Application of the Thermodynamic System to Analyze the Relationship of the Money Amount Circulating Against Inflation

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Abstract. Based on an analogy between thermodynamics and economic theories, one of many economic problems can be represented by the ideal gas equation. Scientists have considered modifying the formulae from an ideal gas in thermodynamic principle to be applied to economic problems. An ideal gas is composed of many molecules. This ideal gas with the outside environment limited by the boundary system. Therefore, this gas is only contained in a volume so that this gas will exert pressure on the walls of the system. The gas molecules will vibrate and move about faster so they will increase their rate of exchange of kinetic energy. Since this gas also accumulates internal energy, an increase in temperature will be generated in this process so pressure and volume potentially increasing too. An equation of ideal gas has a similar structure to the equation of an economic system. Many molecules are assumed as monetary carriers or holders of value, equivalent in size to units of currency. The relationship of the system with the outside environment is that the value held by carriers or holders can be exchanged for goods and services at the boundary system at price (as pressure) and volume over a period of time, according to an index (or a degree of a scale) of trading value (as temperature) with which they can do this over that period. The objective of this study was to obtain inflation index value \( m \), to find out the inflation rate in Indonesia in that year and to analyze the causes and solutions for the better in the following year. The economic analysis of inflation is applied to the ideal gas theory. The parameters needed to be the money supply, the price index, and the speed of the money supply. The calculation and analysis with this ideal gas equation showed that all parameters used were affecting each other. The data from the last ten years showed that there was a significant change in the value of elasticity index value \( n \) for 4 times. All changes were in different time frames. Based on the ideal gas theory, a good value of \( n \) was a value of \( n \) that is less than or equal to one.

1. Introduction
Based on the kinetic theory of gases, the macroscopic properties, such as pressure, volume, and temperature, can be computed to describe microscopic properties even though the motions of the individual gas molecules may only be specified statistically. The kinetic theory of gases has mathematical properties were known by Robert Boyle in the mid-17th century. The theory obtained that relationship for a fixed mass of gas, then the pressure and volume were inversely proportional at a
given temperature. The research was continued by Charles, Gay-Lussac, and Avogadro subsequently so obtained the formulation of the ideal gas law [1].

The thermo-economics is the most recent area in econophysics, this area emerges as a synthesis of thermodynamics and economics. In the area of physics, the study of thermodynamics focuses on the interdependence of the four key values that is pressure, volume, temperature, and entropy [2-4]. The synthesis of economics and thermodynamics is possible in correspondence between thermodynamic and economic processes. Thermodynamic synthesis as typically employed in ecological economics is a simple analogy of reality. Therefore, this theory must empirically be tested against the real world [5-6].

The synthesis of economics and physics can be applied as the methods and models of statistical physics to solve economic problems. The econophysics is presently to analyze the relationship and interdependence between thermodynamics and economics. Because of similarities, analogies, and correspondence between the methods and models of thermodynamics and economics. To analysis, the relationship between economics and thermodynamics in the kinetic theory of gases corresponding to money, income and wealth distribution needs the empirically analyze temperature differences [7].

Economic research based on the concept of the other science, especially physics, it is increasingly being carried out because of the demands for quantitative analysis on the financial system are higher. The depiction of physics phenomena in economics, in this case, thermodynamics, is commonly referred to as "econophysics." Econophysics applies ideas, methods, and models in statistical physics and complexity systems to analyze data from economic phenomena. Physics has a lot of models but it is not balanced with the amount of data it has, in contrast to economics that has a lot of data but a little model. One of the data in the economic field, namely inflation and influencing factors [8].

Inflation is one of the important monetary events and is almost found in every country as an increase in the price of goods in general and applies continuously. Monetary policy is one of the policies in controlling inflation carried out by the monetary authority to influence monetary variables. Monetary variables as part of the causes of inflation include the money supply, exchange rates, and interest rates. The creation of high economic growth rates and low inflation rates is one result of the success of the monetary policy [8].

Inflation in Indonesia during the Old Order government was caused by a deficit in the government budget. As a monetary authority, Bank Indonesia (BI) has the function of regulating the amount and allocation of money supply and interest rates to achieve macroeconomic targets. The relationship of the money supply to inflation can be seen from the Irving Fisher equation in the economic theory. The Irving Fisher equation is following one of the principles of circumstances in the field of physics. The principle of the state is an ideal gas system in thermodynamics. The quantities of these physical and economic equations can be analogized as follows, pressure as the price level, ideal gas volume as output volume, the amount of gas as the money supply, and temperature as the indexing speed of trade.

The focus of this research is to analyze inflation factors using an ideal gas thermodynamic system. This analysis system uses data on the money supply, gross domestic product, and the price index as obtained in the last ten years. The ideal gas equation with actual data will produce an index of \( n \) which is then used to determine the value of \( m \) as an approach to the value of the inflation index.

2. Research Method

2.1. Inflation and money circulation

Inflation is an increase in the level of prices of goods and services in general within a certain period. The price level generally reflects the overall price level of goods and services for a certain period in an economic system. Inflation can be seen from two sides, namely demand and supply [8].

In terms of demand, inflation can be caused by an increase in the money supply (money supply), an increase in government spending, an increase in exports, and others. When demand increases and is not matched by an increase in the amount of money in circulation, there will be an increase in prices
which causes inflation. While on the supply side, inflation can be influenced by rising raw material prices, increases in salaries or wages, etc. which can cause production costs to increase. Thus, the prices of goods and services tend to increase on an ongoing basis which can cause inflation.

Increasing the money supply in the community can cause the value of money to decrease. The relationship between the money supply and the price level can be explained by the equilibrium of exchange approach. This exchange equation is an explanation of the theory of the quantity of money produced by an economic thinker, Irving Fisher. The relationship can be written with the following equation:

\[ PY = MV \]  

Equation (1) in above represents that the amount of money used to buy goods and services, that is the money supply \( M \) multiplied by the number of times the average money changes hands or turns in the period \( V \) is equal to the money supply of money received from sales of goods and services, which are the product of the average price of the goods \( P \) and the number of transactions that occur \( Y \) \[9\].

The theory of inflation can be grouped into 3 parts, i.e.

1. **The quantity theory of money**, quantity theory highlights the inflation process in terms of the money supply and psychology or people's expectations of future price increases (expectation). According to this theory, inflation can only occur if there is an increase in the money supply. The rate of inflation is determined by the rate of increase in the money supply and by people's expectations of future price increases. In quantity theory, there are two types, namely Traditional Quantity Theory and Modern Quantity Theory. Traditional Quantity Theory is a hypothesis about the main causes of money value or price level. This theory produces a conclusion that changes in the value of money or the price level are a result of changes in the money supply. The increase in the money supply in the community will cause the value of money to decrease. Because a decrease in the value of money has the same meaning as an increase in the price level, the theoretical conclusions generated by the quantity theory mentioned above can also be said that an increase in the money supply has a tendency or tendency to increase the price level. Vice versa, the reduction in the money supply tends to decrease the price level. Thus, according to the traditional quantity theory inflation can only occur if there is an increase in the money supply.

2. **Keynes's theory**, Keynes's theory of inflation considers inflation to occur because people want to live beyond the limits of their economic capacity. In other words, the inflation process is a process of fighting over the share of output among groups of people who want a larger share than the community can provide. The struggle for this process was finally realized as a condition where people's demand for goods always exceeded the number of goods available or the emergence of what was called the inflationary gap. The inflationary gap is possible because the community has succeeded in obtaining funds to turn their purchase plans into effective demand. If the effective demand from all classes of society exceeds the amount of available output, prices will rise. Inflation will stop if people no longer obtain funds to finance their purchase plans at the current price so that the total effective demand does not exceed the amount of output available (the inflationary gap is lost).

3. **Structuralist theory**, the structuralist theory explains the long-term inflation process in developing countries. According to this theory, several things can cause inflation in the economies of developing countries, i.e.: a) The inelasticity of export revenues, namely the value of exports which is growing slowly compared to growth in other sectors. This lag is caused by the supply or production of export goods that are not responsive to price increases. This slow growth in export revenue means slow growth in the ability to import the goods needed (for consumption and investment). As a result, developing countries are trying to achieve certain growth targets and adopt development policies that emphasize promoting domestic production than previously imported (import substitution), although often domestic production has higher production costs than imported similar goods. If the import substitution process is increasingly widespread, then the increase in production costs will also expand to various goods, thus inflation will occur.
b) Insecurity from the supply or production of food ingredients in the country. This increase in food ingredients encouraged an increase in employee wages, thereby increasing production costs which would later increase the price of goods. An increase in the price of these goods will lead to another wage increase, which is then followed by an increase in prices. And so on, where the process will stop if the price of food does not continue to rise.

According to Mankiw theories about the quantity of money, inflation, and the role of the central bank, namely "So, the quantity theory of money states that the central bank which oversees the money supply has the highest control over the inflation rate. If the central bank maintains the money supply remains stable, the price level will be stable. If the central bank increases the money supply quickly, the price level will increase rapidly" [10].

2.2. Ideal gas in Thermodynamics

The molecular interpretation of the ideal gas law is a kinetic theory of gas which has three basic assumptions. First, the gas consists of molecules with random motion without stopping. Second, molecules only interact when collisions occur. Third, the size can be ignored meaning that the diameter is much smaller than the average distance traveled between collisions. The molecule hits the container wall continuously, and the pressure comes from the kinetic energy transmitted to the wall in the presence of a collision with the wall [11, 12].

The ideal gas model in thermodynamics assumes that the money supply is equal to the ideal number of gas molecules. If the money supply $N$ in its movement is fixed, when the price of output $P$ (described as pressure) and output volume $V$ (described as volume) change with each other under certain circumstances, then the change in $P$ and $V$ can affect the speed of money supply $T$ (described as temperature). Therefore, $T$ depends on the volume and amount of money supply within a certain period. The equation of the four variables can be written as follows:

$$PV = [Nk]T,$$

and the differential equation of the equation (2) is

$$\frac{dP}{P} + \frac{dV}{V} = \frac{dN}{N} + \frac{dT}{T}.$$

It means that all variables change. Thermodynamic systems flow for all systems that have four variables, other than the constant $k$, namely: the number of molecules flowing $N$, the volume flowing $V$, pressure $P$, and temperature $T$, but this equation will be more effective if simplified into three variables by dividing the pressure by the number the molecule flows into a specific pressure that is $P_N$, so the equation can be written:

$$P_NV = kT,$$

and the differential equation of the equation is

$$\frac{dP_N}{P_N} + \frac{dV}{V} = \frac{dT}{T}.$$

There are several circumstances so that the ideal gas has a variety of processes in thermodynamic systems. This process is a manifestation and expansion of ideal gas compression. The ideal gas expansion and compression law are generally stated by:

$$P_NV^n = constant = C,$$

the value of $n$ depends on changes in the state of expansion or compression and the natural state of the gas and the value of $n$ is around $0 \leq n \leq \infty$.

The various state values of $n$ are as follows:

1. If $n = 0$, then $P_NV^0 = constant = C$, meaning that $P_N$ is fixed or called isobaric;
2. If $n = 1$, then $P_NV^1 = constant = C$, meaning that $P_NV$ is fixed or called isothermal;
3. If $n = \gamma$, then $P_NV^\gamma = constant = C$, meaning this process is called adiabatic;
4. If $n = \infty$, then $P_NV^\infty = constant = C$, meaning that $V$ is fixed or called isochoric.

The analogy is stated by Bryant [12, 13], and the analogy used in economic equations is that $M$ is the money supply, $V$ is the trade index or velocity of money supply, $P$ is the price level, and $Y$ is the
volume of output or Gross Domestic Product (GDP). While the analogy used in physics equations, namely \( N_k \) states the number of gas molecules, \( T \) represents the temperature of the gas in Kelvin, \( P \) represents the ideal gas pressure, and \( V \) represents the ideal gas volume.

| Table 1. Relationship Between Economic and Physics Variables |
|-------------------------------------------------------------|
| Economic variables | Physics variables | Equation |
|--------------------|-------------------|----------|
| \( M \)             | \( N_k \)         | Economic: \( MV = PY \) |
| \( V \)             | \( T \)           |                      |
| \( P \)             | \( P \)           | Physics: \( PV = [N_k]T \) |
| \( Y \)             | \( V \)           |                      |

2.3. Data analysis
Data analysis begins with knowing the nature and analogy of each component in physics and economics equations. The money supply \( (M) \) is analogous to the ideal amount of gas \( (N) \) which has the same nature, which is located and occupying a certain space. Gross Domestic Product \( (Y) \) is the sum of all public and government transactions in Indonesia that is analogous to the volume of space occupied \( (V) \) by gas. The price level \( (P) \) depends and is directly proportional to \( N \). \( P \) is analogous to pressure \( (P) \) where pressure is also dependent and directly proportional to the amount of gas. The trade index or velocity of money supply \( (V) \) is analogous to the temperature \( (T) \) in the space occupied by the gas where both will be equally considered constant in this study.

The results of calculations and tracking of these data will be used as analysis material. This study uses the elasticity index value \( (n) \) to determine the value of the inflation index \( (m) \). There are 4 index values \( (n) \), namely zero, one, more than one (not infinite) and infinite. The parameters obtained from the data and calculations will be used for consideration of government policy in determining the money supply and related to it.

3. Results and Discussion
The model of the nature of the economy in the field of physics depends on data on the money supply, gross domestic product, and the financial price index being read. All three of these data will get the speed of the money supply. All components of this data will influence one another, such as when the money supply rises it will cause an index of financial prices to rise and vice versa. This study focuses on analyzing the effect of specific price changes and gross domestic product on inflation or in physical properties, namely the effect of pressure in a certain volume on the elasticity index \( n \).

This study uses data from Bank Indonesia [14] in the form of actual data from the causes of inflation in 10 years. Data in the form of curves are shown in Figure 1. The actual data will be used in calculations using the ideal gas equation in thermodynamics (equation (6)), then this data is processed using Microsoft Excel. The actual data used in this study is in the form of data changes over 4 periods. This aims to simplify the calculation. The first period starts from January 2008 to December 2010, the second period starts from January 2011 to June 2013, the third period starts from January 2014 to June 2014, and the fourth period starts from July 2014 to December 2017. The data taken in this study are the price index every month, the money supply every month, and quarterly gross domestic product. Based on the actual data (Table 10 in appendix), there were fluctuations in each period, but no significant changes occurred so that the changes in the data can be considered as the ideal gas state of polytrophic thermodynamics.
Figure 1. The Relationship between Actual Data on the Gross Domestic Product (GDP) \((V)\) with Specific Prices for 2008-2017.

The nature of polytrophic in the field of physics means that the velocity of circulation \(T\) has a value that tends to be constant, then the change in volume causes a change in the relationship between the pressure and the number of gas molecules or is called a specific pressure. Based on equation (6) polytrophic conditions have an index of \(n\) which can indicate elasticity. The elasticity index here is a change in all factors. Changes from one factor will affect changes in other factors.

The results of the trend indicate a significant change in the relationship between gross domestic product \((V)\) with a specific price \((P_N)\) in certain years to get a more relevant value of \(n\) that is by dividing the trend into several segments. Based on Figure 1, the trend is divided into four segments, namely in Figures 2, 3, 4, and 5. After getting the value of \(n\), the value of \(m\) can be determined as an approach to the value of the inflation index in Indonesia.

The division of trends in these four segments occurs because there is a significant change from the relationship of specific price changes to the gross domestic product \((GDP)\). Physics properties state that there is a significant change in specific pressure on the volume of space occupied by the gas molecules in it. The greater the specific price, the smaller the gross domestic product and vice versa.

In the first period, from January 2008 to December 2010, data on the money supply tends to increase at each period, while the price index value tends to change within a certain period. In the first period in this study, it was seen that the price index value increased in early 2008 and dropped significantly in the middle of the year, then increased again. This economic behavior can be seen in Figure 2. The value of the gross domestic product \((GDP)\) slightly increased. From the changes in each of these elements, data from this first period is fitting and calculated in Table 2, so it produces the elasticity index \((n)\) value obtained is 2.069808. The average parameter values of actual data for the period 2008-2010 are shown in Table 3. This \(n\) value is greater than one meaning, there are inflation or price increases. This inflation can be caused by the money supply continuously increasing but not offset by changes in the corresponding price index.
Figure 2. The Relationship between Actual Data on the Gross Domestic Product (GDP) \(V\) with Specific Prices for 2008-2010.

Table 2. The Results of the Calculation of Actual Data for the Period 2008-2010.

| \(dP\)   | \(dV\)   | \(n\)   |
|----------|----------|---------|
| 2.329512 | 1.504663 | 2.069808|

Table 3. The Average Parameter Values of Actual Data for the Period 2008-2010.

| Parameter | Average values          |
|-----------|-------------------------|
| \(P\)     | 724.230                 |
| \(V\)     | 1399579.80              |
| \(C\)     | 380990891.2             |

\[ PV^{2.069808} = 5.426627 \ (R^2 = 0.5833) \]

In the second period, from January 2011 to June 2013, the money supply slightly increased, the price index tended to be constant, and gross domestic product (GDP) increased. This economic behavior can be seen in Figure 3. Data from this second period is fitting and calculated in Table 4, so it produces the index value of \(n\) of the changes in these factors is 0.214772. The average parameter values of actual data for the period 2010-2013 are shown in Table 5. The value of \(n\) is less than one meaning, in this period there is deflation.
Figure 3. The Relationship Between Actual Data on the Gross Domestic Product (GDP) \( V \) with Specific Prices for 2010-2013.

Table 4. The Results of the Calculation of Actual Data for the Period 2010-2013.

| \( dP \)     | \( dV \)     | \( n \)     |
|-------------|-------------|-------------|
| 1.060451    | 1.314277    | 0.214772    |

Table 5. The Average Parameter Values of Actual Data for the Period 2010-2013.

| Parameter | Average values |
|-----------|----------------|
| \( P \)   | 422.638        |
| \( V \)   | 1945821.05     |
| \( C \)   | 0.000947747    |

\[ pV^{0.214772} = 1.124556 \ (R^2 = 0.5754). \]

The third period, namely July 2013 to June 2014, with the money supply, tended to increase, the relative price index did not change, and gross domestic product increased. This economic behavior can be seen in Figure 4. Data from this third period is fitting and calculated in Table 6, so it produces the index value of \( n \) in the third period, which is 2.048625. The average parameter values of actual data for the period 2013-2014 are shown in Table 7. The \( n \) index value is more than one, meaning that there is inflation as well as the first period.
Figure 4. The Relationship between Actual Data on the Gross Domestic Product (GDP) \( V \) with specific prices for 2013-2014.

| \( dP \) | \( dV \) | \( n \) |
|---|---|---|
| 1.41589 | 1.185011 | 2.048625 |

Table 6. The Results of the Calculation of Actual Data for the Period 2013-2014.

Table 7. The Average Parameter Values of Actual Data for the Period 2013-2014.

| Parameter | Average values |
|---|---|
| \( P \) | 349.989 |
| \( V \) | 2,414.505 |
| \( C \) | 416,944,493.8 |

\[ PV^{2.048625} = 2.004743 \quad (R^2 = 0.8388). \]

The fourth period is July 2014 to December 2017. In this period, the price index tends to increase, the money supply is relatively stable, and gross domestic product (GDP) decreases. This economic behaviour can be seen in Figure 5. Data from this fourth period is fitting and calculated in Table 8, so it produces the index value of \( n \) for this period is 0.623053. The average parameter values of actual data for the period 2013-2014 are shown in Table 9. That is, there is a deflation but the deflation that occurred in the fourth period is better than deflation in the second period.
Figure 5. The Relationship between Actual Data on the Gross Domestic Product (GDP) (V) with Specific Prices for 2014-2017.

Table 8. The Results of the Calculation of Actual Data for the Period 2014-2017.

|       | dP      | dV      | n        |
|-------|---------|---------|----------|
|       | 1.196027 | 1.332829 | 0.623053 |

Table 9. The Average Parameter Values of Actual Data for the Period 2013-2014.

| Parameter | Average values     |
|-----------|--------------------|
| \( P \)   | 265.995            |
| \( V \)   | 3054777.80         |
| \( C \)   | 0.291984884        |

\[ PV^{0.623053} = 1.430481 \quad (R^2 = 0.9708). \]

Based on the four-time periods, changes (increase or decrease) in the price of goods are influenced by several factors, such as changes in the value of \( N \) and \( V \) fluctuations. In the first and third periods, the value of \( n \) is more than one, this is caused by the same factors, namely the fluctuation of the price index data, the continuous increase in the money supply, and the increase in gross domestic product. In periods of two and four \( n \) is less than one. But in period four, the value of \( n \) is closer to one than the value of \( n \) in the second period. The values of \( P \) in the second and fourth periods have the equation that is increasing continuously, but there is a fluctuation in the value of \( N \) while the value of \( V \) tends to increase continuously. A value of \( n \) more than one means that there is inflation, whereas when a value of \( n \) less than one means there is a financial deflation. The more the value of \( n \) is far from the number one, the greater is the occurrence of inflation or deflation.
Based on the $n$ values that have been obtained using the ideal gas equation in general, it can be used to calculate the estimated $m$ value as an approach to the actual inflation index value that has been recorded in Bank Indonesia. Calculation of the value of $m$ is by:

$$m_x = n + (8.2 - x)$$

(7)

where $x$ is the 1, 2, 3, 4 .... The value of $x$ in equation (7) starts from the first period of this study. A comparison of the actual data inflation index with experimental data has an error value of 6 ± 5 %.

4. Conclusion

Analysis of the influence of factors causing inflation using the thermodynamic ideal gas equation in the field of physics has several advantages compared to using the equation of the influence of inflation factors using economic equations. Because with the ideal gas equation can determine the elasticity index which shows how the state of goods prices, whether inflation or deflation occurs. Relatively high inflation and deflation are shown in the first, second, and third periods while the fourth period shows deflation with a better intensity than the previous period. This can occur because of changes in different factors from previous years, namely the price index that tends to increase, the reduced gross domestic product, and the money supply which is relatively stable. This $n$ value is then used to determine the $m$ value which is the actual data inflation index approach.

This research has not been able to calculate the value of $m$ with a low error rate. Therefore, further research using other numerical solution methods that are following the ideal gas equation is needed. Besides, more than ten years of data is needed to see the pattern of index values ($n$) in the ideal gas equation, making it easier to predict inflation in the following year.

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Appendix

Table 10. Actual price index data, money supply, gross domestic product (GDP), and specific price index results calculated for 10 years taken from www.bi.go.id [14].

| Years | Months | \( P \) (Index) | \( N \) (Billion Rupiahs) | \( V \) (Billion Rupiahs) | \( P \) Specific |
|-------|--------|-----------------|--------------------------|--------------------------|----------------|
| 2008  | 1      | 158.26          | 1588962.00               | 1117579.50               | 0.000101       |
|       | 2      | 159.29          | 1596090.00               | 1229645.40               | 0.00648        |
|       | 3      | 160.81          | 1586795.00               | 1768250.00               | 0.00648        |
|       | 4      | 161.73          | 1608874.00               | 1802932.00               | 0.00604        |
|       | 5      | 164.01          | 1636383.00               | 1841163.00               | 0.00604        |
|       | 6      | 111.59          | 1679020.00               | 1883851.00               | 0.00604        |
|       | 7      | 112.16          | 1675431.00               | 1908510.00               | 0.00604        |
|       | 8      | 113.25          | 1768250.00               | 2018510.00               | 0.00604        |
|       | 9      | 113.76          | 1802932.00               | 2021517.00               | 0.00604        |
|       | 10     | 113.9           | 1841163.00               | 2062206.00               | 0.00604        |
|       | 11     | 113.86          | 1883851.00               | 2141384.00               | 0.00604        |
|       | 12     | 113.78          | 1859891.00               | 2066480.99               | 0.00598        |
| 2009  | 1      | 114.02          | 1890430.00               | 2112082.70               | 0.00598        |
|       | 2      | 114.27          | 1909681.00               | 2116023.54               | 0.00598        |
|       | 3      | 113.92          | 1905475.00               | 2143234.05               | 0.00598        |
|       | 4      | 113.97          | 1917092.00               | 2231144.33               | 0.00598        |
|       | 5      | 114.10          | 1977532.00               | 22217588.81              | 0.00598        |
|       | 6      | 114.61          | 1960950.00               | 2236459.45               | 0.00598        |
|       | 7      | 115.25          | 1995294.00               | 2274954.57               | 0.00598        |
|       | 8      | 116.46          | 2018510.00               | 2308845.97               | 0.00598        |
|       | 9      | 116.68          | 2021517.00               | 2347806.86               | 0.00598        |
|       | 10     | 116.65          | 2062206.00               | 2471205.79               | 0.00598        |
|       | 11     | 117.03          | 2141384.00               | 2681580.10               | 0.00598        |
|       | 12     | 118.01          | 2066480.99               | 2681580.10               | 0.00598        |
| 2010  | 1      | 118.36          | 2112082.70               | 2505857.00               | 0.00598        |
|       | 2      | 118.19          | 2116023.54               | 2700138.00               | 0.00598        |
|       | 3      | 118.37          | 2143234.05               | 2709845.97               | 0.00598        |
|       | 4      | 118.71          | 2231144.33               | 2727495.47               | 0.00598        |
|       | 5      | 119.86          | 22217588.81              | 2762956.13               | 0.00598        |
|       | 6      | 121.74          | 2236459.45               | 2795285.98               | 0.00598        |
|       | 7      | 122.67          | 2274954.57               | 2822783.81               | 0.00598        |
|       | 8      | 123.21          | 2308845.97               | 2864556.13               | 0.00598        |
|       | 9      | 123.29          | 2347806.86               | 2929614.74               | 0.00598        |
|       | 10     | 124.03          | 2471205.79               | 2963331.45               | 0.00598        |
|       | 11     | 125.17          | 2877219.57               | 2922392.02               | 0.00598        |
|       | 12     | 126.29          | 2436678.95               | 2877219.57               | 0.00598        |
| 2011  | 1      | 126.46          | 2420191.14               | 1750625.00               | 0.00514        |
|       | 2      | 126.05          | 2451356.92               | 1820150.00               | 0.00501        |
|       | 3      | 125.66          | 2434478.39               | 1820150.00               | 0.00501        |
|       | 4      | 125.81          | 2475285.98               | 1929614.74               | 0.00488        |
|       | 5      | 126.50          | 2522783.81               | 1922392.02               | 0.00452        |
|       | 6      | 127.35          | 2564556.13               | 1922392.02               | 0.00452        |
|       | 7      | 128.54          | 2621345.74               | 1922392.02               | 0.00452        |
|       | 8      | 128.89          | 2643331.45               | 1922392.02               | 0.00452        |
|       | 9      | 128.74          | 2677205.02               | 1922392.02               | 0.00452        |
|       | 10     | 129.18          | 2729538.27               | 1922392.02               | 0.00452        |
| Year | Value   | Value 1 | Value 2 | Value 3 | Value 4 | Value 5 |
|------|---------|---------|---------|---------|---------|---------|
| 2012 | 1       | 130.90  | 2854978.21 | 1975475 | 0.0045  |
|      | 2       | 130.96  | 2849795.50 |         |         |         |
|      | 3       | 131.05  | 2911919.94 |         |         |         |
|      | 4       | 131.32  | 2927259.39 |         |         |         |
|      | 5       | 131.41  | 2992057.03 | 2051048 | 0.00433 |
|      | 6       | 132.23  | 3050354.88 |         |         |         |
|      | 7       | 133.16  | 3054836.46 |         |         |         |
|      | 8       | 134.43  | 3089011.20 | 2119649 | 0.0043  |
|      | 9       | 134.45  | 3125333.38 |         |         |         |
|      | 10      | 134.67  | 3161725.60 |         |         |         |
|      | 11      | 134.76  | 3205129.12 | 2095693 | 0.0041  |
|      | 12      | 135.49  | 3304644.62 |         |         |         |
| 2013 | 1       | 136.88  | 3268789.15 |         |         |         |
|      | 2       | 137.91  | 3280420.25 | 2144941 | 0.00418 |
|      | 3       | 138.78  | 3322528.96 |         |         |         |
|      | 4       | 138.64  | 3360928.07 |         |         |         |
|      | 5       | 138.60  | 3426304.92 | 2210062 | 0.0041  |
|      | 6       | 140.03  | 3413378.66 |         |         |         |
|      | 7       | 136.88  | 3268789.15 |         |         |         |
|      | 8       | 137.91  | 3280420.25 | 2144941 | 0.00418 |
|      | 9       | 138.78  | 3322528.96 |         |         |         |
|      | 10      | 138.64  | 3360928.07 |         |         |         |
|      | 11      | 138.60  | 3426304.92 | 2210062 | 0.0041  |
|      | 12      | 140.03  | 3413378.66 |         |         |         |
| 2014 | 1       | 110.99  | 3652349.28 |         |         |         |
|      | 2       | 111.28  | 3643059.46 |         |         |         |
|      | 3       | 111.37  | 3660605.98 |         |         |         |
|      | 4       | 111.35  | 3730376.45 |         |         |         |
|      | 5       | 111.53  | 3789278.64 |         |         |         |
|      | 6       | 112.01  | 3865890.61 |         |         |         |
|      | 7       | 113.05  | 3895981.20 |         |         |         |
|      | 8       | 113.58  | 3895374.36 |         |         |         |
|      | 9       | 113.89  | 4010146.66 |         |         |         |
|      | 10      | 114.42  | 4024488.87 |         |         |         |
|      | 11      | 116.14  | 4076698.88 |         |         |         |
|      | 12      | 119.00  | 4173326.50 |         |         |         |
| 2015 | 1       | 118.71  | 4174825.91 |         |         |         |
|      | 2       | 118.28  | 4218122.76 |         |         |         |
|      | 3       | 118.48  | 4246361.19 |         |         |         |
|      | 4       | 118.91  | 4275711.11 |         |         |         |
|      | 5       | 119.50  | 4288369.26 |         |         |         |
|      | 6       | 120.14  | 4358801.51 |         |         |         |
|      | 7       | 121.26  | 4373208.10 |         |         |         |
|      | 8       | 121.73  | 4404085.03 |         |         |         |
|      | 9       | 121.67  | 4508603.17 |         |         |         |
|      | 10      | 121.57  | 4443078.08 |         |         |         |
|      | 11      | 121.82  | 4452324.65 |         |         |         |
|      | 12      | 122.99  | 4548800.27 |         |         |         |
| 2016 | 1       | 123.62  | 4498361.28 |         |         |         |
|      | 2       | 123.51  | 4521951.20 |         |         |         |
|      | 3       | 123.75  | 4561872.52 |         |         |         |
|      | 4       | 123.19  | 4581877.87 |         |         |         |

14
|   | 2017 | 2018 |
|---|------|------|
| 5 | 123.48 | 4614061.82 |
| 6 | 124.29 | 4737451.23 |
| 7 | 125.15 | 4730379.68 |
| 8 | 125.13 | 4746026.68 |
| 9 | 125.41 | 4737630.76 |
| 10 | 125.59 | 4778478.89 |
| 11 | 126.18 | 4868651.16 |
| 12 | 126.71 | 5004976.79 |
|   | 3206377.20 | 0.00265 |
| 5 | 127.94 | 4936881.99 |
| 6 | 128.24 | 4942919.76 |
| 7 | 128.33 | 5033780.29 |
| 8 | 128.83 | 5125383.79 |
| 9 | 129.72 | 5225165.76 |
| 10 | 130.00 | 5178078.75 |
| 11 | 130.91 | 5219647.63 |
| 12 | 131.28 | 5419165.05 |