

# Revisit Hemline Index Theory: Forecasting Daily Trading of Short Skirts by Stock Market in China

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**Abstract**—There are many similarities on fluctuations between clothing styles and finance so that many theorists approach to analyze the relationship of them, the best known of which is the Hemline Index Theory. When the economy is flourishing, hemlines increase, and when the economic situation is deteriorating, the hemlines drop, perhaps even to the floor. In contrast with measuring the illustrations from the fashion magazines of monthly publication traditionally, we collected daily time series of the hemline indicator using the searching volume and trading volume of short skirts on Taobao Index website. Then we evaluated it against the closing price of Shanghai Composite Index by Granger causality analysis and liner regression model during the period of March 1, 2013 to November 30, 2013. The main finding is that the closing price of stock market is the Granger causality of the searching volume and trading volume of short skirts. The rising of closing price in stock market can predict the more searching volume and purchase of short skirts one day later which verifies the hemline index theory on daily basis. Further confirmation based on different data resources and fashion measures is needed.

**Keywords**—*Hemline Index; Shanghai Composite Index; Granger Causality Analysis; Taobao; China*

## I. INTRODUCTION

Fashion is a social process which have occurred considerable stylistic change, while how the fashion fluctuates has been widely debated. Some take the point of view that fashion is a separate reality with internally generated fluctuations and cycles [1], which is used as a synonym of “fad” or “herd behavior” in general theory [2]. While most theorists favored that fashion is driven by exogenous forces and external events which responds in an orderly way [3, 4],

but what the influences might be is plausible. Although there are fashions in many things as its essence of change [5], the clothing style has been received greater academic attention from a post-modernist perspective [6].

The term “fashion” is a useful metaphor for “finance” as there are many similarities between designing clothing and making investment. First, successful couture or making money in investment is to take an unconventional design or position which eventually becomes conventional. Second, successful couture can’t transcend the acceptable boundaries as the same with the successful investment mustn’t be so unusual. Third, successful couture and investors all can be fashion setters which influence the direction of fashion or financial markets. Fourth, fashion may be rejected, likewise, finance investment may be failure too. These four sociological similarities in both industries indicated that there are close relationship between clothing styles and finance [7]. Some empirical studies supported this approach too. Such as, fashion stylistic change was related to the mean age of population and economic health of the country [8]. The dress styles signaling bodily attractiveness are reflective of reproductive economics [9].

The best known theory about the relationship of fashion and economy is the Hemline Index Theory which was introduced by George Taylor in 1926. The urban legend has it that the women’s dress hemline is correlated with the economy measured by stock prices or gross domestic product. When the economy is flourishing, the women’s hemlines increase to show off their beautiful stockings inside, and when the economic situation is deteriorating, the hemlines drop, perhaps even to the floor, to avoid the embarrassment of no money buying expensive stockings [10, see also 11].

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The research is supported by Major Project of the National Social Science Grant 12&ZD218 and 14ZDA063, National Social Science Foundation Grant 15BSH034 and Talent Introduction Project of Ludong University Grant LY2015040.

Common sense would argue that fashion designers may reflect the emotion of general public using their creations directly and efficiently. The short skirts indicate that the general public is more confident on that the stock market is going upwards, thus the economy is heading to great, thriving times. While the fashion designers could capture the optimism quickly and have those elegant ladies with long legs show a bit more of their leggy assets to reflect that optimism. In the other direction, the less confident the public is towards the stock market, meaning the economy might become worse by the time. The conservatism reigns supreme, and designers reflect this mood by having longer skirts or lowering the hemlines [12]. So if the fashion trend of the day is calling for shorter skirts and dresses, that signifies the economy is booming and the good times roll. But if skirt lengths are heading south, so is the economy.

On the other hand, the job opportunities for women which are affected by economy seriously may influence the hemline too. When the economy expands, women may have more opportunity to work outside. More sexual attractive increases the professional competence of women which reflected in dress styles [13]. So the longer skirts to advertise their lack of sexual accessibility may be emphasized in dress styles in economy deteriorating periods as maintaining marriage stability is more important since men tend to value sexual restraint in partner. In contrast, as economy expands and the job opportunities for women increase, dress should be shorter as women is more economic independence and have less need to express sexual restraint, as well as to appear more professional competent.

The Hemline Index mentioned above has been challenged to see if it can be falsified or not for decades. The first formal report about the correlation of hemlines and economy was from Mabry [14]. He found that the correlation between the model's dress length in women's magazines including *Vogue*, *Good Housekeeping*, *Ladies Home Journal* and *Harper's Bazaar*, and Dow Jones Industrial Average (DJIA) is negative significantly from 1921 to 1970. As the stock price rose, women's dress became shorter. Using a diachronic method which analyzed 1496 skirt pictures in fashion magazines published from the year of 1980 to 2013 and related it to stock market in Korea, Seonsook found that the skirt length and stock market related negatively which verified the Hemline Index Theory by George [15]. Then Barber assumed that the marital economics such as the marital and job opportunities for women may mediate the correlation between the dress fashion and the stock market as the skirt length is advertising sexual accessibility. Based on the prediction of marital and occupational variables to dress fashion, he found that the short skirts is correlated with low sex ratios, increasing economic opportunities for women and marital instability [16]. Some other researchers presumed that the stock market is so arbitrary intrinsically that cannot be used to account for fashion cycles. So they collected the monthly data of NBER business chronology and studied its lead and lag effect with the hemline from the magazines of *L'Officiel* during the period of 1921 to 2009 [17]. They found that the correlation between the economy cycle and the hemline is negative but with a time lag of three years so the current economic crisis of

2008 or 2009 can predict the ankle length skirts around 2011 or 2012. Ahn investigated the relationship between hemline index and macro-economic index such as GDP, recession and unemployment from 1950 to 2014 [18]. By averaging the hemline data of 2260 samples from *US Vogue* to create a yearly average, he found that the recession and unemployment influenced hemline length for four years positively which support the Hemline Index Theory that a longer hemline is popular with recessionary economy but becoming shorter in flourishing economic periods.

But how to measure the women's hemline? The traditional method is that transposing the measurements of illustrations from the magazines into the percentages of the total figure height. Kroeber measured the total height from the center of the mouth to the base of the foot in order to avoid the influence of varying hair styles. Skirt length was measured from the mouth to the skirt hemline at center front [19]. Then he found any kind of pictorial representations such as books, drawings, engravings and so on, as well as the monthly fashion magazines to study the women's formal evening dress fashions, and measured eight dress dimensions including skirt length around different European countries and the USA [20]. The following researchers used similar techniques. For example, E. D. Lowe and J. W. Lowe studied the fashion process extending the quantitative data of formal evening dress to the year of 1980 by selecting plates from the top fashion magazines such as *Vogue*, *Harper's Bazaar*, *L'Officiel* and so on [21]. They thought the evening wear was greater consistency and far less subject to utilitarian considerations than daywear. Meanwhile, Weeden paid more attention to the daytime dress and measured models from the fashion columns of *New York Times* and found that the skirt lengthen by 8.7% between 1920 and 1922 but the hemline increases again by 22.7% from 1922 to 1928 [22]. Richards was interested in the women's daytime costume in 1920s too. He collected 20 women's daytime costume illustrations monthly from the magazine of *Good Housekeeping* from February 1920 to December 1929, and found that the hemlines lengthened during 1922 and 1923, then beginning upward 1924 and reached the most elevated position in 1927. But being different with the result of Weeden, he found the elevation during the period of 1922 to 1928 was only 14.07% [23]. Ahn studied the hemline cycles utilizing the *Vogue* data on women's daywear from 1950 to 2013. Being different from Kroeber, the total length of figure in the picture was from shoulder to ankle but not from the mouth to the foot to avoid the foot invisible [24]. The fashion illustrations of magazines, photographs or other arts are useful in measuring the stylistic characteristics of fashion, but with some shortcomings. On one hand, the large-scale measurement is expensive and time-consuming to conduct while small sample size may be deficient. On the other hand, the daywear and the evening wear is different which made the conclusions of different researches can't be compared directly. Moreover, the orientation and targeted consumers of different fashion magazines are distinguishing. For example, the results about the skirt hemline in 1920s obtained by Weeden [22] and Richards [23] were different as their fashion figures were from different magazines. The *Good Housekeeping* was directed toward the majority of middle class women while the *New*

York Times or Vogue represented the exaggerated high-fashion trends and provided the fashion perspective of upper class women. In addition, high fashion periodicals only represented a sort of western ideal which would be different from actual consumer choice and popular dress. The skirt length for women on the street was congruent with the fashion models but the magnitude of that change was less extreme [25]. What's more, the fashion magazines which are published once one month at the most can't reflect the fashion trends changing on an almost daily basis. Specially, when the Internet became a popular sharing platform, fashion trends were much quicker to be "in" and to go out of fashion so the fashion analysis of daily basis is more necessary [26].

Today, with the Internet penetration in electronic commerce industry, online shopping market is in high-speed development, especially the C2C (consumer to consumer) [27]. C2C, with the low barriers to entry, small investment and so on, has been the rapid development of E-business models, changing the traditional consumer shopping patterns. A variety of C2C websites continues to emerge providing great convenience to people's life and work. Tremendous amounts of purchasers and sellers who are in various locations and different time are engaged in driving transactions, accumulating so much valuable data and information which can be used to analyze the individual or collective psychological and behavioral characteristics for buyers, sellers and third-party organizations.

In this paper, we used quantitative data and time series analysis to validate the urban legend in China. We collected the hemline indicators using the daily data of the searching volume and trading volume of short skirts on Taobao Index website and applied the econometric techniques to test the lead-lag effect with the closing price of Shanghai Composite Index of 177 days from March 1, 2013 to November 30, 2013, excluding data of weekends and holidays. We found that the closing price of the stock market can predict the searching volume and trading volume of short skirts positively.

## II. DATA REVIEW

### A. Operationalization of hemline

Taobao website is the representation of C2C and the most popular online shopping site in China, with virtually as many as 85% in market share of the C2C third-party business platforms. Taobao Index, launching on January 2012, is the data sharing platform provided by Taobao.com on the basis of Tmall.com, Alipay.com and other network platforms. There are two main functions of search interface and billboard on Taobao Index. Entering the keywords in the search bar, we can capture the daily time series of the search index, turnover index and geographical distribution map. The search or turnover index provides the search or turnover trend, the crowd positioning and the correlation of both [28].

There are no well-supported criterion about the length of skirts. Representative skirt styles include short skirt, midi skirt and long skirt classified by the length off of the ground. The short skirt is above the knee, and the hemline of midi skirt is about the knee approximately, and the length of long skirt

exceeds knee including the long floor length skirts, ankle length skirts and so on. So the key word "short skirts" is a series of similar products such as the miniskirt, one step skirts, which is shorter than midi skirts and long skirts with all kinds of manufacturing, fabrics and designs.

In this paper, we are concerned the short skirts mainly. Recently, the two-layered skirt is popular in which the upper skirt is much longer than the underskirt, as well as the skirt hemlines of front and back are different, both of which are difficult to classified according to the length easily. So we obtained the daily time series of the searching volume and trading volume using the specific key word "short skirts" through Taobao search interface over a period of March 1, 2013 to November 30, 2013 to exclude the winter season as the operational definition of dress hemline.

### B. Operationalization of economy

Although stock market is highly volatile and arbitrary extremely as the collective impulses of irrational investors, most scholars believed that the financial development and economic growth correlate to each other positively to a certain extent [29, 30], even reflecting the economic growth in advance [31]. So we used the Shanghai Composite Index as the representation of macro-economy of China. The Shanghai Composite Index has achieved rapid development since the establishment of Shanghai Stock Exchange in 1990. It discloses opening and closing price, stock gain and decline and other indicators every day excluding the weekends and holidays. Here we choose the closing price of Shanghai Composite Index as the operational indicator of economy in China during the period of March 1, 2013 and November 30, 2013.

## III. RESULTS

### A. Granger causality of closing price of stock market and the searching volume or trading volume of short skirts

In this section, we are concerned with the question whether the variations of economy correlate with the changes of the women's skirt length. To answer the question, we apply the econometric technique of Granger causality analysis to the daily time series of the searching volume and trading volume of the short skirts vs. the closing price of Shanghai Composite Index. The Granger causality analysis rests on the assumption that if a variable X causes Y then changes in X will systematically occur before changes in Y. We will thus find the lagged values of X will exhibit a statistically significant correlation with Y. Correlation however does not prove causation but one time series has predictive information about the other or not. We tested the unit root of three time series including the closing price and the searching volume and trading volume of short skirts and found that all of them are 1st integrative which co-integrated and suitable for Granger causality analysis directly.

Based on the results of our Granger causality in table I, we found that the closing price of Shanghai Composite Index has the Granger causality relation with the searching volume of short skirts for lagging 1 day and 2 days, while it is the

Granger causality of the trading volume of short skirts only lags 1 day. While the searching volume of short skirts is the Granger causality of its trading volume for lagged ranging from 1 to 3 days. By contrast, the searching volume and trading volume of short skirts aren't the Granger causality of the closing price and the trading volume of short skirts has no Granger causality with the searching volume too.

TABLE I. GANGER CAUSALITY CORRELATION OF CLOSING PRICE VS. SEARCHING VOLUME AND TRADING VOLUME OF SHORT SKIRTS

Null hypothesis	1day	2days	3days
Closing price does not Granger cause short skirts' searching volume	0.012*	0.039*	0.110
Short skirts' searching volume does not Granger cause closing price	0.921	0.548	0.675
Closing price does not Granger cause short skirts' trading volume	0.011*	0.057	0.119
Short skirts' trading volume does not Granger cause closing price	0.840	0.498	0.395
Short skirts' searching volume does not Granger cause short skirts' trading volume	0.013*	4.E-05**	7.E-05**
Short skirts' trading volume does not Granger cause short skirts' searching volume	0.285	0.426	0.303

<sup>a</sup> The statistical significance (p-values) is for testing the bivariate Granger causality correlation between the lagged values of closing price and the searching volume or trading volume of short skirts.

<sup>b</sup> \*p-value < 0.05; \*\*p-value < 0.01

To visualize the correlation between the closing price and the searching volume and trading volume of short skirts in more detail, we plot time series of the closing price of Shanghai Composite Index lagging 1 day, as well as the searching volume and trading volume of the short skirts on Taobao Index in Fig. 1.

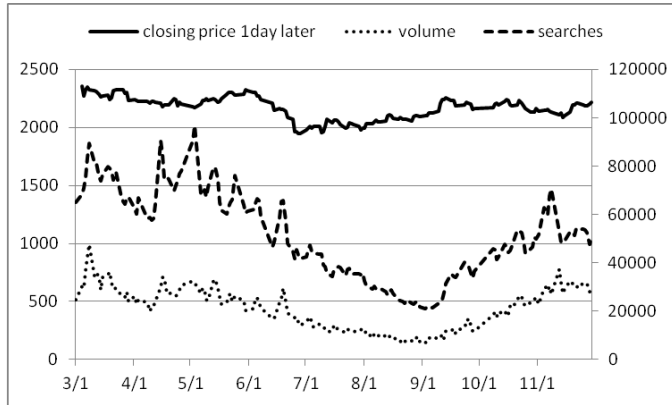


Fig. 1. The overlap of the day-to-day difference of the searching volume and the trading volume of the short skirts (dotted line) with the closing price of Shanghai Composite Index lagging 1 day (actual line). The searching volume of short skirts is on the right side of the coordinate, while the trading volume of short skirts and the closing price of stock market are on the left side of the coordinate.

### B. The effect of searching volume on trading volume of short skirts

The Pearson correlation between the searching volume and the trading volume of short skirts is 0.88 ( $p < 0.01$ ). And from the table I of the results of our Granger causality, we observed that the searching volume has causal relation with the trading

volume of short skirts. So we used the 1 lagged value of the trading volume to predict that very day trading volume for the null model M0, then we created the predictive models using the 0 and 1 day lagged values of the short skirts' searching volume as the predictive model M1 and M2. The specific formula is as follows:

$$M0: Y_t = b + b_1 Y_{t-1} + \varepsilon_t \quad (1)$$

$$M1: Y_t = b + b_1 Y_{t-1} + a_0 X_t + \varepsilon_t \quad (2)$$

$$M2: Y_t = b + b_1 Y_{t-1} + a_0 X_t + a_1 X_{t-1} + \varepsilon_t \quad (3)$$

The result of the regression analysis is shown in table II, the predictive accuracy significantly increased by 2.1% adding that day value of the searching volume in model 1. While the predictive accuracy significantly increased by 0.4% adding 1 day lagged values of the searching volume in model 2 ( $p < 0.01$ ).

TABLE II. LINER REGRESSION RESULT FOR THE TRADING VOLUME OF SHORT SKIRTS VS. THE SEARCHING VOLUME OF SHORT SKIRTS

Model	R <sup>2</sup> (%)	$\Delta R^2$ (%)	AIC	SIC	DW	F
M0	89.7		11.02	11.06	2.11	1513.95***
M1	91.8	2.1***	10.82	10.87	1.82	969.68***
M2	90.1	0.4**	11.00	11.05	1.98	786.95***

<sup>c</sup>  $R^2$  is the predictive accuracy of trading volume of short skirts combining the lagged value of 1 day of the corresponding trading volume and the lagged values of 0 day and 1 day of the searching volume according to the Granger causality result.  $\Delta R^2$  is the increasing predictive accuracy adding the lagged value of the searching volume respectively and their statistical significance. AIC (Akaike information criterion) and SIC (Schwarz information criterion) are used to determine the best lagging day in lagged variable model, which the value is smaller, the model better. DW (Durbin-Watson) statistic is a test for serial correlation, with no serial correlation the value is around 2.

<sup>d</sup> \*\*p-value < 0.01; \*\*\*p-value < 0.001

Combined with the value of AIC, SIC and DW, we can see the predictive model M1 in which the independent variables including that very day searching volume and the lagging one day trading volume of short skirts is the best model, the result of each variables of predictive model M1 is shown in table III. From the table, we can see that searching more, purchasing more ( $B > 0$ ) and the trading volume lagging one day can predict the volume today positively too.

TABLE III. THE VARIABLE VALUE OF PREDICTIVE MODEL M1

Model	variable	b	B	t
M1	c	-17.562		-1.47
	trading volume (-1)	0.683	0.682	15.10***
	searches	0.003	0.302	6.69***

<sup>e</sup> b and B is the unstandardized and standardized regressive coefficients of each variable to the trading volume of short skirts. T-test is for testing the statistical significance of the b and B value.

<sup>f</sup> \*\*\*p-value < 0.001

### C. Prediction of closing price of stock market to the searching volume and trading volume of short skirts

On the basis of Granger causality analysis in table I, we can see that closing price has significant predictive value on the searching volume and trading volume of short skirts. Therefore, we make closing price the independent variable to predict the dependent variable of the searching volume and

trading volume of short skirts. So the original model uses only 1 day lagged value of dependent variable for prediction (called the null model M0), while the predictive models use only 1 day lagged value of the dependent variable and the lagged value of independent variable (called the predictive model M1).

First, we analyze the prediction of closing price of stock market to the searching volume of short skirts. The original model uses only 1 day lagged value of short skirts' for prediction (called the null model M0), while adding 1 day lagged value of closing price for predictive model M1. The result is shown in table IV. As can be seen from the result, the predictive accuracy increased by 0.3% adding 1 day lagged value of closing price significantly and the regressive coefficient of the closing price of stock market to the searching volume of short skirts is positive ( $B > 0$ ).

TABLE IV. LINER REGRESSION RESULT FOR SEARCHING VOULME OF SHORT SKIRTS VS. THE CLOSING PRICE OF SHANGHAI COMPOSITE INDEX.

Model	variable	$R^2$ (%)	$\Delta R^2$ (%)	B	t
M0	searches (-1)	92.4		0.96	45.97**
M1	closing price (-1)	92.7	0.3*	0.07	2.50*

<sup>g</sup>  $R^2$  is the predictive accuracy of searching volume of short skirts combining the lagged value of 1 day of the corresponding searching volume and the lagged values of 1 day of closing price of stock market according to the Granger causality result.  $\Delta R^2$  is the increasing predictive accuracy adding the lagged value of closing price respectively and their statistical significance.  $B$  is the regressive coefficients of each variable to the searches of short skirts.  $T$ -test is for testing the statistical significance of the  $B$  value.

<sup>h</sup> \*p-value < 0.05; \*\*p-value < 0.01

Second, we analyze the prediction of closing price of stock market to the trading volume of short skirts. We make closing price independent variable to predict the trading volume of short skirts. The original model uses only 1 day lagged value of short skirts' trading volume for prediction (called the null model M0), while adding 1 day lagged value of closing price for predictive model M1. The result of regression analysis is shown in table V. The regression coefficient of closing price to the trading volume of short skirts is positive and increases the predictive accuracy by 0.4% significantly ( $p=0.01$ ).

TABLE V. LINER REGRESSION RESULT FOR TRADING VOLUME OF SHORT SKIRTS VS. THE CLOSING PRICE OF SHANGHAI COMPOSITE INDEX

Model	variable	$R^2$ (%)	$\Delta R^2$ (%)	B	t
M0	trading volume (-1)	89.7		0.947	38.91**
M1	closing price (-1)	90.0	0.4*	0.077	2.56*

<sup>i</sup>  $R^2$  is the predictive accuracy of volume of short skirts combining the lagged value of 1 day of the corresponding trading volume and the lagged values of 1 day of closing price of stock market according to the Granger causality result.  $\Delta R^2$  is the increasing predictive accuracy adding the lagged value of closing price respectively and their statistical significance.  $B$  is the regressive coefficients of each variable to the volume of short skirts.  $T$ -test is for testing the statistical significance of the  $B$  value.

<sup>j</sup> \*p-value < 0.05; \*\*p-value < 0.01

#### IV. DISCUSSION

The result presented in this paper substantiated that the dress fashion is predictable but not far from being arbitrary. The socionomics theory is about the causal relationship between social mood and social action which believed that the dominant social mood for a given time period is the underlying cause and governs the tone and characters of the

social events or actions [32]. So the economic, political and cultural domains all can reflect the changes of social mood with different time lagging but can't measure the social mood directly. The hemlines and stock markets both measure the temperature of social mood, which both rising implies the increase of daring among the population while both declining, a decrease. But the stock market changes quickly and instantaneously so that it is a more efficient meter stick than other indicators including the hemline [33], which is concord with our result that the closing price of stock market leads the searching volume and trading volume of short skirts but not the contrary.

With the development of the popularity of the Internet and electronic commerce industry, C2C has been the rapid development of E-business models. Taobao, with the low requirements and small investments, has been the industry leader in China. Nowadays, the total sales have broken one trillion yuan and the current number of sellers has exceeded twenty million, accumulating valuable information and becoming a massive data source. Taobao Index, launching on January 2012, is the data sharing platform provided by Tabobao.com. These data is free for all registered users of Taobao which can be used to achieve the functions of sales and sales volume, sales ranking, merchandise sales rankings, price distribution, the seller and the seller ranking. Currently, the main practical applications of these data is to provide sales and increase product sales, while ignoring other significant academic value. We used the searches and turnover data of specific commodity to test an important academic problem of fashion and economy. The result manifested that the data is useful in capturing the public consuming behaviors.

However, there are some limitations in our paper and does not acknowledge some important factors which need further research. Although both the number of users and the popularity and influence of Taobao are increasing rapidly, the main stream of Taobao users are still the young people. Whatever, Taobao is only one of E-business platforms in China, though the largest. In addition, most people purchase offline sometimes. On the other hand, the data from Taobao Index may be controlled even modified deliberately so that the accuracy of data is doubtful. So what extent to which these users and data on behalf of the general fashion trend is still debatable. We need further confirmation using different data sources, different fashion measures, and different independent variables. What's more, we don't consider other factors influencing the consuming behavior so that the relationship between stock market and short skirts isn't causality but correlation.

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