Hypothetical demand curve and price for the COVID-19 vaccine

ANITA KOLNHOFER-DERECSKEI, GYÖNGYI CSONGRÁDI, ARNOLD TÓTH, GYÖRGY HAUBER

> "I had a growing feeling in the later years of my work at the subject that a good mathematical theorem dealing with economic hypothesis was very well unlikely to be good economics: and I went more and more on the rules – (1) Use mathematics as shorthand language, rather than as an engine of inquiry. (2) Keep to them till you have done. (3) Translate into English. (4) Then illustrate by examples that are important in real life. (5) Burn the mathematics. (6) If you can't succeed in 4, burn 3. This last I do often."
>
> (Alfred Marshall, 1906)

DOI: 10.23762/FSO_VOL10_NO4_9

Abstract

This research aims to study the demand for a COVID-19 vaccine. The main objective of this research was to investigate the willingness to pay (WTP) of those people who are eligible for the government-financed vaccination programme under which this medication is available free of charge. Based on this, the study aimed to assess the optimum price that people are willing to pay for the vaccine. More than 300 undergraduate students were questioned in classroom experiments about their personal preferences in order to derive the demand curve for a hypothetical market for the COVID-19 vaccine. A regression analysis of the results showed that the linear and power functions could describe consumer behaviour and predict an optimal market price for the investigated item. In addition, the linear model fitted better. Finally, we compared our result with the real prices of the various vaccines available on the market to see if the predicted price was viable under the prevailing market conditions. The optimal price informs us how many people will receive the next vaccine if it is offered at a specific market price. It also informs us what price the government should assign to the vaccine to secure a particular target vaccination rate.

Key words

willingness to pay, pricing, demand curve, COVID-19 vaccine

Anita Kolnhofer-Derecskei
e-mail: kolnhofer-derecskei.anita@uni-bge.hu

Gyöngyi Csongrádi[1]
e-mail: csongradi.gyongyi@uni-bge.hu

Arnold Tóth
e-mail: toth.arnold@uni-bge.hu

György Hauber
e-mail: hauber.gyorgy@uni-bge.hu

Budapest Business School, Hungary

[1] Corresponding author

Paper received: 29 August 2022 • Paper revised: 7 November 2022 • Paper accepted: 22 November 2022

Introduction

The analysis of market demand is a central and crucial topic in economics. Researchers have shown great interest in the motivating factors behind individual and market consumer decisions. In addition to the general theoretical approach to demand, several empirical surveys confirm the importance of people's willingness to pay on given markets. Behavioural economics, which in no way breaks mainstream theories, also views customer behaviour analysis as a significant issue. By studying decision making based on classical rationality in a different light, we can gain a more comprehensive picture of consumer decision making.

From the other – supply side – viewpoint, pricing is important to many market players. In addition to being useful for consumers, market research and mapping consumer behaviour provide effective information for companies, markets and policymakers. With a more sophisticated picture of the evaluation of a product, we can make more solid pricing decisions.

For many products on the drugs and vaccines market, information related to customer feedback is measured, analysed and used in real market situations. During the pandemic, the analysis of consumer perceptions regarding vaccines received special attention. Therefore, the pricing decisions of consumers can also be examined in the case of vaccines, where vaccine recipients could assign values to individual doses of vaccines. Solvent demand for COVID-19 vaccines was shown; however, the characteristics of this demand were not analysed in detail.

This research seeks to answer the question of whether and how the demand curves known from textbooks work for this specific market in the current circumstances of the pandemic in 2022. The properties of the demand curve are examined in detail, such as its slope, fit, elasticity and reservation price, with the goal of determining an optimal price level according to the level of demand on the market.

The product presented in our research is the next dose of a vaccine designed to combat or cure the effects of COVID-19. At the time of research, it was known that more doses of a vaccine from either the same type or a different one could be taken to avoid the infection more effectively. Most participants had already received two doses, but some of them (with chronic illnesses) had also received a third dose. Research papers cover, among other things, the interpretation of the concepts of willingness to pay and accept, the differences between them, and the conclusions drawn from the evaluations thereof. The value of the product, measured by an individual's willingness to pay for it, formed the base of our demand curve. All of this was embedded into the teaching of the subject, in the form of a classroom experiment.

In our survey, we measured the willingness of our subjects to pay for each dose of the COVID-19 vaccine and analysed the information related to the next available dose. We performed a regression analysis on the data obtained and examined which regression model fitted the data best. We also calculated the optimal market price for the vaccine based on price elasticity.

The following section will present the basic ideas behind the market demand curve based on consumers' willingness to pay in a theoretical market. This market should be considered special where the community has an interest in the government paying for the vaccines so that they become a public good. Then, in the literature review research on the demand and supply of COVID-19 vaccines, risk awareness and willingness to pay in different countries is presented, along with other factors affecting demand behaviour.

The remaining article is structured as follows: the process and the results of the

classroom experiment are presented along with the questionnaire. This is followed by the statistical analysis of the results, which show that a linear demand curve could well describe the situation, allowing for the calculation of the optimal market price. Then, we compare the theoretical price with real market conditions including the actual selling price of the vaccines to discern the viability thereof. The final section of the paper provides implications for policymakers and the limitations of the study.

1. Literature review

The classical model of mainstream economics broadly discusses the logic of market mechanisms and the relationship between supply and demand. The demand curve describes customer behaviour and can be used to determine how many goods consumers are able and willing to buy at different prices. This logic also applies to the price at which a buyer would be willing to buy a given quantity of a product.

In a simple economic model, where the demand curve is represented as d(p), the quantity demanded can be defined as a decreasing linear function of price (p): $d(p) = a - b \times p$, where a stands for the reservation price, b stands for the slope, and the slope b is higher than 0. Accordingly, the following equation can be used to calculate the market price: $0 \leq p \leq a/b$.

The simplest nonlinear (power) model is the isoelastic model. In this model, the demand function can be described as: $d(p) = a \times p^{-b}$, where $a > 0$ and $b > 1$ (Huang, 2013).

Holt (2019) writes broadly about the role of pricing in classroom experiments and has used his experiments in several studies to prove how the supply and demand sides of the market behave and how equilibrium is reached. The above is used to demonstrate how a simulated situation differs from a perfectly competitive model market. This model also derives the results obtained in the "usual" coordinate system, where it interprets the concepts of reservation price and consumer surplus. These concepts are taught by distinguishing between individual willingness to pay and individual surpluses, as well as between the reservation price and the consumer surplus interpreted for the entire market (Mankiw, 2011).

On the other side of the market, many retailers offer products with labels such as "compare at" or "original". This implies that the consumer would get a good deal if they bought that product. More and more substance are given to the reference price process; therefore, empirical studies and surveys are conducted to determine it effectively (Steckel, 2017). Transaction usefulness or reference result refers to the price that the buyers pay relative to the reference price. This is the market price value of the product, where the estimated reference price is defined by the individual. The most significant variable in this definition is fairness, which is mainly determined by the expected costs of the seller. Overall, the former depends on the perceived merits of the transaction and the latter depends on the value of the goods received in relation to the input (Kolnhofer-Derecskei, 2020). This research deals with the price of the next dose of the COVID-19 vaccine (without revealing the brands) to investigate our subjects' willingness to pay regardless of the supply.

The mainstream theory of pricing has been extensively studied by Friedman (2007). Based on his explanations, the focus of this article will be on pricing theory rather than monetary theory. The former is based on the allocation of scarce resources and presupposes a rational decision by market participants, whereas the latter deals with price levels generically, from a macroeconomic point of view. At an individual level, students' financial behaviours and rational behaviours can influence their economic decisions (Kálmán, 2021). Pricing problems have also been analysed in Kálmán's research. Some

studies have explored the relationship between inflation and pricing using a causal technique (Wale-Awe and Sulaiman, 2020).

In the traditional, mainstream economic theory, the demand curve reflects consumers' willingness to pay for different quantities of a product. The amount that individuals are willing to pay (i.e. the market reservation price resulting from their willingness to pay) minus the amount actually paid (i.e. the market price) is called consumer surplus. Consumer surplus is easily predictable, as it follows stable preferences and rational decisions.

The concepts of willingness to pay (WTP) and willingness to accept (WTA) can be evaluated in several areas. Greek researchers conducted a study on the issue of air quality and found that the government's estimates of welfare losses varied greatly with respect to the value measure (Vassilopoulos et al., 2020). It is now generally accepted that a consumer's willingness to accept is greater than their willingness to pay.

Researchers have proposed various theories on the reasons for this difference. For instance, according to Morrison (1998), the difference can be due to the literacy, substitutability, or inaccuracy of respondents. In their survey of a wide variety of commodities, Horowitz and McConnell (2002) found that the less a commodity is like an ordinary market commodity, the higher the difference between WTA and WTP. This ratio is highest for non-market goods and comparatively lower for private goods. It can also be said that the ratios found in real experiments do not differ greatly from hypothetical experiments. Around the same time, Zhao and Kling (2001) suggested that the difference between WTA and WTP may also be driven by the fact that uncertainty, irreversibility, and limited learning opportunities can lead to commitment costs.

Some researchers employed a random price auction in a cash experiment. The main reason for the difference between WTA and WTP, in this case, was that the parties involved in the experiment were reluctant to suffer a net loss on any transaction, whether buying or selling, and tended to consider the sale price well below the assumed market price. This was due to so-called loss avoidance (Brown, 2005).

Georgantzís and Navarro-Martinez (2010) interpreted the difference between the two propensities from a psychological perspective, using tools based on five psychological concepts: attitudes, feelings, good knowledge of the goal, risk attitudes, and personality. The results of their research provide insight into the psychological underpinnings of the differences between the two concepts.

The difference between WTP and WTA is also revealed in the case of health care. Data from a study by Whynes and Sach (2007) showed that the types of responses differed between the two evaluation approaches. In particular, the presumption of the substitutability of the health intervention was an obstacle to the performance of the WTA task when compared to the WTP.

Behavioural economics also points to the limitedness of rationality. Kahneman and Tversky (1979) pointed out that the manner of communication could modify people's decisions; therefore, it matters how we formulate our messages. By following their results, behavioural sciences show the importance of understanding people's decisions in order to be able to predict or have an influence on their health maintenance decisions. Others use well-validated methods from behavioural economics as discounting and demand frameworks (Strickland et al., 2022).

As the long-term effectiveness of the COVID-19 vaccine is not known, the internationally published short-term results were accepted for our research. The necessity of vaccination was highly debated in the media; however, no previous information about this subject was shared with the subjects, to avoid the anchoring effect.

Sroka et al. (2020) focused on the pricing mechanism while studying people's buying decisions. According to their study, participant reactions were affected by discounted prices. According to the participants, price determination of pharmaceuticals is based on their quality. They believed that the higher the price, the better the quality of the product. Sun (2020) developed an alternative approach to estimating consumer behaviour by considering the WTP model as a basis for the creation of a general demand function.

The consumer behaviour of different groups is also examined in detail: the elasticity of demand depends significantly, and nonlinearly, on the severity of consumers' poverty (Jensen and Miller, 2008). According to Lichtenstein et al. (1988), there is a positive relationship between the level of acceptability of price and the width of the latitude of price acceptance. Thaler (1983) studied why individuals are sometimes reluctant to buy or sell a particular product at a particular price, and why they find maximising the profit of sellers is at a lower cost than the market equilibrium price. Firms should be aware of market demand when they make decisions about the sustainability of their organisation, as consumer behaviour has a huge effect on all three dimensions of the financial condition: profitability, liquidity, and financial stability (Shpak et al., 2022).

Consumer choices are influenced not only by the initial price but also by the change in price. The perceived fairness of price increases when the compatibility of cost and price increases; as such, adjustable price rises are considered more acceptable than non-adjustable price rises (Bolton and Alba, 2006). Goods purchased in advance are typically treated as an investment rather than an expense. Based on this, vaccination could be seen as an investment in one's future health; in this way, it saves the patients money, effort, and time. However, the consumption of goods previously purchased and used as intended is often coded as free goods (Thaler and Schafir, 2006).

Moreover, price elasticity may also be a determinant factor of the demand for a product, as it shows how consumption changes when the price is modified, as well as describing the demand for a commodity in numerical terms. When price elasticity is high, the change in demand in response to a slight change in price is massive (Fibich et al., 2005). In an extended experimental study performed in the USA between 2008 and 2014 (Ellis et al., 2017), it was observed that the demand for health care and the demand for drugs was highly elastic (-0.44), which confirmed the RCT's RAND Health Insurance Experiment's results for 6000 individuals (Aviva et al., 2013). On the other hand, Lázár (2011), among others, stated that the price elasticity of demand (PED) cannot always be described by a single number. When the demand curve is linear, the elasticity varies along the curve. When the demand curve is determined by a formula with power projection, the elasticity is fixed. The price elasticity of pharmaceuticals is important when the market is described by cost-sharing, i.e. the state or insurance companies pay for a certain share of the products (Chernew et al., 2008). In this research, the price of vaccines was fully paid by the state because of the seriousness of the pandemic; however, as the pandemic winds down, the vaccine might be domesticated into a market product.

Another important factor in the demand for a good that is worth observing is the price of the commodity, which is usually determined by the producers. The decision about the price should be supported by market analysis as well as cost analysis, among other things. Ahmetoglu et al. (2014) reviewed six pricing strategies by means of empirical research, which included drip pricing, reference pricing, using the word 'free', bait pricing, bundling, and time-limited offers.

The first three had a significant impact on consumer behaviour; the remaining three also influenced consumer decisions, but a sufficiently thorough examination of this phenomenon was not conducted.

Lu and Comanor (1998) found that the price of a new, innovative drug is much higher than similar drugs in the market. This difference could result from the significance and the innovativeness of said drug, the number of branded or generic substitutes available, or the type of illness. Consequently, this initial price could fall after the introductory period as new substitutes appear.

It was also observed that the final price of a product in the pharmaceutical industry includes substantial R&D and marketing costs; however, because it is partly or completely financed through some form of insurance, the processes of the free market do not always work (Cabrales and Jiménez-Martín, 2013). Market conditions can also be modified by price control by governments, rate of return regulations, or administrative barriers (Ballance et al., 1992; Scherer, 2000). Nevertheless, this does not mean that the regulations are economically inefficient (Cabrales and Jiménez-Martín, 2013). On the other hand, however, price settings could limit competition (Danzon and Chao, 2000) and obstruct small innovations (Ganuza et al., 2009). They could also result in drugs reaching fewer markets with longer delays (Kyle, 2007).

In addition to the above, the price of pharmaceuticals is also determined by the number of competitors (Ellison et al., 1997). In the case of COVID-19 vaccines, the supply was limited despite the availability of multiple vaccine brands. However, the fact that other price determinants were unknown in this field (Schweitzer and Lu, 2018) and repeated purchases were possible only if the demand for the first dose was almost fulfilled should also be taken into consideration. Moreover, the required number of repeated dosages of the vaccine was not clear at that point in time. Additionally, the number of competitors changed as new entrants appeared on the market and others disappeared because of unforeseen problems and unpredictable side effects due to the vaccine.

A demand curve reflects the connection between the price and demand of a good. It was first published by Alfred Marshall in the Principles of Economics and is one of the fundamental notions of economics (Klein, 1973). This tool could easily describe market demand using the ceteris paribus assumption, wherein it is assumed that other variables do not change. In this paper, the market conditions do not change because the empirical research was conducted within a single week, and this period can be treated as a stable, static situation. In other words, the spread of the COVID-19 virus was constant.

This research was implemented in unique circumstances as the pandemic has had several negative consequences on the economy as well as society as a whole. Among other things, financial difficulties have increased, and many people have lost their jobs. Shopping habits have changed; people now have access to many products online (Kitukutha et al., 2021). The pandemic has also affected buying behaviour. Most businesses faced new challenges that forced them to take varying measures to sell their products (Kažmierska-Jóźwiak et al., 2021). The effects of the pandemic were also observed in higher education; for instance, the use of digital solutions came to the fore. Universities looked for efficient solutions that could make education more effective (Yamoah and Haque, 2022). Closures and online teaching certainly seemed inadequate. A vaccine was one of the means of preventing and halting the spread of COVID-19. However, confidence in vaccination was not the same for everyone. Therefore, it is also important to analyse how people felt about vaccines (Kozlovskyi et al., 2021).

Because of the rapid spread of mutations of the virus and the high level of contagiousness, public funding to corporations supported all stages of vaccine development, including research, development, testing, and manufacturing. Companies kept the manufacturing costs for all vaccines hidden, similar to what they do with prices, and only a few independent studies have thoroughly investigated these facts (Light and Lexchin, 2021). The World Health Organization reports that the COVID-19 vaccine is being developed at an unprecedented rate. To meet demand and guarantee that each manufacturer earns the desired profit, the government may bargain over prices with the manufacturers to keep public sector costs as low as is feasible. The spread of COVID-19 was soon countered by the development of vaccines (Martonosi et al., 2021). People may have had a strong incentive to purchase a vaccine due to this circumstance. In this case, the high WTP value offers a chance to develop public health strategy. Governments can offer the vaccination to low-income groups for free while allowing people with higher incomes to pay for it in the private sector (Cerda and Leidy, 2021). Despite the significant socioeconomic impact, potential patients would pay the same price for a perfect vaccination programme against COVID-19 as they would for current vaccine programmes (Berghea et al., 2020).

Increased hesitation amongst the general public was a result of several factors, including a negative opinion of vaccine efficacy, safety, affordability, and convenience. Increased scepticism about the vaccine in many socio-demographic groups was observed, such as women; younger participants; people with lower levels of education, poor incomes, no insurance or residing in rural areas; and those identifying as members of racial or ethnic minorities (Cascini et al., 2021).

There was a significant difference in the gender, age, income, occupation, educational background, and place of residence of the subjects; this could have affected their general intention to be vaccinated. Vaccination intentions were, however, more often influenced by the vaccination of family members and friends. The better people understood the pandemic, the stronger their intention to get vaccinated (Peng et al., 2022).

Research from all over the world showed increased attention being paid to the determinants of vaccine demand. Chinese research showed that COVID-19 vaccination subsidies and effective health communication are required to increase vaccine confidence. The number of people who would receive the COVID-19 vaccine without question fell by 20% when they were told they had to pay for it, compared to it being provided for free (Wong et al., 2020). In Brazil, researchers found that price setting of vaccines may benefit from the knowledge regarding customers' WTP for a hypothetical vaccine against SARS-CoV-2 (Dias-Godói et al., 2022). In Australia, findings indicated that preferences for mild adverse cases, administration method, administration site, cost, and effectiveness were diverse (Borriello et al., 2021). In Ecuador, a regression analysis of the WTP for the vaccine was correlated with income, employment status, perceived likelihood of requiring hospitalisation in case of COVID-19 infection, and geographic region of residence (Sarasty et al., 2020).

Tsutsui (2021) examines how Japanese citizens perceived the severity of and likelihood of contracting the coronavirus illness, as well as how these perceptions and attitudes towards the risk of infection affected their willingness to purchase a fictitious vaccination. As risk aversion improved during the observed period, people's willingness to purchase the vaccine increased; however, misleading beliefs and fear were identified as factors that could have possibly moderated their WTP levels. Catma and Varol (2021) tried to estimate individual willingness to pay for the COVID-19 vaccine in the United States. People's WTP values were related to income,

the perceived risk of the virus, and whether a member of the household was already infected. The effectiveness of the vaccine and the duration of protection were also shown to be important factors.

Furthermore, parents' opinions about the COVID-19 vaccine, including their WTP choices for both themselves and their children, were also observed. In this study, children were discovered to have a higher WTP, and a clear correlation was established between the number of children and WTP (Catma and Varol, 2021). Carpio et al. (2021) asked U.S. respondents about their confidence in vaccination and concluded that 88% of the population would accept the COVID-19 vaccine. It was also concluded that payments of approximately US$500 or more would be needed to adequately incentivise at least 50% of those who had already received some level of vaccination.

An online randomised trial assessed attitudes towards the coronavirus vaccines in the United States by examining participants' willingness to pay for and/or accept the vaccines. The researchers concluded that reluctant citizens can usually be persuaded to seek vaccination with the help of financial incentives, and an incentive payment of US$1000 can increase vaccine uptake to as much as 86.9%. Those who refuse vaccination generally think the disease is not severe enough, do not have a great deal of trust in the public health system, and are older (Iyer et al., 2022). In Bangladesh in 2019, similar research showed high demand for a hypothetical vaccine to cure dengue fever, which also causes severe symptoms in infected individuals (Kabir et al., 2011). Others argue that from the public health viewpoint, the focus should be on equal access to COVID-19 vaccination to ensure a high vaccination rate and to offer an efficient and ideal financing approach (Wang et al., 2021).

The capability, opportunity, and motivation-behaviour (COM-B) model was used by Liu and Liu (2021) to undertake a theory-based text analysis on Twitter to identify the variables impacting behavioural intentions toward COVID-19 vaccination. 97 tweets reflected constructive behavioural intent while 182 tweets revealed a destructive behavioural goal. In terms of any potential negative effects of fees on vaccination uptake, particularly among individuals who are willing to pay, it was found that those who were ready to pay could also choose not to give money for the vaccine in case the fees were tied to income (Sprengholz and Betsch, 2021). Another study showed that the manufacturer of the vaccine could also influence the level of confidence in vaccination (Lin et al., 2020).

As indicated in the previous section, the price of a drug should not be considered the only contributing factor to demand, and it is equally important to examine whether the price of the given drug is comparable to the income of the patients (Han et al., 2021). The necessity of the product is a determinant of its demand. During the period under examination, i.e. the autumn of 2021, the death rate of COVID-19 patients was relatively high in Hungary, with approximately 50 people dying of COVID-19 every day (Miniszterelnöki Kabinetiroda, 2021). As it was the leading news item on a daily basis, concerns about it also increased. Consequently, anxiety among people expanded, which could have affected the rationality of their choices (Holmes et al., 2020).

When exploring the consumption demand for drugs, it is supposed that the exponential curve should be used as proposed by Hursh and Silberberg (2008), who aimed to scale the strength on the basis of demand. However, the demand function in this article need not be normalised (Hursh and Winger, 1995), as the dosage and the effectiveness of vaccination are supposed to be equal and fixed. Unlike the research conducted by Newman and Ferrario (2020), this paper shows the demand for vaccines from real people, and the price of the vaccine is expressed in Hungarian forint,

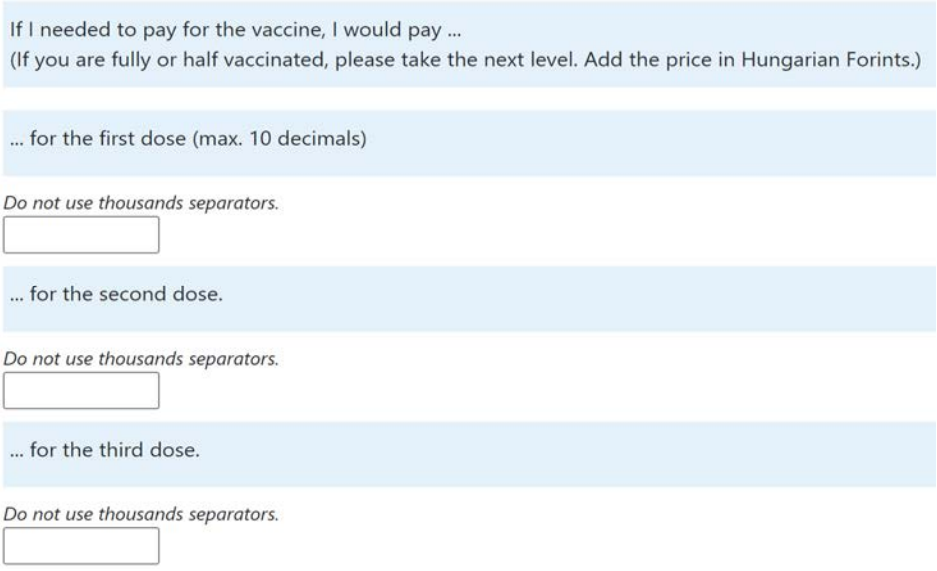
2. Methodology

This research aims to investigate how individually measured WTPs can be interpreted as a possible demand curve for the COVID-19 vaccine market. The data was collected through an online survey on the Moodle platform. In the first step, a literature review was carried out to generate the research tools to be used in this paper and direct the survey questions. Validated questions from the literature were adapted and a pilot version of the questionnaire was checked by language experts (as some questions were translated from English) and economists.

Our survey, based on Sasaki et al.'s (2022) preliminary results, focused on measuring the participants' WTP in order to explore the market of the vaccine. Various techniques to measure consumers' WTPs have been detailed in research by Miller et al. (2011) and McDougall et al. (2020); from these techniques we used a simple direct method, as detailed below.

Sasaki et al. (2022) defined WTP as the midpoint of the amounts around the switching point (a switching point means each border of a measurement class), which lies in the middle of each measurement class. By contrast, we used a simple direct measurement instrument known as contingent valuation. This method is easy to use and rooted in simplicity, wherein consumers are directly asked about their WTP for a certain product or service. The strength of this approach is its effectiveness in terms of time and cost, while its weaknesses are based on the hypothetical nature of the technique. In this study, based on the direct method of contingent valuation, the subjects were simply asked about their WTP for the ongoing COVID-19 vaccine dose ("what do you want to pay for your next vaccination?"). This means that our primary outcome was the participants' WTP for the next available dose. The WTP for the next real vaccination depending on the number of doses was investigated (Figure 1).

Figure 1. Screenshot from the survey



Source: own elaboration

There are not just various 'types' of validities, but also different procedures to assess them as well. In our case, the results were measured on a ratio scale expressed in Hungarian currency. Therefore, the criterion validity was checked across the two (not detailed in this paper) parts of the survey (which also shows internal consistency) because it is the extent to which scores on a measure correlate with other variables or criteria.

The criteria of validity was another WTP for a possible hypothetical pill. In this study, however, we concentrated only on the possible market for the available vaccine, while Kolnhofer-Derecskei and Csongrádi (2022) investigated WTP for a hypothetical pill offered using different wording (detailed in: Kolnhofer-Derecskei and Csongrádi, 2022). Test-retest correlation between the two sets of scores was calculated using Pearson correlation. Results from the test showed an extremely strong significant correlation ($N = 268$, $r = 1.00$, $p < 0.0001$) between the scores, which proved the validity and reliability of the measurement tool.

The questionnaire was completed by students from the Faculty of Finance and Accounting at Budapest Business School in the autumn semester of the 2021/2022 academic year. The participants were selected randomly and participated in the study anonymously and voluntarily.

At the time of the study, according to the Hungarian National Bank, the official exchange rate was approximately 360 HUF = 1 EUR (MNB, 2021a), and inflation was 6.5% (MNB, 221b). All ethical and GDPR protocols were properly followed. The average age of the participants was 19.71 years (the range was 17 years). A total of 214 men and 131 women participated in the study. No significant differences were observed between the responses of the two genders.

In this article, we only investigated questions that covered the individually priced vaccines. Other parts of the survey were widely studied and presented by Kolnhofer-Derecskei and Csongrádi (2022) and Kolnhofer-Derecskei et al. (2022). The data were evaluated using MS Excel software, and the calculations were checked using SPSS.

3. Research results

Several pricing methods exist for calculating the prices of products; from among these, we explored the demand-based pricing method, along with the customer-driven method. Our prior research concluded that several factors influenced subjects' WTP; we also found that the use of different kinds of wording to present the same product could have an impact on people's WTP (Kolnhofer-Derecskei and Csongrádi, 2022). Other marketing tools may also have a severe effect on pricing including buyers' reactions and reference price information. Because the vaccines are in the early stage of the product life cycle, various brands cannot be compared effectively. Moreover, because these vaccines are offered for free, psychological effects such as the anchoring effect can be eliminated. We measured our results using the direct method of contingent valuation; therefore, the results reflect the real price evaluations of our target group.

We studied the participants' expressed WTPs for all three doses of a vaccine (regardless of the brand). We asked for participants' WTP for each dose (i.e., the first, second, and third), but in some cases, the first and second measurements only served validation purposes. 16 participants only answered for the first dose, based on which it was assumed that they were not vaccinated at all. Nine participants answered only for the second dose, which gave the impression that, at the time, they had only received their first dose. A total of 104 subjects (28.45%) expressed a WTP of 0 HUF for any doses, which showed that they could not be considered potential and reasonable paying buyers of the vaccine; this does not, of course, mean

that they would not accept vaccination for free. Finally, seven meaningless or missing answers were observed in the responses and sorted out from the total. Around two-thirds of the sample would pay for the vaccine or accept it for a certain fee. The next question was what price would be optimal.

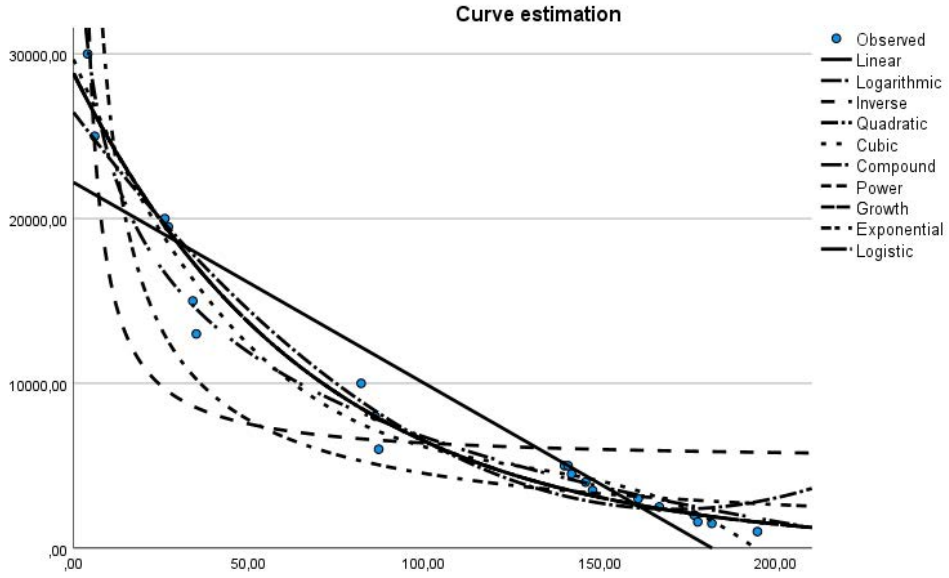
Regarding the respondents who answered all questions (although the instructions directly referred to the missing or next available vaccine), 30 participants followed a descending pricing strategy, while three participants had an ascending pricing strategy. In addition, 24 participants followed a level-headed and balanced pricing strategy. This observation may be thought-provoking if we look at the mean price of each dose, which was 5697.90 HUF (standard deviation of 11,190.62 HUF) for the first dose, 4666.42 HUF (standard deviation of 6466.58 HUF) for the second, and 10,580.00 HUF (standard deviation of 35,845.90 HUF) for the third. Although three options were presented (at that time, the fourth dose was not available, and the booster was available only for vulnerable, high-risk people), in this paper, we observe only the merged market and do so using deeper regression analysis.

This paper aims to investigate the possible market for the COVID-19 vaccine, where each consumer wishes to purchase the next required dose (regardless of how many vaccinations they have received), thereby creating an effective demand for the vaccine. Consequently, a merged demand curve must be defined, whereby every possible valid WTP counts. In every case where double or triple WTPs were listed, the last WTP was selected independent of the former value(s).

In the end, 227 responses were analysed as detailed below. The prices given (i.e. the WTP values) ranged from 50 HUF to 9,999,999,999 HUF. The greatest number reasoned with the importance of vaccines by the respondent. The mean is 44,067,639.4 HUF. The median and mode are equal at 5000 HUF, and the standard deviation is 663,722,327.66967 HUF. Due to the ambiguous result, the dataset was cleaned. First, the highest value had to be sorted out. Second, extreme outlier values were filtered out when the value was greater than Q3–1.5 (Q3–Q1), where Q1 is the lower quartile with a value of 3000 and Q3 is the upper quartile with a value of 10,000 HUF. Based on this, values above 31,000 HUF were filtered out (15 cases). Although vaccines are available free of charge, we focused only on the possible hypothetical market for the vaccines; as such, vaccine prices under 1000 HUF were filtered out (16 cases) as well. This resulted in a total of 195 valuable responses.

From the individual WTPs, cumulative demanded quantities can be calculated (Vassilopoulos et al., 2020). Due to the economic basement, we know that the two variables, the market price (y axis) and quantity demanded (x axis), are strongly related to each other; thus, regression analysis can be conducted.

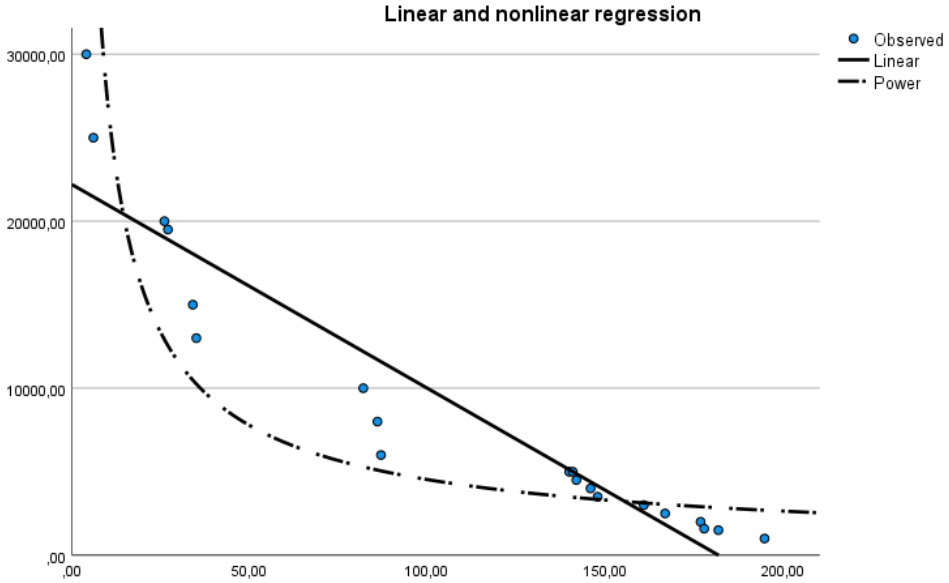
Figure 2. Fitted demand curves to the WTPs and cumulative demand



Source: own elaboration

Several regression models were created as presented in Figure 2 where the x axis indicates Q (quantity) and the y axis refers to P (price). However, the study focuses only on two economically relevant (i.e. accepted in the mainstream economy) models (Hursh and Silberberg, 2008): (1) the linear function and (2) the nonlinear power function, where the latter can be adjusted into linear equations. Following the regression procedures, two regression lines were drawn, and graphical representations were determined. Comparing the two relevant options, the following lines can be fitted to the expressed demands (Figure 3).

Figure 3. Fitted linear and nonlinear demand curves to the WTPs and cumulative demand



Source: own elaboration

Comparing these two alternatives, Table 1 provides a detailed statistical description.

Table 1. Elaboration of the two selected demand curves

Function	beta 0 (constant intercept)	beta 1 (slope)	R	R square	adjusted R square	F Sig.
Linear	22194.333	-121.903	0.934	0.872	0.865	122.613 Sig. 0.000
Power	162739.268	-0.778	0.886	0.785	0.774	65.886 Sig. 0.000

Source: own elaboration

The nonlinear or power demand curve is also known as the constant elasticity demand function, wherein if the dependent variable q is the quantity demanded, and p is the price (independent variable), they are related by $log(q) = 162739.268 - 0.778\ log(p)$. This means that the price elasticity of demand is -0.778. A 1% increase in price leads to an approximate fall of 0.778 in the quantity demanded. Consequently, several optimum prices can be defined. However, the constant parameter of this function is problematic and cannot be clearly interpreted.

The linear function model seemingly fits better (as proven by a higher R square value) than the power function, so we continued our evaluation with the former.

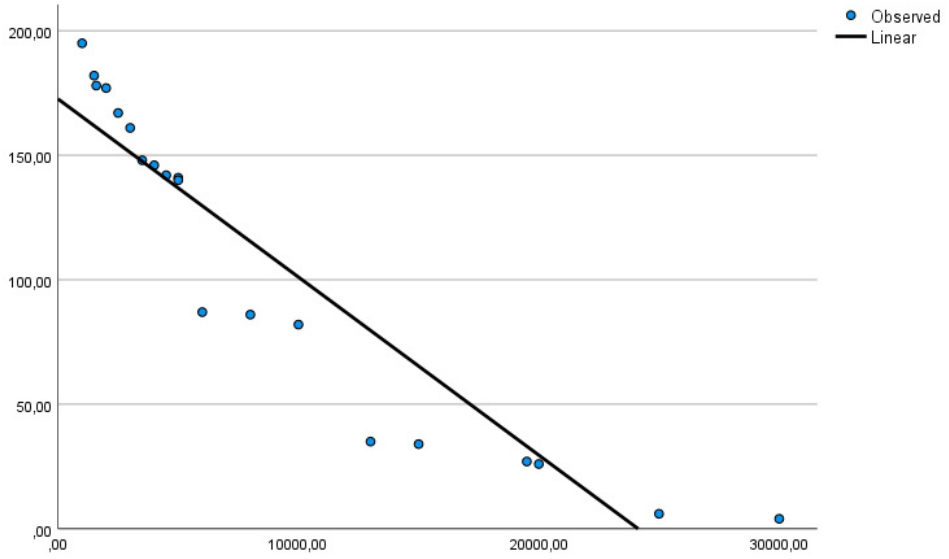
The final regression equation can be set up as follows: $\hat{Q} = 22194.333\text{-}121.903 \times P$, where $\hat{Q}$ is the estimated demand for the vaccine and P is the market price. The constant y-intercept coefficient (22,194.333) is the estimated expected value of the dependent variable when the independent variable is equal to zero. Here, it can be zero, but since we limited the market price to 31,000 HUF, this value is less. The slope is approximately -122, which suggests that each additional decrement of 122 HUF in the vaccine price would result in an additional vaccine request.

Regarding the reliability of the model, the sample coefficient of determination indicates that approximately 87% of the total variation in the demand is explained by, or due to, the market price, while 13% remains unexplained. Both parameters show significant test statistics. This is sufficient evidence to infer that a linear relationship exists between price and demand.

Based on Lázár (2009, 2010, 2011), various demand curves were fitted to the expressed WTPs and price elasticities were calculated. Knowing the price elasticity coefficient allows us to assess the so-called optimum price along with maximising the revenue. According to Lázár (2011), we can earn the optimum price from the maximum point of the total revenue function, where the price elasticity equals -1.

Therefore, the optimum price level was calculated. Taking the inverse of the demand curve with relative frequencies, the following function can be obtained (Figure 4) and defined as follows: $\hat{Y} = 172.610\text{-}0.007 \times X$

Figure 4. The inverse curve with relative cumulative frequencies



Source: own elaboration

As Lázár (2011) argued, the optimum market price can be estimated based on the

$$p_{OPT} = -\frac{beta\ 0}{2 \times beta\ 1}$$

where p_{OPT} symbolises the optimum price and the betas are parameters of the adjusted model. The optimum market price can be expressed with the following formula: regression model (beta 0 is the intercept and beta 1 is the slope).

In our case, the optimum market price is

$$p_{OPT} = -\frac{beta\,0}{2 \times beta\,1} = -\frac{172.610}{2 \times (-0.007)} = 12329.2857 \text{ HUF},$$

and consequently, the optimum price level is 12,329.2857 HUF per dose.

Based on our findings, we can conclude that the optimum price level for the next vaccine dose, tailored to the targeted subpopulation, was around 12,500 HUF at the time of research. Those who state a higher value will be likely to express a higher WTP. A higher WTP indicated better acceptability or greater willingness to receive the next vaccination in the context of the circumstances surrounding the COVID-19 pandemic (Cardella et al., 2021). However, the subjects hereby indicate their willingness to pay without directly purchasing or paying that price for the product, nor do they receive the product at that or any other price.

Based on another preliminary study conducted by the Budapest Business School, we realised that students were vaccinated at a high rate. We asked our sample about their vaccination acceptancy as follows: "On a scale from 0 to 10, where 0 means not at all and 10 means completely, how many of your close friends and relatives are vaccinated?" The result of this question was promising, with a mean of 8.2144 and a standard deviation of 1.6828. Thus, the targeted subpopulation may be a solvent demand for the vaccine.

4. Discussion

In this study, consumer pricing decisions are analysed at a micro-level, where individual WTPs are aggregated into the demand function (Huang et al., 2013). Regardless of other marketing functions, we focused only on the pricing of the next available dose. Several exponential demand functions were formulated to describe the proportion of participants pricing the vaccine for various promotional scenarios. Our research revealed a linear regression.

Based on our results, the received elasticity level of the COVID-19 vaccines was higher in absolute value than what Ellis (2017) found in the case of pharmaceuticals. This, however, could also be the result of a specific feature of the examined population. Since price discrimination differentiates between consumers based on their sensitivity to price (Borenstein, 1985), students are supposed to have a higher price elasticity than society. Alternatively, the fact that this kind of vaccination was available for free may also explain the high result.

Chinese research which revealed a relatively high willingness to receive the vaccine was observed when the most reasonable price range for the COVID-19 vaccine was US$75–149 (Zhang et al., 2021). According to UNICEF (2021), the reported prices per dose of COVID-19 vaccine are between US$19.90 and US$36, with an average mean of US$27.95 in Hungary. Our calculated optimum price, which amounted to 12,330 HUF (approximately US$33.69 at that time), therefore fits the supply, although it is well below the optimal Chinese price range. When we go into the details of the prices of real vaccines used in Hungary, the following prices were realised (Table 2):

Table 2. The real price of various COVID-19 vaccines

Vaccine	Pfizer/BIONTECH	Moderna	J&J	AstraZeneca	Sputnik V	Sinopharm*
price/dose	$19.5	$25-$37	$10	$3-$4	$10	$36

Source: Biospace and New York Times

It should be stated that there was significant variability in the real prices of the vaccines because different governments received these doses at different prices. Moreover, the prices changed over time (Terry, 2021). The data in Table 2 can help to gain an overall picture of the supply in the market. The price of a dose starts at around $3, which is affordable for most citizens. Only the price of the Chinese vaccine (Sinopharm) was higher than the optimal price calculated in our research, so the market would not be narrowed down in the face of real prices. It should be noted that these are wholesale prices, as these vaccines were not sold directly to consumers. As such, no intermediaries were required; therefore, the pricing margins have not been considered.

In this model, the vaccines are not distinguished and neither their effectiveness nor their side effects are shown; moreover, only one type of injection (as we labelled it in the questionnaire: the next dose) was possible.

In the book Predictably Irrational, Ariely (2010) described an experiment in which a new painkiller called Veladone-R (which contains only Vitamin C) was priced differently. In the first case, the dose was priced at US$2.50, while in the second case, it was priced at only US$0.10. Surprisingly, the participants experienced a better effect when the price was higher. At $2.50, almost all subjects reported pain relief from the pill, as opposed to only half of the sample when the price was lowered to 10 cents. Earlier, Shiv et al. (2005) tested the so-called placebo effect using energy drinks and demonstrated how pricing can impact the actual efficacy of products. Berns (2005) later questioned their findings and underlined that these decisions happened unconsciously. He found that the influence was strongest when participants' expectation was nonconscious; therefore, the human mind should answer differently as suggested.

Plassmann and Weber (2015) took a novel, automated structural brain imaging (interdisciplinary consumer neuroscience) approach to determine individual differences and combine this approach with traditional behavioural experiments. They argued that some consumers are more responsive to marketing placebo effects than others. The question is whether the same process can be observed in the case of vaccines.

In sum, we think that well-targeted specific communication and conscious pricing can successfully promote a vaccination campaign during the current pandemic. Vaccination is a medical procedure which has—in ideal circumstances—well-defined risks and where the medical decisions made by individuals could be influenced by many other factors. In this decision, one rather important detail might be the price of the vaccines.

It is always challenging to attempt to collect the best sample that perfectly represents the target population. In addition, several concerns exist when using student samples in a laboratory or during experimental research (Druckman and Kam, 2009). We treated the sample as the potential new generation of vaccine buyers, who are at an age (young adulthood) when they can make financial decisions on their own, who have already understood the value of money, and bear the necessary information about the entire situation of the COVID-19 pandemic.

Additionally, to urgently control the rapidly spreading virus, governments have called on the public to actively participate in vaccination drives and offered (or, in some places, forced) free vaccinations. The real value of free items is often considered dubious. Shampanier et al. (2007) investigated the behavioural economical influence of zero pricing and demonstrated its unique properties, although the observed products in their experiments were relatively cheap and unimportant (such as chocolate bonbons). In the case of vaccines, their relevance and the consequences of the pandemic cannot be compared to sweets. When individuals have the option of choosing from several

available products, they tend to choose the option with the highest cost-benefit difference. However, choices in terms of free products may be different because people perceive that free products have higher benefits (Shampanier et al., 2007).

Conclusions

The research showed what consumers' willingness to pay for a given product looked like under a very specific market condition. It also showed that the well-known correlation between price and quantity exists in a hypothetical market as well. Among different types of demand curves, the linear curve was able to show a theoretical maximal price in the given market and an optimal price which was higher than the prices used by most pharmaceutical companies for the given commodity. The power type demand function, on the other hand, showed a constant value for elasticity, which describes a high and negative correlation between price of the vaccine and the quantity demanded. These results can illustrate to our students how a real market, and especially this market, operates. Moreover, economists and market experts could gain useful insight into demand for the COVID-19 vaccine among young people.

The results show that while the government forced people to get vaccinated and offered the dosages for free, rational young adults assessed the threat of the disease, and may have been willing to pay for the same treatment to protect their health and that of their relatives. Moreover, considering Ariely's (2010) results, a non-zero price could have increased the effectiveness of the vaccines.

Due to our homogenous sample, only gender differences were investigated; however, the investigation did not reveal any significant deviations. Whether there are any differentiations between heterogeneous samples in terms of socio-economic factors could be an interesting aspect to be analysed. Another problem with a simple single sample (i.e. one where the participants are usually college students) is that the validation can limit the generalisability of the findings. Therefore, future researchers may wish to conduct cross-validation studies.

The authors deem it worth mentioning that the pharmaceutical market is highly concentrated on both the supply and demand sides, which can modify the results. The value of the WTP may also change due to differences between countries, as seen from the fact that, in Hungary, the medicine turnover is quite large in comparison to the population. This difference can be the basis for further research and practical implementation on real markets.

References

Ahmetoglu, G., Furnham, A., Fagan, P. (2014), Pricing practices: A critical review of their effects on consumer perceptions and behaviour, Journal of Retailing and Consumer Services, 21(5), 696–707. DOI: 10.1016/j.jretconser.2014.04.013.

Ariely, D. (2010), Predictably Irrational: The Hidden Forces That Shape Our Decisions, New York: Harper Collins.

Aviva, A., Einav, L., Finkelstein, A. (2013), The RAND Health Insurance Experiment, Three Decades Later, Journal of Economic Perspectives, 27(1), 197–222. DOI: 10.1257/jep.27.1.197.

Ballance, R., Pogány, J., Forstner, H. (1992), The World's Pharmaceutical Industries, Aldershot: Edward Elgar Publishing Ltd.

Berghea, F., Berghea, C.E., Abobului, M., Vlad, V.M. (2020), Willingness to pay for a for a potential vaccine against SARS-CoV-2/COVID-19 among adult persons, Human Vaccines & Immunotherapeutics 16(12), 3074–3080. DOI: 10.21203/rs.3.rs-32595/v1.

Berns, G.S. (2005), Price, Placebo, and the Brain, Journal of Marketing Research, 42(4), 399–400. DOI: 10.1509/jmkr.2005.42.4.399.

Bolton, L.E., Alba, J.W. (2006), Price Fairness: Good and Service Differences and the Role of Vendor Costs, Journal of Consumer Research, 33, 258–265. DOI: 10.1086/506306.

Borenstein, S. (1985), Price Discrimination in Free-Entry Markets, The RAND Journal of Economics, 16(3), 380–397. DOI: 10.2307/2555565.

Borriello, A., Master, D., Pellegrini, A., Rose, J.M. (2021), Preferences for a COVID-19 vaccine in Australia, Vaccine, 39(3), 473–479. DOI: 10.1016/j.vaccine.2020.12.032.

Brown, T.C. (2005), Loss aversion without the endowment effect, and other explanations for the WTA-WTP disparity, Journal of Economic Behavior & Organization, 57(3), 367–379. DOI: 10.1016/j.jebo.2003.10.010.

Cabrales, A., Jiménez-Martín, S. (2013), The determinants of pricing in pharmaceuticals: are US prices really so high?, Health economics, 22(11), 1377–1397. DOI: 10.1002/hec.2887.

Cardella, G.M., Hernández-Sánchez, B.R., Sánchez-García, J.C. (2021), Development and validation of a scale to evaluate students' future impact perception related to the coronavirus pandemic (C-19FIPS), PloS ONE, 16(11), e0260248. DOI: 10.1371/journal.pone.0260248.

Carpio, C.E., Coman, I.A., Sarasty, O., Gracía, M. (2021), COVID-19 vaccine demand and financial incentives, Applied Health Economics and Health Policy, 19(6), 871–883. DOI: 10.1007/s40258-021-00687-9.

Cascini, F., Pantovic, A., Al-Ajlouni, Y., Failla, G., Ricciardi, W. (2021), Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review, EClinicalMedicine, 40, 101113. DOI: 10.1016/j.eclinm.2021.101113.

Catma, S., Varol, S. (2021), Willingness to pay for a hypothetical COVID-19 vaccine in the United States: A contingent valuation approach, Vaccines, 9(4), 318. DOI: 10.3390/vaccines9040318.

Cerda, A.A., Leidy Y.G. (2021), Willingness to pay for a COVID-19 vaccine, Applied Health Economics and Health Policy, 19(3), 343–351. DOI: 10.1007/s40258-021-00644-6.

Chernew, M., Gibson, T.B., Yu-Isenberg, K., Sokol, M.C., Rosen, A.B., Fendrick, A.M. (2008), Effects of increased patient cost sharing on socioeconomic disparities in health care, Journal of General Internal Medicine, 23(8), 1131–1136. DOI: 10.1007/s11606-008-0614-0.

Danzon, P.M., Chao, L.W. (2000), Does regulation drive out competition in pharmaceutical markets?, Journal of Law and Economics, 43, 311–357. DOI: 10.1086/467458.

Dias-Godói, I.P., Tadeu Rocha Sarmento, T., Afonso Reis, E., Peres Gargano, L., Godman, B., de Assis Acurcio, F., Alvares-Teodoro, J., Guerra Júnior, A.A., Mariano Ruas, C. (2022), Acceptability and willingness to pay for a hypothetical vaccine against SARS CoV-2 by the Brazilian consumer: A cross-sectional study and the implications, Expert Review of Pharmacoeconomics & Outcomes Research, 22(1), 119–129. DOI: 10.1080/14737167.2021.1931128.

Druckman, J.N., Kam, C.D. (2009), Students as experimental participants: A defense of the "Narrow Data Base.". DOI: 10.2139/ssrn.1498843.

Ellis, R.P., Martins, B., Zhu, W. (2017), Health care demand elasticities by type of service, Journal of Health Economics, 55, 232–243. DOI: 10.1016/j.jhealeco.2017.07.007.

Ellison, S.F., Cockburn, I., Griliches, Z., Hausman, J. (1997), Characteristics of demand for pharmaceutical products: An examination of four cephalosporins, The Rand Journal Of Economics, 28(3), 426–446. DOI: 10.2307/2556023.

Fibich, G., Gavious, A., Lowengart, O. (2005), The dynamics of price elasticity of demand in the presence of reference price effects, Journal of the Academy of Marketing Science, 33(1), 66–78. DOI: 10.1177/0092070304267108.

Friedman, M. (2007), Price Theory, London: Routledge.

Ganuza, J.-J., Llobet, G., Domínguez, B. (2009), R&D in the pharmaceutical industry: A world of small innovations, Management Science, 55(4), 539–551. http://www.jstor.org/stable/40539168.

Georgantzís, N., Navarro-Martínez, D. (2010), Understanding the WTA–WTP gap: Attitudes, feelings, uncertainty and personality, Journal of Economic Psychology, 31(6), 895–907. DOI: 10.1016/j.joep.2010.07.004.

Han, K., Francis, M. R., Zhang, R., Wang, Q., Xia, A., Lu, L., Yang, B., Hou, Z. (2021), Confidence, acceptance and willingness to pay for the COVID-19 vaccine among migrants in Shanghai, China: A cross-sectional study, Vaccines, 9(5), 443, DOI: 10.3390/vaccines9050443.

Holmes, E.A., O'Connor, R.C., Perry, V.H., Tracey, I., Wessely, S., Arseneault, L., Ballard, C., Christensen, H., Cohen Silver, R., Everall, I., Ford, T., John, A., Kabir, T., King, K., Madan, I., Michie, S., Przybylski, A.K., Shafran, R., Sweeney, A., Worthman, C. M., Bullmore, E. (2020), Multidisciplinary research priorities for the COVID-19 pandemic: A call for action for mental health science, The Lancet Psychiatry, 7(6), 547–560. DOI: 10.1016/S2215-0366(20)30168-1.

Holt, C.A. (2019), Markets, Games and Strategic Behavior: An Introduction to Experimental Economics (2nd edition.), Princeton, NJ: Princeton University Press.

Horowitz, J.K., McConnell, K.E. (2002), A review of WTA/WTP studies, Journal of Environmental Economics and Management, 44(3), 426–447. DOI: 10.1006/jeem.2001.1215.

Huang, J., Leng, M., Parlar, M. (2013), Demand functions in decision modeling: A comprehensive survey and research directions, Decision Sciences, 44(3), 557–609. DOI: 10.1111/deci.12021.

Hursh, S.R., Silberberg, A. (2008), Economic demand and essential value, Psychological Review, 115(1), 186–198. DOI: 10.1037/0033-295X.115.1.186.

Hursh, S.R., Winger, G. (1995), Normalized demand for drugs and other reinforcers, Journal of the Experimental Analysis of Behavior, 64(3), 373–384. DOI: 10.1901/jeab.1995.64-373.

Iyer, G., Nandur, V., Soberman, D. (2022), Vaccine hesitancy and monetary incentives, Humanities Social Sciences Communications, 9, 81. DOI: 10.1057/s41599-022-01074-y.

Jensen, R.T., Miller, N.H. (2008), Giffen behavior and subsistence consumption, American Economic Review, 98(4), 1553–1577. DOI: 10.1257/aer.98.4.1553.

Kabir, M., Mondal, M., Eliyas, M., Mannan, M.A., Hashem, M., Debnath, N., Miazi, O., Mohiuddin, C., Kashem, M., Islam, M., Elahi, M. (2011), An epidemiological survey on investigation of tick infestation in cattle at Chittagong District, Bangladesh, African Journal of Microbiology Research, 5(4), 346–352. DOI: 10.5897/AJMR10.706.

Kahneman, D., Tversky, A. (1979), Prospect theory: An analysis of decision under risk, Econometrica, 47, 263–291. DOI: 10.1142/9789814417358_0006.

Kálmán, B., Bárczi, J., Zéman, Z. (2021), Financial knowledge of higher education students of economics, in: Z. Pál, Y. Serpeninova and L. Hrytsenko (Eds.), Aspects of Financial Literacy: Proceedings of the International Scientific and Practical Conference March 22–23 (pp. 176–191), Sumy State University.

Kaźmierska-Jóźwiak, B., Sekula, P., Socha, B. (2021), Analysis of the effects of COVID-19 on companies listed on the Warsaw Stock Exchange, Forum Scientiae Oeconomia, 9(4), 99–116. DOI: 10.23762/FSO_VOL9_NO4_5.

Kitukutha, N., Vasa, L., Oláh, J. (2021), The impact of COVID-19 on the economy and sustainable e-commerce, Forum Scientiae Oeconomia, 9(2), 47–72. DOI: 10.23762/FSO_VOL9_NO2_3.

Klein, P.A. (1973), Demand theory and the economist's propensity to assume, Journal of Economic Issues, 7(2), 209–239. http://www.jstor.org/stable/4224224.

Kolnhofer-Derecskei, A., Csongrádi, G. (2022), How do the framing effects, environmental factors and personal risk perceptions influence our decision about a hypothetical COVID-19 pill?, Journal of Decision Systems. DOI: 10.1080/12460125.2022.2085854.

Kolnhofer-Derecskei, A. (2020), How much can a beer cost in a fancy resort hotel? The possible replication of Thaler's well-known experiment, in: W. Sroka (Ed.), Perspectives on Consumer Behaviour. Theoretical Aspects and Practical Applications (pp. 241–257), Cham: Springer. DOI: 10.1007/978-3-030-47380-8_11.

Kolnhofer-Derecskei, A., Csongrádi, G., Tóth, A. (2022), Hogyan befolyásolja a keretbe foglalási hatás a fizetési hajlandóságot egy újonnan bevezetendő COVID-19 gyógyszer esetén?, Gradus, 9(1), 1–9. DOI: 10.47833/2022.1.ECO.001. (Original work published in Hungarian).

Kozlovskyi, S., Daria Bilenko, D., Kuzheliev, M., Ivanyuta, N., Butenko, V., Lavrov, R. (2021), Comparison and assessment of factors affecting the COVID-19 vaccination in European countries, Problemy Ekorozwoju–Problems of Sustainable Development, 16(2), 26–33. DOI: 10.35784/pe.2021.2.03.

Kyle, M. (2007), Pharmaceutical Price controls and entry strategy, Review of Economics and Statistics, 89(1), 88–99. DOI: 10.1162/rest.89.1.88.

Lázár, E. (2009), New methods in demand based price optimization, Journal of Economics and Business Research, XV(2), 43–63.

Lázár, E. (2010), Microeconometric models in market research price optimization, Journal of Economics and Business Research, XVI(1), 47–59.

Lázár, E. (2011), Ároptimalizálás, ökonometriai modellezésen és az empirikus keresleti függvény meghatározásán alapuló árazási technikák, Vezetéstudomány 42(6), 68-56. DOI: 10.14267/VEZTUD.2011.06.06. (Original work published in Hungarian).

Lichtenstein, D.R., Bloch, P.H., Black, W.C. (1988), Correlates of price acceptability, Journal of Consumer Research, 15(2), 243–252. DOI: 10.1086/209161.

Light, D.W., Lexchin, J. (2021), The costs of coronavirus vaccines and their pricing, Journal of the Royal Society of Medicine, 114(11), 502–504. https://doi:10.1177/01410768211053006.

Lin, Y., Hu, Z., Zhao, Q., Alias, H., Danaee, M., Wong, L.P. (2020), Understanding COVID-19 vaccine demand and hesitancy: A nationwide online survey in China, PLoS Neglected Tropical Diseases, 14(12), e0008961. DOI: 10.1371/journal.pntd.0008961.

Liu, S., Liu, J. (2021), Understanding behavioral intentions toward COVID-19 vaccines: Theory-based content analysis of tweets, Journal of Medical Internet Research, 23(5), e28118. DOI: 10.2196/28118.

Lu, Z.J., Comanor, W.S. (1998), Strategic pricing of new pharmaceuticals, The Review of Economics and Statistics, 80(1), 108–118. http://www.jstor.org/stable/2646733.

Mankiw, G. (2011), Principles of Economics, Cincinnati, OH: South-Western College Pub.

Marshall, A. (1906), Letter to A.L. Bowley, in: D.L. Sills and R.K. Merton, R.K. (Eds.) Social Science Quotations: Who Said What, When, and Where (p. 151), Transaction Publishers.

Martonosi, S.E., Behzad, B., Cummings, K. (2021), Pricing the COVID-19 vaccine: A mathematical approach, Omega, 103, 102451. https://doi: 10.1016/j.omega.2021.102451.

McDougall, J.A., Furnback, W.E., Wang, B.C.M., Mahlich, J. (2020), Understanding the global measurement of willingness to pay in health, Journal of Market Access & Health Policy, 8(1). DOI: 10.1080/20016689.2020.1717030.

Miller, K.M., Hofstetter, R., Krohmer, H., Zhang, Z.J. (2011), How should consumers' willingness to pay be measured? An empirical comparison of state-of-the-art approaches, Journal of Marketing Research, 48(1), 172–184.

Miniszterelnöki Kabinetiroda. (2021), 5 millió 947 ezer beoltott, 4039 az új fertőzött, elhunyt 45 beteg, retrieved from: https://koronavirus.gov.hu/cikkek/5-millio-947-ezer-beoltott-4039-az-uj-fertozott-elhunyt-45-beteg. (accessed 15 February 2022). (Original work published in Hungarian).

MNB. (2021a), Exchange rate, retrieved from: http://www.mnbkozeparfolyam.hu/arfolyam-2021-10.html. (accessed 20 May 2022).

MNB. (2021b), Inflation, retrieved from: https://www.mnb.hu/letoltes/inflacios-folyamatok-ertekelese-hu-2021-oktober.pdf. (accessed May 20, 2022)

Morrison, G.C. (1998), Understanding the disparity between WTP and WTA: Endowment effect, substitutability, or imprecise preferences?, Economics Letters, 59(2), 189–194. DOI: 10.1016/S0165-1765(98)00049-4.

Newman, M., Ferrario, C.R. (2020), An improved demand curve for analysis of food or drug consumption in behavioral experiments, Psychopharmacology, 237(4): 943–955. DOI: 10.1007/s00213-020-05491-2.

Peng L., Jiang H., Guo Y., Hu, D. (2022), Effect of information framing on wearing masks during the COVID-19 pandemic: Interaction with social norms and information credibility front, Public Health, 10, 811792. DOI: 10.3389/fpubh.2022.811792.

Plassmann, H., Weber, B. (2015), Individual differences in marketing placebo effects: Evidence from brain imaging and behavioral experiments, Journal of Marketing Research, 52(4), 493–510. DOI: 10.1509/jmr.13.0613.

Sarasty, O., Carpio, C.E., Hudson, D., Guerrero-Ochoa, P.A., Borja, I. (2020), The demand for a COVID-19 vaccine in Ecuador, Vaccine, 38(51), 8090–8098. DOI: 10.1016%2Fj.vaccine.2020.11.013.

Sasaki S., Saito T., Ohtake F. (2022), Nudges for COVID-19 voluntary vaccination: How to explain peer information?, Social, Science Social Science & Medicine, 292(2022), 114561, DOI: 10.1016/j.socscimed.2021.114561.

Scherer, F.M. (2000), The Pharmaceutical Industry, in: A. Culyer, J. Newhouse (Eds.), Handbook of Health Economics (pp. 1297–336), New York: Elsevier.

Schweitzer, S.O., Lu, Z.J. (2018), Pharmaceutical economics and policy, Oxford: Oxford University Press.

Shampanier, K., Mazar, N., Ariely, D. (2007), Zero as a special price: The true value of free products, Marketing Science, 26(6), 742–757. https://doi.org10.1287/mksc.1060.0254.

Shiv, B., Carmon, Z., Ariely, D. (2005), Placebo effects of marketing actions: Consumers may get what they pay for, MIT Sloan Research Paper No. 4533-05. http://dx.doi.org/10.2139/ssrn.707541.

Shpak, N., Podolchak, N., Karkovska, V., Sroka, W., Horbal, N. (2022), The application of tools for assessing the financial security of enterprises, Forum Scientiae Oeconomia, 10(2), 29–44. DOI: 10.23762/FSO_VOL10_NO2_2.

Sprengholz, P., Betsch, C. (2021), Comment on: "Willingness to pay for a COVID-19 vaccine", Applied Health Economics and Health Policy, 19(4), 619–621. DOI: 10.1007%2Fs40258-021-00656-2.

Sroka, W. (Ed.) (2020), Perspectives on consumer behaviour: Theoretical aspects and practical applications, Cham: Springer.

Steckel, J., Shampanier, K., O'Laughlin, L., Shea, J., Fair R.K. (2017), What Consumers Really Think About Reference Price Labels, Analysis Group Inc.

Strickland, J.C., Reed, D.D., Hursh, S.R., Schwartz, L.P., Foster, R.N.S., Gelino, B.W., LeComte, R.S., Oda, F.S., Salzer, A.R., Schneider, T.D., Dayton, L., Latkin, C., Johnson, M. W. (2022), Behavioral economic methods to inform infectious disease response: Prevention, testing, and vaccination in the COVID-19 pandemic, PLoS ONE, 17(1), e0258828. DOI: 10.1371/journal.pone.0258828.

Sun, S. (2020), An alternative approach for demand estimation. http://dx.doi.org/10.2139/ssrn.3550415.

Terry, M. (2021), Comparing COVID-19 vaccines: Timelines, types and prices, Biospace, Retrieved from https://www.biospace.com/article/comparing-covid-19-vaccines-pfizer-biontech-moderna-astrazeneca-oxford-j-and-j-russia-s-sputnik-v/ (accessed 25 May 2022).

Thaler, R. (1983), Transaction utility theory, Advances in Consumer Research, 10, 229–232.

Thaler, R., Schafir, E. (2006), Invest now, drink later, spend never: On the mental accounting of delayed consumption, Journal of Economic Psychology, 27, 694–712. DOI: 10.1016/j.joep.2006.05.008.

Tsutsui, Y., Shahrabani, S., Yamamura, E., Hayashi, R., Kohsaka, Y., Ohtake, F. (2021), The willingness to pay for a hypothetical vaccine for the coronavirus disease 2019 (COVID-19), International Journal of Environmental Research and Public Health, 18(23), 12450. DOI: 10.3390%2Fijerph182312450.

UNICEF (2021), COVID-19 Vaccine Market Dashboard, retrieved from: https://www.unicef.org/supply/covid-19-vaccine-market-dashboard (accessed 10 May 2022).

Vassilopoulos, A., Avgeraki, N., Klonaris, S. (2020), Social desirability and the WTP–WTA disparity in common goods, Environment Development and Sustainability, 22, 6425–6444. DOI: 10.1007/s10668-019-00490-6

Wale-Awe, O., Sulaiman, L. (2020), Premium motor spirit (PMS) pricing and inflationary dynamics in Nigeria, Forum Scientiae Oeconomia, 8(3), 49–60. DOI: 10.23762/FSO_VOL8_NO3_3.

Wang, J., Lyu, Y., Zhang, H., Jing, R., Lai, X., Feng, H., Fang, H. (2021), Willingness to pay and financing preferences for COVID-19 vaccination in China, Vaccine, 39(14), 1968–1976. DOI: 10.1016/j.vaccine.2021.02.060.

Wee, S.L., Novak, B. (2021), Hungary pays big for a Chinese vaccine. The New York Times, retrieved from: https://www.nytimes.com/2021/03/12/world/hungary-sinopharm-covid.html (accessed 21 April 2022).

Whynes, D.K., Sach, T.H. (2007), WTP and WTA: Do people think differently?, Social Science & Medicine, 65(5), 946–957. DOI: 10.1016/j.socscimed.2007.04.014.

Wong, L.P., Alias, H., Wong, P.F., Lee, H.Y., AbuBakar, S. (2020), The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay, Human Vaccines & Immunotherapeutics, 16(9), 2204–2214. DOI: 10.1080/21645515.2020.1790279.

Yamoah, F., Haque, A. (2022), Strategic management through digital platforms for remote working in the higher education industry during and after the COVID-19 pandemic, Forum Scientiae Oeconomia, 10(2), 111–128. DOI: 10.23762/FSO_VOL10_NO2_6

Zhang, Y., Luo, X., Ma, Z.F. (2021), Willingness of the general population to accept and pay for COVID-19 vaccination during the early stages of COVID-19 pandemic: A nationally representative survey in mainland China, Human Vaccines & Immunotherapeutics, 17(6), 1622–1627. DOI: 10.1080%2F21645515.2020.1847585.

Zhao, J. Kling, C.L. (2001), A new explanation for the WTP/WTA disparity, Economics Letters, 73(3), 293–300. DOI: 10.1016/S0165-1765(01)00511-0.

Anita Kolnhofer-Derecskei currently works as an associate professor at the Budapest Business School, Faculty of Finance and Accountancy, where she teaches Economics and Research Methodology, among other subjects. She participates in and leads several research projects including this one. As an economic psychologist, she has conducted research in the fields of behavioural and social economics as well as economic psychology, a field in which she has a proven track record of high-profile academic papers and many publications. ORCID no. 0000-0002-1780-7674

Gyöngyi Csongrádi is an associate professor at the Budapest Business School, Faculty of Finance and Accounting, teaching economics, international economics, and financial markets in Hungarian and English. He received his PhD in 2019; the subject of his dissertation was the role of the private sector in financing nonprofit organisations. His main research interests are the operation of the civil sector and nonprofit organisations, the voluntary and altruistic behavior of people, the ways and methods of knowledge transfer, and tax avoidance and tax-optimising performance of businesses. ORCID no. 0000-0003-4739-6674

Arnold Tóth is an associate professor at the Budapest Business School (Hungary), and a secretary at the Hungarian Academy of Sciences. His PhD was on the financial returns of marketing communication at Corvinus University (Hungary). He graduated from studies in both engineering management and economics (2002). Thereafter, he taught courses such as economics, labour economics, finance and related subjects at various universities in Budapest. He has taught many Hungarian and foreign students at several universities, and he has also been able to visit foreign educational institutions as part of shorter study trips. During his teaching career, he has been a consultant to many graduate students, as well as a reviewer of theses. In addition to acquiring theoretical knowledge, the acquisition of practical experience is also an important aspect of his career. ORCID no. 0000-0003-0860-6405

György Hauber is an associate professor at the Budapest Business School (Hungary) and the head of the Department of Business Economics. He teaches economics, corporate economics, and economic protection. Dr Hauber received his PhD in 2017. The primary objective of his research is to examine the opportunities and chances of realising energy independence in a given subregion and to determine the targets of the essential interventions. His primary research interests are the economic and social causes of tax evasion, tax avoidance and corruption in the operation of SMEs. ORCID no. 0000-0003-2294-8954