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# *Crude Oil Production in the Russian Empire: 1818- 1919\**

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## INTRODUCTION.

Because of current energy problems there is an increased interest among economists in the development, organization, and performance of the petroleum industries of various countries. The oil industry of Tsarist and Soviet Russia should be of great interest because of its long history and the variety of forms of organization which have prevailed in that industry.

There is a rapidly growing literature on the Soviet oil industry,<sup>1</sup> but writings on the Tsarist oil industry have fallen to a trickle since

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<sup>1</sup> Useful historical information on the development of the oil industry during the Soviet period can be found in: ROBERT W. CAMPBELL, *The Economics of Soviet Oil and Gas* (Baltimore, 1968); ROBERT E. EBEL, *The Petroleum Industry of the Soviet Union* (Washington, D.C., 1961) and *Communist Trade in Oil and Gas* (New York, 1970); HEINRICH HASSMANN, *Oil in the Soviet Union*, trans. A. M. Leeston (Princeton, 1953); EVGENII D. SAFRONOV, *Stanovlenie Sovetskoi neftianoi promyshlennosti* (Moscow, 1970); and VALENTIN D. SHASHIN (ed.), *Neftedobyvaishchaia promyshlennost' SSSR: 1917-1967* (Moscow, 1968). Hassmann, which stood for a number of years as the major source on the subject in the English language, provides an historical picture of the

the 1917 revolution.<sup>2</sup> This neglected period of petroleum history will undoubtedly be reexamined now as the West searches for answers to contemporary energy problems. But before serious historical efforts can be pursued, there is a need for reliable long-run series on basic measures such as crude oil production and for a look at some of the issues which might be addressed in such historical studies.

The purposes of this article are: 1) to present a better and more complete series on crude oil production in the Russian Empire from 1818 to 1919,<sup>3</sup> 2) to present improved measures of the rate of growth and the variability of growth of the industry during different time periods and under different forms of industrial organization, and 3) to offer a number of suggestions for future research.

The discussion is organized as follows. Part I provides a brief history of the industry. Part II presents the new series

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industry through World War II. Ebel (1961) carries the picture forward to 1960, while Ebel (1970) provides additional historical information, plus a major analysis of Soviet export capabilities. Campbell, which is the most technically sophisticated of the sources cited above, provides a thorough economic analysis of growth during the 1950's and early 1960's, with special emphasis on Soviet decision making. In Russian, Shashin provides one of the best historical overviews of the Soviet period (including large amounts of regional data), while Saftonov presents a view of political agitation in Baku and the process of nationalization of the industry during the years 1917 to 1924. Finally, the reader interested in developments in the past few years will want to consult CHRISTOPHER E. STOWELL, *Oil and Gas Development in the U.S.S.R.* (Tulsa, Oklahoma, 1974).

<sup>2</sup> The few pieces published since 1920 which provide historical treatments of the Tsarist oil industry include: PAUL APOSTOL and ALEXANDRE MICHELSON, *La lutte pour le pétrole et la Russie* (Paris, 1922); HASSMANN, WERNER VON KNORRE, « Die russische Erdölwirtschaft », *Petroleum* (Vienna) XXIII, No. 18 (1927), pp. 719-750; and K. A. PAZHITNOV, *Ocherki po istorii Bakinskoi nefedobyvatshchei promyshlennosti* (Moscow and Leningrad, 1940). The best of these is Pzhitnov.

While the materials cited above provide interesting information on the development of the Tsarist oil industry, all of them lack a complete series on crude oil production in Tsarist Russia, plus the thorough documentation and criticism of the data which is attempted here. Likewise, none of them provides the sort of statistical measurement of growth which is undertaken here. These contributions, plus the questions raised here, should encourage and facilitate further exploration of the rich store of historical information on the Tsarist and Soviet oil industries.

<sup>3</sup> The year 1818 was chosen because it was the first year for which we were able to find information on output, and 1919 because it will allow researchers to more easily splice Soviet series to our series. We have not gone beyond 1919 because the predominant unit of measure changes soon after that date (from *poods* to metric tons) and because we do not have any new insights into Soviet series on crude oil production.

together with commentary on the reliability of the figures. In Part III we use the new series in examining the rate of growth and the variability of growth of crude oil production. Part IV contains a discussion of the results presented in Part III plus suggestions for future research. Additional data plus details on the derivation of the output series are presented in two appendixes.

## I

### HISTORY OF THE RUSSIAN OIL INDUSTRY<sup>4</sup>

The historical centre of the Russian oil industry — Baku — was occupied by the Russians in 1806 and finally ceded to Russia by Persia through the Treaty of Gulistan (1813). Since all but two of the naphtha pits thus acquired had been the property of the last ruler of Baku — Hussin — the Tsarist government took possession of them. The government showed little interest in these oil sources until 1820 when it asserted its ownership prerogatives and began to farm out the rights to extraction and trade in oil to the highest bidder in return for an annual payment. This monopoly contract system, which called for a rebidding every four years, prevailed from 1821 to 1834, with the exception of a single year (1825) when the government operated the monopoly itself.

In 1834 the authorities abandoned this contract system in favour of direct government operation and from 1835 through 1849 the industry was operated as a state monopoly. From 1850 through 1872 the monopoly was again farmed out to a private bidder.<sup>5</sup>

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<sup>4</sup> This section is based on SERGEI L. PERSHIKE and LIUDVIG L. PERSHIKE, *Russkaia neftianiaia promyshlennost', eia razvitie i sovremennoe polozhenie v statisticheskikh dannykh* (Tiflis, 1913), pp. 3-6; VIKENTII SIMONOVICH, *Nef' i neftianiaia promyshlennost' v Rossii: Istoriko - statisticheskii ocherk* (St. Petersburg, 1909), pp. 25-28; Pazhitnov, pp. 62-89; JAMES D. HENRY, *Baku: An Eventful History* (London, 1906); and HANS HÖFER, *Das Erdöl und seine Verwandten* (2nd ed.; Braunschweig, Germany, 1906), pp. 15-18.

<sup>5</sup> There is great confusion about the history of the industry before 1872, particularly in the English language literature. This stems largely from oversimplifications and inaccuracies in the widely-quoted books of CHARLES MARVIN, *Baku, The Petrolia of Europe* (London, 1884) and *The Region of the Eternal Fire* (London, 1884). One of the worst of these is his statement in the first book (p. 20) that, « From 1813 to 1872 the extraction of petroleum was checked by its being rendered a state monopoly farmed out to a merchant named Meerzoeff ». As noted above, this period in fact

In 1872 the Tsarist government again abandoned this system and began to auction off oil-bearing government lands on a long-term basis in return for a lump sum payment and a low yearly rental charge. This system, modified by various excise taxes, prevailed until 1918. In the 1870's the industry was highly competitive, but as the years passed it gradually evolved into an oligopoly.<sup>6</sup> The Council of People's Commissars nationalized the industry on June 1, 1918 and, with the exception of a brief period of foreign occupation between 1918 and 1920, the industry has remained under state control since.<sup>7</sup>

## II

### CONSTRUCTION OF A NEW OUTPUT SERIES

#### *Deficiencies of the Available Data*

Information on Russian crude oil production is available in many places, but these data are often of poor quality.<sup>8</sup> Specific problems include a wide variety of measures employed, vague and incomplete coverage of series, and the failure of writers to discuss the sources or reliability of their statistics.

The Russians have generally measured crude oil in units of weight.<sup>9</sup> During the Tsarist period it was typically measured in

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saw an alternation between the farming out system and direct state operation. Simonovich indicates that Meerzoeff did not become the contractor until after 1862. Simonovich, p. 26. Unfortunately, Marvin's version has reappeared in other sources including BOVERTON REDWOOD, *Petroleum* (2 vols.; 2nd ed. rev.; London, 1906), p. 5 and A. BEEBY THOMPSON, *The Oil Fields of Russia* (2nd ed. rev.; London, 1908), p. 3.

<sup>6</sup> ROGER PORTAL, *The Industrialization of Russia*, in Vol. VI of «The Cambridge Economic History of Europe», ed. H. J. Habakkuk and M. Postan (Cambridge, Eng., 1965), p. 849.

<sup>7</sup> HASSMANN, pp. 32-33.

<sup>8</sup> See, for example, the remarks in JAMES C. CHAMBERS, *Russian Petroleum Trade*, «Reports from the Consuls of the United States», No. 74 (Washington, D.C., 1887), pp. 400. (Cited hereafter as «Chambers (1887)»).

<sup>9</sup> The exceptions we have found are in: Russia, Ministerstvo Finansov, *Ezhegodnik Ministerstva Finansov* (St. Petersburg, 1869), p. 36. (This series will be cited hereafter as «Russia, EMF» followed by the year of publication). This source shows part of the production for 1864, 1865, and 1866 in terms of the «vedro», a unit of volume which is equivalent to 12,299 litres according to Henry, p. 255.

"poods" (one pood equalled 36,112 English pounds)<sup>10</sup> while in the Soviet period it has almost always been measured in metric tons. However, Western writers have frequently translated native series into long tons, or into volume measures such as gallons or barrels. Translation between measures of weight poses only minor problems,<sup>11</sup> but translation of weight measures into volume measures is more difficult.<sup>12</sup>

The problem of vague geographical coverage involved Galicia, an oil-producing region of interwar Poland which became part of the Soviet Union in 1939.<sup>13</sup> The 1964 edition of *Promyshlennost' SSSR* (unlike the 1957 edition) apparently added output from Galicia to that of Russia for the years 1874 to 1916.<sup>14</sup> Since we are interested in Tsarist Russia as it actually existed rather than as it would have existed had it included this area, we have not included this extra output.

In constructing the new series we have chosen among competing series using the following criteria. First, we have sought to inform the reader of competing figures, even if they were not used. Second, we have expressed our series in *poods*, because this was the original measure employed in the industry. We have rejected

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<sup>10</sup> Sources disagree on the conversion rate between English pounds and Russian poods. We chose the rate commonly employed in *Mineral Resources of the United States*.

<sup>11</sup> If writers specify what type of ton (short, long, or metric) or pound (English or Russian) they are using.

<sup>12</sup> Marvin, for example, uses barrels of 40 imperial gallons. MARVIN, *Baku*, p. 37. American sources commonly present volume series in barrels of 42 U.S. gallons. More difficult is the fact that there is no simple conversion between units of weight and volume since the specific gravity of petroleum products varies between countries, within countries, and over time.

<sup>13</sup> Galicia was under the control of Poland for about 400 years until it fell to Austria late in the XVIIIth century. In 1918 Galicia and its oil fields became part of Poland, following the partial dismemberment of Tsarist Russia. In 1939, most of Galicia became part of the Ukrainian SSR. THEODORE SHABAD, *Galicia*, «Encyclopedia Americana», XII (New York, 1973), p. 238.

<sup>14</sup> USSR, Tsentral'noe Statisticheskoe Upravlenie, *Promyshlennost' SSSR: Statisticheskii sbornik* (Moscow, 1964). (Cited hereafter as «USSR, *Promyshlennost'*», followed by the years of publication). No adjustment was made for the years before 1874 since little oil was produced in Galicia before then. Both the 1957 and 1964 editions show (identical) output figures for the Soviet Union as it actually existed in each year from 1917 on. But since the country absorbed most of Galicia in 1939, this means that these series have a discontinuity built in and hence overstate growth rates during years of boundary changes. This is discussed further in Part. III.

NEW SERIES ON CRUDE OIL PRODUCTION: 1818-1849  
(in thousands of poods)

TABLE 1

Year	Production	Year	Production
1818	253	1834	345
1819	252	1835	352
1820	—	1836	353
1821	211	1837	344
1822	211	1838	340
1823	211	1839	358
1824	211	1840	337
1825	216	1841	326
1826	257	1842	329
1827	261	1843	327
1828	261	1844	328
1829	261	1845	327
1830	261	1846	332
1831	261	1847	316
1832	272	1848	287
1833	251	1849	262

*Source notes:*

1818: Pazhitnov, p. 28.  
 1819: Boverton Redwood, «The Russian Petroleum Industry», The Journal of the Society of Chemical Industry, IV, No. 2 (February 28, 1883), p. 71.  
 1821-49: Average of figures in Pershke and Pershke, p. 5, and Pazhitnov, p. 28.  
 Data modifications: Added 11,000 poods to figures for each year for 1818-33 to allow for production on Selimkhanov properties.

Years of substantial disagreement (see text):

1833 Pershke and Pershke = 300,000 poods  
 Pazhitnov = 180,000 poods

NEW SERIES ON CRUDE OIL PRODUCTION: 1850-1862  
(in thousands of poods)

TABLE 2

Year	Production
1850	260
1851	—
1852	—
1853	—
1854	—
1855	217
1856	—
1857	220
1858	—
1859	200
1860	224
1861	200
1862	267

*Source notes:*

1850, 1855, 1857: Pazhitnov, p. 28.  
 1859, 1861: USSR, SNP, p. 301.  
 1860, 1862: Average of Pazhitnov and USSR, SNP.  
 Years of substantial disagreement (see text):  
 1860 Pazhitnov = 247,814  
 USSR, SNP = .2 million  
 1862 Pazhitnov = 334,926  
 USSR, SNP = .2 million

TABLE 3

NEW SERIES ON CRUDE OIL PRODUCTION: 1863-1888  
(in thousands of poods)

Year	Production	Year	Production
1863	340	1876	14,100
1864	540	1877	20,100
1865	558	1878	27,100
1866	697	1879	30,100
1867	999	1880	34,100
1868	1,754	1881	47,100
1869	1,685	1882	51,100
1870	1,704	1883	60,100
1871	1,376	1884	89,100
1872	1,536	1885	115,100
1873	3,400	1886	123,300
1874	5,400	1887	156,000
1875	8,600	1888	183,400

## Source notes:

1863: Pershke and Pershke, p. 5.

1864-72: Russia, *EMF* (1869, 1871-75).1873-88: USSR, *SNP*, pp. 301-302.

Special conversion: Part of production for 1864-66 measured in unit called «vedro» converted to poods using conversion factors from Henry, pp. 255-256: 1 vedro of crude = 26.34 Russian lbs. = 26.34/40 poods.

series based on other measures because they are further removed from the original event and unlikely to be better measures of that event. Third, where evidence suggests that one series has probably been estimated by a superior method or has been collected by a more reliable organization that series is used in preference to series of inferior or unknown quality. Fourth, if there is no reason to favor one series over competing series then all competing values have been averaged. Irrespective of source or method of computation, no value is carried beyond four digits.<sup>15</sup> Finally, we have indicated the sources for each figure in the new series and how each figure was determined. When competing figures used showed

<sup>15</sup> We have not discovered any means of measuring the absolute accuracy of our series. But in discussing XXth century U.S. experience, Morgenstern found a divergence of 4.2 percent in estimates of American crude oil production made by the U.S. Bureau of Mines and the Bureau of the Census. OSKAR MORGENSTERN, *On the Accuracy of Economic Observations* (2nd ed. rev.; Princeton, 1963), p. 198. Because Tsarist figures are unlikely to be more accurate we are skeptical of any figures after the second place. We have included up to four digits, however, so that the reader may exercise his own judgement.

wide divergence (i.e., largest value  $\div$  smallest value  $\geq 1.10$ ), all competing values are presented in table notes.

The presentation of the new series is broken into two periods on the basis of data considerations: before 1889 (three subperiods) and 1889-1919.

### *Before 1889*

Following Morgenstern's dictum (p. 2) — « qui numerare incipit errare incipit » — we think it wise to inquire about the quality of the data sources before proceeding further. Oil statistics from before 1889, like Tsarist statistics in general,<sup>16</sup> are considered of questionable accuracy by many commentators. Henry speaks of data from before 1888 as « mere estimates », while Weeks, reporting on output through 1888, says his statement « is largely an estimate, as are all statements of production from Russia, no accurate figures of the product of petroleum being kept ».<sup>17</sup>

The most favorable comments on any source of pre-1889 petroleum data comes from Dr. A. Kaufmann, a statistics professor in St. Petersburg. He indicates that the Chief Administration for Indirect Taxes and the Vodka Monopoly (under the Ministry of Finance),<sup>18</sup> issued an annual report, one volume of which dealt with production liable to taxation, including « naphtha ». Kaufmann

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<sup>16</sup> Dr. A. Kaufmann was generally critical of the official statistical apparatus of the country and of the data which emerged from it, with only a few exceptions such as the work of the Central Statistical Office under Ssemenow (1863-mid 1880's) and the Zemstvo statistics. A. KAUFMANN, *Russia, « The History of Statistics »*, ed. John Koren (New York, 1918 [reprinted 1970]). In discussing Tsarist official factory statistics, Lenin was even more condemnatory. V. I. LENIN, *The Development of Capitalism in Russia*, Vol. III of « Collected Works » (Moscow, 1960), p. 484. Time has not reversed this judgement and modern students of Tsarist development express a comparable scepticism. See, for example, M.E. FALKUS, *The Industrialization of Russia, 1700-1914* (London and Basingstoke, 1972), p. 15.

<sup>17</sup> HENRY, p. 117. JOSEPH D. WEEKS, *Petroleum*, in U.S. Geological Survey, « Mineral Resources of the United States: 1888 » (Washington, D.C., 1890), p. 479. Dyer, reporting in 1880, said, « From what has been said it will at once be seen that any correct statement of the present production of the district is impossible ». LEANDER E. DYER, *Petroleum Development in Russia*, « Reports from the Consuls of the United States », Nos. 1, 2, and 3 (1880 and 1881) (Washington D.C., 1881), p. 473.

<sup>18</sup> THEODORE H. VON LAUE, *Sergei Witte and the Industrialization of Russia* (New York and London, 1963), p. 73.

says this administration had « a well developed statistical organization which . . . was perfected by former *zemstvo* statisticians ».<sup>19</sup> Although the Ministry of Finance and its statistics have not entirely escaped criticism,<sup>20</sup> we feel it is the most reliable source available in the pre-1889 period.

As to the method by which estimates were formed, U.S. Consul Chambers explains:

In a previous report from this consular agency you were informed that no attempt was made to keep any accurate record of crude production at Baku, but the amount of production was estimated from the output of refined oil and illuminating distillate, of which fairly correct statistics are obtainable, upon a basis of 3½ gallons crude for every gallon of the aforesaid products, to which is added the crude oil shipped<sup>21</sup>.

Chambers estimated that the total amount taken from the ground could be determined if the figure thus obtained was increased by 20 per cent to allow for wasted crude.<sup>22</sup>

In view of the relatively poor estimation methods used before 1889 and the unfavorable comments by contemporaries on statistics from this period, we have proceeded cautiously and have performed whatever tests we could to establish the quality of these data. The series for this period is presented in three parts on the basis of data and industrial organization considerations.

### 1818-1849

This period includes the first contract and public monopoly periods. As can be seen from the notes to Table 1, the figures

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<sup>19</sup> KAUFMANN, p. 510. In speaking of the annual volume dealing with taxed commodities, Kaufmann says on the same page:

. . . In short, the statistics of the chief administration for indirect taxation are a valuable source of Russian industrial statistics and also the most reliable, as the officials concerned gain a complete insight into the conditions of the respective undertakings *ex officio* and as the registration of statistics stands in the closest relation to the business control exercised.

<sup>20</sup> See the discussions in VON LAUE, pp. 279, 292-3 and in GEOFFREY DRAGE, *Russian Affairs* (London, 1904), p. 310.

<sup>21</sup> JAMES C. CHAMBERS, *The Russian Petroleum Trade*, « Reports from the Consuls of the United States », No. 92 (Washington, D.C., 1888), p. 4.

<sup>22</sup> *Ibid.*, pp. 4-5. See also footnote 37.

are based largely on those of Pershke and Pershke, who cite the archives of the Transcaucasian Excise Administration,<sup>23</sup> and Pazhitnov.

There is substantial confusion about output during this period. Pazhitnov reports two sets of figures for the period 1834 through 1849, one showing production on government properties and one showing production from two oil pits which were in the hands of the Selimkhanov brothers. Pazhitnov indicates that both sets were taken from a table by Koshkul' which appeared in volume VI (1864) of *Transactions of the Caucasian Section of the Russian Geographical Society (Zapiski Kavkazskogo otdela Russkogo geograficheskogo obshchestva)*. The second set shows production on the Selimkhanov properties of 108,000 poods per year for most years from 1834 through 1846, a figure which Pazhitnov argues is ten times higher than it should be and is due to a misunderstanding by Koshkul' of the arrangements under which the Selimkhanovs were allowed to produce.

We would find this argument attractive in the absence of figures in Pershke and Pershke (which Pazhitnov does not cite). They report total output figures for this period which generally differ only slightly from those obtained by adding together the two Koshkul' series in Pazhitnov. Since the Pershke and Pershke figures are drawn from the archives of the Transcaucasian Excise Administration, an official organization which should have been close to the original events reported, we are inclined to dismiss Pazhitnov's hypothesis as unsuccessful second guessing of Koshkul'. Our series from 1821 through 1849 is consequently based on an average of: a) figures reported in Pershke and Pershke and b) the sum of the two Koshkul' series reported in Pazhitnov. Substantial disagreement between these sources occurs only for 1833.

The figures obtained for the period from 1818 through 1833 were modified to allow for one form of suspected deficient coverage. According to Henry, the Selimkhanov family was allowed to keep the two oil pits when the Russian Government took Baku, but was required to deliver the oil produced on this property

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<sup>23</sup> Arkhiv Zakavkazskago aktsiznago upravleniia.

— about 174 tons per annum — to the government.<sup>24</sup> Since the Koshkul' figures reported in Pazhitnov<sup>25</sup> give output for the family from 1834 through 1849, but no output for the years 1818 through 1833, we have added 11,000 poods to our figures for the earlier period in an attempt to compensate for this deficient coverage.<sup>26</sup>

As a rough test of our series we have compared it with Dyer's figures on the quantity of petroleum products shipped<sup>27</sup> out of Baku from 1832 through 1849. Since the annual pattern of goods shipped out will not necessarily coincide with annual crude production, due to inventory changes, the two series were compared by taking the sum of each during two nine year periods: 1832 through 1840 and 1841 through 1849. During the second period production exceeds shipments (by a small margin) as one would hope. But in the first period the reverse is true. This is largely due to the year of substantial disagreement; if Pershke's figure of 300,000 poods is substituted for our average for 1833, production becomes greater than shipments in the first subperiod and our series bears a logical relationship to Dyer's.

### 1850-1862

This period, which coincides with the time when Ter-Gukasov was the contractor,<sup>28</sup> is distinguished by a paucity of data. Most

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<sup>24</sup> HENRY, p. 29.

<sup>25</sup> PAZHITNOV, p. 28.

<sup>26</sup> We assume Henry meant English tons and have used his figure of 62,028 poods per English ton of 2,240 lb. The resulting annual adjustment of 10,793 poods has been rounded up to 11,000 poods to avoid spurious accuracy and to make it easier for readers who disagree with this adjustment to undo it. This adjustment raises our original figures by a minimum of 4.2 and a maximum of 5.5 percent. The output attributed to the Selimkhanovs is about one tenth of that reported in Pazhitnov for the period 1834 through 1846. Reported output for the Selimkhanov property fell off rapidly after 1846 and no output is reported after 1849.

We are not comfortable with the available sources nor with this adjustment which we fear may be an understatement of the Selimkhanov production before 1834. Perhaps future scholars with access to better data sources will be able to resolve this problem.

<sup>27</sup> DYER, p. 483. Dyer uses the term "exported" rather than shipped, but from the sizes of his figures it seems likely that he means to represent all oil products (his figures are not limited to crude oil) irrespective of whether they were destined for other parts of Russia or foreign countries.

<sup>28</sup> SIMONOVICH, p. 26.

writers do not report any output figures at all during this period.<sup>29</sup> No figures were found for six of the thirteen years, one figure was found for five of the thirteen years, and in only two years — 1860 and 1862 — were there as many as two figures. Because of this lack of data and the impossibility of testing these figures, they should be used with extra caution.

### 1863-1888

This series is based largely on data from a Soviet source<sup>30</sup> and from the annual of the Ministry of Finance.<sup>31</sup> Ministry of Finance data were chosen where available because of Kaufmann's praise of that Ministry's chief administration for indirect taxation which we presume collected the petroleum data published in the annual. Unfortunately, publication of crude oil figures in the annual was interrupted for many years after the 1872 figure was released.

Few suitable sources were found for the period after 1872. Pazhitnov, Pershke, and Thompson were discarded as sources for this period because their figures appeared to cover only Baku. This left the Soviet publication<sup>32</sup> as the most reasonable source for the period from 1873 to 1888.

Comparison of our series with Dyer's data on shipments for 1863 through 1879 revealed no discrepancies in our series, even on a year by year basis.<sup>33</sup> But as with years before 1863 we know relatively little about who collected the figures or how they were derived. We presume that the figures for 1864 through 1872 were collected by the Ministry of Finance and that during the period before 1889 the estimation method outlined by Chambers (see above) was used. However, our knowledge of the details is quite limited. We therefore recommend that the reader be cautious

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<sup>29</sup> DYER (p. 483) says shipments of oil products out of Baku were not reported during this period. HÖFER (p. 251) reports production figures from 1832 through 1849 and from 1863 through 1904 but presents nothing for 1850 through 1862.

<sup>30</sup> USSR, Sovet Neftianoi Promyshlennosti, *Spravochnik po neftianomu delu*, Vol. II (Moscow, 1925). (Cited hereafter as «USSR, SNP»).

<sup>31</sup> Russia, EMF (various years).

<sup>32</sup> USSR, SNP.

<sup>33</sup> DYER, p. 483.

about regarding any digit beyond the second one as significant in the pre-1889 portion of our series.

1889-1919

According to our sources the quality of crude oil statistics must have improved greatly after 1889 when the Baku Association of Naphtha Producers established its statistical bureau.<sup>34</sup> In contrast with earlier sources which reportedly estimated crude oil production from output of refined products, the BANP bureau compiled its statistics from printed forms which were sent to all companies in the Baku area.<sup>35</sup>

During this period, two concepts of crude oil production were distinguished:

The *total production* includes all the crude produced at the wells. The *profitable production* is the amount of crude that is actually tanked in the reservoirs. A large amount of the Russian product goes to waste or is not collected, and a considerable amount is consumed at the wells for pumping purposes. This is not considered in the table of profitable production [our emphasis].<sup>36</sup>

We have sought to ensure that the series for 1889-1919 is based on profitable production figures.<sup>37</sup>

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<sup>34</sup> See the remarks in THOMPSON, p. 19; HENRY, p. 117; and KAUFMANN, p. 518.

<sup>35</sup> THOMPSON, p. 19.

<sup>36</sup> F. H. OLIPHANT, *Petroleum*, in U.S. Geological Survey, «Mineral Resources of the United States: 1900», (Washington, D.C., 1901), p. 599.

<sup>37</sup> We have little doubt that the 1882-1904 portion of our series for Baku corresponds to the «profitable production» concept. After 1904 our sources no longer made the distinction between "total" and "profitable" production, but since all of the post-1904 series found show pre-1904 figures which correspond to the "profitable" production figures in earlier sources, we presume that the "total" production measure was dropped and that all post-1904 figures show "profitable" production.

In spite of Chambers' description of the estimation method before 1888 we retain some suspicions that wastage might be included in the figures for some years before 1882. We have found no way to determine whether this is true, but, if so, then based on the 1888 to 1900 experience reported in OLIPHANT (pp. 598-599) the degree of overstatement of profitable production should be less than seven percent.

In order to learn whether wastage varied with the price of crude oil we calculated the difference between the total and profitable production series reported by OLIPHANT (pp. 598-599), expressed as a percentage of total production (W), and regressed this against the price of crude oil in Baku (P) as reported in USSR, SNP (p. 348) for the

The biggest source of disagreement in series for this period is in the degree of coverage as production expanded outside the four original Baku fields: many series which seem to show total Tsarist production actually show only a portion of the total. We met this problem by constructing our series from data for individual oil fields. Table 4 presents our estimates of the total production for Russia plus subtotals for the four old Baku fields and for the remaining oil producing areas of Russia. Details on production and sources for each field and year are contained in Appendix II.

Once output figures for this period are disaggregated by field there are few disagreements between series. For this reason, and because of the favorable comments on the statistical bureau of the BANP, we feel that this portion of the series is more reliable than the pre-1889 portion. Potential sources of bias for all periods are discussed in Appendix I.

### III

#### GROWTH CHARACTERISTICS OF RUSSIAN CRUDE OIL PRODUCTION

The purpose of this section is to discuss the growth of crude oil production in the Russian Empire and to compare the rate of growth and the variability of growth under various forms of industrial organization.

Tables 1 and 2 indicate that production of crude oil in the Russian Empire was more or less stagnant from 1818 to 1862. But in the early 1860's production began to expand rapidly. From 1872 through 1901 annual production exceeded that of the previous year in every year except 1894 and 1896. In 1901 production reached 706 million poods (513 times as much as in 1871!) and for a brief moment Tsarist Russia was the world's leading producer of crude oil. But output slipped in subsequent years, exceeding

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years 1890-1900. The relationship proved to be inverse, as one would expect, but was not significant. The estimated equation was:

$$W = 4.297 - 0.075 P \qquad R^2 (\text{unadj}) = .074$$

(0.088) N = 11

The standard error of the regression coefficient is shown in parentheses.

the 600 million pood mark only once between 1905 and 1919. In 1918 production stood at only 32 percent of the 1901 high.

The obvious question suggested by the foregoing is "Why?". Why did output at first stagnate, then rise almost continuously, and then fall?

There are a number of possible explanations for this pattern of growth and decline. The historical record suggests that new technological developments in extraction and transportation lowered the cost of Russian petroleum products within a wide area around Baku, while technological changes in the application of these products made them more useful and resulted in outward shifts of their demand curves.

Superimposed on these technological developments was a number of complicating factors. One cannot drill a well and receive an eternal unflinching stream of crude oil, even in Baku. Wells age and die and must be replaced by new ones. Unless annual drilling is sufficient to replace the ageing wells, annual capacity to produce must begin to slip eventually. If increasingly inferior lands are drilled over time, annual drilling must rise continually just to keep productive capacity constant, *ceteris paribus*.

Under capitalism, new drilling and production from existing wells depend on profit expectations. These expectations are dependent on a number of factors including technology, demand for the product, prices of competing fuels, government policies, etc. Specific considerations for producers in the Tsarist oil industry included the prices of competing fuels (coal and wood), excise taxes on kerosene, railroad freight rates for various fuels, import taxes on foreign petroleum products, and the position of competitors in foreign markets (especially Standard Oil). Finally, overlaying all of these, was the domestic political situation of the Russian Empire which ultimately deteriorated into a revolt in 1905, World War I, and two revolutions in 1917.

With improved data on crude oil production it should now be possible to explore these many factors in a more systematic fashion. The purpose of the balance of this article is to break ground for an exploration of the effects on crude oil production of alternative forms of industrial organization. This will be done through the

derivation and statistical comparison of selected measures of the rate of growth and variability of growth of crude production in the industry under various forms of industrial organization.

TABLE 4

NEW SERIES ON CRUDE OIL PRODUCTION: 1889-1919  
(in millions of poods)

Year	Four-Old Baku Fields <sup>a</sup>	Other Fields <sup>b</sup>	All Russia
1889	192.3	.8	193.1
1890	226.8	2.2	229.0
1891	274.6	1.4	276.0
1892	286.5	1.3	287.8
1893	324.7	8.0	332.7
1894	297.5	5.2	302.7
1895	377.4	28.4	405.8
1896	386.1	17.2	403.3
1897	421.7	27.8	449.5
1898	485.7	17.9	503.6
1899	525.1	25.4	550.5
1900	600.3	31.1	631.4
1901	670.8	35.2	706.0
1902	636.0	34.6	670.6
1903	596.3	33.2	629.5
1904	613.3	41.4	654.7
1905	409.4	45.9	455.3
1906	447.7	45.1	492.8
1907	476.0	46.2	522.2
1908	466.8	59.9	526.7
1909	490.2	70.0	560.2
1910	478.0	104.5	582.5
1911	425.2	127.6	552.8
1912	419.0	140.5	559.5
1913	390.3	159.8	550.1
1914	338.0	207.2	545.2
1915	342.8	223.2	566.0
1916	329.4	273.2	602.6
1917	262.9	271.7	534.6
1918	132.8	92.5	225.3
1919	161.8	109.1	270.9

## Sources:

USSR, SNP; Russia, *EMF* (1902, 1906, and 1915); Soviet *S'ezda Neftepromyshlennikov v Baku, Neftianoe delo*, VI, No. 2. (February 9, 1904); VII, Nos. 1-2 (February 15, 1905); Thompson; USSR, Narodnyi Komissariat Finansov, *Narodnoe khoziaistvo v 1915 godu* (Petrograd, 1918); PAUL APOSTOL and ALEXANDRE MICHELSON, *La lutte pour le pétrole et la Russie* (Paris, 1922) as cited in MARGARET S. MILLER, *The Economic Development of Russia, 1905-1914* (London, 1926), pp. 291-292; and WERNER VON KNORRE, « Die russische Erdölwirtschaft », *Petroleum* (Vienna), XXIII, No. 18 (1927), pp. 719-750.

<sup>a</sup> Balakhany, Sabunchi, Romany, and Bibi-Eybat.

<sup>b</sup> Binagady, Surakhany, Groznyy, Maykop, Emba, Cheleken, Fergana, and Sviatoy. [Spellings differ widely; we have followed Hassmann].

### *Comparison of Growth Rates*

In his discussion of the growth of Soviet industrial production, professor Warren Nutter sought to compare rates of growth of selected industrial commodities during the Soviet and Tsarist periods.<sup>38</sup> Several objections can be raised to his comparisons for crude oil. First, his choice of periods for comparison — 1870-1913 versus 1913-1955 — raises a number of questions. The first three years of the Tsarist period include a peculiar form of capitalistic organization of the industry, namely the period when the industry was organized as a monopoly and farmed out to the highest bidder. It would be better to begin with 1873 when the period of freer competition began so that a more meaningful comparison of performance under capitalism and state control could be made. Nutter's choice of 1913 as a dividing line is also open to criticism since it throws four years of Tsarist history in with Soviet history and saddles the Soviet data with the effects of World War I and the two revolutions in 1917. This latter choice serves to stack the deck against Soviet performance.

Finally, one might object to Nutter's comparisons based on growth rates calculated from output in beginning and ending years using the compound interest formula. An alternative growth measure — the year to year percentage growth of output — allows one to compare the entire distribution of annual growth rates and to perform tests for significant differences between parameters of the distributions.

While Nutter had good reasons for the measures and periods he chose,<sup>39</sup> our improved output series allow us to find out whether his results for oil hold up when subjected to statistical tests. We therefore calculated the annual rate of growth of crude oil output for each year during two periods: 1873 through 1916 and 1927 through 1969. The initial Tsarist year — 1873 — was chosen because it was the first year of the post-contract period; 1916 was chosen as the final Tsarist year because it was the last year in which

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<sup>38</sup> G. WARREN NUTTER, *Growth of Industrial Production in the Soviet Union*, NBER Study (Princeton, 1962), Chapter 4.

<sup>39</sup> *Ibid.*, pp. 4-8, 84-86.

output was not seriously disrupted by World War I and the revolutions.

The early Soviet period has always presented a problem because of the great economic disruption which resulted from revolution and war. Oil output fell by more than 50 percent in 1918 because of the thorough political and social disruption of Russia. It seems unreasonable to include either this phase of disruption or the subsequent recovery period because the former will understate the performance of industry under Soviet control and the latter will overstate performance. We therefore chose to begin this period with 1927 — the first year in which production exceeded the level of 1916, our terminal year for the Tsarist period.

As can be seen from Table 5, our data indicate that oil output grew faster in the Tsarist period (16.8 percent per year) than in the Soviet period (9.5 percent per year). Our redefinition of the periods of comparison and the measure of growth has resulted in higher growth figures for both periods than Nutter found (14.3 and 5.0 percent, respectively) but has not reversed his conclusion that growth was slower during the Soviet period.<sup>40</sup> A one-tail

TABLE 5  
COMPARISON OF RATES OF GROWTH OF OUTPUT OF CRUDE OIL

	1822-34	1835-49	1860-72	1873-1916	1927-69
Average annual growth rate (x)	4.6	— 1.7	19.8	16.8	9.5
Standard deviation (s)	12.1	4.0	27.7	25.1	10.6
Sample size (n)	12	15	13	44	43
Coefficient of variation ( $\frac{s}{x} \times 100$ )	260	230	140	150	110

Sources for Tsarist period: Tables 1-4.

Sources for Soviet period:

- 1927-40, 1945-55: USSR, *Promyshlennost'* (1957), p. 153 [same source as Nutter].  
 1941-44: ROBERT E. EBEL, *The Petroleum Industry of the Soviet Union* (Washington, D.C., 1961), p. 74.  
 1956-62: USSR, *Promyshlennost'* (1964), p. 205.  
 1963-69: USSR, Tsentral'noe Statisticheskoe Upravlenie, *Narodnoe khoziaistvo SSSR v 1969 g* (Moscow, 1970), p. 197.

<sup>40</sup> *Ibid.*, p. 90. Both our calculations and those of Nutter overstate the Soviet growth rate, *ceteris paribus*, because we have both used Soviet series which involve territorial changes. As was mentioned in footnote 14, Soviet data for the post-1917 period show production within Soviet boundaries as they actually existed in each year. Hence, the figures for 1939 and later years include production in territories such as Galicia which were incorporated into the Soviet Union in 1939. This increases the likelihood that Nutter is correct.

test for differences of our means<sup>41</sup> indicated that the difference was significant at the .05 level.

Our series can also be used to study the performance of the industry under the various forms of organization which prevailed during the Tsarist period. Of particular interest is the growth of output during the second contract period (1850-72) in comparison with the post-1872 period. Previous commentators have been highly critical of the institutional arrangements under the contract system and have asserted that they served to retard the growth of the industry. These remarks by Marvin are typical:

Experience in all countries, in all ages, has shown that nothing is more fatal to the development of an industry, than for the State to render it a close monopoly. The petroleum industry at Baku was no exception to the general rule. The protective system of the Russians, following upon centuries of free trade under the Persians, stunted the growth of the petroleum trade. The industry grew, but its development was nothing like what it would have been, had there been no Government restriction<sup>42</sup>.

One of the chief reasons for expecting such a retardation was not so much the existence of a monopoly *per se* as the limited property rights which the contractor had under his four-year monopoly. He ran the risk that investments in exploration would be lost if he failed to retain the monopoly at the end of his four year term and hence would be reluctant to make investments which would not pay off quickly. Catherine II summed up the relevant property rights theory long before the oil question arose, when she observed:

Every Man will take more Care of his own Property, than of that which belongs to another; and will not exert his utmost Endeavours upon that which he has Reason to fear another may deprive him of<sup>43</sup>.

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<sup>41</sup> JOHN E. FREUND, *Mathematical Statistics* (Englewood Cliffs, N.J., 1962), p. 267.

<sup>42</sup> MARVIN, *The Region of the Eternal Fire*, p. 209.

<sup>43</sup> BASHI, DMYTRYSHYN (ed.), *Modernization of Russia under Peter I and Catherine II* (New York, 1974), p. 104.

In view of these comments we sought to compare the rate of growth of output under the contract system and under the post-1872 system of private ownership and long-term leases when, presumably, incentives for investment would be greater.

Because of the dubious nature of production figures for the first contract period (1821-34, except 1825) and the lack of data during the first part of the second contract period (1850-59), we have relied on data for the later part of the second contract period (1860-72). The post-contract period is represented by the years 1873-1916.

Table 5 shows that the average annual growth rate during the contract period was not lower, as the theory would suggest, but higher. However, a one-tail test for differences of means indicated that there was no significant difference between the average growth rates at the .05 level.<sup>44</sup>

In order to provide a fuller (though preliminary) picture of growth of output in the Tsarist period we also calculated growth rates for the earliest periods — the first contract period (1821-34, exclusive of 1825) and the period of direct government operation of the monopoly (1835-49). From Table 5 it can be seen that the period of direct government operation (1835-49) shows the worst performance of the five periods with an average rate of minus 1.7 percent. The first contract period shows better performance with an average growth rate of 4.6 percent. However, a small-sample test for significance (one-tail)<sup>45</sup> showed the difference to be insignificant at the .05 level (though significant at the .10 level). We remind the reader that the underlying data for both periods do not inspire us with confidence.

We also tested the difference between the growth rates in the government operation period (1835-49) and the second contract period (1860-72) and found the latter rate to be significantly greater at the .05 level.

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<sup>44</sup> We assumed that  $\sigma_1 = \sigma_2$  based on the calculated standard deviations shown in Table 5 and employed the test statistic given in equation (12.2.6) of FREUND, p. 268.

<sup>45</sup> *Ibid.*, p. 264. The same test was used for the 1835-49 v. 1860-72 and 1822-34 v. 1860-72 comparisons which follow.

We then compared the growth rates in the two contract periods. A small-sample one-tail test indicated that the excess of the growth rate of the second contract period (1860-72) over that of the first period (1822-34) was not significant at the .05 level (but was at the .10 level).

Our findings on growth rates may be summarized as follows. During the first contract period (1822-34) and the period of direct government operation (1835-49), output grew at a relatively slow rate, but because of suspected inaccuracies in the data and the high variability of growth we cannot be confident that performance was better under the contract system than under direct government operation. However, we have little doubt that the rate of growth increased significantly during the second contract period and continued at levels which were not significantly lower during the post-contract Tsarist period. Following the disruptions attendant on the 1917 revolutions etc., growth resumed but at a significantly slower rate than in the post-1872 Tsarist period.

### *Variability of Growth Rates*

A final use of our series is to investigate the variability of growth of output in the oil industry under different forms of industrial organization and during various time periods. Has growth been more variable under capitalism than under state operation? Has the variability of growth rates changed over time independently of organization forms?

The data in Table 5 on variability in absolute terms (i.e., in terms of  $s$ ) indicate that variability has been greater during the three periods of capitalism (12.1, 27.7, and 25.1) than during the two periods of state operation (4.0 and 10.6). But if we switch

to the coefficient of variation ( $\frac{s}{x} \times 100$ ), the pattern which

emerges is a time trend: the coefficient of variation has fallen over time irrespective of the form of organization of the industry.

#### IV

#### SUGGESTIONS FOR FUTURE RESEARCH

The output series and the summary statistics presented above answer several questions about the development of the industry, but raise many more.

A simple comparison of growth rates for the two periods of direct government operation (1835-49 and 1927-69) with those for the two intervening periods of capitalism (1860-72 and 1873-1916), might tempt one to conclude that capitalism was a better form of organization for the oil industry. But this judgement can be questioned on several grounds. First, the rate of expansion of production is only one of many possible indicators of success. If variability of growth is a concern, then the Soviet period might be judged to be superior to the two periods of capitalism. Second, there is strong evidence of an underlying time trend in the statistics shown in Table 5. Annual growth rates are very low during the first two periods, rise to almost 20 percent per year in 1860-72, and then fall in each of the subsequent periods. The standard deviations in Table 5 show a similar pattern while the coefficients of variation suggest an almost uninterrupted downtrend over time.

There are a number of reasons for paying attention to time trends, the most important of which is depletion. It is logical for producers to exploit the most promising lands first and to leave fields which are not as potentially productive or which are more difficult to develop until later. Second, production from any given well tends to fall over time as natural pressure falls and the well is exhausted. In 1905 Henry wrote of Russian wells that, « generally speaking, at the end of the fourth year the yield of a well declines to about a third of the original production ».<sup>46</sup>

If output is to be maintained, producers must continually drill new wells to replace those which are "ageing". But since the most accessible and promising lands are exploited first, the cost of finding new deposits must rise over time and the cost of petroleum products also must rise in the absence of counter forces. These

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<sup>46</sup> HENRY, p. 139.

circumstances seem likely to generate a time trend of rising costs which will slow and ultimately check the growth of crude oil production, irrespective of the form of industrial organization. Other factors such as excise taxes, tariffs, foreign competition, innovations, and political stability can then be seen as disturbing factors which can temporarily accelerate or slow the time trend but which cannot reverse it permanently. In a sense, depletion is the ultimate truth in this industry.

The foregoing lines should not be taken as statements of fact, but rather as fragments of hypotheses to be investigated in future studies. A number of specific questions suggest themselves.

What was the impact of industrial organization and market structure on the supply of crude oil in Tsarist and Soviet Russia? As a specific exercise one might attempt to estimate the price elasticity of supply and demand for oil in Tsarist Russia.<sup>47</sup> One might then attempt to relate the results of such studies of market structure to Metzger's thesis about railroad development and market integration in Tsarist Russia<sup>48</sup> and to recent attempts to apply that hypothesis to petroleum products.<sup>49</sup>

It would also be interesting to study the effects of other phenomena on the development of the industry. Thompson estimated that coal rates were in some cases as low as one tenth of average from Baku to Batoum in 1901 were almost five times as high as the resource cost of this transportation, while Westwood indicates that coal rates were in some cases as low as one tenth of average shipment costs by rail.<sup>50</sup> To what extent did Tsarist transportation policies retard the growth of the oil industry?

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<sup>47</sup> During the transition from the contract period to the period of competition after 1872 production of crude oil more than doubled while, according to Marvin, the price of crude fell by almost 90 percent. MARVIN, *The Region of the Eternal Fire*, pp. 210-222. These figures suggest an elasticity of demand well below unity at this time.

<sup>48</sup> JACOB METZER, *Railroad Development and Market Integration: The Case of Tsarist Russia*, «Journal of Economic History», XXXIV, No. 3 (September 1974), pp. 529-550.

<sup>49</sup> WILLIAM J. KELLY, *Railroad Development and Market Integration in Tsarist Russia: Evidence on Oil Products and Grain*, «Journal of Economic History», XXXVI, No. 4 (December 1976), pp. 908-916.

<sup>50</sup> THOMPSON, p. 31; J. N. WESTWOOD, *A History of Russian Railways* (London, 1964), pp. 146-147.

A number of institutional studies are also conceivable. The transition from the contract system to competition in the early 1870's could provide a testing ground for the theories of Davis and North on institutional change.<sup>51</sup> Who were the parties with an interest in change and how did they bring it about? How did the petroleum reserve situation impact on industrial organization over time?

Finally, one might attempt to estimate the effects of international competition, import tariffs, specific technological innovations, and domestic violence on the growth of crude oil production.<sup>52</sup> As these questions are answered, new ones will undoubtedly be asked.

## CONCLUSION

In this paper we have presented a new series which gives a more comprehensive and accurate picture of annual crude oil production in Russia from 1818 to 1919. On the basis of this series plus information on the reliability of the production figures, we have been able to make more informed estimates of the annual rates of growth and the variability of growth of crude oil production and to compare the growth performance of the Russian oil industry under various forms of private and public control. Our evidence indicates that since 1834 growth and the variability of growth have been higher when the industry was under private control than under state control. We have been unable to show that the growth rate was significantly different under monopoly than under competition. These and other questions raised should be investigated more thoroughly in the future.

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<sup>51</sup> LANCE E. DAVIS and DOUGLASS C. NORTH, *Institutional Change and American Economic Growth* (Cambridge, Eng., 1971).

<sup>52</sup> W. J. KELLY, "Economic Adjustments to Shifts in Crude Oil Supplies in Russia: The 1905 Revolution", Annual Conference of the Western Economic Association, Anaheim, California, June 1977.

APPENDIX I  
POTENTIAL SOURCES OF BIAS

One source of possible bias is in the completeness of coverage. We believe that the degree of coverage has increased over time. Production figures for the period before 1864 seem to be limited to the old Baku fields (e.g. Balakhany and Bibi-Eybat), thereby excluding minor amounts of production in other areas such as Cheleken Island and Groznyy<sup>1</sup>. If the figures we have found for Baku before 1864 are complete statements of production for that area and only for that area then, based on the Ministry of Finance data for 1864 (which seem complete), the degree of understatement of production before 1864 is probably less than one percent; even if Ministry of Finance data for 1865 or 1866 are used the degree of understatement is probably less than three percent<sup>2</sup>. Since after 1888 the degree of coverage rises to close to 100 percent, the entire series tends to overstate the long run growth rate of Russian production. However, a bias of 1-3 percent in the early figures is so small relative to the probable error from other sources that we doubt that one should worry much about this problem of coverage.

A second source of potential bias is the deliberate under- or over-reporting of production. This source of bias has frequently been discussed in connection with Soviet statistics, but has seldom entered into discussions of Tsarist statistics.

If, before 1889, crude production was estimated from output of refined products as Chambers says, then the key to deliberate distortion must be the incentive to misstate production of refined products. We have been unable to find any tax or other motive for distorting these figures before 1872. In that year a kerosene tax was imposed and continued until 1877. However, according to Henry, the tax was not assessed on the number of units of kerosene produced or sold, but rather on the capacity of stills, as determined by government inspectors<sup>3</sup>. This may have led to some tendency to understate capacity (perhaps accompanied by bribes to inspectors) and may also have led to lower reported output of refined products to avoid embarrassing discrepancies between actual output and capacity. However, even without resorting to such a theory of falsification we can see likelihood of a bias during this 1872-1877 period: it is possible that the tax discouraged refining efforts and hence lowered the ratio of refined products to crude production. As a result, if the 3.5 factor mentioned by Chambers continued to be used crude production may be understated in this period<sup>4</sup>. Deliberate falsification would increase this bias.

<sup>1</sup> HENRY, pp. 24, 29; REDWOOD, *Petroleum*, pp. 6, 9, 11; HASSMANN, p. 24.

<sup>2</sup> Russia, *EMF* (1869), p. 36.

<sup>3</sup> HENRY, pp. 35-37.

<sup>4</sup> We tested for this possibility using Marvin's data on production of refined

The still capacity tax was removed late in 1877 or early in 1878 but was replaced in 1888 by a tax of 40 copecks per pood on kerosene<sup>5</sup>. Since taxes were also assessed on other refined products and no tax was assessed on certain residuals, it is possible that these taxes lowered the ratio of refined products to crude production. Fortunately, the statistical bureau of the Baku Producers Association was established in 1889, and began to collect direct information on crude production, so the bias, if any, would apply only to 1888.

Aside from taxes of the Russian government, there were some smaller assessments such as a tax by the city of Baku on refinery capacity and taxes on crude oil production by various producer associations (.35 copecks per pood in Baku; 1/16 copeck per pood in Groznyy),<sup>6</sup> but these seem too modest to have inspired much misreporting of capacity or production.

Our conclusions with respect to biases are as follows. Our series may understate total production up to 1833 because of understatement of production on the private Selimkhanov fields in Baku and because of omission of production in other parts of Russia. From 1833 to 1864 output may be understated due to exclusion of production outside of Baku, but total production is probably reduced by no more than 1-3 percent by this factor. From 1872 to 1877 and in 1888 there may be some understatement of production as a result of taxes on refining capacity and refined products. Operating against these sources of understatement is the possibility of an overstatement of production before 1882 of up to seven percent as a result of inclusion of wastage (cf. fn. 37). If both under- and over-statement factors are operating, "profitable production" would probably be overstated on net by several percent before 1882. After 1882 we are confident that our series measures "profitable" production. After 1888 coverage is almost complete and assessments on crude oil too light to cause any serious understatement of production. We therefore consider the post-1888 portion of our series to be the most reliable.

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products and crude oil during the period 1873-83: MARVIN, *The Region of the Eternal Fire*, pp. 212-214, 243. Marvin's weight figures were converted to volume figures using factors presented in HENRY (p. 256) and then the converted figures on crude production were divided by the converted figures on refined products. To reduce inventory problems the ratio was calculated for 1873-77 (the tax period) and 1878-83 (non-tax period) and the ratios for the two periods were compared. Rather than finding the ratio to be higher in the first period than in the second, as our tax evasion theory suggests, we found the reverse to be true. This does not necessarily prove our theory to be false, however, since we have not been able to reduce our crude oil figures by the amount of shipments of crude as Chambers' formula suggests we should. More disturbing is the fact that the ratios we were able to calculate (2.93 and 3.06, respectively) did not exceed 3.5, the minimum we expected to find (under the condition where crude shipments were zero). We do not know whether Marvin, Chambers, or both are in error.

<sup>5</sup> HENRY, pp. 35-37.

<sup>6</sup> DYER, pp. 468-469; THOMPSON, p. 20.

APPENDIX II

DATA, SOURCES, AND METHODS: 1889-1919

The purpose of this appendix is to show the data and methods used in deriving Table 4. That table, which presents the new series on crude oil production in Russia from 1889 to 1919, shows the total production of oil in all of Russia during those years plus two breakdowns labelled, "Four Old Baku Fields" and "Other Fields". Tables 7a and 7b below show the production for each of the four old Baku fields (Balakhany, Sabunchi, Romany, and Bibi-Eybat) together with notes on sources and methods of deriving individual figures. Tables 8a, 8b, 8c, and 8d below show the production for oil fields other than the four old Baku fields. These other fields include Groznyy, Binagady, Surakhany, Sviatoy, Fergana, Cheleken, Maykop, and Emba.

Table 6 presents the symbols used to represent particular references and methods of processing competing figures. Special notes will also be found in individual tables and are indicated by lower case letters. The general philosophy with regard to competing figures is outlined in Part II of the main text.

TABLE 6

KEY TO SYMBOLS

- 1, 2, 3, - - 7: Indicates the reference which is the source of the number for the corresponding year.
- 3 = 5: References 3 and 5 give identical numbers.
- 3 + 5: Number shown is the average of numbers given in references 3 and 5.
- 4 (= 3 = 5): Reference 4 was relied upon for special reasons (e.g., reputation of collector or superior method); references 3 and 5 give identical numbers.
- : No Figure found for that year.

TABLE 7 a

CRUDE OIL PRODUCTION IN THE FOUR OLD BAKU FIELDS: 1889-1919  
(in millions of poods)

Year	Balakhany	Notes	Sabunchi	Notes
1889	76.	3	98.5	3
1890	72.5	3	134.8	3
1891	86.	3	151.7	3
1892	69.9	3	142.3	3
1893	71.1	3	133.	3
1894	69.6	3	132.4	3
1895	76.9	3 = 5	142.	3 = 5
1896	90.4	3 + 5	147.8	3 = 5
1897	100.4	3 + 5	162.6	3 = 5
1898	108.9	3 + 5	179.8	3 <sup>a</sup>
1899	114.9	3 = 5	230.8	3 = 5
1900	124.7	3 = 5	251.6	3 = 5
1901	117.8	3 = 5	295.3	3 = 5
1902	101.5	4	267.2	4 (= 3 = 5)
1903	88.7	4	230.4	4 (= 3 = 5)
1904	82.0	4	218.1	3 = 5 = 7 <sup>b</sup>
1905	56.3	3 + 5	139.2	3 = 5
1906	67.9	3	156.9	3
1907	71.3	3	184.0	3
1908	70.2	3	198.8	3
1909	72.9	3	207.0	3
1910	68.2	3	195.0	3
1911	63.8	3	175.8	3
1912	65.3	3	170.4	3
1913	65.7	3	160.3	3
1914	67.0	3	143.8	3
1915	66.8	7	143.1	7
1916	63.5	7	128.1	7
1917	50.6	7	103.1	7
1918	27.3	7	49.0	7
1919	30.7	7	57.0	7

*Special Notes:*

<sup>a</sup> Reference [5] gives 197.8. Other sources support the figure we have used (179.8), suggesting that the alternative figure contains a transposition.

<sup>b</sup> The volume of [3] published in 1906 and the issue of [4] published February 15, 1905 give 216.8. This was apparently revised, as it appeared as 218.1 in the 1915 volume of [3] and in other sources.

Differences between [3] and [5] are generally quite small.

*Crude Oil Production in the Russian Empire: 1818-1919*

TABLE 7b

CRUDE OIL PRODUCTION IN THE FOUR OLD BAKU FIELDS: 1889-1919  
(in millions of poods)

Year	Romany	Notes	Bibi-Eybat	Notes
1889	—	—	17.8	3
1890	1.5	3	18.	3
1891	13.	3	23.9	3
1892	41.	3	33.3	3
1893	73.1	3	47.5	3
1894	61.7	3	33.8	3
1895	111.4	3 = 5	47.1	3 = 5
1896	78.1	3 = 5	69.8	3 = 5
1897	96.2	3 + 5	62.5	3 = 5
1898	100.5	3 = 5	96.5	3 = 5
1899	98.6	3 = 5	80.8	3 = 5
1900	114.8	3 = 5	109.2	3 = 5
1901	124.1	3 = 5	133.6	3 = 5
1902	139.9	4 (= 3 = 5)	127.4	4 (= 3 = 5)
1903	119.9	4 (= 3 = 5)	157.3	4 (= 5)
1904	133.4	3 = 5*	181.1	4 (= 3 = 5)
1905	87.2	3 + 5	126.7	3 = 5
1906	95.3	3	127.6	3
1907	89.5	3	131.2	3
1908	78.2	3	119.6	3
1909	87.6	3	122.7	3
1910	96.1	3	118.7	3
1911	83.1	3	102.5	3
1912	78.7	3	104.6	3
1913	70.5	3	93.8	3
1914	55.1	3	72.1	3
1915	53.8	7	79.1	7
1916	48.2	7	89.6	7
1917	48.1	7	61.1	7
1918	24.4	7	32.1	7
1919	36.6	7	37.5	7

*Special Notes:*

\* The February 15, 1905 issue of [4] and the 1906 volume of [3] give 133.8. This was apparently revised downward later, appearing as 133.4 in the 1915 volume of [3] and in [5].

TABLE 8 a

CRUDE OIL PRODUCTION IN OTHER FIELDS: 1889-1919  
(in millions of poods)

Year	Groznyy	Notes	Binagady	Notes
1889	.8	7		
1890	2.2	7		
1891	1.4	7		
1892	1.3	7		
1893	8.0	7		
1894	5.2	7		
1895	28.4	7		
1896	17.2	5	.03	5
1897	27.6	5	.20	5
1898	17.7	5	.23	5
1899	25.2	5	.21	5
1900	30.7	5	.41	5
1901	34.7	5	.47	5
1902	34.1	5	.49	4 (= 5)
1903	32.8	5	.26	4 (= 5)
1904	40.1	5	.30	4
1905	43.1	5	.34	5
1906	40.0	5	.3	1 = 3 = 6
1907	39.4	7 (= 1 = 6)	3.2	1 + 3 + 6 <sup>a</sup>
1908	52.1	7 (= 1 = 6)	3.5	1 + 3 + 6 <sup>a</sup>
1909	57.0	7 (= 1 = 6)	5.1	1 + 3 + 6 <sup>a</sup>
1910	74.0	7 (= 1 = 6)	6.1	1 + 3 + 6 <sup>a</sup>
1911	75.2	7 (= 1 = 6)	7.0	1 = 6
1912	65.4	7 (= 1 = 6)	15.1	1 + 6 + 7 <sup>a</sup>
1913	73.7	7 (= 1 = 6)	20.6	1 + 6 + 7 <sup>a</sup>
1914	98.4	7 (= 1 = 6)	24.3	1 + 6 + 7 <sup>a</sup>
1915	88.1	7 + 6	36.3	6 + 7 <sup>a</sup>
1916	102.7	7	44.6	7
1917	107.7	7	36.6	7
1918	25.2	7	—	—
1919	37.7	7	15.1	7

*Special Notes:*

<sup>a</sup> Substantial disagreements in figures for Binagady were observed in the following years:

1907:	[3] = .2 million;	[1] = [6] = 4.7 million
1908:	[3] = .2 million;	[1] = [6] = 5.2 million
1909:	[3] = .5 million;	[1] = [6] = 7.4 million
1910:	[3] = .4 million;	[1] = [6] = 9.0 million
1912:	[7] = 25.2 million;	[1] = [6] = 10.0 million
1913:	[7] = 32.7 million;	[1] = [6] = 14.6 million
1914:	[7] = 29.2 million;	[1] = [6] = 21.9 million
1915:	[7] = 40.4 million;	[6] = 32.1 million

TABLE 8 b

CRUDE OIL PRODUCTION IN OTHER FIELDS: 1889-1919  
(in millions of poods)

Year	Surakhany	Notes	Sviatoy	Notes
1900				
1901				
1902				
1903				
1904			.5	6
1905			.4	1 = 6
1906			.5	1 = 6
1907	.2	1 = 6	.2	1 = 6
1908	.3	1 = 6	1.1	1 = 6
1909	1.7	1 = 6 = 7	1.7	1 = 6 = 7
1910	10.4	1 = 6 = 7	1.4	1 = 6 = 7
1911	19.7	1 = 6 = 7	2.6	1 = 6 = 7
1912	31.4	1 = 6 = 7	3.3	1 = 6 = 7
1913	39.7	1 = 6 = 7	4.7	1 = 6 = 7
1914	51.3	1 = 6 = 7	5.9	1 + 6 + 7
1915	61.5	6 + 7	6.8	6 + 7
1916	96.6	7	6.8	7
1917	96.4	7	6.9	7
1918	50.9	7	3.0	7
1919	47.4	7	3.0	7

TABLE 8 c

CRUDE OIL PRODUCTION IN OTHER FIELDS: 1889-1919  
(in millions of poods)

Year	Fergana	Notes	Cheleken	Notes
1900				
1901				
1902				
1903	.1	6		
1904	.5	6		
1905	2.1	1 = 6		
1906	4.3	1 = 6		
1907	3.2	1 = 6		
1908	2.8	1 = 6		
1909	.9	1 = 6	3.0	1 = 6
1910	1.7	1 = 6	9.6	1 = 6
1911	2.0	1 = 6	13.3	1 = 6
1912	2.0	1 = 6 = 7	13.1	1 + 6 + 7
1913	2.4	1 + 6 + 7*	7.9	1 + 6 + 7
1914	1.8	1 = 6 = 7	5.1	1 + 6 + 7
1915	2.0	6 = 7	4.0	6 = 7
1916	2.0	7	3.0	7
1917	2.0	7	1.5	7
1918	1.5	7	—	—
1919	1.3	7	—	—

*Special Notes:*

\* Year of substantial disagreement:  
1913: [6] = 2.0 million; [1] = [7] = 2.6 million

TABLE 8 d

CRUDE OIL PRODUCTION IN OTHER FIELDS: 1889-1919  
(in millions of poods)

Year	Maykop	Notes	Emba	Notes
1905				
1906				
1907			??	
1908	.1	1 = 6		
1909	.6	1 = 6		
1910	1.3	1 = 2 = 6		
1911	7.8	1 + 6		
1912	9.2	1 + 6 + 7	1.0	1 + 6 + 7 <sup>b</sup>
1913	4.8	1 + 2 = 6 = 7	6.0	1 = 6 = 7
1914	3.7	1 + 2 + 6 + 7 <sup>a</sup>	16.7	1 + 6 + 7
1915	7.9	2 + 6 + 7 <sup>a</sup>	16.6	6 + 7
1916	2.0	1 + 2 + 7	15.5	7
1917	5.0	2 + 7 <sup>a</sup>	15.6	7
1918	3.0	2	8.9	7
1919	3.3	7	1.3	7

## Special Notes:

<sup>a</sup> Years of substantial disagreement:

1914: [6] = 2.96 million; [2] = [7] = 3.9 million; [1] = 4.0 million  
 1915: [2] = 7.5 million; [7] = 7.6 million; [6] = 8.54 million  
 1917: [2] = 8.5 million; [7] = 2.0 million

<sup>b</sup> Year of substantial disagreement:

1912: [7] = 1.1 million; [1] = [6] = 1.0 million

## REFERENCES

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- <sup>2</sup> KNORRE, WERNER VON, « Die russische Erdölwirtschaft », *Petroleum* (Vienna), XXIII, No. 18 (1927), pp. 719-750.
- <sup>3</sup> Russia. Ministerstvo Finansov (vols. publ. in 1869, 1871, 1872, 1873, 1874, 1875, 1902, 1906 and 1915). *Ezhegodnik Ministerstva Finansov*. St. Petersburg.
- <sup>4</sup> Sovet S'ezda Neftepromyshlennikov v Baku. *Neftianoe delo*, VI, No. 2 (February 9, 1904), p. 155; VII, Nos. 1-2 (February 15, 1905), p. 94.
- <sup>5</sup> THOMPSON, A. BEEBY, *The Oil Fields of Russia*. 2nd ed. rev. London, 1908, pp. 113-114, 132-133.
- <sup>6</sup> Russia. Narodnyi Komissariat Finansov. *Narodnoe khoziaistvo v 1915 godu*. Petrograd, 1918.
- <sup>7</sup> USSR. Sovet Neftianoi Promyshlennosti. *Spravochnik po neftianomu delu*. II. Moscow, 1925, pp. 314-317.