



e-ISSN 3083-6018

SOCIAL DEVELOPMENT: Economic and Legal Issues

<https://www.eu-scientists.com/index.php/sdel>


Scaling Up Telemedicine Services in Ukraine: A Scenario-Based Assessment of Economic Effects and Break-Even Thresholds

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ARTICLE INFO

ABSTRACT

Research Article

DOI:

[10.70651/3083-6018/2026.4.29](https://doi.org/10.70651/3083-6018/2026.4.29)

Received:

23 March 2026

Accepted:

24 April 2026

Published online:

26 April 2026

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The economic effects of scaling up telemedicine services depend on infrastructure utilisation, the cost structure, and the proportion of remote interactions that effectively replace in-person visits. In Ukraine, assessment of these conditions is constrained by the absence of standardised cost accounting and data on the actual substitution of in-person care. To assess changes in the fixed-cost component per service as the volume of telemedicine services increases in Ukraine, determine the break-even conditions for healthcare providers and the healthcare system, and estimate the opportunity cost of paid working time saved by patients and accompanying persons. A secondary analysis of publicly available data for 2021–2023 was conducted. The methods included the classification of fixed, variable, and step-fixed costs; cost–volume–profit analysis; break-even analysis; and scenario analysis. The study considered the healthcare provider, healthcare system, and societal perspectives. Cost estimates from other countries were used solely as relative scenario parameters. The number of registered remote interactions in Ukraine increased from 5.7 million in 2021 to 9.8 million in 2023. Assuming constant total fixed costs, the fixed-cost component per interaction decreased by 41.8%. The overall change in average cost cannot be determined without data on fixed and variable costs. In the normalised scenario that included only direct medical costs, system-level break-even was not achieved even when remote consultations fully replaced in-person consultations. When patients' travel costs were included, the break-even substitution rate was approximately 92.8%; when intermunicipal travel was considered, it decreased to 86.9%. At a volume of 9.8 million remote interactions and a 50% substitution rate, the estimated annual time saved ranged from 4.9 million to 14.7 million person-hours. Across the scenarios examined, its monetary value ranged from UAH 219.1 million to UAH 1,314.6 million. Increasing the volume of telemedicine services reduces the fixed-cost component per service only within existing capacity. Break-even depends on the cost structure, revenue per interaction, the actual substitution rate, and the amount of avoidable costs. Estimating break-even thresholds for Ukrainian healthcare institutions requires separate accounting of costs, subsequent in-person visits, travel expenses, and the time spent by patients and accompanying persons.



KEYWORDS

telemedicine, scaling up, economies of scale, break-even point, cost structure, substitution of in-person visits, opportunity cost of time, health economics, Ukraine.



e-ISSN 3083-6018

СОЦІАЛЬНИЙ РОЗВИТОК: економіко-правові проблеми

<https://www.eu-scientists.com/index.php/sdel>


Масштабування телемедицинських послуг в Україні: сценарна оцінка економічних ефектів і порогів беззбитковості

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СТАТТЯ

АНОТАЦІЯ

Дослідницька

DOI:

[10.70651/3083-6018/2026.4.29](https://doi.org/10.70651/3083-6018/2026.4.29)

Отримана:

23.03.2026 р.

Прийнята:

24.04.2026 р.

Опублікована:

26.04.2026 р.

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Економічні результати масштабування телемедицинських послуг залежать від рівня використання інфраструктури, структури витрат і частки дистанційних взаємодій, які фактично заміщують очні звернення. Для України оцінювання цих умов обмежується відсутністю стандартизованого обліку витрат на телемедицинські послуги та даних щодо фактичної частки заміщення очної медичної допомоги. Оцінити зміну питомої складової постійних витрат зі збільшенням обсягу телемедицинських послуг в Україні, визначити умови беззбитковості для надавача медичних послуг і системи охорони здоров'я та оцінити грошову вартість збереженого оплачуваного робочого часу пацієнтів і супроводжуваних осіб. Проведено вторинний аналіз відкритих даних за 2021–2023 рр. Застосовано класифікацію витрат на постійні, змінні та ступінчасто-постійні, аналіз «витрати – обсяг – прибуток», аналіз порогів беззбитковості та сценарний аналіз. Розрахунки виконано з позицій надавача медичних послуг, системи охорони здоров'я та суспільства. Дані зарубіжних досліджень використовувалися лише як відносні сценарні параметри без перенесення абсолютних значень витрат на українські умови. Кількість зареєстрованих дистанційних взаємодій в Україні зросла з 5,7 млн у 2021 р. до 9,8 млн у 2023 р. За припущення незмінності сукупних постійних витрат їх питома складова на одне дистанційне взаємодіяння зменшилася на 41,8 %. Водночас повну зміну середньої вартості неможливо визначити без локальних даних щодо постійних і змінних витрат. У нормалізованому сценарії, що враховував лише прямі медичні витрати, системна беззбитковість не досягалася навіть за повного заміщення очних консультацій дистанційними. За включення транспортних витрат пацієнта порогова частка заміщення становила приблизно 92,8 %, а за врахування міжмуніципальної поїздки – 86,9 %. За обсягу 9,8 млн дистанційних взаємодій і 50 % заміщення очних звернень розрахунковий річний обсяг збереженого часу становив 4,9–14,7 млн людино-годин, а його грошова оцінка – 219,1–1 314,6 млн грн залежно від тривалості поїздки, частки звернень із супроводжувачем особою та частки часу, що збігалася з оплачуванним робочим часом. Збільшення обсягу телемедицинських послуг може зменшувати питому складову постійних витрат лише в межах наявної потужності. Беззбитковість визначається співвідношенням відшкодування та змінних витрат, обсягом послуг, фактичною часткою заміщення очних звернень і величиною витрат, яких можна уникнути. З позиції суспільства додатковий економічний ефект може формуватися за рахунок запобігання транспортним витратам і збереження оплачуваного робочого часу пацієнтів та супроводжуваних осіб. Для визначення порогів беззбитковості українських закладів охорони здоров'я необхідний окремий облік постійних, змінних і ступінчастих витрат, доходу на одне дистанційне взаємодіяння, фактичної частки заміщення, подальших очних відвідувань, транспортних витрат і часу пацієнтів та супроводжуваних осіб.

КЛЮЧОВІ СЛОВА

телемедицина, масштабування, економія від масштабу, точка беззбитковості, структура витрат, заміщення очних звернень, альтернативна вартість часу, економіка охорони здоров'я, Україна.



1. Introduction

The economic outcomes of scaling up telemedicine services depend on infrastructure utilisation, the cost structure, and the proportion of remote interactions that effectively substitute for in-person care. In Ukraine, assessing these conditions is particularly important because of geographical constraints on access to healthcare and the absence of standardised cost accounting for telemedicine services. Increasing service volume may reduce the fixed-cost component per interaction; however, overall cost savings arise only when infrastructure is sufficiently utilised, variable and step costs are controlled, and remote interactions effectively replace in-person visits. The objective of this study was to assess changes in the fixed-cost component per interaction as the volume of telemedicine services increases in Ukraine, derive break-even conditions for healthcare providers and the healthcare system, and estimate the monetary value of paid working time saved by patients and caregivers under alternative scenarios.

2. Literature Review

Evidence from economic evaluations of telemedicine is heterogeneous. In an umbrella review of 98 systematic reviews, 7 of the 18 reviews assessing cost-effectiveness (39%) concluded that telemedicine interventions were cost-effective or cost-saving; the generalisability of the findings was limited by the methodological quality and heterogeneity of the underlying evidence [4]. More recent evidence indicates that studies of the monetary and production costs of telehealth, including patient and provider time costs, remain limited [6]. Economic outcomes depend on the model of care delivery and the analytical perspective adopted. Cost savings are more likely when remote interactions substitute for in-person visits, avoid travel, and use existing capacity. When telemedicine is additive to rather than a substitute for in-person care, total healthcare costs may increase [18; 19]. Economic analysis should distinguish among the costs of establishing and maintaining a telemedicine system, delivering individual services, and expanding service volume. Telemedicine programmes incur costs associated with information technology, equipment, implementation, maintenance, and personnel [9; 10]. In the present model, costs that do not vary within the relevant capacity range are classified as fixed, costs incurred per interaction as variable, and costs arising from capacity expansion, including additional staffing, as step-fixed. No universal break-even threshold exists. In a Norwegian study of remote orthopaedic consultations, the break-even threshold varied according to the analytical perspective and model parameters [1]. A review of telemedicine programmes found that the time to break-even ranged from less than one year to nine years [17]. The societal perspective additionally incorporates travel costs and the value of time spent by patients and caregivers. Excluding these components may understate the societal benefits of remote care; however, their monetary valuation does not constitute budgetary savings for healthcare providers [3; 16]. Scaling up telemedicine depends on its integration into clinical workflows, sustainable financing, organisational readiness, and the local context. Consequently, prices and break-even thresholds derived from other countries cannot be directly transferred to Ukraine, although relative measures may be used as scenario parameters [5; 8; 22]. Ukraine has established legal and strategic frameworks for telemedicine; however, these do not prescribe a methodology for the separate accounting of fixed, variable, and step-fixed costs or define a universally applicable, economically justified service volume [2; 20]. No model was identified in publicly available Ukrainian sources that simultaneously accounts for the volume of remote services, the cost structure, the substitution of in-person visits, and the time costs borne by patients and accompanying persons.

3. Materials and Methods

A secondary analysis of publicly available data for 2021–2023 was conducted using cost classification, cost-volume-profit analysis, threshold analysis based on avoidable costs, and scenario analysis. The analysis was performed from the perspectives of the healthcare provider, the healthcare system, and society. The unit of analysis was one registered remote interaction, irrespective of its clinical modality. The data for Ukraine comprised information from the Ministry of Health on the number of remote interactions, findings from an assessment of healthcare institutions' resources, and the average wage indicator published by the Pension Fund of Ukraine. The source reporting the number of remote interactions does not provide a standardized description of their composition for each year; the time series

was therefore treated as an aggregate measure. Studies from other countries were used to specify relative scenarios and conduct sensitivity analyses without transferring foreign prices to the Ukrainian setting. Reporting of analytical perspectives and assumptions followed CHEERS 2022, while costing and implementation-planning considerations were informed by the WHO Digital Implementation Investment Guide [7; 21]. In the baseline model, total and average costs at service volume N within a single relevant range of capacity were defined as follows:

$$TC(N) = F + vN$$

$$AC(N) = \frac{F}{N} + v$$

where F – the incremental fixed costs of the telemedicine programme within the relevant capacity range;

v – the incremental variable cost per remote interaction;

$TC(N)$ – total costs;

$AC(N)$ – average cost per interaction.

The composition of F and v is determined separately for each analytical perspective. Additional labour costs directly attributable to a remote interaction are included in v , whereas the remuneration of existing staff within spare capacity is included in F . Recruiting additional staff gives rise to step-fixed costs. The relative reduction in average total cost as service volume increases from N_1 to N_2 is defined as follows:

$$ES_{AC} = \frac{AC(N_1) - AC(N_2)}{AC(N_1)} \times 100\%$$

If values for F and v are unavailable, only the change in the fixed-cost component per service is calculated:

$$ES_F = \left(1 - \frac{N_1}{N_2}\right) \times 100\% \quad (1)$$

The provider's financial break-even point is defined as follows:

$$N_{BE,prov} = \frac{F}{T - v}, \quad T > v \quad (2)$$

where T is the provider's revenue per remote interaction; under fee-for-service payment, it is equal to the tariff. From the healthcare system perspective, revenue is replaced by the medical costs of an in-person visit that can actually be avoided:

$$N_{BE,sys} = \frac{F}{qC_{med,avoid} - v}, \quad qC_{med,avoid} > v \quad (3)$$

where q is the proportion of remote interactions that actually replace in-person visits, $0 \leq q \leq 1$; $C_{med,avoid}$ – denotes the avoidable medical cost per in-person visit. The corresponding substitution threshold at a given service volume is defined as follows:

$$q_{BE}(N) = \frac{v + \frac{F}{N}}{C_{med,avoid}} \quad (4)$$

If $q_{BE} > 1$, system-level break-even cannot be achieved under the specified parameters, even with complete substitution of in-person visits. To compare relative costs reported in international sources, a normalised measure of the change in cost per remote interaction was used:

$$\Delta c_{norm} = \frac{C_{TM} - qC_{F2F}}{C_{F2F}} = \frac{C_{TM}}{C_{F2F}} - q \quad (5)$$

where C_{TM} and C_{F2F} are comparable costs of remote and in-person consultations calculated from the same analytical perspective and using the same price basis.

A negative value indicates cost savings, whereas a positive value indicates an increase in costs. The normalised scenario excludes the Ukrainian F/N value and reflects the incremental effect once the infrastructure is in place. From the societal perspective, the avoidable cost of an in-person visit includes avoidable medical costs, avoided travel expenditures, and the opportunity cost of paid working time saved:

$$C_{avoid,soc} = C_{med,avoid} + C_{tr} + C_{time} \quad (6)$$

The monetary value of paid time saved per in-person visit replaced by a remote interaction is defined as follows:

$$C_{time} = t_{tr}(w_p\theta_p + aw_c\theta_c) \quad (7)$$

The total annual monetary value of paid time saved is defined as follows:

$$B_{time} = NqC_{time} \quad (8)$$

where B_{time} – total annual monetary value; Nq – the number of remote interactions that replaced in-person visits. The threshold for societal economic feasibility is defined as follows:

$$N_{BE,soc} = \frac{F}{qC_{avoid,soc} - v}, \quad qC_{avoid,soc} > v \quad (9)$$

where,

C_{tr} – avoided monetary travel expenditures;

C_{time} – monetary valuation of paid working time saved by the patient and caregiver;

w_p and w_c – hourly wage of the patient and caregiver, respectively;

t_{tr} – round-trip travel time;

θ_p and θ_c – shares of patient and caregiver travel time that overlap with their paid working hours;

a – proportion of substituted face-to-face visits requiring one caregiver.

When the calculations are combined, travel costs are counted only once: if C_{F2F} already includes travel costs, adding C_{tr} again to the avoided cost is not permissible because this would result in double counting. The equations for total and average costs are based on the standard cost-volume-profit (CVP) model. The system-level break-even threshold is derived from the condition $F + Nv = NqC_{med,avoid}$. The cost structure was specified with reference to the cost components considered by Buvik et al. [1] and Snoswell et al. [17]; the equations presented here constitute the authors' adaptation for the three analytical perspectives.

The scenarios included the number of interactions $N = 5.7, 6.9$, and 9.8 million; the substitution rate $q = 25\%, 50\%, 75\%$, and 100% ; round-trip travel time $= 1$ and 2 hours; the proportion of visits requiring a caregiver $a = 0\%, 25\%$, and 50% ; and the proportion of time overlapping with paid working hours $\theta = 50\%$ and 100% . Monetary outcomes were rounded to UAH 0.1 million, and relative outcomes to 0.1 percentage points.

4. Results

According to the Ministry of Health of Ukraine, $5.7, 6.9$, and 9.8 million remote interactions were registered in 2021, 2022, and 2023, respectively. The year-on-year increase was 21.1% in 2022 and 42.0% in 2023; over the entire period, the volume increased by 71.9% [11]. Assuming that F remains constant, the index of the fixed-cost component per interaction is N_{2021}/N_t . The results calculated using Equation (1) are presented in Table 1. The index does not reflect changes in average total cost or potential stepwise expansion of capacity.

Table 1. Change in the unit fixed-cost component under the condition that $F = \text{const}$

Year	Volume of remote interactions, million	Index, 2021 = 100%	Reduction from 2021, %
2021	5.7	100.0	–
2022	6.9	82.6	17.4
2023	9.8	58.2	41.8

Source: Calculated by the authors based on [11].

As shown in Table 1, with fixed costs unchanged, the unit fixed-cost component in 2023 was 58.2% of its 2021 level. Average costs in 2023 are expressed as follows:

$$AC_{2023} = v + \frac{F}{N_{2023}} = v + 0.582 \frac{F}{N_{2021}}$$

Under this assumption, the unit fixed-cost component decreased by 41.8%. The reduction in average total cost does not exceed 41.8%; when $v > 0$, it is smaller and can be calculated only if F and v are known. According to the results of the assessment of 30 Ukrainian healthcare institutions published by the Ministry of Health, investment in telemedicine accounted for less than 1% of the total resource base. Most investment was allocated to computers, headsets, office equipment, and workstation outfitting. Personnel remuneration was the largest component of current expenditure, while the services were financed predominantly under the Programme of Medical Guarantees [12]. These data describe the institutions included in the assessment and cannot be generalized to all healthcare institutions in Ukraine.

In the model, the remuneration of existing staff is classified as a fixed cost within available capacity, additional remuneration per contact as a variable cost, and hiring costs associated with capacity expansion as step-fixed costs. The provider's break-even volume under Equation (2) was not calculated because local values of F , v , and T are unavailable in publicly available sources. For the analysis from the healthcare system perspective, relative results from foreign micro-costing studies were used. In a study of 246 consultations in Brazil's public sector, direct costs were 92.4 reais for a remote consultation and 88.4 reais for an in-person consultation, giving a ratio of 1.045. When patient travel was included, the corresponding costs were 97.8 and 105.4 reais, respectively, giving a ratio of 0.928. For intermunicipal travel, the ratio was $92.4/106.3 = 0.869$ [13]. These ratios were used solely as scenario parameters and not as estimates of service costs in Ukraine. The results of the normalised scenario calculation based on Equation (5) are presented in Table 2.

Table 2. Normalised effect at different substitution rates, % of the cost of an in-person consultation

Scenario	q = 25%	q = 50%	q = 75%	q = 100%	q _{BE} at F/N = 0
Direct medical costs only	+79.5	+54.5	+29.5	+4.5	Not attainable
Including patient travel costs	+67.8	+42.8	+17.8	–7.2	≈92.8%
Including intermunicipal travel costs	+61.9	+36.9	+11.9	–13.1	≈86.9%

Source: Calculated by the authors based on [13].

As shown in Table 2, under the direct medical cost scenario, break-even cannot be achieved even with complete substitution because the relative cost of a teleconsultation is 104.5% of the cost of a face-to-face consultation. When patient travel costs are included, the break-even substitution rate is approximately 92.8%, whereas for intermunicipal travel it is 86.9%. These threshold values are intended solely as an order-of-magnitude check and should not be interpreted as normative values for Ukraine.

For the provider perspective, local values of F , v , and T are required. Calculations using equations (3) and (4) from the healthcare system perspective additionally require estimates of avoidable medical costs and the actual substitution rate q . The national volume of 9.8 million interactions does not, by itself, demonstrate the break-even of an individual healthcare facility. The composition of avoided costs from the societal perspective is specified in equation (6). A separate Ukrainian scenario was used to estimate the time-related effect: $N = 9.8$ million telemedicine interactions, $q = 50\%$, round-trip travel time of 1 or 2 hours, and a proportion of visits involving one caregiver of 0%, 25%, or 50%. The number of substituted face-to-face visits is:

$$N_{rep} = Nq = 9.8 \text{ million} \times 0.5 = 4.9 \text{ million}$$

where N_{rep} – denotes the number of telemedicine interactions that replaced face-to-face visits. The average monthly wage on which insurance contributions were paid in 2023, UAH 14,308.46, was used as a proxy for the value of working time [15]. Assuming 160 working hours per month, the hourly value of working time was assumed to be the same for the patient and caregiver:

$$w_p = w_c = \frac{14\,308.46}{160} = 89.43 \text{ UAH/hour}$$

The scenario calculations based on equations (7) and (8) are presented in Table 3. It was assumed that $w_p = w_c$ and $\theta_p = \theta_c = \theta$. The saved hours reflect travel time only and do not include any potential difference in the duration of face-to-face and telemedicine consultations.

Table 3. Scenario-based estimate of time saved with 50% substitution of face-to-face visits

Round-trip travel time	Visits with a caregiver	Patient time, million hours	Caregiver time, million hours	Total, million person-hours	Monetary valuation at $\theta = 50\%$, UAH million	Monetary valuation at $\theta = 100\%$, UAH million
1 hour	0%	4.900	0	4.900	219.1	438.2
1 hour	25%	4.900	1.225	6.125	273.9	547.7
1 hour	50%	4.900	2.450	7.350	328.6	657.3
2 hours	0%	9.800	0	9.800	438.2	876.4
2 hours	25%	9.800	2.450	12.250	547.7	1,095.5
2 hours	50%	9.800	4.900	14.700	657.3	1,314.6

Source: Calculated by the authors based on [15].

As shown in Table 3, with a one-hour round trip, 25% of patients accompanied by a caregiver, and $\theta = 50\%$, 6.125 million person-hours are saved, with an aggregate annual monetary value of UAH 273.9 million. With a two-hour round trip, 50% of patients accompanied by a caregiver, and the same value of θ , 14.7 million person-hours are saved, with a monetary value of UAH 657.3 million. This indicator represents the opportunity cost of paid working time saved rather than an increase in production, GDP, or government revenue [14; 16].

5. Discussion

The estimated reduction in F/N reflects economies of scale only within unchanged capacity. It does not demonstrate an equivalent reduction in full average cost, because the share of F in the cost structure is unknown and capacity expansion generates step costs. Findings from the assessment of 30 healthcare facilities indicate the importance of labour costs within the surveyed sample but do not characterise the Ukrainian healthcare system as a whole. A reduction in F/N does not generate savings if the teleconsultation supplements rather than substitutes for a face-to-face visit. Therefore, in addition to the number of telemedicine contacts, subsequent face-to-face visits, consultation duration, and the use of released resources should also be taken into account. Table 2 shows that the system-level break-even threshold is determined not by scale alone, but by the combination of relative cost and the actual substitution rate.

In the Norwegian study of remote orthopaedic consultations, the base-case societal break-even threshold was 151 consultations per year, while the corresponding healthcare-sector threshold was 183 consultations per year. Sensitivity analyses produced thresholds ranging from 127 to 314 consultations per year [1]. These values describe volume-based thresholds in a different clinical and organisational model, whereas Table 2 presents a threshold substitution rate; the two measures are therefore complementary but not directly comparable. The difference in analytical perspectives explains why a programme may be financially unattractive to the provider while remaining economically justified from the healthcare system or societal perspective. According to equations (6) and (9), the inclusion of C_{tr} and C_{time} increases $C_{avoid,soc}$ and, provided that the denominator is positive, reduces the societal break-even volume. A numerical societal break-even threshold for Ukraine was not estimated because of the lack of local data on travel, time, and avoidable costs. Shared use of an IT platform, centralisation of technical functions, and allocation of consultations across healthcare facilities may increase infrastructure

utilisation and reduce duplication of fixed costs. This effect was not quantified in the present study. The financing mechanism should account for the type of telemedicine service and its capacity to substitute for a face-to-face visit, rather than merely the occurrence of a remote contact.

The study is limited by the aggregated nature of national statistics and the absence of local estimates of F , v , T , $C_{\text{med,avoid}}$, and the actual substitution rate. The relative cost estimates from Brazil and the volume thresholds from Norway reflect different clinical and institutional settings. The time calculation assumes 160 working hours per month, equal hourly values of paid working time for patients and caregivers, and scenario-based values of q , a , and θ . It does not account for unpaid work, differences in employment status or wages, or actual travel and consultation times, nor does it measure changes in productivity or GDP.

6. Conclusions

The number of recorded telemedicine interactions in Ukraine increased from 5.7 million in 2021 to 9.8 million in 2023. Under the assumption of constant total fixed costs, this increase would reduce the fixed-cost component per interaction; however, the overall change in average cost cannot be determined from the available data. Provider break-even depends on reimbursement, variable costs, and service volume. At the healthcare-system level, budget neutrality depends primarily on the extent to which telemedicine substitutes for face-to-face care and on the medical costs that can actually be avoided. From a societal perspective, avoided travel expenditures and the monetary value of time saved by patients and caregivers may further improve economic efficiency. These benefits should be assessed separately from provider budget savings and without double counting travel costs. Estimating break-even thresholds for Ukrainian healthcare facilities requires separate accounting for fixed, variable, and step costs, revenue per interaction, the actual substitution rate, travel expenditures, and the time of patients and caregivers.

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