Supply Response Analysis of Palm Oil in Malaysia 1961–1985

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ABSTRACT

This article examines the nature of supply response of palm oil in Malaysia between 1961 and 1985. Supply responsiveness of palm oil was estimated using three area models. Price and cross-price elasticities with respect to palm oil and rubber prices were calculated. The long-run price elasticity of palm oil was estimated to be about 1.48. It implies that the overall long-run supply response of palm oil in Malaysia between 1961 and 1985 is elastic. Although the short-run elasticity was estimated to be about 0.72, i.e. inelastic, it is also quite high. The study also showed that the rubber price was not significant in determining the new planted area of palm oil.

INTRODUCTION

The palm oil sector is important to Malaysia’s agricultural growth. The output of the agricultural sector grew at a rate of 3.4 per cent per annum between 1980 to 1985. This growth was sustained largely by the output of palm oil, without which the sector would have expanded by only 1.4 per cent per annum (Fifth Malaysia Plan 1986).

An interesting feature of Malaysia’s agricultural land-use pattern since the 1960’s has been the decline in the total area under...
rubber and rice which was counterbalanced by an almost proportional increase in land area under palm oil. The preference of palm oil over rubber was due to primarily the secular decline in rubber prices which prompted estates, and to a certain extent rubber smallholders, to switch to palm oil. New land development schemes also preferred palm oil to rubber as its principal crop. Apart from favourable prices, palm oil also generates higher income of M$679 per month compared with $426 per month for rubber (Jamaluddin Lamin 1982). As a whole, the net monthly income of palm oil settlers over the 1976–81 period was 59.4 per cent higher than rubber.

Appendix A shows the total production, area and prices of palm oil in Malaysia for selected years over the period 1922–1985. It can be seen that the commercial cultivation of palm oil on a fairly large scale took place as far back as 1922. However, it was not until the late 1950s that concerted efforts were made to develop it into one of the major agricultural commodities for export. In 1960 about 54,634 hectares were in production and the output was 91,793 tonnes. By 1965 the area under palm oil had increased to 96,947 hectares and the output to 150,411 tonnes. In 1980, 1.07 million hectares were under palm oil, of which 956,000 were located in Peninsular Malaysia, 24,000 in Sarawak and 90,000 in Sabah.

The average growth rates of the land area and production of palm oil over the last 16 years (1970–1985) has been substantial with average annual increases of 25.18 per cent in area and 53.67 per cent in production respectively. The difference is being accounted for by the increase in yield. By 1985, the total area had increased to 1.465 million hectares. Currently, Malaysia is the world's leading exporter of palm oil, accounting for 60 per cent of world production and 70 per cent of world trade of palm oil (FAO 1986).

The main objectives of the study are to assess the impact of national agricultural policies in terms of incentives and disincentives toward oil palm; to identify the structural relationship between selected economic variables; and to measure the price and cross-price elasticities of movements of palm oil and rubber prices and the area under palm oil.

AGRICULTURAL POLICIES TOWARDS OIL PALM: AN OVERVIEW

In 1927 Malaysia accounted for less than 1 per cent of the world's net exports of palm oil. After the concerted efforts of the agricultural
diversification programme in the late 1950s, the Malaysian share of the world’s net exports of palm oil went up to 19 per cent in 1962 (David Lim 1973). By 1966, Malaysia had become the world’s leading producer of palm oil, a position which she has been able to maintain by the sustained increase in her production of palm oil (Appendix A).

The bulk of the increase in Malaysian palm oil production comes from the private estates sector. In 1969 this sector accounted for over 88 and 61 per cent of the mature and immature areas, respectively. By then, most estates had either been newly-planted with palm oil or had been converted from old rubber estates, mainly as a result of the relative buoyancy of the world fats and oils market and the grants made available under Fund A of the Rubber Industry (Replanting) Fund Ordinance of 1952. Under the Fund A, rubber estates were eligible to receive replanting grants of M$400 per acre for up to 21 per cent of their planted area as at the end of December 1954. These grants were meant to assist the estates in their programme to replace their low-yielding rubber trees with high-yielding trees. However, in encouraging the palm oil sector at that time, permission was given to the estates to use the funds over the period 1954–1962 for replanting with palm oil areas which previously had been under rubber.

Government aid in increasing palm oil production after that time has been delegated to the Federal Land Development Authority (FELDA) programme. The rapid increase in the cultivation of palm oil came about after FELDA found out that most of the available economic evaluations of its schemes had shown higher rates of return for palm oil over rubber. Thus, in this respect the policy for the FELDA programme over the past twenty years had emphasized palm oil and this trend has continued into the period for the Fifth Malaysia Plan.

Support for the private palm oil estates, nonetheless, has been continued by the government. The 30 per cent export tax exemption given to private palm oil estates and smallholders, especially in Sabah and Sarawak (East Malaysia), would encourage a faster rate of palm oil cultivation and subsequently palm oil production in these States in the ensuing years.

Pursuant to the provisions of the Palm Oil Research and Development Act, which was passed in January 1979, the Palm Oil Research Institute of Malaysia (PORIM) was established officially by the government in May 15, 1979. PORIM is financed largely by a cess collected on crude palm oil. As of January 1980 the industry pays
M$4 as a research cess for every tonne of crude palm oil it produces. More extensive research activities have been undertaken not only in the priority areas like end-use research, quality control, processing and utilization of effluents or by products but also in the broader areas of providing effective and efficient technical advisory services for consumers of palm oil products.

The government has undertaken various measures to ensure a sustained growth of the palm oil industry. For instance, a task force under the Palm Oil Registration and Licensing Authority (PORLA) was set up in July 1980 to improve the competitiveness of Malaysian palm oil in the world market. PORLA has continued to collect a cess of M$1 per tonne of crude palm oil produced at the mills to finance its operations. The task force is to look into the need to expand modern infrastructural and ancillary facilities including milling, storage and bulking capacities for the palm oil industry.

The National Agricultural Policy (NAP), enunciated in January 1984, provided the broad direction of the strategy for the agricultural sector as well as a long-term framework for its development up to the year 2000. For palm oil, the main target is towards increasing the efficiency of production in existing areas. Efforts to expand production of palm oil have continued almost invariably through the development of well-managed estates with emphasis on improved technology, while non-organized smallholdings have been discouraged.

ANALYSIS OF SUPPLY RESPONSES

Very few studies have been conducted to substantiate with statistical or empirical evidence the prevailing assertion about the inelastic nature of palm oil producers' response. This is due to the fact that palm oil is a perennial crop with a long period of gestation and extended lifespan unlike that of annual crops. One of the preliminary empirical studies by S. A. Oni and Olayide in the case of palm oil producers in Nigeria has shown that the price elasticity ranges from 0.22 and 0.502 (Askari H. & Cummings J. T. 1976). In Malaysia most studies have stressed more on the price elasticities of rubber (Chan 1962; Wharton 1963; and Berhman 1969) rather than that of palm oil.

This section attempts to study the long and short-run supply response of palm oil producers in Malaysia. Production data for the period 1961–1962 to 1985 is employed from which long-run and
Supply Response of Palm Oil

short-run supply elasticities are estimated. This period approximate­ly represents one complete cycle from the time of planting to the ter­mination of the commercial life of the palm. This study will also analyse the cross-price elasticities of palm oil with respect to rubber prices. The inclusion of the rubber prices is primarily because rubber competes with palm oil for land use.

MODEL I

It is contended that the major determinant of the expected profitabilit­y of growing the tree crop in question is the producer's expecta­tions with regard to the pattern of future prices (Bateman M. J. 1966). Thus, the relationship between planting and the producer's price expectation is formulated as follows:

\[ X_t = a_0 + a_1 \bar{P}_t + a_2 \bar{R}_t + U_t \]  

where \( \bar{P}_t = \sum_{i=0}^{n} (P_{t+i}^* + i)/ n + 1 \)

\( \bar{R}_t = \sum_{i=0}^{n} (R_{t+i}^* + i)/ n + 1 \)

\( X_t = \) number of hectares of newly planted palm oil in year \( t \).

\( P_{t+i}^* + i = \) expected real producer price of palm oil in year \( t + i \).

\( R_{t+i}^* + i = \) expected real producer price of rubber in year \( t + i \).

\( n = \) the expected age after which the palm oil trees planted in year \( t \) cease to bear (\( n = 25 \) years).

It is assumed that the producer's expectations concerning the future prices are formed adaptively in the following manner:

\[ \bar{P}_t - \bar{P}_{t-1} = B(\bar{P}_t - \bar{P}_{t-1}) \]  

\[ \bar{R}_t - \bar{R}_{t-1} = B(\bar{R}_t - \bar{R}_{t-1}) \]  

It is sometimes more useful to rewrite equations (2a) and (2b) as:

\[ \bar{P}_t = BP_t + (1 - B)\bar{P}_{t-1} \]  

\[ \bar{R}_t = BR_t + (1 - B)\bar{R}_{t-1} \]  

where \( Pt = \) real producer price of palm oil in year \( t \).

\( Rt = \) real producer price of rubber in year \( t \).

\( B = \) adjustment coefficient where \( 0 < B < 1 \).
The equations 3a and 3b suggest that the expected level of palm oil and rubber prices are a weighted average of the present level and the previous expected level of both prices. Expected levels of both prices are adjusted period-by-period by taking into account present levels of both prices. Given the area function (equation 1) and the price expectations models (equations 3a, and 3b), it is possible to combine them and eliminate the price expectations variables provided one additional assumption is made, i.e., that the adjustment coefficients (B) are one and the same (Further calculation may be found in Nerlove M. 1956). Solving $\bar{P}_t$ and $\bar{R}_t$ in (3a) and (3b) and then substituting them in (1) gives us:

$$X_t = a_0B + a_1BP_t + a_2BR_t + (1 - B)X_{t-1} + V_t$$

where $V_t = Ut - (1 - B)Ut - 1$.

The parameters to be estimated are $a_0B$, $a_1B$, $a_2B$, and $(1 - B)$. Once $(1 - B)$ is estimated the a’s and B can be computed. The coefficients $a_1$ and $a_2$ are the long-run responses of new planted area to prices and $a_1B$ and $a_2B$ denote the short-run responses of new planted area to price changes.

In this model it is assumed that the producer desires to maximize the present discounted value of the return from his investment (Bateman M. J. 1966). The equation implicitly suggests that yield per hectare and costs associated with planting and harvesting are not expected to change significantly during the relevant time period. The expected yield pattern of palm oil is relatively stable, and changes in potential yield occur slowly. However, the changes in costs may be a function of the changes in the price of the product. In summary, it is assumed that actual producer prices fluctuate more than do costs or yields.

**MODEL 2**

One of the major determinants of expected profits in model 1 is the expected price stream. If the palm oil producer expects a downward trend in future prices and that the average price level will be low relative to past prices, gross investment in this product will fall and may even be zero or negative. The capital losses incurred in such a practice suggest the irrationality involved unless the fall in palm oil price is substantial. Thus the second supply model employs a relationship which is less responsive to price decreases.
The second model suggests adjustments in the stock of trees to movement in prices. The model is:

\[ T_t = b_0 + b_1 \bar{P}_t + b_2 \bar{R}_t + U_t \]  

(5)

where \( \bar{P}_t \) and \( \bar{R}_t \) are defined as before, and 

\( T_t = \) the total stock of trees in year \( t \).

When the price expectations models of (3a) and (3b) are added, then substituted and combined with equation (5), the expected price terms can be eliminated to give:

\[ X_t = b_0 B + b_1 B P_t + b_2 B R_t - B T_{t-1} + V_t \]  

(6)

where \( T_t - T_{t-1} = X_t \)

and the error term

\[ V_t = U_t - (1 - B)U_{t-1} \]

The new planting in period \( t \) is a function of the same variables that appeared in the first model with the exception that the lagged planting variable has been replaced by the stock of trees, with a lag of one period and parameter of the latter is a negative beta. In this model Bateman uses the term “stock” to mean “area”.

MODEL 3

The desired total area model recognizes that certain constraints exist which keep the palm oil producer from adjusting the actual stock of trees to the desired level given a change in price. The model is as follows:

\[ T_t^* = c_0 + c_1 \bar{P}_t + c_2 \bar{R}_t \]  

(7)

where \( T_t^* = \) the desired total area of palm oil trees in year \( t \).

It is assumed that the actual total area of palm oil trees is adjusted in proportion to the difference between the total area desired in long-run equilibrium and the actual area. The relation is:

\[ T_t - T_{t-1} = \theta(T_t^* - T_{t-1}) + U_t \]  

(8)

where \( \theta = \) hectarage adjustment coefficient, depends on the nature and type of constraints facing the producer.
When the price expectations model of (3a) and (3b) are combined with equations (7) and (8), substitutions can be made to eliminate the desired total palm oil area and expected price variables. The result is as follows:

\[ X_t = c_0 B\theta + c_1 B\theta Pt + c_2 B\theta Rt + (1 - B - \theta)X_{t-1} - 1 - B\theta T_t - 2 + V_t \]  

(9)

where the error term

\[ V_t = \theta [U_t - (1 - B)U_{t-1}] \]

The desired total area model has been reduced so that new planting is once again the dependent variable. One of the features of the desired total area model is that it contains the same variables as the planting equation, with one addition—the total area of palm oil trees lagged two periods.

STATISTICAL PROCEDURE

The estimating procedure used is that of ordinary least square (OLS) multiple regression. The difficulties associated with serial correlation peculiar to distributed-lag models have been discussed by Nerlove (1956) and Johnston (1985). The OLS approach also ignores the likely complexity of the resulting error structure. The presence of serial correlation and lagged dependent variables is sufficient to render the OLS estimation process biased and inconsistent.

On the basis of theoretical considerations, the variables explaining new planted palm oil area will be correlated with the error term in the model. However, the extent of any bias will be smaller when the estimated coefficient is close to unity and the closer the variance of error term \( (\sigma^2) \) is to zero. Johnston also discussed the statistical problems of estimating such models when the explanatory variable is not independent of the error term. He suggested that, provided the error term is serially independent, the application of OLS yields consistent and asymptotically efficient estimators, although in small samples these estimators are biased. The mean squared error of the OLS estimator is also smaller than that of other estimators.

In the analysis of OLS multiple regression, whether the assumption of no serial correlation is approximately valid will depend both on prior judgement about the disturbances and an analysis of the residuals. Normally, the value of the Durbin-Watson statistic is used for testing of the presence or absence of serial correlation. But,
in this analysis the Durbin-Watson test could not be applied to evaluate the degree of serial correlation because of the inclusion of the lagged dependent variable among the explanatory variables.

RESULTS

Table 1 shows the results of regression analysis of palm oil from the three models above. For \( n = 25 \) which is the \( n \) used in the first and second model, the critical \( t \) value is 1.71 for \( P = 0.05 \) on the basis of a one-tailed test. It can be seen that the coefficients of the palm oil price in both models are significantly different from zero at the 5 per cent probability level. The coefficient of palm oil price in model 3 is only significant at the 10 per cent level. Although all the coefficients of rubber price are of the expected negative sign, they are not significant.

The coefficient of total area in \( t - 1 \) and \( t - 2 \) for models 2 and 3 are not consistent with respect to the expected negative sign although total area in \( t - 1 \) appears significant at the 5 percent level. The positive response in newly planted area at \( t \) to total area at \( t - 1 \) and \( t - 2 \) might reflect overall adjustment in total area (stock of trees) in the last 1 and 2 years as new trees significantly increased during the period of study. Finally, it can be concluded that from the statistical inferences of \( t \) and \( R^2 \) values, model 1 is the best representation of the supply response of palm oil area in Malaysia.

Estimated price elasticities of supply and cross-elasticities in the short-run and long-run are shown in Table 2. The elasticities are computed on the basis of the coefficients obtained and the mean values of the variables for the sample period. All price and cross-price elasticities are of the expected sign. It can be seen that the long-run elasticities, as expected, are greater in absolute value than those of the short-run. The short-run price elasticities range from 0.53 to 0.72 while the long-run price elasticities range from 0.57 to 1.48. For the cross-price elasticities, short-run elasticities range from \(-0.07\) to \(-0.97\) and in the long-run range from \(-0.15\) to \(-0.99\). However, the long-run elasticity estimates corresponding to model 2 and 3 are of dubious value since the coefficients of the lagged variable are nearly zero. The short-run and long-run price elasticities of model 1 are 0.72 and 1.48 while cross-price elasticities are \(-0.07\) and \(-0.15\), respectively.
TABLE 1. Results of regression analysis of palm oil in Malaysia, 1961/62 to 1985

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-6910.64</td>
<td>12589.2</td>
<td>5215.54</td>
</tr>
<tr>
<td>Palm oil Price (Pt)</td>
<td>41.77b</td>
<td>46.45b</td>
<td>33.13</td>
</tr>
<tr>
<td>Rubber Price (Rt)</td>
<td>-23.17</td>
<td>-133.08</td>
<td>-57.06</td>
</tr>
<tr>
<td>New planted area in year t-1 (Xt-1)</td>
<td>0.51a</td>
<td>-</td>
<td>0.38b</td>
</tr>
<tr>
<td>Total area in year t-1 (Tt-1)</td>
<td>-</td>
<td>0.0421b</td>
<td>-</td>
</tr>
<tr>
<td>SD. of errors</td>
<td>20450.63</td>
<td>21528.29</td>
<td>20524.97</td>
</tr>
<tr>
<td>R²</td>
<td>0.68</td>
<td>0.64</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Numbers in parentheses are t-statistics.

a. Significant at the 1% level.
b. Significant at the 5% level.


<table>
<thead>
<tr>
<th>Model</th>
<th>Price Elasticity</th>
<th>Cross-price Elasticity</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short-run*</td>
<td>Long-run*</td>
<td>Short-run*</td>
</tr>
<tr>
<td>Model 1</td>
<td>0.72</td>
<td>1.48</td>
<td>-0.07</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.81</td>
<td>0.84</td>
<td>-0.43</td>
</tr>
<tr>
<td>Model 3</td>
<td>0.53</td>
<td>0.57</td>
<td>-0.97</td>
</tr>
</tbody>
</table>

*evaluated at the mean values of the variables for the sample period.
CONCLUSION

The findings of this study have brought out some interesting features of the price elasticities of palm oil supply. From Model 1, which is the best model in this analysis, the long-run price elasticity of palm oil area was estimated to be about 1.48 and it can be concluded that the overall long-run supply response of palm oil in Malaysia between 1961 to 1985 is elastic. Although the short-run elasticity was estimated to be about 0.72, i.e., inelastic, it is also quite high. Both figures are higher than those estimated, for instance, by S. A. Oni for palm oil in Nigeria. The study also showed that rubber prices are not significant in determining the new planted area of palm oil, although the results were of the expected sign.

If a price policy is to be implemented by the government, the authorities must have an estimate of the price elasticity of supply. In this sense, a positive and significant price elasticity of supply would be desirable. A large elasticity would require a small price support in order to get a large output effect. However, a very large elasticity could cause stability problems and these also may be undesirable. It is not enough to have a large and significant elasticity, the authorities must also take into account the possible effects on other sectors of price policies in order to increase palm oil output through increasing new planted areas annually. Thus, depending on the form of price policies to be adopted, additional measures may be necessary to balance any possible adverse effects.

Finally, it should be noted that the models have not taken into account certain factors such as technological change, prices of input, the effect of weevil and weather. The study represents a beginning—a first attempt at using the model of price response to confirm the existence of supply responsiveness of palm oil at the aggregate level. Other statistical information is needed in order to obtain further evidence of price responsiveness of this crop at the regional levels.
Appendix A

Production, Area and Prices of Palm Oil, and Rubber Prices in
Malaysia over the period 1922–1985.

<table>
<thead>
<tr>
<th>Year</th>
<th>Palm Oil Production (tonne)</th>
<th>Palm Oil Area (hectare)</th>
<th>Palm Oil Prices (M$/tonne)</th>
<th>Rubber Prices (M cent/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1922-26</td>
<td>500</td>
<td>2700</td>
<td>n.a</td>
<td>n.a</td>
</tr>
<tr>
<td>1937-41</td>
<td>51300</td>
<td>30500</td>
<td>122.2</td>
<td>n.a</td>
</tr>
<tr>
<td>1950-55</td>
<td>54850</td>
<td>41900</td>
<td>741.9</td>
<td>n.a</td>
</tr>
<tr>
<td>1960</td>
<td>91793</td>
<td>54634</td>
<td>679.2</td>
<td>238.28</td>
</tr>
<tr>
<td>1961</td>
<td>94846</td>
<td>57143</td>
<td>695.8</td>
<td>184.11</td>
</tr>
<tr>
<td>1962</td>
<td>108171</td>
<td>62079</td>
<td>648.6</td>
<td>172.40</td>
</tr>
<tr>
<td>1963</td>
<td>125691</td>
<td>71030</td>
<td>644.4</td>
<td>159.66</td>
</tr>
<tr>
<td>1964</td>
<td>122913</td>
<td>83200</td>
<td>718.7</td>
<td>150.22</td>
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<tr>
<td>1965</td>
<td>150411</td>
<td>96947</td>
<td>828.3</td>
<td>154.41</td>
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<td>189687</td>
<td>122703</td>
<td>721.1</td>
<td>144.14</td>
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<td>225758</td>
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<td>282984</td>
<td>190765</td>
<td>514.7</td>
<td>117.13</td>
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<tr>
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<td>352096</td>
<td>231176</td>
<td>536.0</td>
<td>153.95</td>
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<td>1970</td>
<td>431069</td>
<td>291263</td>
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<td>1971</td>
<td>589090</td>
<td>328821</td>
<td>790.1</td>
<td>101.61</td>
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<td>1972</td>
<td>728958</td>
<td>389751</td>
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<td>93.97</td>
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<td>812614</td>
<td>459194</td>
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<td>1045975</td>
<td>557846</td>
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<td>1257573</td>
<td>641910</td>
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<td>1391965</td>
<td>722397</td>
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<tr>
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<td>1612747</td>
<td>802110</td>
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<td>1785525</td>
<td>885392</td>
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<td>2188699</td>
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<td>1140538</td>
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<td>3510920</td>
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<td>3016481</td>
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<td>3714795</td>
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<td>4131782</td>
<td>1464904</td>
<td>1,322.4</td>
<td>190.58</td>
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</table>

n.a: not available.

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