

# AN INTERNATIONAL COMPARISON OF URBAN CONSUMPTION: RUSSIA AND THE UNITED STATES BEFORE WWI\*

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The aim of this paper is to compare the level and pattern of personal consumption of urban population in Russia and the United States in the period prior to WWI. The study has two objectives. The first objective to which Sections I-III are devoted is to present a reliable estimation of the indexes of per capita consumption comparing these two countries in the period before Russian Revolution so that one may evaluate with this estimation the two countries' performance in terms of the growth of consumption in later years. The second objective, which Section IV attempts to illustrate, is to find an explanation in economic terms for the gap between the two consumption indexes (one in terms of Russian prices and the other in U.S. prices).

## I. *Data on Russia*

We obtain the bulk of our information on the consumption pattern from the household budget survey of St. Petersburg workers conducted by Prokopovich in 1908.<sup>1)</sup> To supplement these data, we also use the information (in Druzhinin [1]) on other budget surveys.<sup>2),3)</sup>

The Prokopovich survey was conducted by means of questionnaires, and thus the sample was drawn mostly from literate workers. The data do nevertheless include workers both in modern factories and those in traditional handicraft firms. There are, however, a number of difficulties which limit the usefulness of the data as a representative example of Russian workers' living conditions. The obvious deficiency is that the sample was taken in a single city. Other shortcomings are as follows: first, because the sample was drawn from literate workers, the average income in the data is higher than the national average earnings. Further, these data contain more families in upper income brackets than what an information on the size distribution of income of Russia with larger sample size suggests. Secondly, the average family size and the number of breadwinners

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1) This Prokopovich survey [7] covers 307 workers living with their families and 263 others living alone.

2) Other budget surveys here referred to are Davidovich's survey on 41 St. Petersburg textile workers in 1908, Shaposhnikov's survey on 324 Moscow textile workers in the same year and Stopani's survey on 2244 Baku workers in 1909.

3) Although the retail trade data are of course also available for Russia in this period, we rely on the budget survey as the main source of our information. It is because one finds it difficult to exclude the institutional purchases and the peasants' expenditures in urban markets from the trade figures in order to obtain the urban consumption.

in a household in the data are below the national average. The data thus do not adequately reflect the national per capita consumption level. Thirdly, the St. Petersburg prices tended to be higher than the national average of retail prices. As well as the high living cost in large cities, there was a regional price differential between food and manufactured goods. Fourthly, the household budget surveys prior to the development of national income accounting make no rigid distinction between consumption, saving and transfer payments. Moreover, they record only money transactions. Clearly, all components other than consumption should be excluded, and the income in kind in its various forms should be included.<sup>4)</sup> Additionally, quite apart from the deficiencies in the family budget data, the *personal* consumption expenditure is not an adequate indicator for measuring the amount of certain public services which directly affect the well-being of population. Education is an obvious example. The personal payment of tuition fees and the value of the education services received vary greatly from country to country.<sup>5)</sup>

To minimize the effects of these shortcomings, several adjustments are necessary.

(1) Wage earnings per household are derived from annual wage earnings of industrial workers as reported by factory inspectors [4] and [8], but several adjustments are made. We estimate average wages for each age-sex group (from source [14]). From the 1897 population census [10] and [12] we obtain the distribution of industrial workers in three-ways—age, sex and the family relation<sup>6)</sup>—and adjust this for the subsequent change using Rashin's data [8].

(2) The information on the size distribution of wages is available for each age-sex group; known only for daily earnings [14]. From this information on size distribution, we obtain the size distributions of family workers separately, by using the three-way classification of industrial workers. Further, assuming the same variance of lognormal distribution between daily and annual earnings and using the relationship between wage earnings and household expenditure in the budget survey, we revise the number of households in each expenditure bracket of the survey.

(3) The third adjustment concerns the average family size. We here use the average size of 4.84 persons per industrial workers' family (excluding households with one member) as recorded in the population census of 1897. The figure of 4.84 is in fact considerably higher than the average family size of 3.78 persons (excluding "single" workers) as shown in the Prokopovich budget survey. Moreover, since the households in the budget data are classified into different brackets by their total money expenditures, we make upward adjustments to the family size for each expenditure bracket according to the population census [10].

(4) Most of Russian prices we use for our comparison represent national average retail prices.

4) Free meals in factory canteens, consumption of backyard-farm products, housing supplied free by employers were most important of workers' income in kind.

5) There is an obvious discrepancy in our data as to the date in which the information was obtained. The budget survey was conducted in 1908, whereas the wage and price data refer to the year 1913. This inconsistency is dictated by data availability.

6) We classify workers into three groups, depending on whether the worker in question is a "single" worker living alone, the head of a family, or other member of a family.

This information has been supplemented by the data collected by the Soviet central statistical office which give retail prices in 1913 for 34 commodities at 106 cities.<sup>7)</sup>

(5) In an attempt to achieve the comprehensiveness we include as often as possible income received in kind. We also exclude from the expenditure side of the budget such payments as made by the single workers to their home villages.<sup>8)</sup>

After these additions and subtractions have been made, we classify total consumption expenditure into 11 groups. This classification conforms with the U.N. classification [37] and thus provides possibilities for international comparison of expenditure shares.<sup>9)</sup>

We limit our research to what is generally considered "personal" consumption. Certain services, however, (education, for example) may be financed by private households in one country and by the government in the other. Thus the comparison of personal consumption in a strict sense may well be misleading as an indicator for the standard of living. Apart from the estimation of personal consumption, we take both public expenditures on education and personal expenditures for school tuition, and attempt to evaluate them at factor costs.<sup>10)</sup>

Russian budget surveys of this period do not contain cross classifications. We here take the data classified by family expenditures as the source of our information, since we consider that the family income is presumably the most important economic variable in determining consumption. It should be understood, therefore, that our adjustments by other variables—most notably, the size and composition of a family and the regional price differentials—are incomplete. In spite of these admitted limitations, however, we nevertheless believe that the partial adjustments we make are better than no adjustments.

## II. *Data on the United States*

We obtain the information on household consumption from the survey of 25,440 family budgets conducted by the Department of Commerce and Labor in 1901 [20]. However, we derive our estimation mostly from a subgroup in this survey, namely 11,156 households termed "normal families".<sup>11)</sup>

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7) We take the averages of these regional prices with city populations (in the Population Census [11]) and regional wages (in Factory Inspectors' Report [4]) as weights. See [2, 6, 9, 14, 15 and 16] for the information on prices. We omit other miscellaneous sources.

8) The budget survey includes many "single" workers who lived alone in cities, but retained ties in various forms with their native villages.

9) Our grouping into 11 categories falls short of the U.N. classification into 12 groups, for it is impossible in our data to separate the expenditure on household operations and the purchase of household goods, which are separate categories in the U.N. classification.

10) Our research only deals with primary and secondary school education in Moscow City in 1912, but covers both the City public schools and the private schools run by the Holy Synod. The administration cost at the level of the City and Church authorities is excluded [3 and 5].

11) We discard the information on households with unemployed family heads and those who lived in owner-occupied housings or received rent from boarders and lodgers.

The budget survey of these normal families classifies consumption expenditure only into six groups. We make a further break-down based on the information on 2567 families that form a subgroup within the "normal

The major source material for the retail prices of food, rent and fuel are the studies by the Bureau of Labor Statistics [20], [21], and [22] and the British Board of Trade [18]. Prices of clothing, footwear and household goods are derived chiefly from catalogs issued by Sears Roebuck and Montgomery Ward. We assume that these prices may be considered to be representative of the price range of the whole country.

Our choice of the year, 1901, was dictated by data availability. We estimate the change in U.S. consumption for 1901-1913 from Shaw [34] and [35], Kuznets [28] and Russel Sage Foundation [31], and link the change over time with our comparison between Russia in 1913 and the U.S. in 1901. Unfortunately, this linkage is not possible to calculate for each individual commodity group and, therefore, only provides a link for aggregate consumption.<sup>12)</sup>

### III. *Comparison of Russia and the United States*

We select 69 individual goods and services which are of the same quality in the two countries. Their retail prices are then compared. From these individual price comparisons we calculate the prices of Russia relative to the U.S. for total consumption. This method produces two different prices for Russia in 1913 vis-a-vis the U.S. in 1901, depending upon whether the consumption pattern of Russia or the U.S. is used as weights. We link these international price ratios with the U.S. retail price index for 1901-13 and thereby estimate the purchasing power parities of a ruble in terms of dollars. Our calculation shows that in 1913 a dollar was equivalent to 1.85 rubles (with the U.S. consumption pattern as weights) and 1.01 rubles (with the Russian pattern as weights). The exchange rate in 1913, on the other hand, was 1.94 rubles to a dollar. If one assumes that the equilibrium exchange rate falls in the range between the estimated two ruble-dollar ratios, the ruble at the quoted exchange rate seems to have been undervalued. One should be reminded, however, that our estimation of ruble-dollar ratios covers only consumer goods and services. Had we, more selectively, excluded non-traded personal services whose Russian prices were low and included investment goods generally high-priced in Russia, then it is likely that the exchange rate would have fallen somewhere between the two estimated purchasing power parities. ("Balassa effect" [17].)

For six commodity groups (grain products, meat products, household goods and operations, transportation and communication, personal care and health, and miscellaneous services) prices in Russia relative to the U.S. are lower than both purchasing power parities. For five groups (tobacco, clothing, rent, fuel and light, recreation and entertainment), on the other hand, Russian

families." A serious limitation in these data on 2567 families is that the expenditures are given not for each income bracket but only in the average. Thus we have to assume constant expenditure shares in using these data, when we need to subdivide the six categories.

12) As to the estimation of education cost, we make several adjustments to the data [38] in order to obtain the comparable U.S. figure. We take into account both public expenditures and private tuition payment, but we exclude the overhead cost, such as the expenditure of the Board of Education and Superintendent's Office. Primary and secondary schools include both public and private schools. And they cover only 50 cities whose population exceeded 100,000 in the 1910 census.

relative prices are high compared to both purchasing power parities.<sup>13)</sup>

With the estimation of price ratios we obtain the per capita consumption of Russia in 1913 relative to the U.S. in 1901 in index numbers. As shown in Table 1, the total consumption of Russia is 63% of the U.S. when U.S. prices are used. This ratio is 34% when Russian prices are used. This relationship between the two indexes conforms with the usual observation that the difference in consumption levels between two countries becomes greater when the prices of a low income country rather than a high income country are used.<sup>14)</sup> In order to make a comparison for the same year, 1913, we link this result with our estimation of the change in U.S. consumption for 1901–13. The data show that the per capita consumption of Russian family members relative to the United States in 1913 is 40% in terms of U.S. prices and 22% in Russian prices.

Since we make no estimation as to more recent period, we are as yet unable to find the change over time in the relative position of two countries in terms of per capita consumption. For

**Table 1** Consumption per capita in Russia relative to the United States\*  
(with the U.S. consumption as 100)

<i>Russia in 1913 and the U.S. in 1901</i>	<i>In U.S. prices in 1901</i>	<i>In Russian prices in 1913</i>
Food	98	67
Grain products	561	437
Meats, poultry, fish and dairy products	52	41
Other foods	34	29
Beverages	98	83
Tobacco	15	14
Clothing and other personal effects	26	21
Housing rent	16	16
Fuel and light	22	18
Household goods and operations	61	41
Personal care and health expenses	64	26
Transportation and communication	15	13
Recreation and entertainment	20	14
Miscellaneous services	175	263
<b>Total personal consumption per capita</b>	<b>63</b>	<b>34</b>
<i>Russia and the U.S. in 1913 (linked indexes)</i>		
Total personal consumption per capita	40	22
Annual industrial wage per worker	41	23
Primary and secondary school education expenditure per capita**	30	22

\* Consumption of "single" workers is excluded.

\*\* Expenditures are estimated at factor costs. They include public expenditures.

13) Price ratios of individual commodities and individual commodity groups are not presented in this article. See Toda [36].

14) This relationship is often called the Gerschenkron effect of negative correlation. (Scott [33] and Jonas and Sardy [26]).

annual earnings of industrial workers, however, the study by Kaplan and Wainstein [27] compared the two countries in 1950 and 1954. According to this study, workers' average earnings in the U.S.S.R. in 1950 are 18% of the U.S. (in terms of the U.S. prices) and 12% (in Soviet prices). In 1954 the relative position of Soviet workers improved to 23% and 16%. In the period under our study, Factory Inspectors' Report on Russia [4 and 8] and Douglas' study on the U.S. [23] enable us to compare the industrial wages in 1913. According to the estimation based on our purchasing power parities, the average wage of Russian workers in 1913 is 41% and 23% of the average U.S. earnings in the same year. It would seem, therefore, the comparison of our estimation with Kaplan and Wainstein's study indicates that the relative position of Russian workers in terms of wage earnings has worsened in the course of four decades.<sup>15)</sup>

Let us turn now to compare each commodity group in Table 1. Per capita consumption is higher in Russia in 1913 than in the U.S. in 1901 for two groups: grain products and miscellaneous services (church, education, trade union fees, etc.). The high figure of grain consumption in a low income country is plausible, particularly when the relative price of grain was low in Russia compared with the U.S. In the case of miscellaneous services, our result is much more difficult to explain, because the estimated expenditure elasticity indicates that this group was not a necessity to any great extent for Russian households and indeed was a luxury for U.S. consumers, although the relative price of this group was lower in Russia than in the U.S. One may doubt the validity of assuming similar tastes between two nations.

Per capita consumption in Russia was definitely less than one-half of the U.S. level for seven commodity groups, namely other foods, tobacco, clothing, housing, fuel and light, transportation and communication, recreation and entertainment. The fact that the majority of the seven groups were luxuries and their relative prices were high in Russia compared to the U.S. can explain the wide discrepancies of per capita consumption.

Apart from personal consumption, the per capita education cost (including both public and private expenditures) at primary and secondary school level in major cities is lower in Russia in 1913 than in the U.S. Further, this is even lower than the relative level of Russian personal consumption. Our findings may be explained by the general fact that the educational service is income elastic.

#### IV. *Disparity between Two Consumption Indexes*

As seen in Table 1, the relative consumption level of Russia vis-a-vis the U.S. is markedly

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15) Needless to say, the comparison for such a wide time-span should be viewed with caution. The wage figures in Factory Inspectors' Report include over-time payment and income in kind in the form of free meals (though not free housing), whereas the study on U.S.S.R. in 1950-54 deals exclusively with money earnings. Further, while our estimation covers only factory workers, Kaplan and Wainstein's estimation includes white collar and administrative personnel as well. Therefore, our conclusion can be altered if one takes into account the change in the amount of free services to workers and the income differential between blue collar and white collar.

different, depending on whether Russian prices or U.S. prices are used as weights. The question arises as to the economic meaning of these indexes and the gap between the two. One may recall the old debates on the cost-of-living index numbers, which centered around the question whether or not the two indexes of the Laspeyres and Paasche formulae such as shown in Table 1 could be a lower limit and an upper limit to the true index numbers. Under the assumption of common tastes between two nations, it was found that in general they could not be the limits. In addition to the two indexes which can be viewed as indicating the points of over-compensated change in income, one needs to estimate two more indexes related to the points of under-compensated change in income,<sup>16)</sup> in order for the limits to be complete.

We estimate the under-compensation points by tracing Russian and U.S. Engel curves obtained from two countries' budget surveys.<sup>17)</sup> Our estimation of these indexes is presented in the second row of Table 2.<sup>18)</sup> The indexes in each column of Table 2 thus form the upper and lower limits to each of the two true indexes. Since our result shows that the highest and the lowest of the four estimated indexes are those widely-used ones comparing two quantity observations, we conclude that these conventional indexes do provide limits to the true indexes.

**Table 2** Four Indexes of Urban Consumption per capita: Russia in 1913 and the United States in 1901. (with the U.S. level as 100)

	In U.S. prices	In Russian prices
Indexes related to the over-compensation points ( $\bar{Q}^A$ and $\bar{Q}^R$ )*	63	34
Indexes related to the under-compensation points ( $Q^A$ and $Q^R$ )	36	58

\* Identical to the indexes in Table 1, the 4th row from bottom.

The two indexes in each row of Table 2 differ widely. This gap results from the fact that the income level, the price structure and the taste vary from one country to the other. Let us assume that the taste is the same. In order to explain the gap, we attempt to isolate the effect of the difference in income levels from the effect of the difference in price structure. For this purpose we need to estimate, in addition to two observational points, the point of compensated change in income from the Russian observation due to the price shift from Russian to U.S. structure. With

16) See Samuelson [32] for the definition.

17) The Engel curve we estimate for each commodity group assumes constant expenditure elasticities. In the U.S. estimation the size of a family is taken as a variable in addition to the total consumption expenditure per capita. The results are shown in Toda [36]. Of course, to draw an Engel curve for each nation assumes the common taste among the people in different income brackets.

18) As it is convenient for later explanations, we may denote the indexes in the first row of Table 2 with  $\bar{Q}^A = \sum p^A x^R / \sum p^A x^A = \sum p^A \bar{x}^A / \sum p^A x^A$  (where  $\bar{x}_i^A$  represents the consumption of a good at the overcompensation point from Russia with the price shift to the U.S. structure) and  $\bar{Q}^R = \sum p^R x^R / \sum p^R x^A = \sum p^R x^R / \sum p^R \bar{x}^R$ . Similarly, the indexes in the second row may be denoted with  $Q^A = \sum p^A x^A / \sum p^A x^A$  (where  $x_i^A$  represents the consumption at the undercompensation point from Russia) and  $Q^R = \sum p^R x^R / \sum p^R x^R$ .

19) The difference in tastes expressed by the differences in demographic factors (the size and composition of a family) may be dealt with by putting additional variables into expenditure functions.

this estimated compensation point as a dividing point, we divide into two parts the difference in consumption of individual goods and services between two countries. One part is the difference along the U.S. income-expenditure path between the U.S. observation and the estimated compensation point, while the other represents the difference between this compensation point and the Russian observation which lie on the same indifference curve. We may call the index representing the first part the income effect along the U.S. path ( $i^A$ ) and call the index measuring the second part the substitution effect at Russian income level ( $s^R$ ).<sup>20)</sup> With these two effects combined, we obtain the overall effect, namely the original gap caused by the differences both in income and prices. As we showed elsewhere [36], if this  $i^A$  is positive, then  $\bar{Q}^R$  forms a lower boundary to both true indexes.

Since we are not specifying any utility function, we only estimate the over-compensation point and approximate the exact compensation point with this estimation. Thus we split the gap into two parts in the approximate forms,  $\bar{i}^A$  and  $\bar{s}^R$ . It is convenient to express the original gap in relative terms,  $(\bar{Q}^A - \bar{Q}^R) / \bar{Q}^A$ , because this relative gap can be shown by a covariance between quantity and price terms with the expenditure shares as weights.<sup>21)</sup> We may also express  $\bar{i}^A$  and  $\bar{s}^R$  in covariance terms and make their addition equal to the relative gap.<sup>22)</sup> That is,

$$(\bar{Q}^A - \bar{Q}^R) / \bar{Q}^A = \bar{i}^A + \bar{s}^R. \quad (23)$$

We made this division to examine the sign of two effects. The sign of substitution effect provides a test for the validity of our assuming the same taste for two nations. If this effect is positive, one cannot reject the hypothesis of the same taste. If a negative effect is found, one has to reject this hypothesis.<sup>24)</sup>

If the income effect is positive, this effect provides a proxy for a sufficient condition under which  $\bar{Q}^A$  and  $\bar{Q}^R$  form an upper limit and a lower limit, respectively, to the true indexes.<sup>25)</sup>

20) Hicks [24], ch. 19.

21) This formulation has been known since Bortkiewicz's work. See the same formulation in more recent literature such as Marris [30, pp. 218-219], and Jonas and Sardy [26].

22) Marris [29]. Our formulation is different from Marris, since the latter takes an exact compensation point instead of an overcompensation point as an intermediate point.

23) In covariance terms,

$$\begin{aligned} (\bar{Q}^A - \bar{Q}^R) / \bar{Q}^A &= -\text{Cov}_A \{ (x^R/x^A) / (\sum p^A x^R / \sum p^A x^A), (p^R/p^A) / (\sum p^R x^A / \sum p^A x^A) \}, \\ \bar{i}^A &= -\text{Cov}_A \{ (\bar{x}^A/x^A) / (\sum p^A \bar{x}^A / \sum p^A x^A), (p^R/p^A) / (\sum p^R x^A / \sum p^A x^A) \} \text{ and} \\ \bar{s}^R &= -\text{Cov}_A [ \{ (x^R - \bar{x}^A) / x^A \} / (\sum p^A \bar{x}^A / \sum p^A x^A), (p^R/p^A) / (\sum p^R x^A / \sum p^A x^A) ]. \end{aligned}$$

The subscript to the covariance indicates that the expenditure shares at the U.S. observation are used as weights.

24) This test is thus in the same spirit as the weak-axiom test applied to two observational points. However, our test of substitution effect is useful when the income levels of two countries under comparison are different. The test applied to observational points is powerless if per capita consumption of one country is higher than the other no matter which country's prices are used as weights.

The weak axiom refers to an individual preference. The theoretical difficulties in applying this to the data of a group of consumers are well known. The same difficulties hold for the test of substitution effects.

25) If  $\bar{i}^A$  is positive,  $i^A$  is most likely to be positive. Then  $\bar{Q}^R$  is smaller than the true index in U.S. prices. Hence,  $\bar{Q}^R$  is smaller than both true indexes. Similarly, if  $\bar{i}^R$  is positive,  $i^R$  is most likely to be positive. Then  $\bar{Q}^A$  is greater than the true index in Russian prices. Hence  $\bar{Q}^A$  is greater than both true indexes.



Apart from the theoretical implication, the sign of an income effect has an empirical relevance. As seen in the covariance expression, the positive income effect means that arc-expenditure-elasticities between the over-compensation point from Russia and the U.S. observational point are inversely related to U.S.-Russian price ratios. To put it in another way, this implies a tendency that in a high income country the prices of necessities are high and the prices of luxuries are low.<sup>26)</sup>

As we split the overall effect into  $\bar{i}^A$  and  $\bar{s}^R$ , we may also divide this effect into  $\bar{i}^R$ , the income effect along the Russian path and  $\bar{s}^A$ , the substitution effect at the U.S. income level, by putting the point of over-compensated change in income from the U.S. observation as an intermediate point. This division is shown in the second row of Table 3 and, together with the figures in the first row, indicate that both income and substitution effects are positive.

As well as the gap between  $\bar{Q}^A$  and  $\bar{Q}^R$ , one may also deal with the relative gap between  $\underline{Q}^R$  and  $\underline{Q}^A$ , the two indexes shown in the second row of Table 2.<sup>27)</sup> We divide this gap into two by putting the U.S. observation as an intermediate point, and obtain the income effect along the U.S. income-expenditure path,  $\underline{i}^A$  and the substitution effect at the U.S. income level,  $\underline{s}^A$ . Similarly, the gap may be broken down into  $\underline{i}^R$ , the income effect along Russian path and  $\underline{s}^R$ , the substitution effect at the income level of Russia. That is,  $(\underline{Q}^R - \underline{Q}^A) / \underline{Q}^R = \underline{i}^A + \underline{s}^A = \underline{i}^R + \underline{s}^R$ .<sup>28)</sup> The signs of these  $\underline{i}^A$  and  $\underline{i}^R$  as proxies for the positive income effects are required to be negative, as  $\bar{i}^A$  and  $\bar{i}^R$  were required to be positive.<sup>29)</sup> As the third and fourth rows of Table 3 show, the income effects related to under-compensation points are both negative, whereas the substitution effects are positive. Again one may conclude that the hypothesis of similar tastes cannot be rejected because of the positive substitution effects and, as evidenced by negative  $\underline{i}$ 's, price ratios

26) The hypothesis of positive income effect is more restrictive than "the Gerschenkron effect of negative correlation" which is equivalent to a positive overall effect. This is because an overall effect consists of an income effect and a substitution effect, and a substitution effect is likely to be positive unless tastes are very different between two nations.

27) These two indexes can be viewed as quantity index numbers comparing the two under-compensation points, since

$$\underline{Q}^A = \sum p^A x^A / \sum p^A x^A = \sum p^A x^A / \sum p^A x^R \quad \text{and} \quad \underline{Q}^R = \sum p^R x^R / \sum p^R x^R = \sum p^R x^A / \sum p^R x^R.$$

The relative gap between the two may be expressed in a weighted covariance in such a way as:

$$\begin{aligned} (\underline{Q}^R - \underline{Q}^A) / \underline{Q}^R &= -\text{Cov}_A \{ (x^R/x^A) / (\sum p^A x^R / \sum p^A x^A), (p^R/p^A) / (\sum p^R x^A / \sum p^A x^A) \} \\ &= -\text{Cov}_R \{ (x^A/x^R) / (\sum p^R x^A / \sum p^R x^R), (p^A/p^R) / (\sum p^A x^R / \sum p^R x^R) \} \end{aligned}$$

In this expression in contrast with the covariance expression of the overall effect  $(\bar{Q}^A - \bar{Q}^R) / \bar{Q}^A$ , the quantity term refers to the difference between undercompensation points. Weights used for the covariances are expenditure shares at under-compensation points,  $p^A x^A / \sum p^A x^A$  and  $p^R x^R / \sum p^R x^R$ .

28) Similar to the overall effect, the income and substitution effects are also expressed in weighted covariances, namely,

$$\begin{aligned} \underline{i}^A &= -\text{Cov}_A \{ (x^A/x^A) / (\sum p^A x^A / \sum p^A x^A), (p^R/p^A) / (\sum p^R x^A / \sum p^A x^A) \}, \\ \underline{s}^A &= -\text{Cov}_A \{ (x^R - x^A) / x^A / (\sum p^A x^A / \sum p^A x^A), (p^R/p^A) / (\sum p^R x^A / \sum p^A x^A) \} \end{aligned}$$

and so forth.

29) Comparing this  $\underline{i}^A$  with the  $\bar{i}^A$  shown before, one may notice that the arc-expenditure-elasticity terms are reversed in  $\underline{i}^A$ . In  $\bar{i}^A$  the approximate compensation point from Russia was in the numerator and the U. S. observation was in the denominator. And the opposite is found in  $\underline{i}^A$ . Thus  $\underline{i}^A$  and  $\bar{i}^A$  are most likely to be of the opposite sign.

are inversely related to expenditure elasticities. But these negative  $\bar{i}$ 's are so small in absolute value and are predominated by positive  $\bar{s}$ 's that one obtains positive overall effects.<sup>30)</sup>

**Table 3** Division of the Relative Gap into the Income and Substitution Effects (in percent)

	Overall Effect (1)	Income Effect (2)	Substitution Effect (3)
(1) = (2) + (3)			
<i>Indexes related to over-compensation points</i>			
$(\bar{Q}^A - \bar{Q}^R) / \bar{Q}^A = \begin{cases} \bar{i}^A + \bar{s}^R \\ \bar{i}^R + \bar{s}^A \end{cases}$	45.6	2.7	42.9
	45.6	30.4	15.2
<i>Indexes related to under-compensation points</i>			
$(Q^R - Q^A) / Q^R = \begin{cases} i^A + s^A \\ i^R + s^R \end{cases}$	37.4	-5.9	43.3
	37.4	-8.5	45.9

### V. Concluding Comments

The major purpose of our study has been to use data available for Russia and the United States in a consistent manner in order to estimate the consumption levels of the two countries before WWI and to suggest a starting point for the comparative study of growth rates in later periods. The results are such as shown in Table 1. Several adjustments were made to provide representative national average levels of urban household consumption. Since the data have many defects and our adjustments necessarily remain incomplete, we do not regard our results as in any sense final.

Our evidence of the substitution effect in Table 3 conforms with findings in other studies which suggest the similarity in tastes between two nations (Houthakker [25]). Our research has tested this hypothesis for two countries whose per capita income levels were markedly different.

Inverse relationship between prices and income elasticities (as shown by positive  $\bar{i}$ 's and negative  $\bar{i}$ 's) is also in keeping with the findings in the earlier study made by the present author on the international cross-sectional data of Gilbert and Kravis (Toda [36]). Although our evidence is still limited to these two illustrations, it is suggested that this inverse relationship might be found in other international comparisons. One should be cautioned, however, that this inverse relationship may not be found as uniformly as the evidence of "the Gerschenkron effect of negative correlation," since the latter contains both income and substitution effects. Furthermore, the magnitude and even the sign of income effects may vary, depending on the specific form of expenditure functions which one adopts to estimate the compensation points.

30) As the income effects are expressed in covariances, one might calculate correlation coefficients and test whether the positive  $\bar{i}$ 's and the negative  $\bar{i}$ 's are statistically significant or not. Given the small magnitudes of the estimated income effects, it is unlikely that the hypothesis of zero correlation will be rejected. However, one hesitates to take this step, because it is difficult to think that the arc-expenditure-elasticities and the price ratios of individual goods are random variables which scatter around the income ratio and the purchasing power parity. We prefer to regard the covariance expressions just as a convenient device to demonstrate clearly the price-quantity interrelation in index numbers.

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