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## Proto-marginalist approach in Russia: Yuli Zhukovsky's interpretation of Ricardo

**Abstract.** The paper focuses on the interpretation of David Ricardo's theory of value and distribution suggested by Yuli Zhukovsky, a 19<sup>th</sup> century Russian economist. In his interpretation, Zhukovsky introduced a two-factor production model characterized by decreasing marginal productivity as well as supply-and-demand price mechanism. Zhukovsky's interpretation of Ricardo was an attempt to deliver a more rigorous approach to the agrarian issue – the hot topic that marked the public debates in Russia after the abolition of serfdom in 1861. Zhukovsky, an early critic of Marx, outlined a different path in the reception of the classical approach in Russia that preceded later developments in mathematical economics. The paper introduces Zhukovsky's interpretation as a case of proto-marginalist analysis. It also demonstrates that Zhukovsky treated the mathematical apparatus as an instrument for the practical application of political economy to the issue of economic development.

**Keywords:** *Russian economic thought, proto-marginalism, David Ricardo, Yuli Zhukovsky.*

JEL Classification: B12, B16, B31.

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### 1. Introduction

The years 2020–2021 mark the 150<sup>th</sup> anniversary of the Marginalist (or Marginal) revolution, yet the very fact of this revolution is contested in the historiography of economics. The revolution was hardly noticed by the majority of contemporary economists. It was not until the 1950s that historians of economic thought routinely began to describe the transformation initiated with the contributions of Léon Walras, Carl Menger, and William Stanley Jevons as such (Schumpeter, 2006, p. 793; Birken, 1988; Roncaglia, 2005, p. 278–279). The plausibility of applying the notion of “revolution” to the (long) transformation of economic science was arguably reinforced by the post-modern methodology associated with contributions of Thomas Kuhn (Kuhn, 2012) and Imre Lakatos (Lakatos, 1970). However, this approach did not become a consensus. Mark Blaug (Blaug, 1972, p. 274, 280) doubted the Kuhnian character of the transformation that economic science had undergone in the end of the 19<sup>th</sup> century. His thesis was two-fold: on the one hand, the innovative methods (compared to the methods of classical political economy) had already been known and applied in economic analysis. On the other hand, the academic community did not immediately accept the marginalist approach. Blaug proposed to consider the development of economic science as a cumulative process of weeding out erroneous and developing correct theories (Blaug, 1985, p. 1–9). Such an approach, however, dated back to the origins of marginalism itself. Jevons in the preface to the second edition of “Theory of political

economy” acknowledged the work of his predecessors in developing various aspects of marginalist methodology (Jevons, 1879, p. x–xvii). Along the same lines, Alfred Marshall emphasized the continuity of his approach with the classical economists, in particular with David Ricardo (Marshall, 2013, p. 686–689).

Research in economics that preceded marginalism but contained similar analytical elements was retrospectively defined as proto-marginalist (McLure, 2004; Ekelund, Hébert, 2002). Indeed, such approaches were widespread in Britain as well as in continental Europe and across the Atlantic (Ekelund, Hébert, 2002, p. 199–205; White, 2004). Proto-marginalist developments can be characterized by the application of mathematical methods and theoretical principles attributed to the marginalist approach (Kauder, 2015; Mirowski, 1991). In addition, they were strongly influenced by the natural sciences (Mirowski, 1984; Hutchinson, 1972).

In fact, Jevons himself was the first to outline the list of “proto-marginalists”. Specifically, he distinguished the authors who extensively used mathematical methods but lacked the correct theory (N.-F. Canard, W. Whewell, J. Esmenard du Mazet and J. Du Mesnil-Marigny) (Jevons, 1879, p. xxvi–xxvii) and authors that exhibited “a more or less complete comprehension of the true theory of utility and wealth” without any mathematics (Fr. Hutcheson, A. Destutt de Tracy, T.R. Malthus, H.D. Macleod, J. Bentham) (Jevons, 1879, p. xxvii–xxix). Jevons also acknowledged those few whose works demonstrated both “the true theory” and the use of mathematical apparatus (J. Dupuit, H. Gossen) (Jevons, 1879, p. xxx–xxxii).

It was only by the 1900s that marginalism properly entered Russia (Makasheva, 2009; Eliseeva, 2010). At the same time the proliferation of mathematical methods in economics commenced, as exemplified, by Vladimir Dmitriev (Dmitriev, 1974). The logical-mathematical approach of the Lausanne school had many prominent followers among the Russian academia (Avtonomov, 2021a, p. 6–7). However, Yuli Zhukovsky<sup>1</sup> anticipated that trend a generation earlier. In 1871, evidently unaware of the Jevons’s and Menger’s works, he published the first volume of his intended intellectual history of Europe (which he never accomplished). One chapter there provided a mathematical elaboration on Ricardo.

Political economy in the second half of the 19<sup>th</sup> century in Russia was characterized by the positive reception of Western ideas (Avtonomov, 2002), especially the works of classical authors (Avtonomov, 2021b). Contemporary Western theories were less popular among the Russian academia. Before the 1860s the works of Russian economists could be described as “extractions from Adam Smith” (Ivanyukov, 1891, p. 59). Such prevalence of the classical ideas proceeded until the early 1870s as well. In this regard, Zhukovsky was an exception.

In the 1860s Zhukovsky considered himself as a journalist rather than an academician. In fact, he declined an invitation to pursue the academic career in favor of presenting regular comments on the current events (Zhukovsky, 1909, p. II). Having a degree in jurisprudence (Zhukovsky graduated from the Imperial College of Law) he turned to economic issues which were relevant to the debates in post-1861 Russia (Zhukovsky, 1862). His main sources of influence were representatives of Western political economy: Adam Smith (Zhukovsky, 1864a), Jean-Baptiste Say (Zhukovsky,

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<sup>1</sup> Zhukovsky Yuli Galaktionovich (1833–1907) – Russian publicist and economist. Governor of the State Bank of the Russian Empire (1889–1894), senator. His comprehensive autobiography can be found in the preface to one of his later books (Zhukovsky, 1909) and in (Dmitriev, 2009, p. 237–239).

1871, p. 390–414), Henry Dunning Macleod (Zhukovsky, 1864b), John Stuart Mill (Zhukovsky, 1865), Henry Charles Carey (Zhukovsky, 1872).

Zhukovsky believed that he followed “the Smithian approach”. Yet he also believed that such approach should be reformulated and adjusted to the contemporary world by using mathematics (Zhukovsky, 1909, p. XVIII–XIX). He argued that research in political economy should be based on statistical data which could provide precise information on *losses* and *benefits* and thus solve the fundamental questions of the science (Zhukovsky, 1871, p. 402–403). In his opinion, a rigorous logical approach to economic theory would help avoid errors in verbal reasoning (Zhukovsky, 1906, p. 183).

Zhukovsky was among the first in Russia to provide analytical interpretation to Ricardian theory (Melnik, 2014, p. 198–200) and analytical critique of Marx (White, 2019). Unlike other early Russian reviewers of the first volume of “*Capital*”, he was quite critical of Marx. Yet, Zhukovsky appreciated what he defined as “Ricardo’s methodology” – an abstract method based on logical reasoning, similar to philosophical analysis (Zhukovsky, 1871, p. 390). Plausibly, his analytical interpretation of Ricardo provided a background for the prompt critical response to Marx. Therefore, Zhukovsky’s interpretation of Ricardian theory provides an insight not only to his own approach but also to trends in the Western economic literature of the first half of the 19<sup>th</sup> century – the trends that anticipated the rise of marginalist approach in economics.

Zhukovsky’s name is known both in Russian and foreign historiographies, yet his contribution was not thoroughly studied. For his contemporaries, Zhukovsky’s use of mathematical methods remained alien even though V. Dmitriev highly praised Zhukovsky’s interpretation of Ricardian theory (Dmitriev, 1974, p. 83–84). The assessment of his work by Soviet historiography followed the derogatory remarks of Karl Marx and his disciples in the Russian Empire<sup>2</sup>. It was not until the late 1980s when his application of mathematics to political economy got attention (Shukhov, 1987). Since then, Zhukovsky is characterized as one of the early mathematical economists. Shukhov and Frejdlin, who presented a comprehensive study of the development of mathematical methods in Russia, described Zhukovsky’s contribution to the problem of interest calculation emphasizing its novelty and *modern* approach to the issue (Shukhov, Frejdlin, 1996, p. 259–261). Zhukovsky is considered as a successor of political economy, who used a progressive instrument (mathematics) (Shukhov, Frejdlin, 1996, p. 14). Several works analyzing Zhukovsky’s place in the history of neoclassical production theory (Dmitriev, 2009) and reception of marginalism in Russia (Dmitriev, 2013) appeared in the late 2000s – early 2010s. The contemporary literature in history of Russian economic thought acknowledges Zhukovsky’s role in the reception of Ricardo in Russia (Melnik, 2014; Smith, 2017). His name is also mentioned in the analysis of early Marxism in Russia as one its first critics (Allisson et al., 2020; Shirokorad, 2018, p. 97–101) though only in passing.

Nevertheless, the literature falls short from putting Zhukovsky’s ideas into context. Indeed, his mathematical interpretation of Ricardo’s rent theory was remarkable as it preceded the later development of mathematical economics in Russia. However, that interpretation was only an excursion in Zhukovsky’s corpus of works of 1860s–1870s. The aim of this paper is twofold. Firstly, it introduces Zhukovsky’s interpretation as a case of proto-marginalist analysis. Secondly, the interpretation is con-

<sup>2</sup> For a detailed description of debates between Zhukovsky and Marxists, see (White, 2019).

ceived in the context of Zhukovsky's involvement in vivid debates on the agrarian issue in post-reform Russia.

Section 2 presents the mathematical interpretation of value theory; section 3 elaborates on the notion of market price in Zhukovsky's works; section 4 outlines Zhukovsky's attempt to verify the derived theoretical conclusions; the concluding section 5 features proto-marginalist characteristics of his approach.

## 2. Distribution of social product: from “elements of value” to factors of production

Zhukovsky starts his analysis by defining the *product* as everything that can be made by a combination of land, capital, and labor (Zhukovsky, 1871, p. 309). The product (conceived in its social form) is distributed across three classes: the *proprietor of the land* (landowners), the *owner of the capital* (capitalists), and *laborers* (workers), and consists of *rent*, *profit*, and *wages*. Thus, Zhukovsky follows Ricardo's logic and proceeds with the study of the distribution process through the analysis of *value*. Following Ricardo, Zhukovsky states that the definition of the laws governing the distribution will lead to the solution of all the major questions of political economy (Zhukovsky, 1871, p. 308).

The first element of value that Zhukovsky analyses is labor. He reproduces Ricardo's proposition on the relation between wage and value putting an emphasis, however, on the role of market forces: “The same amount of labor can buy sometimes more, sometimes less, of produce; it is unfair to conclude that the value of a unit of labor remains unchanged, while the value of product changes and the value of labor itself does not. The latter is subject to the same fluctuations depending on supply and demand, as the value of all other things, and therefore cannot serve as a measure of value” (Zhukovsky, 1871, p. 310). Unlike wage, the amount of labor embodied in product remains the same across the time; thus, the absolute amount of labor should be considered in the definition of value.

The next element of value analyzed by Zhukovsky is capital. He closely follows Ricardo and distinguishes two types of labor, namely the *current (direct) labor*—the workforce actually used in production and *past (indirect) labor*—which constitutes capital (Zhukovsky, 1871, p. 312). Thus, the latter can also be expressed as the amount of labor required for the construction of tools, machines, etc. The actual measure of labor, accordingly, combines both elements: the direct labor involved in the production of a commodity and the indirect labor involved in the production of capital.

At this point, Zhukovsky (Zhukovsky, 1871, p. 313–315) introduces mathematics into his interpretation. He suggests a case of two entrepreneurs producing bread and textile, with 10 workers each. In the initial period  $T$ , the first produces  $n$  loaves of bread and the second — one unit of weaving machinery. Thus, the *price* of a machine is equal to the price of  $n$  loaves of bread since the labor inputs are equal. In the next period  $T + 1$ , the amount of bread produced remains the same, while the second entrepreneur produces  $m$  pieces of textile with the machinery. The labor employed in textile production is  $10 + 10 = 20$ . Therefore, the price of  $m$  pieces of textile is twice the price of  $n$  loaves of bread.

Zhukovsky acknowledges that the price of textile should be in fact higher since the first entrepreneur received his profit in the first year and the second one did not. The bread-maker can *put income into turnover* in the next period, i.e., to *reinvest*. So, if the

first entrepreneur gets  $a\%$  from the value of product  $q$ , the profit in  $(T+1)$  would be  $qa + (q + qa) = q(2a + a^2)$ . To equalize the profits, the price of  $m$  pieces of textile should be  $2qa + a^2q$ , not  $2qa$ .

Zhukovsky generalizes this idea for  $k$  years. Consider the labor-intensive bread production. The first-year profit would be  $qa$ , the second  $-a^2q$ , the  $k^{\text{th}}$   $-a^kq$ . Zhukovsky notes that the profits increase in the geometric progression, the sum of which constitutes the total income for  $k$  years:

$$aq \times \left[ \frac{(1+a)^k - 1}{1+a-1} \right] = aq \times \left[ \frac{(1+a)^k - 1}{a} \right] = q((1+a)^k - 1). \quad (1)$$

Consider now the capital-intensive textile production. Zhukovsky suggests that the machinery can be used for  $t$  years, so that its value can be recovered across the same period. Thus, the value of the produced machines  $A$  must include the profit that the entrepreneur could have acquired through  $k$  years:

$$A = kq + q((1+a)^k - 1). \quad (2)$$

Therefore, what can be defined as “the supply price”  $P$  will be:

$$P = \frac{Aa(1+a)^t}{(1+a)^t - 1} = \frac{aq(k + (1+a)^k - 1)(1+a)^t}{(1+a)^t - 1}. \quad (3)$$

Initiating the textile production in the period  $k+1$  with the start of fabrics production, the textile-maker will get the same profit as the bread-maker  $-qa$  – plus the value of the working units of capital  $q(1+a)$ . Thus, the annual profit in the textile production will be:

$$q(1+a) + P = q(1+a) + aq + \left[ (k + (1+a)^k - 1)(1+a)^t / ((1+a)^t - 1) \right]. \quad (4)$$

This expression constitutes the price of  $m$  pieces of textile that the entrepreneur will produce. It should be noted that Zhukovsky implicitly assumes that both producers (i.e., labor-intensive, and capital-intensive sectors of the economy) exchange not with each other directly, but each supplies the consumer market. Zhukovsky accepts the Ricardian notion of equilibrium – the general law of the equality of profits (Zhukovsky, 1871, p. 318). The difference between competitive prices in both labor-intensive (1) and capital-intensive (4) sectors suggests that the equilibrium conditions in Zhukovsky’s interpretation imply the difference in productivity levels (Zhukovsky, 1871, p. 315–316).

Finally, Zhukovsky focuses on the third element – *rent*. It is defined as a share of the product paid to the landowner for the use of his land (Zhukovsky, 1871, p. 316–317). Following the notion of differential rent in Ricardo, Zhukovsky defines rent as the difference between costs of production and market price. Consequently, the origins of rent are due either to differences in productivity among agricultural producers or to an increase in demand (population growth) (Zhukovsky, 1871, p. 320). Zhukovsky points out that any technological improvements in agriculture will lead to a decrease in both prices and rents. Thus, rent can be viewed as a “*thermometer*” of wealth and labor productivity (Zhukovsky, 1871, p. 321), implying their inverse relation (i.e., the higher the labor productivity the lower the rent). Following this logic, the switch to capital-intensive technics in agriculture results in higher productivity, a decrease in rents, and an increase in surplus. According to Zhukovsky, this surplus may be distributed between the landowner and the consumer (Zhukovsky, 1871, p. 320). In the latter case, it is defined by Zhukovsky as a *consumer benefit*. The surplus goes to the landowner when

there is excessive demand on the market. When, however, the increase in productivity follows (and fully meets) the increase in demand, the surplus constitutes the consumer benefit. This way of reasoning allowed Zhukovsky to introduce a sort of “consumer surplus” into the analysis and generalize the notion of rent outside the confines of the agricultural market.

Therefore, the notion of rent is focal in Zhukovsky’s interpretation (Zhukovsky, 1871, p. 321–327). Firstly, he returns to a consideration of the difference between labor- and capital-intensive production. Consider a producer who uses machinery created by  $q$  workers employed during  $k$  years. The machinery will be used for  $t$  years; this constitutes a greater amount of labor  $qk$  available to the producer. Assuming the presence of a labor-intensive producer on the market, the market price of a commodity will still be defined as  $qk$ , since it corresponds to the amount of direct labor employed in the production. The difference between  $q$  and  $q'$  will result in a surplus, which may be distributed among consumers and landowners. The total magnitude of surplus can be written as  $k(q - q')$ .

Zhukovsky proceeds with the generalization of the notion of rent. Consider the case of different productivity levels among producers in the same sector (textile production). Factory 1 produces  $m$  units of textile using the amount of labor  $q(1+k)$  without machinery. Thus, one worker produces  $x$  units, where productivity is:

$$x = m / (q(1+k)). \quad (5)$$

Factory 2 employs machinery previously produced during  $k$  years. This factory under equilibrium conditions should produce more than  $m$  units, otherwise, it would be unprofitable to make investments into construction of machinery. Assume that productivity increment is infinitely small and denote it as  $dm$ . One worker employed in capital-intensive production will produce  $x + dx$  units of textile. Overall, the producer will get  $m + dm = (x + dx)q(1+k)$  units. The increment can be expressed as:

$$m + dm - m = (x + dx - x)q(1+k), \quad (6)$$

$$dm = q(1+k). \quad (7)$$

In this expression,  $dm$  is the increment due to the use of capital-intensive technique measured in product, which now should be transformed into the units of labor. Let the increment of the labor be  $dq$ , and the initial labor productivity be  $x_0$ , then:

$$dq(1+k) = \frac{dm}{x_0} = \frac{dx q(1+k)}{x_0}; \quad dq = \frac{qdx}{x_0}. \quad (8)$$

The coefficient  $dq(1+k) / x_0$  is constant, as it has no influence on productivity. To get the sum of increments of labor (i.e., rent) we must integrate until  $x$ :

$$R = \Delta q = \frac{q(1+k)}{x_0} \int_{x_0}^x dx = q(1+k)(x - x_0) / x_0. \quad (9)$$

Zhukovsky indicates that the value of the rent measured in labor (9) depends on the range of  $x$ , which arguably can denote any possible factor of production. In addition, the form of a definite integral suggests that it depends on the last factor unit employed in production (Zhukovsky, 1871, p. 344).

### 3. Decomposition of market price

Following the traditional classical approach Zhukovsky distinguishes two types of values: the *natural value* and the *exchange price* or *exchange value* (market price) (Zhukovsky, 1871, p. 349–350).

Upon defining the principle of natural value as outlined in section 2, Zhukovsky turns to consideration of factors that result in divergence between natural values and market prices. Zhukovsky suggests that the ratio of the market price  $E$  to the natural value  $E_0$  defined by the most efficient production cost would correspond to the ratio of respective labor productivities  $x$  and  $x_0$  (Zhukovsky, 1871, p. 351):

$$\frac{E}{E_0} = \frac{x_0}{x}; E = \frac{E_0 x_0}{x}. \quad (10)$$

The market price can be expressed as a function of productivity. Consider that  $x$  refers to the productivity of land; so, in a situation of excess demand, the production will have to move to less productive plots of land and thus move  $x$  away from  $x_0$ . In fact, Zhukovsky generalizes the effect of population growth on agricultural prices and considers changes in effective demand as a factor of the *price mechanism*. This means that the market price depends on effective demand (Zhukovsky, 1871, p. 352).

Here Zhukovsky introduces an important clause. Indeed, the quantity demanded is prone to fluctuation *more* than the quantity supplied as it takes time to move the capital from one production to another. Zhukovsky (Zhukovsky, 1871, p. 354) assumes that both *supply* ( $r$ ) and *demand* ( $s$ ) (sic!) influence the exchange value:

$$E = E_0 s / r. \quad (11)$$

He attributes (11) to Ricardo: “According to Ricardo, the price of all things is subject to these fluctuations due to changes in supply and demand” (Zhukovsky, 1871, p. 354). Accepting (11) in principle Zhukovsky finds that it requires modification. To be correct, the supply–demand ratio should be defined not in absolute values, but *in the relative* ones. By relative values, he understands “magnitudes of supply and demand per unit of labor or wage” under the equilibrium conditions  $s = x_0$  and  $r = x$ , as seen in (10) (Zhukovsky, 1871, p. 361). Thus, Zhukovsky tries to combine the market and technological factors.

#### 4. Policy implications: redistribution of rent and economic growth

The important motive behind Zhukovsky’s interest in Ricardo was due to vivid debates on the situation in agriculture, the predominant sector in the economy of the Russian Empire. The debates started with a relative relief of censorship in the late 1850s and elaboration of the fundamental agrarian reform aimed at the abolition of serfdom, which was eventually proclaimed in 1861. The implementation of the reform sparked the debates further, and consideration of relations between distribution and economic growth (“the wealth of nation”) undoubtedly inspired his interpretation. To verify the principles he derived from Ricardo, Zhukovsky chose the dataset from the official statistics of the Kingdom of Prussia for 1858 (Zhukovsky, 1871, p. 335). He decided to use the foreign data for two reasons. Firstly, the data explicitly provided the distribution of plots of arable land according to the yielded income (Zhukovsky, 1871, p. 327). Secondly, Zhukovsky probably tried to avoid a tightened censorship that would result in the ban of his book in case of the direct reference to Russian situation. The data is presented in the table 1 below; the first column shows the distribution of total arable land according to the calculated productivity of one unit (morgen) of land measured in thalers (thal.) (as shown in the second column of Table 1). The last column shows the cumulative distribution of the land.

**Table 1**

The Kingdom of Prussia land statistic

Share of land, %	Productivity, thal.	Cumulative distribution, %
25.6	0–0.5	25.6
15.9	0.5–1	41.5
19.9	1–2	61.4
25.2	2–4	86.6
9.5	4–6	96.1
3.4	6–8	99.5
0.7	8–10	100.0

Source: Zhukovsky, 1871, p. 328.

Zhukovsky denotes the distribution function of land shares as  $g(p)$  and the cumulative distribution of land shares as  $f(p)$ , where  $p$  is the productivity in thalers. So, for evaluation of rent  $R$  in terms of the introduced functions he transforms (9):

$$R = \Delta q = \int dq = \int_{p_0}^p g(p) dp = \int_0^p p f'(p) dp. \quad (12)$$

Assuming the continuous productivity of land he plots the data as seen in Figure 1 below.

Zhukovsky approximates  $f(p)$  for the Prussian data as:

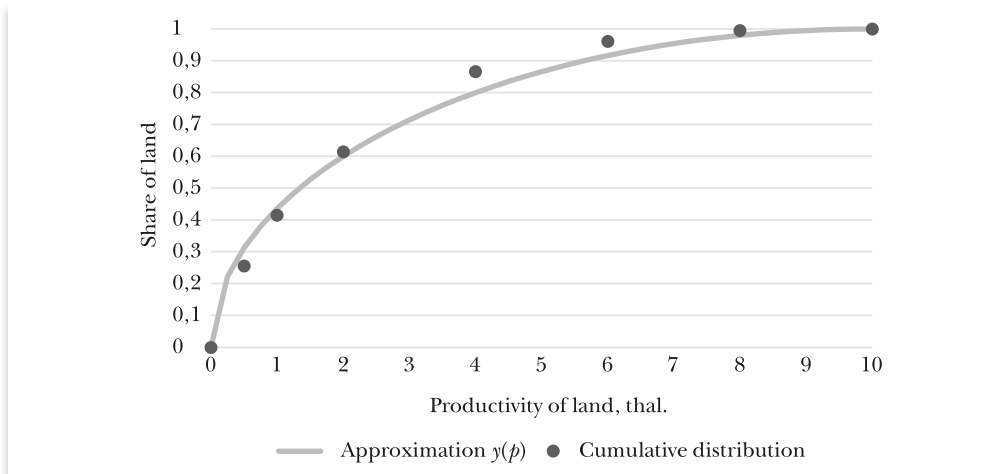
$$y(p) = 0.1\sqrt{20p - p^2}. \quad (13)$$

He notes that (13) can be expressed as an elliptic equation with the center at (0; 10):

$$\frac{p^2}{a^2} + \frac{y^2}{b^2} = \frac{p^2}{10^2} + \frac{y^2}{1^2}. \quad (14)$$

From the definition of rent and (9) Zhukovsky concludes that the average rent per unit of land in Prussia (Zhukovsky, 1871, p. 333) constitutes the area above the  $y(p)$  limited by rectangular 10 by 1, namely:

$$R = 10(1 - 0.25\pi) = 2.146 \text{ thal.} \quad (15)$$

**Figure 1**

Cumulative distribution of arable land in the Prussian Kingdom

Source: Zhukovsky, 1871, p. 329.



**Table 2**

Surplus values for different productivities

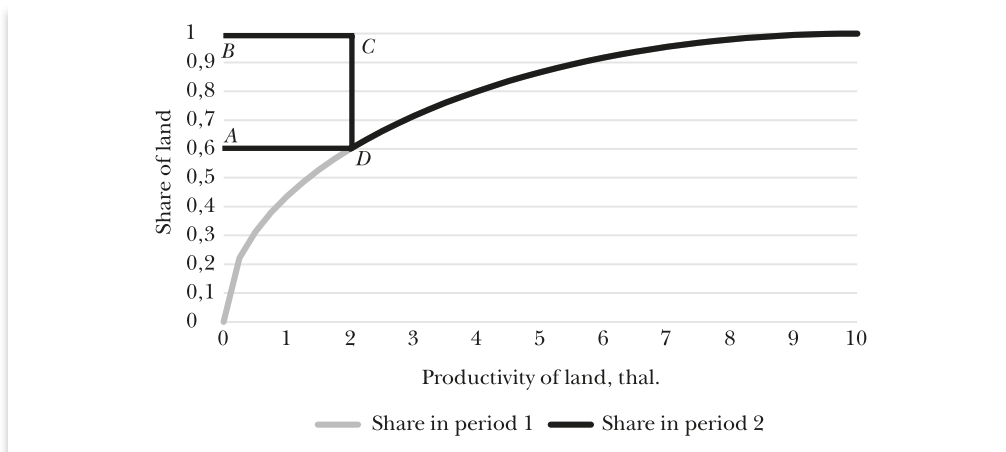
Productivity increase, thal.	Total consumer benefit, thal.	Marginal consumer benefit, thal.
2	1.186	1.186
4	1.776	0.59
6	1.997	0.221
8	2.129	0.132
10	2.146	0.017

Source: compiled by the author on (Zhukovsky, 1871, p. 334).

The next objective is to evaluate the impact of change in the distribution of rent between consumers and landowners due to technological improvements. Consider the following case: in period 1 the cumulative distribution of land productivity coincides with the Prussian data described above. However, in period 2, the areas that yield up to 2 thalers in productivity now provide no rent. The new cumulative distribution curve will thus start not in (0; 0), but in (2; 0.6) – as seen in the Figure 2 below (Zhukovsky, 1871, p. 354).

Zhukovsky points that the consumer benefit will consist of two parts: the first stands for the rent coming from all the areas of productivity up to 2 thalers (triangle  $OAD$ ), while the second (rectangle  $ABCD$ ) constitutes the decrease in rent in all other areas, so the total benefit will be represented by  $OBCD$ . He calculates the consumer benefit for various changes in productivity (Table 2).

Zhukovsky himself stops short of using the term “marginal consumer benefit” but notes the uneven pattern in the increase of benefits: the greater amount of the rent is redistributed to consumers the smaller is the marginal increment of the consumer benefit. As seen in (15) the average rent per unit of land is 2.146 thalers. Thus, if the total amount of land in the Kingdom of Prussia is 1,347,763 morgens, the total value of rent is 2,892,299.4 thalers. If this whole value of rent is redistributed among all the Prussian consumers (18,500,000) then the wealth increment will amount to 0.176 tha-

**Figure 2**

Graphical illustration of consumer benefit due to a decrease in rent

Source: compiled by the author based on (Zhukovsky, 1871, p. 329).

lers (which is insignificantly small). He concludes that the abolition of rent will not lead to a significant increase in consumer welfare: “The insignificant benefit each consumer gains from a reduction in land rent speaks by itself against any idea of increasing *general welfare* by reducing rent, and the idea that the current restrained position of the working classes is due to the presence of rent...” (Zhukovsky, 1871, p. 336). He notes that such straightforward ideas in economic policy are too naïve, while the question of *welfare improvement* is complex and requires precise reasoning.

Zhukovsky views the total rent not as a resource for the improvement of individual wealth, but as a *natural fund* that can finance economic growth (*the growth of civilization*). He points out that the reduction of rent coming from the technological improvements does not mean its abolition, but its *productive use*, namely the *transformation of rent into capital* (Zhukovsky, 1871, p. 336). Looking back at the data, the redistribution of rent among consumers results in an insignificant increase in wealth, while if we consider 3 million thalers as an annual capital inflow this makes a tangible asset. Zhukovsky distinguishes between productive and unproductive use of rent. The first concept refers to its investment in any business that generates profit for the owner, for example, the construction of roads (Zhukovsky, 1871, p. 337). If the rent is used productively, then it should be viewed as a *natural tax* that stimulates economic growth. However, if the rent is used in an *unproductive way* the economy faces “*severe consequences*” (in fact underdevelopment) (Zhukovsky, 1871, p. 338). Thus, according to Zhukovsky, when economists argue against the rent (i.e., against landowners), they in fact should argue against the *unproductive use* of rent. Hence, he outlined the analytical foundations for the liberal approach in contemporary Russian debates.

## 5. Conclusions

The concepts of subjective value theory, marginal utility, rationality, and maximizing behavior associated with the marginalist revolution (Avtonomov, 2017, p. 143) are absent in Zhukovsky’s interpretation. Yet several characteristics that can be defined as proto-marginalist are there. It should be noted that Zhukovsky’s interpretation was based not merely on the technical application of mathematical methods. Rather, it was a particular background that suggested the application of mathematics in the way Zhukovsky did it. That background was defined by the impact of European authors who criticized certain elements in the legacy of Smith and Ricardo, for example H.D. Macleod.

Apart from the application of mathematics, Zhukovsky changed the theoretical standpoint: he understood natural value as the cost of production and explicitly stated that it depends on the two factors of production – labor and capital. Following Ricardo, he agreed that rent has of no influence on the price, though he saw it as a specific case of value theory, when supply cannot meet the growing demand.

Zhukovsky saw the rent as a “thermometer” of welfare and labor productivity. In this in some way he anticipated A. Marshall: “No doubt when the people had been thinned by want, the landowner would suffer in the pocket: but that fact took little of the force from Ricardo’s contention that the enormous rise of agricultural prices and rents which occurred during his life was an indication of an injury to the nation beyond all comparison greater than the benefits received by the landowners” (Marshall, 2013, p. 686). The application of mathematics allowed Zhukovsky to generalize the case of rent. Obviously, equation (9) can be applied to any situation where there is a difference in pro-

ductivity levels among producers of the same sector. But this means that the distribution of the resulting surplus can no longer be considered as such between landowner and consumer. In fact, the surplus may go to any class or stratum of proprietors of some specific resources (e.g., capitalists). However, Zhukovsky does not elaborate on this further.

Based on his consideration of rent Zhukovsky introduced the notion of consumer benefit: the addition to consumer wealth coming from the redistribution of rent. Here some parallel can be drawn with Marshallian consumer surplus, but in Zhukovsky's work this notion is associated with technological improvements exclusively.

Although Zhukovsky's work lacks precise definition and form of the *production function*, he highlighted several assumptions that became crucial in subsequent theories. Firstly, Zhukovsky elaborated on the concept of the decreasing productivity: starting with the Ricardian idea of decreasing productivity of land Zhukovsky generalized it for other factors of production. For example, in his critique of Karl Marx's theory (Zhukovsky, 1877) Zhukovsky acknowledges that at some point the additional factory worker will bring the capitalist less benefit than the previous ones: "...in any production the number of workers can be increased for the benefit of the owner only up to a certain limit, from which the new worker brings the owner less and less benefit." (Zhukovsky, 1877, p. 83).

Considering capital as the factor of production Zhukovsky noted that in certain capital-intensive productions the labor productivity must be higher than in labor-intensive ones. Applying mathematics to a simple case of bread and textile manufacturers, Zhukovsky came to a general formula for the natural value of the product in a capital-intensive industry. The equation (4) also implies that by increasing the amount of labor employed in production by the same amount, the output in the capital-intensive industry will increase greater than in the labor-intensive one (equation (1)).

Zhukovsky acknowledged the importance of his result as he returned to the thesis of different productivities in the capital- and labor-intensive industries in his later works. In the analysis of Marx's concept of *surplus value*, he points at the difference between the outputs of labor itself and the output assisted by capital (Zhukovsky, 1877, p. 82). He supports his thesis with a simple example: it takes more time to dig up the garden "with a curved stick" (i.e., labor-intensive production) rather than at first produce a shovel and then do the digging (i.e., capital-intensive production) (Zhukovsky, 1877, p. 84–85). Zhukovsky notes: "...we want to know what the worker's labor is worth, then we should, it seems, ask what this labor is worth in itself..." (Zhukovsky, 1877, p. 81).

Finally, Zhukovsky approached the description of the price mechanism based on the demand–supply ratio (as in equation (11)). Unlike marginalist authors, however, he did not define supply and demand as functions.

Apart from methodological aspects, Zhukovsky's work is novel in its application. He notes that his predecessors made most of their conclusions from observation, but it was the natural sciences that introduced a precise measurement and benefited from it (Zhukovsky, 1871, p. 273). According to Zhukovsky *measurement* is the key and the *condition* of scientific analysis. His mathematical interpretation of Ricardo's ideas is an attempt to apply quantitative methods to political economy.

Zhukovsky was the first in Russia to apply mathematics for the interpretation of Ricardo—the approach that started in Britain with William Whewell at the beginning of the 19<sup>th</sup> century (Cochrane, 1970). The attempt to translate Ricardo into equations was

driven by the desire to show the flaws of seemingly rigorous Ricardo's approach. This brought W. Whewell closer to formulation of marginalist economics, which was noted by W. Jevons (Jevons, 1879, p. xxvi–xxvii). Thus, Zhukovsky's interpretation marks him according to Jevons's classification as the one who used mathematical methods but fell short of exact marginalist theoretical conclusions.

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## Протомаржиналистский подход в России: интерпретация Юлия Жуковского теории Рикардо

**Аннотация.** Статья посвящена интерпретации теории ценности Рикардо, предложенной российским экономистом XIX в. Юлием Галактионовичем Жуковским. В своей интерпретации Жуковский применил математический метод анализа к теории классической политической экономии, представил двухфакторную модель производства с убывающей предельной производительностью и механизмом формирования цен на основе спроса и предложения. Интерпретация Жуковского являлась попыткой более строгого анализа аграрного вопроса – темы, которая широко обсуждалась в России после отмены крепостного права в 1861 г. Жуковский, один из первых критиков К. Маркса в России, наметил путь восприятия классического подхода в России, который предшествовал развитию математической экономики в конце XIX – начале XX в. в России и маржиналистской революции в мире. В статье представлена интерпретация Жуковского как частный случай протомаржиналистского подхода в экономическом анализе. В статье показано, что математический аппарат для Жуковского был инструментом для решения практических задач политической экономии, в частности проблемы экономического развития.

**Ключевые слова:** *Российская экономическая мысль, протомаржинализм, Давид Рикардо, Юлий Жуковский.*

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