

## **Research on the Principle of Double Inflection Points and its Profitability**

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**Abstract:** Based on the price relative strength difference  $\Delta P$ , we put forward the principle and application rules of a “Double Inflection Points” (abbreviate as DIP) model, derived from three different algorithms, which form three important relative strength difference moving curves and establish a new system to forecast financial trends from a four-dimensional perspective.

Empirical analysis shows that the DIP model evidently outperforms the single turning point models in terms of profitability, which can significantly improve predictability and profitability in financial trading.

**Key words:** *Double Inflection Points, Three Algorithm-Composed Model, relative strength difference moving curve, trend starting point, trend closed loop point, profitability*

### **1. Double Inflection Points Model and its Principle**

In financial trading, smart traders are good at taking advantage of market trends to make profits. People usually use relevant indicators to describe the price trend corresponding with the price changes. One of the solutions is to find out the “inflection point.”

The inflection point refers to the dividing point that changes the upward or downward direction of the price. In financial sense, the inflection point refers to the turning point when the price of a financial trading runs from high to low or from low to high. It’s an important sign of the demarcation between long trading and short trading in financial transactions.

In traditional quantitative technology of price inflection point, there are two indicators that we are familiar with, MACD and MA, and their turning points are actually formed by a single algorithm which are essentially “single turning points.”

From a new perspective, namely the value of price relative strength difference ( $\Delta P$ ), we try to exert the three algorithms compound model to form three relative price

relative strength difference moving curves to describe the prices change track by calculating the relative strength difference value.

As the price changes, the three kinds of price relative strength difference moving curves will present a situation of two intersecting points, namely the first starting point and the second starting point and correspondingly to the two closed-loop points. We call it “*Double Inflection Points*” (*DIP*) for short. They can vividly reflect the trend and its extension of price changes.

### 1.1 Core Elements

DIP has three core technical elements:

- (1) Price factor  $\Delta P$ .
- (2) Price relative strength difference moving curves  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$ , and  $DIP_{(z, t)}$ .
- (3) The trend starting (starting point①, starting point②) and the trend closed loops (closed-loop point①, closed-loop point②).

### 1.2 Logic Ideas

- (1) To find the price factor  $\Delta P$ , which can describe or express the price change.
- (2) To find the appropriate subitems of the price factor  $\Delta P$ , which points to the three kind of price trends changes, immediate price change, the oscillating price change, and the weighted closing price change.
- (3) Starting from the price factor  $\Delta P$ , to find the suitable combinations of its subitems, and to find out the three algorithms to form the composite model (*DIP* model), to calculate “the immediate price relative strength difference index”, “the oscillating price relative strength difference index”, and “the weighted closing price relative strength difference index” respectively.
- (4) The three kinds of indexes above are used to point to (and also to draw) the running tracks of “the immediate price relative strength difference curve”, “the oscillating price relative strength difference curve” and “the weighted closing price relative strength difference curve” respectively.
- (5) The three kinds of curves above will form the trend starting and the trend closed-loops.
- (6) The trend starting (starting point①, starting point②), together with the trend closed-loops (closed-loop point①, closed-loop point②), collectively constitute the complete form of the “*Double Inflection Points*” model.

### 1.3 Variables and Constraints

Table 1, Variables and Constraints

| Variables  | Symbols              | Constraints                          | Remarks   |
|--|----------------------|--------------------------------------|---|
| The immediate price relative strength difference index   | $DIP_{\alpha, \eta}$ | $0 \leq DIP_{\alpha, \eta} \leq 100$ | Its trajectory forms the first price relative strength difference moving curve, x |
| The oscillating price relative strength difference index | $DIP_{\beta, \eta}$  | $0 \leq DIP_{\beta, \eta} \leq 100$  | Its trajectory forms the second curve of price relative strength difference, y    |

|  |                   |   |   |
|--|-------------------|---|---|
| The weighted closing price relative strength difference index              | $DIP_{e,i}$       | $0 \leq DIP_{e,i} \leq 100$   | Its trajectory forms the third curve of price relative strength difference, $z$ |
| Specific price of a specific time.   | $P$               | $\geq 0$  |   |
| Price relative strength difference value                                   | $\Delta P$        | $\Delta P = \sum_{i=1}^t (P_f - P_i)$                                 | Contains two subitems, $\Delta P_{rise}$ and $\Delta P_{fall}$                  |
| Price relative strength difference value with price rise                   | $\Delta P_{rise}$ | $\Delta P_{rise} = \sum_{i=1}^t (P_f - P_i),$<br>$(P_f - P_i \geq 0)$ | The sum of all $P_f - P_i \geq 0$   |
| Price relative strength difference value with price fall                   | $\Delta P_{fall}$ | $\Delta P_{fall} = \sum_{i=1}^t (P_f - P_i),$<br>$(P_f - P_i \leq 0)$ | The sum of all $P_f - P_i \leq 0$   |
| $\Delta P$ while the highest prices rise                                   | $\Delta P_{hr}$   | $\geq 0$  | Subitem of $\Delta P_{rise}$  |
| $\Delta P$ while the highest prices fall                                   | $\Delta P_{hf}$   | $\leq 0$  | Subitem of $\Delta P_{fall}$  |
| $\Delta P$ while the lowest prices rise                                    | $\Delta P_{lr}$   | $\geq 0$  | Subitem of $\Delta P_{rise}$  |
| $\Delta P$ while the lowest prices fall                                    | $\Delta P_{lf}$   | $\leq 0$  | Subitem of $\Delta P_{fall}$  |
| $\Delta P$ while closing prices rise                                       | $\Delta P_{cr}$   | $\geq 0$  | Subitem of $\Delta P_{rise}$  |
| $\Delta P$ while closing prices fall                                       | $\Delta P_{cf}$   | $\leq 0$  | Subitem of $\Delta P_{fall}$  |
| $\Delta P$ while the previous closing prices rise                          | $\Delta P_{pcr}$  | $\geq 0$  | Subitem of $\Delta P_{rise}$  |
| $\Delta P$ while previous closing prices fall                              | $\Delta P_{pcf}$  | $\leq 0$  | Subitem of $\Delta P_{fall}$  |
| $\Delta P$ while differences between closing price and opening prices rise | $\Delta P_{cor}$  | $\geq 0$  | Subitem of $\Delta P_{rise}$  |
| $\Delta P$ while differences between closing price and opening prices fall | $\Delta P_{cof}$  | $\leq 0$  | Subitem of $\Delta P_{fall}$  |
| numbers of time cycles   | $t$               | $\geq 0$  | Applied to each difference factor in the algorithms                             |

## 1.4 Algorithm Design

### 1) The Algorithm of Price Factor $\Delta P^1$

$\Delta P$  = Sum of (price of final time period  $f$  - price of initial time period  $i$ )

In the formula above,  $i$  stands for starting time period,  $f$  stands for ending time period, and  $t$  stands for numbers of time cycles.

For example, if the numbers of time cycles  $t = 6$  (months), then:

$$\Delta P = (\text{current month price} - 5\text{th month price}) + (5\text{th month price} - 4\text{th month price}) + \dots + (2\text{nd month price} - 1\text{st month price})$$

In terms of quantitative formula, it could be presented as:

$$\Delta P = (P_6 - P_5) + (P_5 - P_4) + (P_4 - P_3) + (P_3 - P_2) + (P_2 - P_1)$$

In the formula, the positive price difference between two continuous time periods will be counted into price relative strength difference value with price rise. Oppositely, the negative price difference between two continuous time periods will be counted into price relative strength difference value with price fall.

<sup>1</sup> The price factor  $\Delta P$  is a unique and important breakthrough point to study the principle of "Double Inflection Points". The algorithm of  $\Delta P$  establishes the basic algorithm of "Double Inflection Points" model.

Therefore, it could be reformed as:

$$\Delta P_{rise} = \sum_{i=1}^t (P_f - P_i), \quad (P_f - P_i \geq 0)$$

$$\Delta P_{fall} = \sum_{i=1}^t (P_f - P_i), \quad (P_f - P_i \leq 0)$$

It can be seen from the formulas above that the change of its value conforms to the agreement of “Logic Ideas” (1.2).

## 2) The Algorithm of “Immediate Price Trend”

- (1) Using the immediate price relative strength difference index to reflect the immediate price changing trend.
- (2) Using the average value of the sum of the relative strength difference aimed at the current three kinds of immediate prices (i.e., the highest price, the lowest price, and the closing price) to reflect the average value of the relative strength difference while the immediate prices rise.
- (3) Using the average total value of the relative strength difference aimed at the current three kinds of immediate prices (i.e., the highest price, the lowest price, and the closing price) to reflect the average value of the relative strength difference while the immediate prices rise and fall. If  $\Delta P$  is negative value, then it will be counted into denominator as absolute value for measuring the price changes. This is also applied in following parts of denominators in algorithms.
- (4) Comparing (2) with (3), the immediate price relative strength difference index is formed to reflect the running track of the immediate price relative strength difference curve and reveal the changing trend of the immediate prices.
- (5) According to the algorithm above, the following result is:

The immediate price relative strength difference index

$$= \frac{\text{The average value of relative strength difference while immediate prices rise}}{\text{The average total value of relative strength difference while immediate prices rise and fall}} \times 100 \quad (1.1)$$

In terms of quantitative formula, it could be present as:

$$DIP_{(x,t)} = \frac{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr}}{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cf}|} \times 100 \quad (1.2)$$

The formula above follows the algorithm rules of  $\Delta P = \sum_{i=1}^t (P_f - P_i)$ .

(6) Meanings of the algorithm:

In formula (1.2), if the price rises, the value of the numerator ( $\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr}$ ) will increase. Otherwise, it will decrease. And the denominator ( $\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cf}|$ ) shows the overall situations while the immediate prices rise and fall with the consideration of the price oscillation (i.e., the highest price, the lowest price), its value is also positively correlated with a price change. It reflects the running track

of relative strength difference curve of immediate price.

### 3) The Algorithm of “Oscillating Price Trend”

- (1) Using the oscillating price relative strength difference index to reflect the changing trend of oscillating price.
- (2) Using the average value of the sum of the relative strength differences while the two forms of the current prices (i.e., the highest price and the lowest price) rise to reflect the average value of the relative strength difference while the oscillating prices rise.
- (3) Using the average total value of the relative strength difference while the current prices (i.e., the highest price, the lowest price, the closing price, and the opening price) rise and fall to reflect the average value of the relative strength difference while the oscillating prices rise and fall.
- (4) Comparing (2) with (3) above, “the relative strength difference of oscillating price index” is formed to reflect the running track of the curve of oscillating price relative strength difference curve and reveal the changing trend of oscillating price.
- (5) According to the algorithm above, the following result is:

The oscillating price relative strength difference index

$$= \frac{\text{The average value of relative strength difference while oscillating prices rise}}{\text{The average total value of the relative strength difference while the oscillating prices rise and fall}} \times 100 \quad (1.3)$$

In terms of quantitative formula, it could be present as:

$$DIP_{(y,t)} = \frac{\Delta P_{hr} + \Delta P_{lr}}{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cor} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cof}|} \times 100 \quad (1.4)$$

Here, the formula above follows the algorithm rules of  $\Delta P = \sum_{i=1}^t (P_f - P_i)$ .

(6) Meanings of the algorithm:

In formula (1.4), if the price rises, the value of the numerator ( $\Delta P_{hr} + \Delta P_{lr}$ ) will increase. Otherwise, it will decrease. And the denominator ( $\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cor} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cof}|$ ) shows the overall situations while the oscillating prices rise and fall with the consideration of the difference between rising and falling within the closing price and opening price, its value is also positively correlated with the price change. It reflects the running track of relative strength difference curve of the oscillating price.

### 4) The Algorithm of “Weighted Closing Price Trend”

- (1) Using the weighted closing price relative strength difference index to reflect the weighted closing price changing trend.
- (2) Using the average value of the sum of the relative strength difference while the current prices (i.e., the highest price and the lowest price) and the closing prices (i.e., the current closing price and the previous closing price) in the rising state to reflect the average value of the relative strength difference while weighted closing prices rise.
- (3) Using the average value of the sum of the different values of the current prices (i.e., the highest price and the lowest price) and the closing prices (i.e., the current

closing price and the previous closing price) to reflect the average value of relative strength difference while weighted closing prices rise and fall.

(4) Compared (2) with (3) above, the weighted closing price relative strength difference index is formed to reflect the running track of the weighted closing price relative strength difference curve -- the changing trend of the weighted closing price.

(5) According to the algorithm above, the following result is:

The weighted closing price relative strength difference index

$$= \frac{\text{The average value of relative strength difference while weighted closing prices rise}}{\text{The average total value of relative strength difference while weighted closing prices rise and fall}} \times 100 \quad (1.5)$$

In terms of quantitative Formula, it could be present as:

$$DIP_{(z,t)} = \frac{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + \Delta P_{pcr}}{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + \Delta P_{pcr} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cf} + \Delta P_{pcf}|} \times 100 \quad (1.6)$$

Here, the formula above follows the algorithm rules of  $\Delta P = \sum_{i=1}^t (P_f - P_i)$ .

(5) Meanings of the algorithm:

In formula (1.6), if the price rises, the value of the numerator ( $\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + \Delta P_{pcr}$ ) will increase; Otherwise, it will decrease. And the denominator ( $\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + \Delta P_{pcr} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cf} + \Delta P_{pcf}|$ ) shows the overall situations while the weighted closing prices are rising and falling with the consideration of the previous closing prices rise and fall, the highest prices rise and fall and the lowest prices rise and fall, its value is also positively correlated with the price change. It reflects the running track of relative strength difference curve of the weighted closing price.

## 1.5 DIP Model

### 1) The Algorithm Formulas

According to the stipulations mentioned in “1.3 Variables and Constraints” and “1.4 Algorithm Design”, we can summarize the DIP algorithms as follows:

$$DIP_{(x,t)} = \frac{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr}}{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cf}|} \times 100 \quad \text{Algorithm①}$$

$$DIP_{(y,t)} = \frac{\Delta P_{hr} + \Delta P_{lr}}{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cor} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cof}|} \times 100 \quad \text{Algorithm②}$$

$$DIP_{(z,t)} = \frac{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + \Delta P_{pcr}}{\Delta P_{hr} + \Delta P_{lr} + \Delta P_{cr} + \Delta P_{pcr} + |\Delta P_{hf} + \Delta P_{lf} + \Delta P_{cf} + \Delta P_{pcf}|} \times 100 \quad \text{Algorithm③}$$

$$\Delta P = \sum_{i=1}^t (P_f - P_i)$$

In the formulas above:

$\Delta P$ , price factor.

$t$ , numbers of time cycles.

$i$ , initial time period.

$f$ , final time period.

## 2) Algorithm Features

DIP model is a kind of compound model with three algorithms.

(1) Algorithm①,  $DIP_{(x, t)}$ , which calculates “the immediate price relative strength difference index”, forms the moving curve of relative strength difference of immediate price, showing the moving path of the relative strength difference value for the immediate price.

(2) Algorithm②,  $DIP_{(y, t)}$ , which calculates “the oscillating price relative strength difference index”, forms the moving curve of relative strength difference of the oscillating price, showing the moving path of the relative strength difference value of the oscillating price.

(3) Algorithm③,  $DIP_{(z, t)}$ , which calculates “the weighted closing price relative strength difference index”, forms the moving curve of relative strength difference of weighted closing price, showing the moving path of relative strength difference value of weighted closing price.

(4) The moving paths of the three indexes above jointly determine the trajectory of the three moving curves and their interrelations, principles, rules, and effects.

## 3) Model Meanings

① The price change will lead to a positive change to the price factor  $\Delta P$ .

② The change of  $\Delta P$  describes the changes in various price patterns.

③ The corresponding subitems of  $\Delta P$  constitute the three algorithms above and correspondingly the three indexes above.

④ The three indexes above calculated by DIP model will form three kinds of moving curves.

⑤ The trajectory of the three moving curves will display two intersection starting points and then two closed-loop points, named “**Double Inflection Points**” (DIP), which reveal the trend and its extension of the price moving.

### 1.6 Differences with Single Turning Point Models

Comparing with the single turning point models, there are some notable important differences for DIP model:

1) The different algorithm logics:  $\Delta P$ , etc.

2) The different algorithms: *Three algorithms*.

3) The different properties: *Composite model, from a four-dimensional perspective*.

4) The different connotations: *Immediate price trend, oscillating price trend, weighted closing price trend*.

5) The different curve relationship: *x line/red, y line/yellow, z line/green, and their application rules*.

6) The different effects: *Trend capture, profitability*.

## 1.7 Principle and Applications of DIP

### 1) Principle

- (1) Starting point① and starting point② jointly constitute the “trend starting”.
- (2) Closed-loop point① and closed-loop point② jointly constitute “trend closed loop”.
- (3) “Trend starting” points out the direction and the price of entering a position.
- (4) “Trend closed loop” points out the direction and price of exiting a position.
- (5) Starting point② and closed-loop point② respectively gives confirmation to “starting point①” and “closed-loop point①”.

### 2) Application Rules

**Rule 1:** The logical relationship between the red line(x) and the green line(z)

- (1) When the red line crosses up the green line,  
That is  $DIP_{(x,t)} \geq DIP_{(z,t)}$ , bullish for a long trading order.  
At this time, the starting point① will appear, and there is a profit opportunity to enter a position for long trading.
- (2) When the red line breaks down the green line,  
That is  $DIP_{(x,t)} \leq DIP_{(z,t)}$ , bearish for a short trading order.  
At this time, the starting point① will appear, and there is a profit opportunity to enter a position for short trading.
- (4) When closed-loop① appears, it means the necessity of reducing an appropriate part of position and locking in a part of profits.

**Rule 2:** The logical relationship between the red line(x) and the yellow line(y)

- (1) When the red line goes beyond the yellow line  
When the red line exceeds the yellow line, the starting point② of bullish mood will appear and gives confirmation to the starting point①, which means the market price will continue to rise, so further long trading operation can get more profit.  
In other words, if  $DIP_{(x,t)} \geq DIP_{(y,t)}$ , continuing for long trading.
- (2) When the red line goes below the yellow line  
When the red line goes below the yellow line, the bearish starting point② will appear and gives confirmation to the bearish starting point①, which means the price will continue to fall downward, so further short trading operation can get more profit.  
In other words, if  $DIP_{(x,t)} \leq DIP_{(y,t)}$ , keeping for short trading.
- (3) When closed-loop② appears, it means the necessity of exiting a position and realizing profits.

By means of the price trend revealed by the DIP and the interaction relationships of the three curves above, we can vividly understand the price direction and trend to make financial trading more convenient. It would be more effective for us to analyze the financial trend, and conducive to make decision clearer and more accurate.

## 2. An Empirical Analysis of the Profitability with DIP

### 2.1 Comparative Analysis of the Profitability in Long Trading

Taking the monthly gold prices as an example, we sample the international spot gold prices from November 2018 to July 2020(Figure 1).

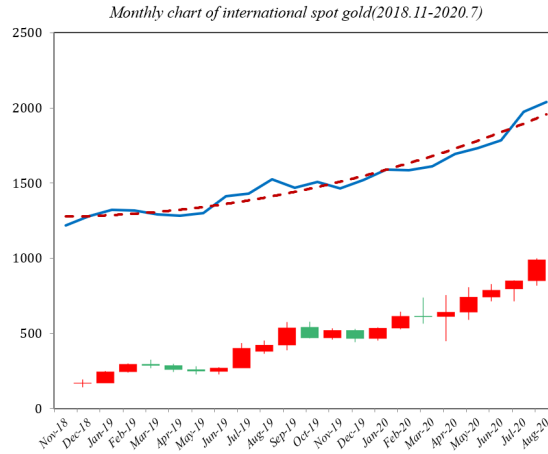


Figure 1. International Spot gold prices from November 2018 to July 2020

According to algorithm①, algorithm② and algorithm③,  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$  and  $DIP_{(z, t)}$  are calculated as follows (Table 2).<sup>2</sup>

Table 2. Calculations of  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$  and  $DIP_{(z, t)}$  in gold long trading

| Year/Mon<br>th | $DIP_{(x, t)}$ | $DIP_{(y, t)}$ | $DIP_{(z, t)}$ | Year/Mon<br>th | $DIP_{(x, t)}$ | $DIP_{(y, t)}$ | $DIP_{(z, t)}$ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 2018/11        | 44.074         | 49.624         | 44.074         | 2019/10        | 67.636         | 54.003         | 64.638         |
|                | 8              | 3              | 8              |                | 8              | 5              | 6              |
| 2018/12        | 49.985         | 49.985         | 44.593         | 2019/11        | 65.901         | 54.068         | 66.126         |
|                | 0              | 0              | 6              |                | 0              | 0              | 8              |
| 2019/01        | 56.035         | 49.985         | 46.291         | 2019/12        | 64.826         | 54.343         | 67.388         |
|                | 8              | 0              | 1              |                | 9              | 9              | 6              |
| 2019/02        | 58.005         | 50.506         | 48.304         | 2020/01        | 68.938         | 54.700         | 67.830         |
|                | 6              | 6              | 2              |                | 6              | 5              | 9              |
| 2019/03        | 55.596         | 50.923         | 50.169         | 2020/02        | 70.615         | 55.144         | 68.425         |
|                | 4              | 2              | 7              |                | 5              | 3              | 7              |
| 2019/04        | 53.038         | 51.387         | 51.818         | 2020/03        | 71.055         | 55.820         | 68.711         |
|                | 0              | 3              | 2              |                | 6              | 2              | 9              |
| 2019/05        | 53.654         | 51.818         | 51.964         | 2020/04        | 74.134         | 57.030         | 68.285         |
|                | 0              | 2              | 1              |                | 1              | 0              | 7              |
| 2019/06        | 60.885         | 52.151         | 53.548         | 2020/05        | 82.651         | 58.030         | 69.719         |

<sup>2</sup>Data source: <https://www.gold2u.com/>, same in following tables.

|         |        |        |        |         |        |        |        |
|---------|--------|--------|--------|---------|--------|--------|--------|
|         | 4      | 4      | 3      |         | 8      | 7      | 1      |
| 2019/07 | 67.532 | 52.893 | 56.767 | 2020/06 | 87.271 | 59.344 | 69.918 |
|         | 0      | 2      | 1      |         | 0      | 0      | 0      |
| 2019/08 | 71.545 | 53.325 | 58.874 | 2020/07 | 89.758 | 61.233 | 81.176 |
|         | 5      | 5      | 9      |         | 4      | 8      | 1      |
| 2019/09 | 70.517 | 53.724 | 62.449 | 2020/08 | 93.264 | 62.297 | 84.820 |
|         | 3      | 8      | 7      |         | 3      | 3      | 5      |

The moving tracks of the  $DIP_{(x,t)}$ ,  $DIP_{(y,t)}$  and  $DIP_{(z,t)}$  can be shown as follows (Figure 2):

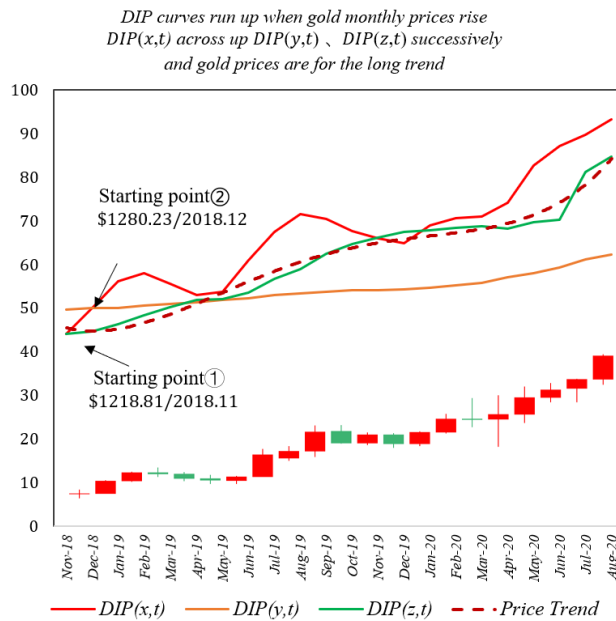


Figure 2.  $DIP$  curves while gold monthly prices rise  
 based on the monthly data of international spot gold (November 2018-august 2020)

## 2.2 Comparative Analysis of the Profitability in Short Trading

Taking the monthly gold prices as an example, we sample the international spot gold prices from August 2011 to February 2016 (Figure 3).

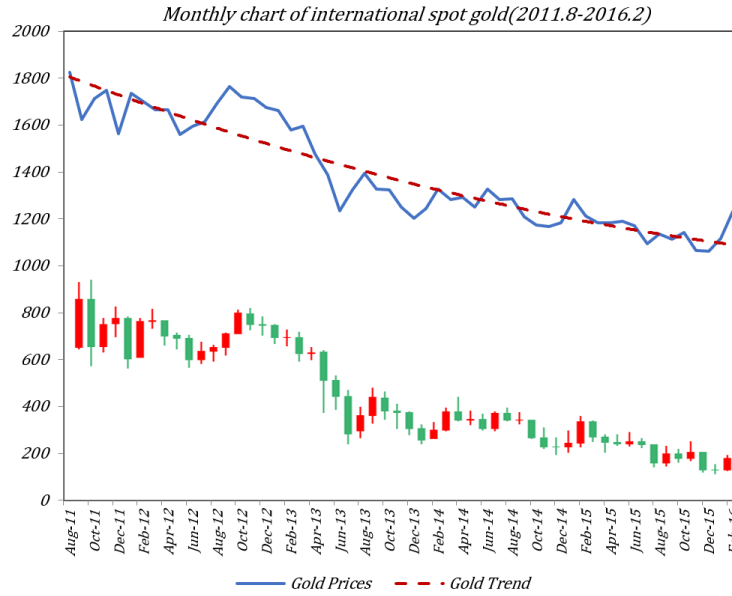


Figure 3. International spot gold market from August 2011 to February 2016

According to algorithm①, algorithm②, and algorithm③, we can calculate  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$  and  $DIP_{(z, t)}$  as follows (Table 3):

Table 3. Values of  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$  and  $DIP_{(z, t)}$  in gold short trading

| Year/Mont | $DIP_{(x, t)}$ | $DIP_{(y, t)}$ | $DIP_{(z, t)}$ | Year/Mont | $DIP_{(x, t)}$ | $DIP_{(y, t)}$ | $DIP_{(z, t)}$ |
|-----------|----------------|----------------|----------------|-----------|----------------|----------------|----------------|
| h         | g              | g              | g              | h         | g              | g              | g              |
| 2011/08   | 73.4938        | 65.62          | 73.49          | 2013/12   | 35.59          | 58.37          | 37.75          |
|           |                | 19             | 38             |           | 79             | 61             | 91             |
| 2011/09   | 72.6745        | 65.92          | 72.67          | 2014/01   | 36.26          | 57.56          | 38.66          |
|           |                | 57             | 45             |           | 77             | 09             | 01             |
| 2011/10   | 65.7028        | 65.67          | 72.20          | 2014/02   | 40.99          | 56.82          | 39.54          |
|           |                | 90             | 16             |           | 16             | 81             | 97             |
| 2011/11   | 65.6370        | 65.63          | 71.12          | 2014/03   | 42.95          | 56.01          | 39.36          |
|           |                | 70             | 49             |           | 03             | 60             | 19             |
| 2011/12   | 62.6216        | 65.63          | 68.83          | 2014/04   | 42.11          | 55.17          | 39.63          |
|           |                | 23             | 11             |           | 18             | 53             | 24             |
| 2012/01   | 60.0402        | 65.68          | 67.87          | 2014/05   | 41.07          | 54.53          | 39.61          |
|           |                | 66             | 63             |           | 58             | 71             | 16             |
| 2012/02   | 63.1499        | 66.13          | 66.13          | 2014/06   | 42.58          | 53.92          | 40.83          |
|           |                | 61             | 61             |           | 31             | 67             | 93             |
| 2012/03   | 61.1623        | 66.27          | 63.15          | 2014/07   | 44.30          | 53.24          | 42.09          |
|           |                | 76             | 64             |           | 64             | 12             | 97             |
| 2012/04   | 58.8808        | 66.30          | 62.39          | 2014/08   | 43.32          | 52.42          | 43.32          |
|           |                | 14             | 18             |           | 56             | 88             | 56             |
| 2012/05   | 55.8682        | 66.09          | 60.34          | 2014/09   | 40.90          | 51.56          | 42.07          |
|           |                | 96             | 65             |           | 94             | 57             | 63             |
| 2012/06   | 53.9710        | 65.91          | 58.42          | 2014/10   | 37.34          | 50.72          | 41.25          |

|         |         |       |       |         |       |       |       |
|---------|---------|-------|-------|---------|-------|-------|-------|
|         |         | 68    | 32    |         | 28    | 54    | 37    |
| 2012/07 | 55.2948 | 65.81 | 58.25 | 2014/11 | 36.19 | 49.76 | 40.38 |
|         |         | 93    | 31    |         | 42    | 33    | 55    |
| 2012/08 | 57.2495 | 65.87 | 57.24 | 2014/12 | 37.11 | 48.69 | 40.12 |
|         |         | 76    | 95    |         | 49    | 71    | 20    |
| 2012/09 | 60.7635 | 65.87 | 57.57 | 2015/01 | 42.61 | 48.27 | 40.39 |
|         |         | 60    | 13    |         | 93    | 80    | 58    |
| 2012/10 | 61.0924 | 65.92 | 57.60 | 2015/02 | 44.82 | 47.65 | 40.27 |
|         |         | 24    | 59    |         | 73    | 33    | 09    |
| 2012/11 | 57.6736 | 65.91 | 57.67 | 2015/03 | 41.60 | 46.96 | 39.90 |
|         |         | 26    | 36    |         | 36    | 51    | 39    |
| 2012/12 | 57.1269 | 65.81 | 57.96 | 2015/04 | 40.52 | 46.54 | 40.16 |
|         |         | 11    | 55    |         | 89    | 87    | 21    |
| 2013/01 | 55.1983 | 65.60 | 58.02 | 2015/05 | 40.78 | 46.00 | 40.88 |
|         |         | 63    | 43    |         | 21    | 22    | 65    |
| 2013/02 | 52.6308 | 65.21 | 57.20 | 2015/06 | 40.75 | 45.42 | 41.46 |
|         |         | 34    | 44    |         | 60    | 90    | 55    |
| 2013/03 | 50.2177 | 64.65 | 56.01 | 2015/07 | 37.43 | 44.81 | 40.97 |
|         |         | 30    | 52    |         | 62    | 59    | 83    |
| 2013/04 | 46.4875 | 64.11 | 53.12 | 2015/08 | 36.85 | 44.32 | 39.81 |
|         |         | 31    | 55    |         | 41    | 76    | 83    |
| 2013/05 | 40.6861 | 63.52 | 50.18 | 2015/09 | 38.38 | 43.94 | 39.13 |
|         |         | 27    | 48    |         | 90    | 19    | 88    |
| 2013/06 | 35.2646 | 62.69 | 46.27 | 2015/10 | 39.24 | 43.59 | 39.14 |
|         |         | 90    | 57    |         | 14    | 11    | 34    |
| 2013/07 | 34.7245 | 62.03 | 43.78 | 2015/11 | 37.98 | 43.07 | 38.41 |
|         |         | 66    | 41    |         | 26    | 63    | 13    |
| 2013/08 | 40.4939 | 61.41 | 40.49 | 2015/12 | 37.53 | 42.48 | 37.53 |
|         |         | 51    | 39    |         | 08    | 56    | 08    |
| 2013/09 | 41.8222 | 60.67 | 40.69 | 2016/01 | 41.95 | 41.95 | 37.73 |
|         |         | 94    | 59    |         | 68    | 68    | 02    |
| 2013/10 | 40.2020 | 59.89 | 39.21 | 2016/02 | 47.09 | 41.78 | 40.29 |
|         |         | 43    | 28    |         | 96    | 59    | 18    |
| 2013/11 | 38.3589 | 59.20 | 38.37 |         |       |       |       |
|         |         | 96    | 35    |         |       |       |       |

The moving tracks of the  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$  and  $DIP_{(z, t)}$  can be shown as follows (Figure 4.):



Figure 4. *DIP curves run down when monthly gold prices fall based on the monthly data of international spot gold (November 2018-August 2020)*

### 2.3 Profitability of DIP Compared with MACD & MA

Table 4. Profitability of DIP compared with MACD

| Direction     | DIP compared with MACD |               |                                     |                             |                            |                   |
|---------------|------------------------|---------------|-------------------------------------|-----------------------------|----------------------------|-------------------|
|               | Profit increase        | Profit ratio% | Profitability improving proportion% | Cost advantage contribution | Profit margin Contribution | Profit increase % |
| Long trading  | \$103.22               | 61.86%        | +12.64%                             | +8.46%                      | +4.18%                     | 25.68%            |
| Short trading | \$146.80               | 71.96%        | +16.73%                             | +5.23%                      | +11.5%                     | 30.29%            |

Table 5. Profitability of DIP compared with MA

| Direction     | DIP compared with MA |               |                                     |                             |                            |                   |
|---------------|----------------------|---------------|-------------------------------------|-----------------------------|----------------------------|-------------------|
|               | Profit increase      | Profit ratio% | Profitability improving proportion% | Cost advantage contribution | Profit margin Contribution | Profit increase % |
| Long trading  | \$103.22             | 61.86%        | +12.64%                             | +8.46%                      | +4.18%                     | 25.68%            |
| Short trading | \$332.99             | 71.96%        | +36.94%                             | +9.83%                      | +27.11%                    | 105.48%           |

The differences of profitability between DIP and MACD and MA can be shown as

follows. (Figure 5.)

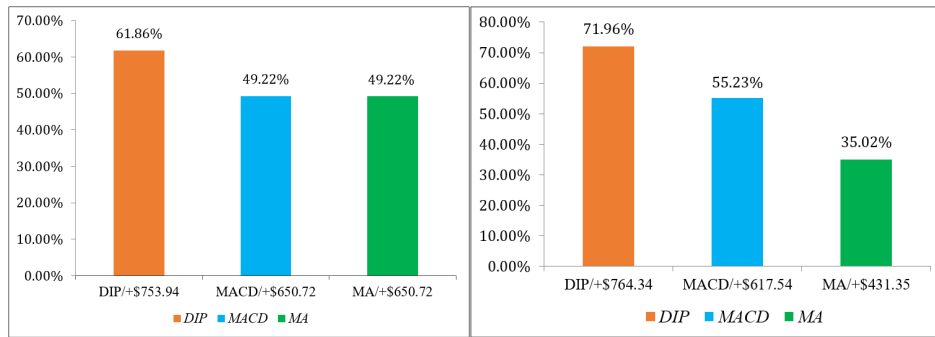


Figure 5. Comparison of profitability between DIP and single turning point

It is clear from Figure 5. the DIP model evidently outperforms the single turning point models in terms of profitability, whether it is in long trading or short trading.

Furthermore, we can also illustrate from Figure 6 that the DIP model is more conducive to capture trend profit margin.

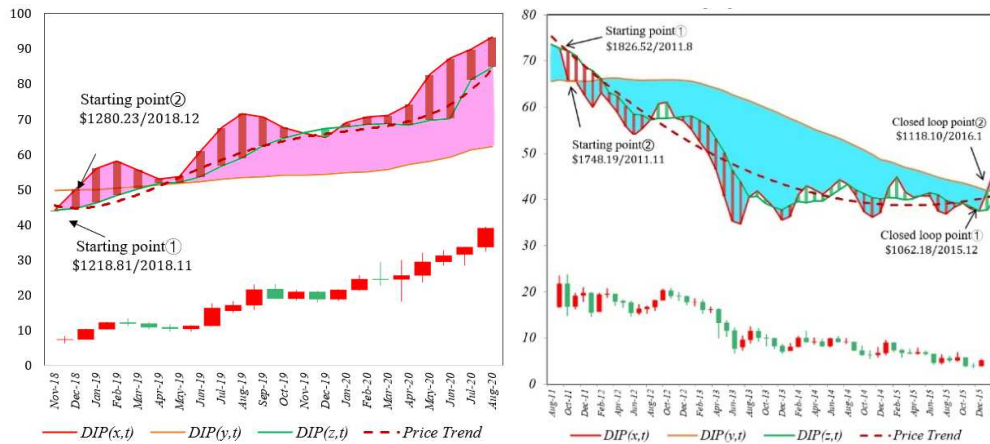


Figure 6. Profit margin of gold long or short trading based on DIP

Figure 6 vividly and clearly depicts the profit margin with DIP model.

In the diagram on the left, the gold prices are in long trading situation, the pink-colored area depicts the profit margin for trend trading. And the dark red column part shows the profit margin for staged trading. There is no doubt that the profit margin for trend trading with DIP model is greater than that of staged trading.

In the diagram on the right, the gold prices are in short trading situation, the blue-colored area depicts the profit margin for trend trading. And the dark red column part shows the profit margin for staged trading. There is also no doubt that the profit margin for trend trading with DIP model is greater than that of staged trading.

### 3. Summary

#### 3.1 What are the DIP Capturing

- 1) The algorithms of DIP respectively point to the changes of immediate price, the oscillating price, and the weighted closing price. DIP captures the signal of the time, the direction and the specific price value of the trend, which is helpful to enter a position to grasp the trading opportunity.
- 2) The starting point<sup>②</sup> of DIP is a confirmation to the starting point<sup>①</sup>. Starting point<sup>①</sup> gives out the signal of entering a position. Starting point<sup>②</sup> captures the signal about the trend extension, which is helpful to judge the current trading position and the profit margin.
- 3) The closed-loop point<sup>②</sup> of DIP is a confirmation to the closed-loop point<sup>①</sup>. The closed-loop point<sup>①</sup> captures the adjustment signal of trading. The closed-loop point<sup>②</sup> captures the ending signal of price trend, which is much more helpful for exiting a position and realizing profit.
- 4) The relationship between  $DIP_{(x, t)}$ ,  $DIP_{(y, t)}$  and  $DIP_{(z, t)}$  and the three moving curves of DIP captures the complete signals for position entering, holding, reducing, and exiting, which helps to grasp trading opportunities, effectively control risks and maximize profits.

#### 3.2 Advantages of DIP Model

Generally speaking, the advantages of DIP model compared to other models mainly lie in two aspects, the more accurate prediction for the trend starting from a four-dimensional perspective and the greater profit margin for profitability improving significantly.

#### 3.3 Contributions

There are two aspects of contributions in this paper, establishing the DIP theoretical system to enrich the financial trend analysis method, as well as providing the scheme with DIP to improve the profitability significantly and proving its feasibility in practice.

### 4. Basic Conclusion

The twofold signals of “trend starting” and “trend closed-loop” are the unique and distinct characteristics of DIP, which is helpful to uncover the financial trend clearly and definitely and achieve the profit-maximization in financial trading.

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