best represented by an ARFIMA model-1. An ARFIMA model involves only currently observable variables and projections of future variables. The model predicted that Land and Houses stock returns would show a positive value for during period of October 1 2010 to November 15, 2010. A potential role for stock return variables has never been considered in the ongoing debate on the stock returns of stock market risk. Intuitive reasoning, formal modeling and empirical evidence show that Land and Houses stock trends are a moving information variable that determines the moving mean of the stock returns to Land and Houses and has a forecasting power for stock market returns that increases with the horizon.

The realization of real estate business profit usually takes longer than in other business sectors. There are many reasons for such an occurrence. One is that the execution of transactions in the real estate business, whether in sales or rentals, usually takes longer than in other markets due to the large amount of money associated with the execution per consumer purchase. A second reason is that it

takes much longer than other industries to produce such a product. Third, real estate also depends heavily upon external factors which positively affect its business outlook. Most of the external factors are government policies, for example, the increase or decrease the interest rate, or the approval and launch of major state infrastructures. The above sometime affect the frequency in stock trading interest from major traders, creating lower frequency data than in other trading sectors. The state-space model here has proven to be more suitable for assets of such a nature.

Although quite suitable and useful for predicting real estate business stocks that are traded in the Stock Exchange of Thailand, the type of models presented in this paper will likely be even more useful for much lower frequency trading/returns data, such as the Property Fund also traded on the Stock Exchange of Thailand. Trading activities for property funds units are much less than those of real estate stocks even though they may be developing/operating within the same business line. One example is the Central Pattana Corporation (CPN), which is one of Thailand's major shopping center developers compared to the Central Retail Growth, a shopping center income-producing property fund. The criticality of the state-space model use should also be heightened when, over time, more and more property funds are being established and launched onto the Stock Exchange of Thailand. Furthermore, when an infrastructure fund will be created and launched in the stock market, as is anticipated for the near future, state-space models will play an even more important role.

Table 4: Various forecasting models based on state-space ARFIM A formulations[3]

Parameters	The State-space Model Represent in ARFIMA	The State-space Model Represent in ARFIMA Model□2
C(1)	-0.0000262	0.008166
	[-0.112791]	[0.001339]
C(2)	-13.13814***	-0.995569***
	[-316.8104]	[-3.533067]
C(3)	0.760677***	-
	[49.82010]	
Final State	Final State	Final State
SV1	0.947473***	0.986741
	[340.4034]	[0.643814]
SV2	0.000661	-
	[0.471310]	
SV3	□	□
Log□likelihood	3420.229	-288.2974
Parameters	3	2
Diffuse priors	2	1
AIC	-10.21593	0.867855
BIC	-10.19573	0.881325
HQ	-10.20810	0.873073

Source: computed

Note: * : significant at 10% level, ** : significant at 5% level, *** : significant at 1% level,

[3] For more detail, please see Appendix A

Table 5: Forecasted vs actual values for stock returns on Landd and Houses on Thailand' Stock Exchange based on state-space model ARFIMA Model-1 during Oct 1 2010 to Nov 15 2010.

Month/Day/Year	Stock Return of LH(Actual)	Stock Return of LH (Forecast)	RMSE
10/1/2010	0.005	0.0119	0.0061
10/4/2010	□ 0.0147	□ 0.0040	0.0107
10/5/2010	0.003	0.0019	0.0011
10/6/2010	□ 0.0090	□ 0.0088	0.0002
10/7/2010	0.003	□ 0.0174	0.0204
10/8/2010	□ 0.0122	□ 0.0003	0.0119
10/11/2010	0.006	0.0027	0.0035
10/12/2010	0.003	□ 0.0031	0.0061
10/13/2010	0.009	0.0055	0.0036
10/14/2010	□	□ 0.0059	0.0059
10/15/2010	0.008	0.0059	0.0029
10/18/2010	0.002	0.0278	0.0249
10/19/2010	□	□ 0.0030	0.0030
10/20/2010	□ 0.0117	□ 0.0193	0.0076
10/21/2010	□ 0.0090	0.0022	0.0112
10/22/2010	□	0.0006	0.0006
10/26/2010	□ 0.0030	□ 0.0015	0.0015
10/27/2010	□ 0.0062	0.0086	0.0148
10/28/2010	0.006	□ 0.0121	0.0182
10/29/2010	□ 0.0062	0.0132	0.0194
11/1/2010	0.003	0.0190	0.0159
11/2/2010	□ 0.0125	0.0058	0.0183
11/3/2010	□	□ 0.0126	0.0126
11/4/2010	□ 0.0096	0.0057	0.0153
11/5/2010	0.006	□ 0.0114	0.0178
11/8/2010	0.003	0.0087	0.0055
11/9/2010	0.006	0.0065	0.0002
11/10/2010	0.006	□ 0.0022	0.0084
11/11/2010	□ 0.0221	0.0091	0.0312
11/12/2010	□ 0.0033	□ 0.0070	0.0037
11/15/2010	0.006	□ 0.0137	0.0202
Average	□ **0.0013**	**0.0004**	**0.0017**

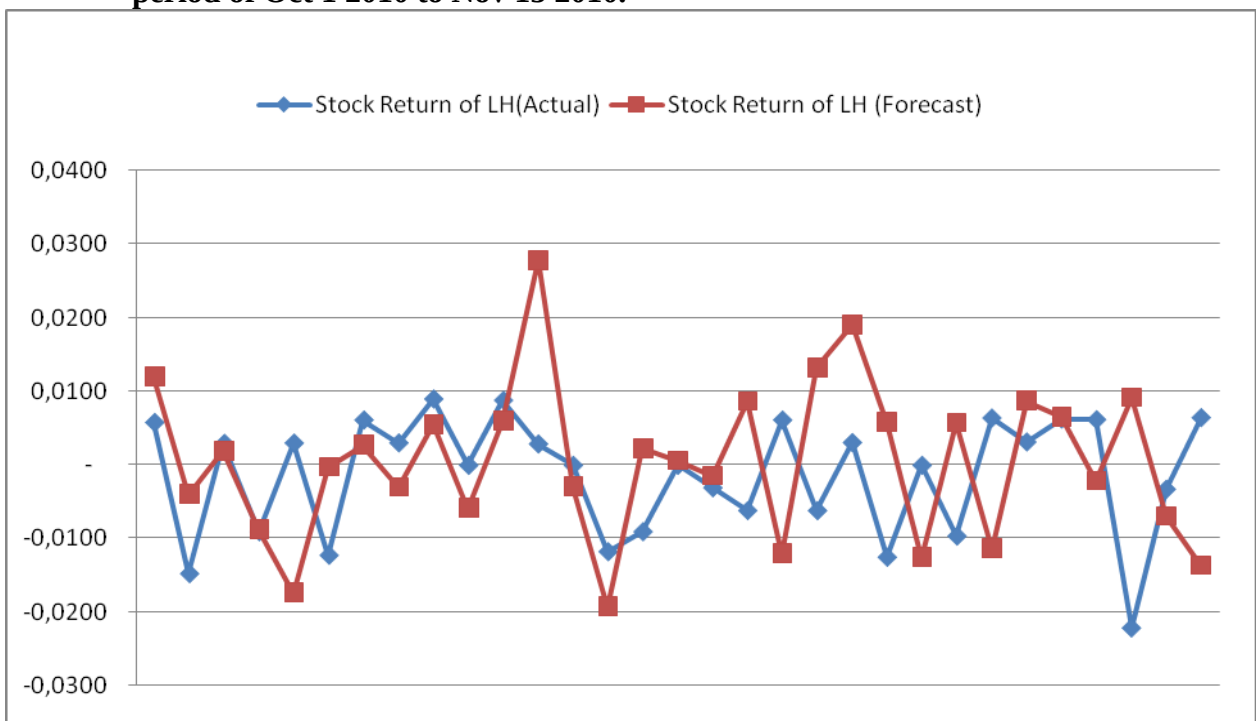
From: computed

Table 6: Forecasted vs actual values for stock returns on Landd and Houses on Thailand' Stock Exchange based on state-space model ARFIMA Model-2 during Oct 1 2010 to Nov 15 2010.

Month/Day/Year	Stock Return of LH(Actual)	Stock Return of LH (Forecast)	RMSE
10/1/2010	0.0058	0.0119	0.0061
10/4/2010	□ 0.0147	□ 0.0025	0.0122
10/5/2010	0.0030	0.0052	0.0022
10/6/2010	□ 0.0090	□ 0.0085	0.0006
10/7/2010	0.0030	□ 0.0176	0.0206
10/8/2010	□ 0.0122	□ 0.0058	0.0065
10/11/2010	0.0062	0.0045	0.0016
10/12/2010	0.0030	□ 0.0036	0.0067
10/13/2010	0.0090	0.0038	0.0052
10/14/2010	□	□	0.0075
10/15/2010	0.0088	0.0041	0.0048
10/18/2010	0.0029	0.0271	0.0242
10/19/2010	□	0.0033	0.0033
10/20/2010	□ 0.0117	□	0.0071
10/21/2010	□ 0.0090	0.0004	0.0095
10/22/2010	□	0.0031	0.0031
10/26/2010	□ 0.0030	□	0.0023
10/27/2010	□ 0.0062	0.0094	0.0156
10/28/2010	0.0062	□	0.0143
10/29/2010	□ 0.0062	0.0096	0.0158
11/1/2010	0.0031	0.0237	0.0206
11/2/2010	□ 0.0125	0.0113	0.0238
11/3/2010	□	□	0.0065
11/4/2010	□ 0.0096	0.0041	0.0137
11/5/2010	0.0064	□ 0.0079	0.0144
11/8/2010	0.0032	0.0050	0.0018
11/9/2010	0.0063	0.0071	0.0008
11/10/2010	0.0062	□ 0.0021	0.0083
11/11/2010	□ 0.0221	0.0071	0.0292
11/12/2010	□ 0.0033	0.0007	0.0040
11/15/2010	0.0065	□ 0.0129	0.0194
Average	□ **0.0013**	**0.0012**	**0.0025**

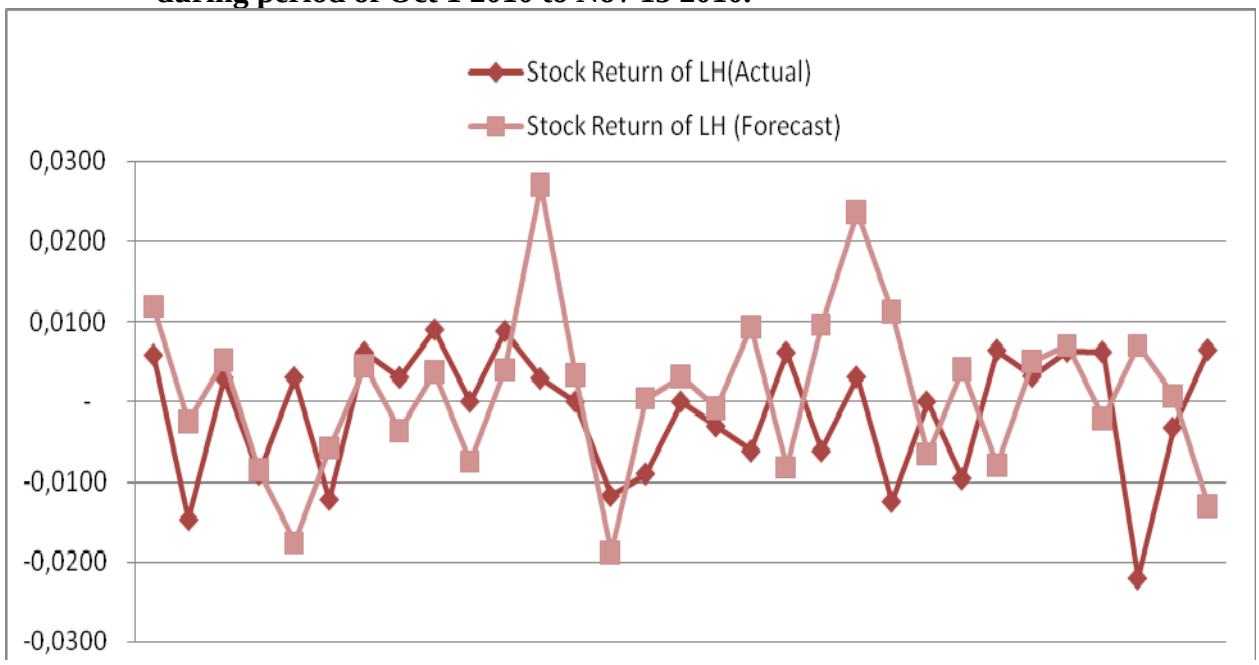
From: computed

Figure 2: Graphical presentation of the the forecasting result of Land and Houses stock return based on the state-space model represent in ARFIMA Model-1 during period of Oct 1 2010 to Nov 15 2010.



From: computed

Figure 3: Graphical presentation of the the forecasting result of Land and Houses stock return based on the state-space model represent in ARFIMA Model-e during period of Oct 1 2010 to Nov 15 2010.



From: computed

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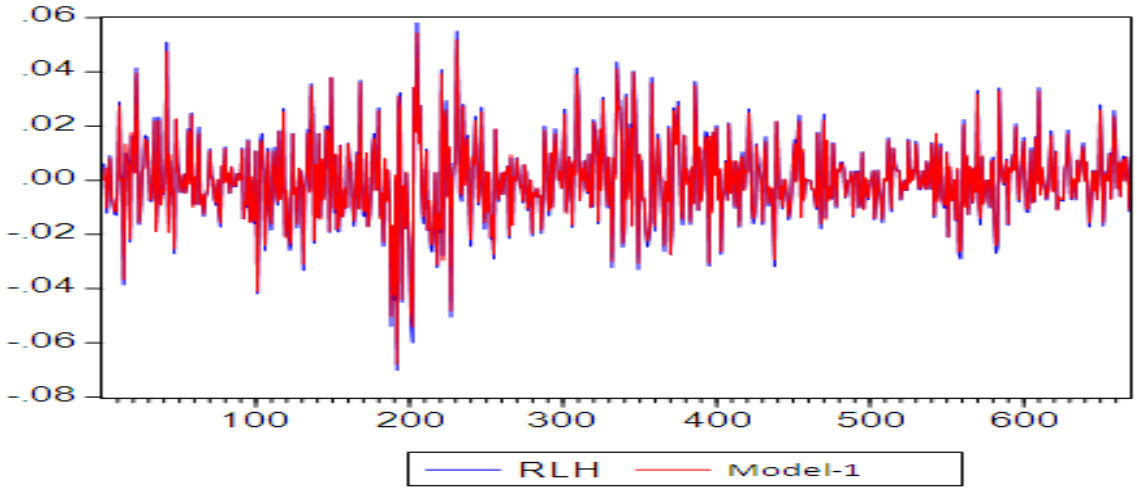
Appendix A
The State-space Model represent in ARFIMA model-1

rlh = c(1) + sv1*d_rlh + sv2
@state sv1 = sv1(-1)
@state sv2 = c(3)*sv2(-1) + [var = exp(c(2))]



The State-space Model represent in ARFIMA model-2

rlh = c(1) + sv1*d_rlh + [var = exp(c(2))]

@state sv1 = sv1(-1)