Analyses of Costs and Financing of the Routine Immunization Program and New Vaccine Introduction in the Republic of Moldova

Study report

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The study was conducted as part of a multi-country analysis of the costing and financing of routine immunization and new vaccines (EPIC) supported by the Bill & Melinda Gates Foundation.

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Acronyms

BMGF	Bill and Melinda Gates Foundation
CNAM	National Health Insurance Company
cMYP	Comprehensive Multi-Year Plan
CPH	Centre of Public Health
DTP	Diphtheria-Tetanus-Pertusis
EVM	Effective Vaccine Management
EPI	Expanded Program for Immunization
FA	Funding Agent
FIC	Fully Immunized Child, which for this report equals to child that received DPT3 dose
FMC	Family Medicine Centre
FS	Funding Source
HC	Health Centre
HF	Financing Scheme Code
HMIS	Health Management Information System
HO	Health Office
HP	Healthcare Provider
IRB	Institutional Review Board
MDL	Moldovan Lei
MoH	Ministry of Health
OFD	Office of a Family Doctor
PHC	Primary Health Care
ULY	Useful Life Year
WHO	World Health Organization
GAVI	Global Alliance for Vaccines and Immunization

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Executive Summary

Introduction and Methodology

The costs and financing of the national immunization programs have been evaluated since 1980s, particularly as part of *Universal Childhood Immunization Initiative*. However, available information is out-dated and up-to-date knowledge on full economic costs and financing of routine immunization programs, as well as the financial cost and financing of a new vaccine introduction is lacking. For going forward and increasing vaccine coverage rates as well as for introduction of new vaccines in national immunization programs, requires better knowledge of costs as well as cost determinants. Therefore, the purpose of this study is to evaluate routine immunization program costs and financing as well as incremental costs and financing of a new vaccine introduction in the Republic of Moldova. Our study is part of a larger effort to evaluate costs and financing of routine immunization in six countries (Moldova, Benin, Uganda, Zambia, Ghana, Honduras) supported by the Bill & Melinda Gates Foundation.

In this study we focus on:

a) Evaluating overall and detailed economic and financial costs (and cost elements) of the routine immunization program in Moldova and describing observed variation in costs and its elements;
b) Evaluating incremental costs for a new vaccine introduction for Rotavirus vaccine;
c) Analyzing the main sources of financing and funds flow for the routine immunization program and for the new vaccine introduction;
d) Evaluating factors determining productivity of the facilities involved in immunization and trying explaining major cost drivers for the immunization program.

Moldova delivers immunization services primarily from 1,318 primary health care facilities[1] using fixed strategy and therefore all costs presented throughout this paper are relevant to this approach. Being part of a multi-country study supported by Gates foundation, we have employed standardized facility based costing approach using similar tools while adjusting to the country context. Consequently this is a cross-sectional facility-based costing study, which looked at total costs of the routine immunization program and estimated incremental costs of a new vaccine introduction, arising at different levels of the health care system (i.e. facility, district and the national level). The study employed multi-stage random sampling to select fifty providers, which included: 8 urban/peri-urban facilities and 42 rural facilities represented by 5 family medicine centres, 10 health centres, 23 offices of family doctors and 12 health offices[2]. Therefore, the findings of this study are representative on a national level. The data was collected with the help of experienced data collectors, who received extensive training. The data collection took place during October 3rd 2012 to January 14th 2013 and included face-to-face interviews with the facility staff and managers, facility observation and record review. Excel™ based database specifically designed for this study was used to transfer the data from questionnaires. The research team validated the data using basic logical links and descriptive statistics, which helped detect odd results and outliers that were followed on and corrected, if necessary.

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[1] The only vaccine, which is administered in hospitals, are BCG and first dose of Hep B. Due to low number of doses of BCGs and Hep B administered at the hospital facilities, the study team decided to concentrate most resources on sampling the facilities where vaccination is one of the critical function.

[2] Detailed description and explanation of facility types listed here is provided on page 23 – Routine Immunization in Moldova

This study used retrospective costing for the routine EPI and evaluated both financial and economic costs of the routine EPI program for 2011. All local costs were converted into 2011 $US using average exchange rate of 11.73 MDL per dollar. Calculations were based on Common Approach developed for this exercise, *cMYP Costing Guideline* and WHO *Guideline for Estimating Costs of New Vaccine Introduction.*

The study questionnaire helped capture the costs of all inputs using an ingredients approach and listing all inputs by activity, quantities and prices. Information was collected for all resources used in delivery of EPI services, including value of donated goods and services. The cost data included a comprehensive list of capital as well as recurrent expenditure items. Items with a useful life of more than one year were treated as capital cost elements and EPI related resources consumed or replaced within a period of up to one year were treated as a recurrent cost item.

Considering that Moldova introduced Rotavirus vaccine in July 2012 the cost of Rotavirus vaccine introduction was estimated prospectively. The data collection captured all costs incurred six-month prior and six month following the date of vaccine introduction. Obtained costs in local currency were converted to 2011 $ US using current exchange rate, annualized and used in the analysis. We looked at all costs for capital equipment, trainings of health care providers, social mobilization and etc. Due to the fact that staff does not work exclusively on the Rotavirus vaccine; incremental personnel costs were assessed on the bases of time allocation. Additional salaries provided out of GAVI grant to the personnel of national public health centre and related to the rotavirus vaccine delivery were also included in the estimations.

Finally financial flows for the routine immunization and new vaccines were analyzed by looking at sources and uses of funds using a *System of Health Accounts* (SHA) framework, which allows systematic description of financial flows related to health care. The aim of our analysis was to describe the national immunization program from an expenditure perspective both for international and national purposes. Therefore our study looked at a funding flow for immunization services and for new vaccine introduction, which helped estimate amount of funds provided by the different national and external sources; amount of funds managed by the different financing agents within and outside of the country; funds spent on a provider level by a type of a provider and by function and by type of inputs.

Total Facility level immunization costs

Study results show that the total facility level immunization costs varied broadly, between 565$US and 112,548$US, mean being 11,943 $US and median $3,822 $US. Total cost was strongly correlated with the size and scale of a facility (measured by the total number of doses delivered at the facility in 2011). The total facility cost varied by facility type, with costs increasing with facility size (HOs to FMCs). Variation within facility type was not large with the exception of FMCs where costs range from $28,335 to $112,548.

Analysis of the total facility cost structure revealed that the labour cost was a main contributor to the total immunization cost that once again confirms that immunization services are labour-intensive. Average share of labour cost out of the total immunization cost was 70.3%, ranging from 61.3% in HOs to 73.4% in HCs and from 69.5% in semi-urban facilities to 71. 5% in the facilities located in urban areas. Vaccines and injection supplies were the second largest component of the immunization cost, accounted for 11.5% of the total immunization cost.

Unit Cost of the Routine Immunization Program

The data analysis showed that unit cost of service provision per dose delivered amounted to 18.3 $US, cost per infant - 316.6 $US and cost per Fully Immunized Child (FIC) - 332.3 $US. However these unit costs differed by facility type, by facility scale (measured by annual doses delivered by a facility) and by urban-rural location, although in a latter case influence were only obvious when shared human resource costs were not accounted in a unit cost. From all of these factors the scale proved to be having strongest influence on the total unit cost of dose delivered. Cost per dose delivered ranged from 14.5 $US in a high scale facilities to 20.5 $US in a low scale facilities. Our findings were comparable with the available global evidence that scale of immunization services has strong and negative relationship with the unit cost of service provision. This means that facilities with a greater scale are able to deliver services more efficiently, by using available inputs more effectively and therefore reducing costs per unit of output.

Furthermore, our study revealed that the labour costs were main contributors to the immunization unit costs on a facility level. Share of labour cost increased along with increase facility size and scale. Average share of a labour cost contribution in the cost per dose delivered was 65.07%, ranging from 54.42% in HOs that are the smallest facilities to 70.48% in FMCs that are the largest facilities and from 55.46% in lower scale to 73.27% in higher scale facilities. Capital costs were the second biggest contributor to the unit costs. The share of recurrent and capital costs differed across facilities. Namely, the share of capital costs was lowest in FMCs - 10.3% and highest in HOs – 22.8%, with the average across all sampled facilities being 16.3%. Furthermore, in the facilities with higher scale share of capital costs was around 9.3% while in a low scale facility it reached 23.1%. Vaccine and injection supplies only accounted for 8.72% of the cost.

Amount of staff time spent on delivering a dose of vaccine reveals strong correlation with the type of a facility. Namely in smaller facilities i.e. health offices, staff time to deliver a dose of immunization amounted to 65.6 minutes, while in FMCs - 8 minutes. This is obviously indicative of a variable productivity of employed staff by a facility type. This could be determined by numerous factors, such as size and/or density of a population in a catchment area, staff quality (nurses vs. doctors), management capacity i.e. availability of immunization plans and supervisory visits, etc. The recent study conducted by the WHO in Moldova showed that staff in rural PHC facilities could be overstretched serving approximately 16.9 patients a day and on average week spending on 42.4 hours at work. Consequently, higher amount of time spend by the staff of small facilities on immunization is indicative that if Moldova decides to increase number of new vaccines introduced in the national immunization program it might become necessary to increase number of FTEs, definitely at smaller PHC facilities in rural areas, unless staff productivity is increased with the help of different tools.

Production and Cost Determinants on a Facility Level

The National Immunization Program in Moldova is performing well and according to the WHO and UNICEF estimates for the last five years Immunization coverage was attained at over 90 percent for all vaccines. In our study we have seen that immunization coverage, measured by DPT3, varied between facility types. The *Health Offices*, located in rural areas, showed the lowest performance – 90.2% and *Offices of Family Doctors* and *Health Centres* showed the best performance 97.8% and 98.1% respectively. Due to the small size of population in the catchment area low performance of the health offices could amount on average to only one child missing its third DPT dose. Consequently most challenging was “low coverage” – 92.7% observed in the *Family Medicine Centres*, which care for the largest catchment population and have on average 430 infants (95%CI: 372-487) to immunize. Based on our findings and available evidence from elsewhere, we hypothesized that facility characteristics as well as management performance on a facility level influence achieved rates of DPT3. Furthermore, coverage rates are also influenced by socio-economic and education status of the population, proximity of clients to health facility, etc. Therefore, the factors determined by our bi-variate analysis were not sufficient for establishing causal links with the facility productivity and costs, unless other contextual determinants (e.g. population characteristics or geography characteristics) were evaluated in a multivariate regression model along with the facility characteristics.

For these purposes we developed the econometric model, which looked separately at production and cost determinants on a facility level. The model once again proved importance of human resources in producing higher outputs (measured as FIC or as total doses administered) for immunization program. In comparison to labor inputs facility infrastructure, such as cold chain equipment or size of a facility measured by square meters retained their statistically significant influence on productivity, but the power of their influence in the multivariate regression model was 48 to 68 times less than working hours devoted to immunization by the staff.

While labor inputs (hours spent on immunization) are critical for increasing the outputs, the quality of such labor inputs seems to be more important in achieving higher production levels. Namely, our model showed that having a doctor in the facility has more significant influence on the volume of outputs (FICs and doses administered) than having just nurses. In all cases, labor related inputs brought positive and significant coefficients at 99% of significance, while proxies for capital had less revealing influence on production.

Production estimations with the help of multivariate model also point to the importance of the population size in the catchment area, increasing of which allows for cost savings at the same level of production. The distance of health centers from a vaccine distribution point, dummy variables for facility type did not reveal significant effects on production, showing higher importance of other production drivers beyond the general characteristics of health care facilities. Finally, facilities with lower wastage rates, when all other factors are kept constant, were more able to produce higher number of FIC or doses.

Our econometric analysis of *total economic cost determinants* on a facility level proved strong presence of economies of scale in immunization programs. These findings once again re-confirm similar arguments, provided by others studies. We also found that input prices for labor and capital had non-conclusive influence on the immunization costs. Considering that in Moldova central government regulates wages, as well as centrally procures and delivers immunization inputs: vaccines, cold boxes, syringes and safety boxes etc. such inconclusive influence of the prices on the total cost of delivering immunization services was not surprising. Furthermore, the analysis showed that costs arising on a district and national level were not that important and mostly facility level costs determined overall variability seen among facilities. Therefore, factors operating on a facility level seemed more important in influencing the cost of immunization. These findings lead to conclusion that predictability of immunization costs might be higher in the centralized models compared to decentralized ones, although this assumption has not been yet validated, with the help of other studies.

The next important finding of the econometric model was importance of the staff time devoted to immunization in determining costs. Increasing average nurse wage by one unit would cause total immunization costs to increase by 1.4, which re-confirms labor intensity of immunization services and therefore price changes in labor inputs or their productivity would have significant impact on the overall cost of the program. Factors such as the distance between the immunization center and the distribution point (as a proxy for vaccine logistics), urban-rural dummy and size of the facility were not statistically significant factors in explaining immunization costs.

Finally, demand side variables show the explanatory power (positive and significant at 99% of confidence) over immunization costs on a facility level; higher educational levels allow demanding for more immunization, triggering vaccination costs. This finding is also comparable with the evidence arising from literature.

In conclusion, presented analysis of production and costs determinants allows separating the effect of four different factors on immunization outputs: operative capacity at the facility level largely related to human resources, managerial efficiency for vaccine and program management, population scale in the catchment and educational level of the population are seem to have the most explanatory power on the productivity and immunization costs.

Cost of New Vaccine Introduction

Our study also looked at the cost of new vaccine introduction which showed that incremental financial cost of a rotavirus introduction was estimated at 378,779 $US. However, out of this amount only 123,912$ was spent on immunization delivery and the rest was used for vaccine procurement. Costs of Rota virus vaccine introduction in Moldova were low because the country had spare cold chain capacity on the national and district level and was able to meet increased vaccine volume needs without additional investments in the cold chain; also no additional staff was hired to cope with the increased workload.

Unit cost analysis showed that incremental financial cost of delivering Rotavirus vaccine was 4.85$US per dose and 9.54$US per infant/child in the birth cohort. However, close to 67% of these financial costs were due to vaccines and only 33% were pure delivery costs.

Economic costs per unit of output (with vaccine costs) were 26% higher over comparable financial costs, because they account for annualized costs of additional staff time at the facility district and national levels and cold chain. Namely, economic cost of delivering a single dose of vaccine increases up to 6.11 $US and cost per infant up to 12.03 $US. Health system related vaccine delivery economic costs were found to be 2.85$ per dose and 5.61$ per infant.

Incremental fiscal costs of a rotavirus vaccine introduction (without vaccines) amounted to 151,489$, out of which 100,000 $US was provided through GAVI grant and the rest was financed by the UNICEF and WHO. These findings may point to the adequacy of GAVI's vaccine introduction grant relative to the financial need of the country in a Moldovan case. However, incremental fiscal cost per infant (without vaccine) was estimated at 3.82$, which is 4.7 times higher than 80 cents established per infant under GAVI vaccine introduction grant policies. Consequently, adequacy of the introduction grant from GAVI for Moldova was only determined by small size of the birth cohort. Furthermore, as noted earlier costs in Moldova were low because the country had spare cold chain capacity on the national and district level and was able to meet increased vaccine volume needs without additional investments. It is well known that most countries face cold chain capacity constraints when they introduce new or underutilized vaccines. Therefore it is expected that difference between GAVI established amount per infant – 80c under vaccine introduction grants and actual financial costs of delivering new vaccine per infant could be even greater in the countries that have bigger birth cohorts.

Furthermore, economic cost per infant/child at 12.03$ estimated by our study when vaccine costs are considered translates into 3.8% increase over the cost per infant under the national immunization schedule, which was estimated at 316.6 $ in 2011.

Our estimates for a rotavirus vaccine introduction were based on 2.5$ per dose of Rotarix™, currently being purchased through UNICEF with GAVI co-financing. However, after GAVI graduation vaccine prices could double because of the national public procurement rules, which mandate local tendering and as a consequence for all non-UNICEF supplied vaccines. Moldova pays almost twice the UNICEF price. If this happens, the cost of immunization program may rise by almost 24.1% which will be significant jump and sustainability of vaccine financing may put at risk. Consequently, financial sustainability of the immunization program will significantly depend on future vaccine prices, which does not make Moldova much different from many other countries, where cost of new vaccines has been found to drive up to 60% of vaccine introduction costs.

Financial Needs of the Immunization Program and with New Vaccines

Estimating unit close per unit of output allowed estimating total cost of the national immunization program without new vaccines, but with routine vaccines and injection supplies, which amounted to $ 9,856,567 (when economic costs are accounted for) and to $ 9,469,796 when only financial costs are taken into account. Aggregated costs, both financial and economic, show that 82% of costs arise on a facility level (not including cost of vaccines and injection supplies) and around 5% of costs are attributable to district level costs, which includes primarily cost of vaccine storage, supervision-monitoring and program management along with *Vaccine Preventable Disease* surveillance. The costs that arise on a national level amount only to 1.4% of the total immunization program costs and vaccines and syringes contribute 11% of these total costs.

Out of the total amount spent on immunization in 2011 the *National Health Insurance Company* managed 80.3% of funds and primarily paid for recurrent expenses on a facility/provider level, 18.9% of funds were managed by the National Centre for Public Health and were primarily used for the NIP management, storage and distribution of direct inputs, e.g. vaccines, injection supplies and safety boxes. Portion of these funds also paid for surveillance of vaccine preventable disease and for trainings. The UNICEF and WHO managed only contributed 0.2% and 0.5% of funds, respectively. And these funds were primarily used for technical assistance and some other inputs for immunization services.

Analysis of funds flow by provider of care revealed following: FMCs consumed the largest amount of funds – 33.4%, followed by offices of family doctors – 30.9% and health centres – 23.3%. The amount of funds spent on health offices was the lowest – 6.5%, because the volume of immunizations services (number of doses administered) offered by these facilities is the lowest. National and municipal/district public health centres spent only 5.2% of immunization funds and amounts administered by the WHO and UNICEF did not exceed 0.7%.

Analysis of funds flow by functions pointed to the fact that most funds are being spent on a facility-based immunization service delivery - 41%, followed by the program management – 18%. Record keeping & HMIS and social mobilization have absorbed 14% and 12% respectively and the amount of funds spent on all other functions was 4% or below.

Direct inputs related to the immunization program (i.e. vaccines & syringes, transport, maintenance, printing and other inputs) consumed only 25.9% of funds or 2.28 million $US while the rest – 74.1% were used to fund shared health system costs. Consequently this breakdown is useful for planning and budgeting national immunization program.

While the role of the external funding sources in funding immunization services seems marginal – 5.2% of the total funding, when external funding is related to only direct immunization inputs their share increases up to 20% and especially GAVI inputs amount to 17% of direct inputs necessary for the immunization program.

The study shows that total financial needs of the national immunization program in Moldova amounts to approximately 1.27% of the *Total National Health Expenditure* for 2011 or 2.4% of *recurrent public financing* (when capital expenditures are excluded) for health, when direct and shared immunization costs are considered. This estimate is 15% higher than the secured and probable funds estimated in the cMYP for 2011. The largest difference arises from overestimating “Routine Recurrent Costs” in the cMYP and underestimating the “Shared Health Systems Costs” primarily through undervaluation of human resource inputs on a provider level. With regards to the role of different funding sources in financing national immunization program the cMYP and the study estimates were comparable.

Finally and as stated earlier, introduction of Rotavirus vaccine in Moldova did not require purchase of additional cold chain, because the country had spare capacity and neither additional staff was added on a facility level to meet increased service delivery needs.

Therefore, financial implication of the NUVI in Moldova was marginal and funding for the Rotavirus vaccine introduction amounted to 406.4 thousand $US. Close to 63% of these additional funds were spent on vaccines and 37% were spent on other inputs.

We also compared cash flow/fiscal cost estimates for the new vaccine introduction derived from our study with the New Vaccine Introduction Plan that was developed by the government of Moldova in 2011, which showed marked discrepancies between the study estimates and the plan, which was based on cMYP. The variation, resulting from cMYP are significant and if on a country level (especially for Moldova) they are negligible, on a regional and Global level such weaknesses could result in a significant bias and waste of resources. Based on this comparison we concluded that the cMYP in its current form and as the critical tool for financial planning for NUVI may not be appropriate unless further improvements are introduced or alternative approaches to financial planning are developed.

Major Conclusions

The major conclusions arising from this study could certainly inform the decisions made by the national immunization program managers in Moldova as well as by the Ministry of Health, especially when they relate to increasing program efficiency, expanding immunization coverage and/or when adding new vaccines to the EPI schedule. However, some findings of this work also have value in informing the global debates around new vaccines and immunization programs. Consequently we would like to summarize our study findings around following issues:

- What could be done in Moldova to increase immunization program efficiency?
- What could be done in Moldova to increase immunization coverage and how this could be achieved in a most cost-efficient manner?
- What is important to consider when making decisions about new vaccine introduction in a country?
- What will be important factors to consider when graduating from GAVI support?

Increasing Immunization Program Efficiency

The government of Moldova is focusing on increasing health system efficiency through various means, including infrastructure optimization. Based on our study findings reducing staff time spent on immunization could help increase efficiency of the program. This objective could be achieved either through task shifting i.e. delegating certain immunization related tasks from doctors to nurses, or through reducing time spend on management and/or record-keeping functions. Our study documented that staff time spend on delivering a dose of immunization is significant in rural PHC facilities where close to 33-34% of time at *Health Offices* and *Family Doctor's Offices* is being spent on the HMIS and program management activities. Considering that Moldova is currently designing e-health system for primary health care, the government may want to design and include the modules for immunization. These modules should be designed in a way that they reduce demand on staff time while collecting all necessary data that is needed for adequate management of immunization services on a facility level.

Increasing Immunization Coverage

Available national and international evidence proves that Moldova achieves high immunization coverage rates compared to other countries in the region. However, marked differences still exist when coverage rates are looked at by facility level. Namely rural facilities located in small villages i.e. *Health Offices* have the lowest DTP3 coverage. However due to very small number of infants in the catchment population of those facilities this low coverage translates into at most one child had missed its third doe of DTP vaccine. Therefore focusing on coverage increase in *health offices* may not be most cost-effective strategy and may fail to significantly affect immunization program performance on a national level. Based on our findings, trying to increase coverage in rural facilities will be most costly option due to high cost per FIC and per dose documented by our study on a *Health Office* level. Consequently, in the Moldovan context, it seems more appropriate to place importance on increasing DPT3 coverage rates in FMCs, where immunization program performance is the second poorest after HOs – 92.7%. Improving performance of these facilities seems more feasible on several counts: they have better staffing and more human resources, they have more infants and improving their performance would have greater impact on the national coverage rate. Finally due to their ability to deliver most cost-efficient immunization services it will be less costly option for the national budget.

However, this strategy may raise equity concerns with regards to rural areas. To mitigate these concerns it seems possible to mostly focus efforts on significantly underperforming rural facilities where DTP 3 coverage rates are below 80% and provide supportive supervision or other assistance that will be necessary.

Introducing New Vaccines

Our study documented that for Moldova the total cost of Rotavirus introduction was marginal because it only amounted to financial costs since the country had spare cold-chain capacity and staff on a PHC level. Our estimates for the incremental fiscal costs that are necessary to introduce a new vaccine in the immunization program proved to be 4.7 times higher compared to 80c currently paid by GAVI. These findings highlighted possible weaknesses in the GAVI policies and call for thorough re-evaluation in light of emerging new evidence.

We have documented that incremental financial costs are not high, when only a rotavirus vaccine introduction is evaluated. However, with possible vaccine price increases after GAVI graduation and with concurrent reduction in the funding from the GFATM, financial sustainability of immunization and other health programs may be put at risk and Moldova may lose the health gains achieved thus far.

Furthermore, due to the fact that staff inputs are important cost drivers of the immunization program and additional vaccines will demand more human resources, it becomes important to control and/or minimize costs resulting from a new vaccine introduction. As we have observed from a multivariate model staff costs have major impact on the immunization program cost. Consequently the discussions around new vaccine introduction should also center on seniority and diversity of health care personnel involved in immunization and how this may affect labor costs.

Finally, we have seen that when introducing new vaccines, actual cost of a vaccine is the largest portion of an incremental cost. Consequently, price of a vaccine dose that is being considered for introduction becomes critical determinant for making policy decision.

Furthermore, after graduating from the GAVI Moldova is considering reforming its immunization program and decentralizing vaccine procurement responsibilities due to specificity of the national health care financing system and due to rules embedded in the national legislation. Our study shows that the cost of vaccines is critical element of the immunization program. Therefore centralized model for vaccine procurement seems to be more effective and decentralization of this function may drive vaccine prices up and could increase overall program cost.

GAVI Graduation and Possible Policy Implications

The econometric model used in this section contributes to the discussion about centralized health systems that subject providers to uniform rules and its influence on immunization costs. Our findings allow us to assume that centralized model of immunization service delivery might be most effective, when national level controls the prices/costs of centrally provided and or regulated inputs, including those of human resources. However, study findings are not conclusive, unless compared with the set of similar studies supported by the Gates Foundation. All of this attracts interest as after graduation from GAVI Moldova may introduce greater decentralization in its immunization programs. In some quarters there are discussions to allow facilities to purchase immunization inputs on their own while CNAM will only reimburse for the volume of services delivered. In light of our findings such decisions, if implemented, could pose risks of resulting in a greater variability in input prices and consequently in cost increases. Therefore, before acting on such decisions thorough evaluation of their impact on the national immunization program costs is warranted.

Furthermore, the study proved that the role of the external sources in the overall funding of the national immunization program is marginal – 5.2%. However, when external funding is related to only direct immunization inputs their share increases up to 20% and especially for the GAVI inputs reach 17%. This share is expected to grow significantly during 2012 and 2013 when new vaccines are introduced and are expected to significantly increase pressure on the national budget when Moldova graduates from the GAVI in 2016.

This financial pressure will be further aggravated by concurrent graduation from the Global Fund, which currently provides funding for most TB and HIV/AIDS inputs. Based on the preliminary estimates provided in the *Medium Term Budgetary Framework for 2014-2016*, Moldova expects that graduation from the GAVI and the Global Fund will increase demand for national public health budget by 2.45 times in 2016 compared to 2011 levels. Due to limited fiscal space and weak economic growth prospects for the same period, this could pose significant challenges for the government during coming years and may put at risk adequate financing of the immunization, TB and HIV/AIDS programs.

In light of this it is thought that when the GAVI and Global Fund boards determine graduation policies, it should not be only linked to a country GDP, as reaching GDP threshold triggers sudden and simultaneous graduation from donor support and places challenges for fiscally constrained governments to pick the price tag of donor funded programs. Such graduations run the risk of inadequate financing from national budgets since graduation, and entails risks of negatively affecting public health achievements realised with the help of GAVI and Global Fund. Consequently, it seems more appropriate for the GAVI and Global Fund to develop phasing out plans for each country in a more coordinated manner, considering different factors and not only GDPs, and while implementing these plans helping health and finance sectors of a country to gradually transition towards the national funding. Such approach seems to have better potential for obtaining durable public health impacts.

Purpose of the Study

The costs and financing of the national immunization programs have been evaluated since 1980s, particularly as part of Universal Childhood Immunization initiative. However, available information is out-dated and up-to-date knowledge on full economic costs and financing of routine immunization programs, as well as the financial cost and financing of a new vaccine introduction is lacking. For going forward and increasing vaccine coverage rates as well as for introduction of new vaccines in national immunization programs, requires better knowledge of costs as well as cost determinants. Therefore, the purpose of this study is to evaluate routine immunization program costs and financing as well as incremental costs and financing of a new vaccine introduction in the Republic of Moldova. Most importantly the study is focused on identifying the factors explaining productivity and variations in total and unit costs on a facility level. Our study in Moldova is part of a larger effort to evaluate costs and financing of routine immunization in six countries (Moldova, Benin, Uganda, Zambia, Ghana, Honduras) supported by the Bill & Melinda Gates Foundation.

Therefore, this study had following objectives:

e) Evaluate overall and detailed economic and financial costs (cost elements) of the routine immunization program in Moldova and describe observed variation in costs and cost elements;
f) Evaluate incremental costs for a new vaccine introduction for Rotavirus vaccine using prospective approach;
g) Evaluate factors determining productivity of facilities involved in the immunization and also try to explain what are major cost drivers for the immunization program;
h) Analyze the main sources of financing and funds flow for the routine immunization program and for the new vaccine introduction.

The findings of the study are expected to help EPI managers and MoH representatives in Moldova to better plan and manage immunization services and a new vaccine introduction. Furthermore, it is hoped that the study results will also contribute to a global knowledge about vaccines, about cost of immunization programs and new vaccine introduction. It is expected that the results of this study could inform future policies aimed at expanding immunization coverage, and therefore estimating and allocating adequate financial and other resources necessary for the coverage expansion.

Background

The Republic of Moldova is a country located in Eastern Europe established as an independent state in 1991 following the collapse of the Soviet Union. Moldova has a surface area of 33,700 square kilometres and shares a border with Romania and Ukraine. The total population is 3.5 million with 58.4 percent living in rural areas [1].

Moldova is divided into 2 municipalities, 32 districts and 2 autonomous territories: Gagauzia, which consists of 3 districts and Transnistria that includes 2 towns and 5 districts [2].

Since claiming independence, there has been civil strife in Transnistria, which sought to maintain its links with the Russia and declared independence from Moldova. In 1992, there was an armed conflict in Transnistria between the Moldovan and Soviet army troops. This conflict has not yet been resolved, and status of Transnistria is being negotiated since [3].

Since 1991 Moldova faced serious economic challenges, losing 66% of its GDP in first decade of independence, followed by sustainable growth starting from 2000 and being challenged again in 2008-2009 by the global economic crises [2].

Moldova is one of the largest net emigration countries in the world, with 39% of the economically active population working abroad [4]. Large-scale labour emigration of young male and female population has negatively affected population growth, as well as the social and economic structure of the society. While crude birth rates were growing and crude mortality was declining, overall population growth rates were negative due to the significant migratory flows. Obviously these demographic shifts have major influence on the cost of the national immunization program and also on the new vaccine introduction costs in the country, as they affect birth cohorts and require constant adjustments in immunization delivery systems.

Fact Sheet1	
Area ('000 km^2)	33,700
Population (million)	3.5
0-14 years (%)	16.4%
15-64 years (%)	73.6%
Over 65 years (%)	10%
Infant mortality rate	10.09
Birth rate per 1000 population	11.0
Growth rate	0.0%

Routine immunization in Moldova

The Ministry of Health (MoH), through the National Centre of Public Health coordinates and manages the Expanded Program for Immunization (EPI) from a national level. At the city/district level the program is managed by the city/district Centres of Public Health (CPH) in close cooperation with the Primary Health Care (PHC) services that deliver immunization to the population.

In urban areas immunization is delivered through Family *Medicine Centres* (FMC), that serve a population ranging from 40,000 to 80,000 inhabitants; in rural areas through *Health Centres* (HC) usually established for 4,500 inhabitants, *Family Doctor Offices* (OFD) serving between 900-3,000 inhabitants and *Health Offices* (HO) being smallest in size, employing only family medicine nurse and serving up to 900 residents.

Managers of primary healthcare facilities are in charge of organization and delivery of immunization services to a population living in a facility catchment area. Private facilities, which are yet small in numbers, though growing in big cities, do not engage in a delivery of the routine immunization services funded by the state.

Personnel involved in immunization activities are paediatricians, family doctors, and patronage and vaccination nurses. Doctors are responsible for setting individual child's immunization schedule, conducting pre-immunization check-ups, supervising nurses in defining target groups and in undertaking monthly planning and reporting. Patronage nurses have their own catchment's area and they are responsible for informing parents about vaccination, vaccine and supply provision, recordkeeping and delivering vaccine shots. Family Medicine Centres with large catchment population usually have special immunization cabinets staffed with a vaccination nurse. Immunization service delivery is fully integrated with other components of the PHC. **In Moldova in all primary health care facilities immunization is delivered as a fixed strategy and no outreach activities are being carried out**. Therefore, costs captured in this study only relate to the fixed strategy.

Immunization services are organized by sessions. Their frequency varies by facility type and depends on a facility's target population. For example, FMCs organize immunization sessions daily, HCs twice a week, OFDs once a week and HOs once or twice per month.

In Moldova the first National Immunization Program was approved for 1994-2000. This program introduced universal immunization of newborns against Hepatitis B. The latest program covered 2011-2015 and guaranteed free of charge immunization services against ten infectious diseases: poliomyelitis, diphtheria, tetanus, pertusis, hepatitis B, measles, mumps, rubella, tuberculosis, and hemophilus influenza type B. The vaccination schedule, which was in force in 2011, is described in Table 1below. Implementation of immunization against Haemophilus influenza type b using combined tetravalent vaccine DTP-Hib was initiated in 2009, but in May 2010 primary vaccination with DTP-Hib vaccine was temporarily halted because of supply challenges faced by the UNICEF Supply Division; as a result, country re-applied to the GAVI Alliance to change formulation of Hib containing vaccine to Pentavalent. In July 2011 the pentavalent DTP-Heb B-Hib vaccine, introduction of which did not require changes in the vaccination schedule, replaced DTP-Hib vaccine.

Table 1: The National Vaccination Schedule of 2011 with Rotavirus addition in 2012

ANTIGEN	24 h	2-5 d	2 month	4 month	6 month	12 month	22-24 month	6-7 y	15-16 y	26,36, 46,56 y
BCG										
DTP										
DTP Hib/DTP-Hep B-Hib										
Rotavirus vaccine										
DT										
OPV										
Hep B										
MMR										
TD										

Prices per dose for each vaccine included in the national immunization schedule of 2011 and number of doses per vial are presented in Table 2 below

Table 2: Vaccine prices in 2011 and doses per vial

Vaccines	Doses per vial	Price per Dose $ USD
BCG	20	0.16
DTP	10	0.31
MMR	1	3.06
MMR	10	2.40
Tetra	2	3.40
DTP-Hib-Hep B	1	3.08
OPV	10	0.28
Hep B	1	0.97
DT	10	0.19
TD	10	0.17

The National Immunization Program in Moldova is performing well and according to the WHO and UNICEF estimates for the last five years Immunization coverage was attained at over 90 percent for all vaccines. Coverage rates for different antigens are presented in Table 3 below

Table 3: Vaccination coverage (in %) by antigens and years (2007-2011) [5]

Vaccine	Year				
	2007	2008	2009	2010	2011
BCG	98	98	96	99	99
DTP1	96	93	88	96	97
DTP3	93	90	85	95	96
OPV	96	97	87	97	97
Hep B3	96	98	89	98	98
Measles	91	97	90	94	95

According to the latest comprehensive multi-year plan for immunization (cMYP) [2] for the year of 2011 wastage rates for different antigens were planned as following:

Table 4: Vaccine wastage rates for 2011 according to the cMYP

Vaccines	Doses per vial	Wastage rates (%)
BCG	20	60
DTP	10	20
MMR	1	5
MMR	10	15
DTP-Hib-Hep B	1	8
OPV	10	15
Hep B	1	5
DT	10	15
TD	10	15

Introduction of new vaccines in Moldova

In May 2011 Republic of Moldova applied to the GAVI Alliance for support of Rotavirus vaccine introduction. Gastroenteritis caused by a Rotavirus is a significant public health problem in Moldova. Starting from 2008 WHO supported rotavirus sentinel surveillance, which showed that about 39% of hospitalized diarrheal cases among children under age of five years (or about 2700 children per year) was due to a rotavirus infection[6]. Based on these findings the Government decided to introduce single dose Rotarix™ vaccine into the routine immunization schedule starting from July 2012. Vaccination against Rotavirus is being conducted along with the DTP-Hep B-Hib and OPV vaccines at 2 and 4 months of age. The revised vaccination schedule reflecting rotavirus vaccine addition to the National schedule is provided in Table 1 above.

Prior to introduction of the new vaccine cascade trainings were delivered, starting from the national level and proceeding to a health care facility level. Immunization records, vaccination coverage and vaccine stock monitoring forms were adapted according to the new schedule. Micro-planning activities for the introduction of the new vaccine were carried out. The European immunization week conducted during 2011 and 2012 was used as an opportunity for informing population and for creating demand for a new vaccine.

In 2011 Effective Vaccine Management Assessment was carried out and evidence-based plan to improve management, monitoring and supervision of the country immunization supply chain was developed. The assessment revealed that existing cold chain capacity at the national as well as at a district and facility level was sufficient to accommodate new *Rotavirus* vaccine and introduction did not require procurement of additional cold chain equipment [7].

Current knowledge on costs and financing of immunization globally

As stated earlier, going forward and increasing vaccine coverage rates as well as for introduction of new vaccines in national immunization programs, requires better knowledge of costs as well as cost determinants. Therefore, provided study is aimed at contributing to this body of evidence and informing future policies on a country and global level.

Most facility based costing studies conducted in different parts of the world show that service volume or scale [8] [9] [10] (e.g. number of doses administered per session), number of staff involved and their salaries, number of immunization sessions [11], type of immunization strategy, vaccine wastage rate [8] [9] [12] and local prices affect total immunization program cost. Similar conclusions, although with slight difference, were reached by the study, which looked at financial sustainability of immunization programs in 50 countries by using their *Comprehensive Multi Year Plans* (cMYP) submitted to GAVI. This study showed that country variability and drivers of immunization program cost were linked to: a) difference in schedules, b) labour cost differences, c) population size, d) country development status and income, e) immunization coverage rates and f) delivery strategies (fixed, mobile services, mass campaigns) [13].

Brenzel et al (2006) found in Tajikistan that public resources allocated to health and number of hours facility staff spent on immunization per month was positively associated with facility outputs i.e. number of doses administered. Also several studies highlighted the role other factors i.e. maternal education, hospital births, etc. had also determining impact on the use of immunization services [14][15][16][17][18][19]and consequently its costs.

While the evidence is diverse, up to date very little analysis is available that looked at immunization program costs and their determinants using facility level costing and multivariate approaches. Therefore in this study we tried to evaluate overall cost of the immunization program and its cost elements arising on different levels of health service provision (i.e. facility level, district and national level). Furthermore we tried to look at facility level productivity as well as evaluate collective influence of various factors in determining overall cost on a facility level and on unit costs.

Current knowledge on costs and financing of immunization in Moldova

For time being the best evidence about cost of immunization services and volume of financing in Moldova is available from the *Comprehensive Multi-Year Plan* (cMYP) for 2011-2015, which shows that total cost of the National Immunization Program without shared costs was estimated at $US 3.405 million in 2011. The shared health system costs were the largest part (≈57%) of the total program cost estimated at $US 7.839 million (see Table 5). And more than 60% of the total immunization program costs were attributable of human resources (including shared personnel costs) and the share of vaccines and injection supply was only 18%. Based on these estimates cost per DTP 3 child was $ US78.2, when shared cost were not considered and to $USD 191 when shared costs were included (see Table 5).

Table 5 Moldova cMYP: Costs and indicators

Main cost indicators	2011
Total immunization cost without shared cost	$3,405,963
Per capita	$0.8
Per DTP 3 child	$78.2
Total immunization cost with shared cost	$7,839,496
Per capita	$1.9
Per DTP 3 child	$191.0

Financing immunization services in Moldova is shared between central budget and National Health Insurance Fund (CNAM). Central Government is responsible for procurement of vaccines, injection supplies, cold chain and laboratory equipment as a part of targeted national budgetary program. It also maintains all facilities at the national level (e.g. National Centre for Public Health). Donor support is mainly used for trainings, strengthening program management and for enhancing *Vaccine Preventable Disease* (VPD) surveillance. GAVI supports procurement of new vaccines and injection supplies [6]. The National Health Insurance Fund (CNAM) funds all recurrent costs related to vaccination on a health care provider level. Based on the cMYP projections for 2011 the Ministry of Health and the National Health Insurance Fund were supposed to be the main financiers of the EPI contributing 88.8% of the total financing that is necessary for the routine immunization program.

Immunization Costing

The Study Methodology

Sampling

This is a cross-sectional facility-based costing study, which looked at total and unit costs of the routine immunization and estimated incremental costs of a new vaccine introduction, arising at different levels of the health care system (i.e. facility, district and the national level).

The study used multistage stratified random sampling. At the first stage we selected 6 districts from total 37 districts of the Republic of Moldova[3]. The Ministry of Health provided the list that included all districts and big cities, which formed the basis of the sampling frame. The total number of vaccine doses delivered helped stratifying districts in three groups. Such stratification assures equal probability of selection of the districts with low, medium and high numbers of vaccine doses administered. Low doses denote districts where up to 20,700 doses were administered in 2011, the districts with annually administered doses were between 20,700 – 30,499 were attributed to medium strata and finally all districts/cities with annual doses more than 35,000 were grouped into high dose strata. In each stratum two districts were chosen by a simple random sampling approach. Consequently, following six districts were selected for the study: Bricheni, Leova, Vulkanesti, Calarasi, Ungheni and Chisinau - the capital city.

The second stage included random selection of facilities within each sampled district. For this purposes only primary health care facilities were selected, as they are the only providers of the immunization services in Moldova[4]. A total list of the facilities in each sampled district/municipality was obtained from the Ministry of Health. The list consisted of 215 primary care facilities and excluded maternity houses and private primary care clinics, which do not participate in the national immunization program. In order to calculate the number of urban and rural facilities in a sample, proportional allocation technique was used. Firstly, proportions of urban/peri-urban and rural facilities from the total number of facilities in sampled districts were estimated: Rural 181 (215) – 84.5%; Urban/peri-urban 34 (215) -15.8%; then these proportions were applied to calculate the number of rural and urban/peri-urban facilities to be included in the sample. Consequently 42 (84.5% of 50 facilities) rural facilities and 8 urban/peri-urban (15.8% of 50) facilities were selected for survey. One peri-urban facility was selected in each of the five sampled districts Briceni, Calarasi, Leova, Ungheni and Vulcanesti and the remaining three urban facilities were randomly selected in the capital city Chisinau. If more than one peri-urban facility existed in a district, simple random sampling approach was used for facility selection. Rural facilities were selected using systematic random sampling. For each selected facility a replacement was identified. In total 50 primary health care facilities were included in the study: 8 urban/peri-urban and 42 rural facilities, which included 5 family medicine centres, 10 health centres, 23 offices of family doctors and 12 health offices[5]. Such selection assures representativeness of the study findings on a national level. The number and location of facilities in which the costs were measured are given in Table 6 and further details of sampling could be found in Annex 1 to this document.

[3] Transnistria, that is a conflict affected zone and access to facilities is problematic, was excluded from the sampling frame.

[4] The only vaccine, which is administered in hospitals is BCG. Due to low number of doses of BCGs administered at the hospital facilities, the study team decided to concentrate most resources on sampling the facilities where vaccination is one of the critical function.

[5] Detailed description and explanation of facility types listed here is provided on page 7 – Routine Immunization in Moldova

Table 6: Number of facilities in which data collection took place by district

District	Sampled Urban facilities	Total Urban Facilities in a District/Municipality	% of total urban facilities sampled	Sampled Rural facilities	Total Rural Facilities in a District/Municipality	% of total rural facilities sampled
Briceni	1	2	50%	7	31	22%
Calarasi	1	1	100%	8	35	22%
Chisinau	3	26	11%	2	9	22%
Leova	1	2	50%	7	32	21%
Ungheni	1	2	50%	17	70	24%
Vulcanesti	1	1	100%	1	4	25%
Total	**8**	**34**	**24%**	**42**	**181**	**23%**

The survey tool and data collection

A generic questionnaire for cost data collection was developed and provided by the BMGF to all country teams involved in this research. The questionnaires underwent significant adjustments to a county context and were translated into Russian prior to implementation. Questionnaires were field-tested and further adjustments were incorporated. The data was collected with the help of experienced data collectors, who received two-day long on the job training. Overall data collection, which took place during October 3rd 2012 to January 14th 2013, was closely supervised by the survey coordinator and quality assured by CIF researchers.

Prior to the survey initiation, CIF research team carried out introductory meeting with the Government officials. The MoH provided official letter, which requested the facility managers to support the research team during the data collection process. The MoH for a specific approval and cooperation contacted directors of *District Public Health Centres*.

District and facility level data collection included interviews with facility administrators and health workers, facility observation, and record review. Manual for data collectors was prepared for use as a reference material. The manual provided detailed instructions for completion of each questionnaire, proposed list of key informants for interviews and required logbooks and statistical forms to be reviewed during facility visit. The survey implementation plan was prepared and agreed with data collectors.

Each facility visit required at least one working day, while larger facilities were visited for more than once. Four facilities were replaced according to the predetermined list, because no vaccinations were performed there (see Annex 1).

Data Quality Assurance

Data quality and verification process implied different strategies. As a first step research team developed Excel™ based data entry form, which replicated the paper-based data collection tool. The data collectors were requested to fill electronic questionnaire individually for each facility soon after the facility visit and submit to the survey coordinator. The Excel™ based questionnaire allowed checking for logical consistency, data completeness and for data accuracy immediately after a facility visit. In case of a missing or data errors the questionnaire was sent back for correction.

Excel™ based database was created and data from electronic questionnaires were transferred into the database at the CIF premises. Following the data entry CIF research team validated the data using basic logical links, descriptive statistics, which helped detect odd results and outliers. Such inconsistencies were further verified with the questionnaires first and with the data collectors, where necessary.

Data weighting

Data weighting used in the study was informed by the multi-stage random sampling approach, described earlier in the document. The first stratum (low number of doses administered) consisted of 12 districts, the second stratum (medium number of doses) included 13 and the third one (high number of doses) - 12 districts. The Capital city Chisinau was included in the third stratum. Total population in Chisinau is 10 times higher compared to other districts and the size of urban facilities in Chisinau is significantly bigger. Therefore, for weighting purposes facilities located in Chisinau were separated in a fourth stratum. As a result urban/peri-urban facilities were divided between urban (Chisinau) and peri-urban (other districts) locations.

Weights for ***selected districts*** were calculated by calculating probability of district selection in each stratum (see Table 7).

Table 7: District weights by strata

N	Strata	Total No of Districts	No of sampled districts	District Weight
		A	B	W=B:A
1	Low doses administered	12	2	0.16667
2	Medium doses administered	13	2	0.15385
3	High doses administered	11	1	0.09091
4	Capital City	1	1	1.00000

Weights *for the facilities* were calculated using probability of selecting a facility within a relevant stratum (see Table 8).

Table 8: Facility weights by strata

N	Strata 1	Strata 2	Total N of Facilities	No. of Sampled Facilities	Facility Weight
	A	B	C	D	W=D:C
1	Low doses administered	Rural	257	8	0.03113
		Semi-urban	15	2	0.13333
2	Medium doses administered	Rural	464	15	0.03233
		Semi-urban	17	2	0.11765
3	High doses administered	Rural	508	17	0.03346
		Semi-urban	22	1	0.04545
4	Capital City	Rural	9	2	0.22222
		Semi-urban/urban	26	3	0.11538

Approaches used for cost estimation

Approach to estimating routine immunization costs

Retrospective costing for 2011 of the routine EPI was conducted in this study. We evaluated both financial and economic costs of the routine EPI program and all local costs were converted into 2011 $US using average exchange rate of 11.73 MDL per 1 $US. Calculations were based on common approach methodology for the costing and financing analysis of routine immunization program [20] and cMYP costing guideline [21].

The routine EPI cost includes both a) immunization specific costs that include monetary values of all inputs and activities which are exclusively used for immunization and b) shared costs, which include costs of different inputs utilization of which for EPI is less than 100%.

Costs of all inputs were captured using an ingredients approach listing all inputs by activity and quantities and prices for each input element [12] [22]. Information was collected for all the resources used for delivery of EPI services, including value of donated goods and services.

Table 9: Useful Life Years for different capital items

Capital Item	ULY
Buildings	40
Vehicles	
Van	13
Passenger car	10
Cold chain equipment	
Refrigerators/freezer	15
Cold boxes	10
Office equipment	5

The cost data included a comprehensive list of capital as well as recurrent expenditure items. Items with a useful life of more than one year were treated as capital cost elements and EPI related resources consumed or replaced within a period of up to one year were treated as a recurrent cost item.

Capital costs were annualized using straight line depreciation method i.e. a replacement value of a capital items was divided by a number of *Useful Life Years* (ULY) and for the economic cost estimation capital costs were annualized using a 3% discount rate[23]. Country specific ULYs for different capital items used in the cost analysis are presented in Table 9.

Following approaches were used for estimating different costs

For estimating different cost categories as a reference material we used a *Common Approach* document that was supplied by the Gates Foundation [20] and detailed descriptions of used categories/variables are provided below:

Cost of labour includes salaries and other allowances for staff involved in the EPI. Costs were calculated based on a percentage of time spent by a staff on different EPI activities.

Cost of Vaccines and syringes for routine immunization were calculated for each antigen/vaccine using stock records. The total vaccine costs for 2011 were estimated by multiplying a number of doses used by a facility in 2011 by a vaccine price per dose, which includes freight costs as well. The number of doses used includes both number of doses administered and doses of a vaccine wasted. The wastage rate was calculated for each antigen using following formula:

Vaccine wastage rate= [(doses supplied-doses administered)/doses supplied] x 100

Where: Doses supplied = (stock at the beginning of the year + Quantities received during the year) – stock remaining at the end of a given year.

Cold Chain equipment cost was calculated using a number of cold chain equipment by type and equipment prices obtained from the WHO Products Information Sheets [24]. These costs were annualized to obtain replacement costs for the equipment.

Cold Chain energy cost was estimated based on energy consumption characteristics of equipment. Electricity usage according to the type of equipment was collected from the WHO Products Information Sheets. A unit price of $US 0.095 per kilowatt/hour were used for energy cost estimation.

For those costs that are not exclusive to immunization, different cost allocation methods were used, which are summarized in Table 10 below:

Table 10: Approaches for allocating shared costs to the routine immunization

Line Item	Approach for allocating shared costs to the total immunization	Approach for allocating immunization cost to different immunization activities
Personnel cost	% Of staff time spent on the immunization	% Of staff time spent on different immunization activities
Cold chain equipment cost		Cost of refrigerators and freezers was allocated to the facility based service delivery, cost of cold boxes was allocated to the vaccine collection and distribution function
Other office equipment and furniture cost	% Of staff time used for routine immunization	% Of staff time spent on different immunization activities. At a facility level cost was allocated to a facility based service delivery, at a district and national levels cost was allocated to a program management, HMIS and surveillance
Cost of vehicles	Proportion of km travelled for routine immunization out of total km travelled in 2011	Proportion of km travelled for each immunization activity out of the total km travelled for routine immunization
Vehicle maintenance cost	Proportion of km travelled for routine immunization out of total km travelled in 2011	Proportion of km travelled for each immunization activity out of the total km travelled for routine immunization
Building cost	Proportion of square meters designated for routine immunization (where vaccines are administered, stored) out of total facility square meters	At the facility level cost was allocated to a facility based service delivery, at a district and national levels cost was allocated to program management and surveillance; cost allocation to these two functions was done using the ratio of staff time spent on program management and surveillance
Building overhead cost	Same as above	Same as above
Transport/fuel cost	Sum of transport/fuel cost of all immunization activities	Allocated directly to the relevant activity; when the trip was used for multiple purposes, % of time spent on each activity was used as a proxy for allocation

Total EPI costs were further distributed by different immunization activities, which included: facility based routine immunization service delivery, record keeping & HMIS, supervision, training, social mobilization, surveillance, cold chain maintenance, vaccine collection and distribution, program management and other immunization activities.

Using total costs of the EPI program, we have also estimated cost per dose delivered, cost per *Fully Immunized Child* (FIC[6]), cost per infant and cost per capita**. The cost per dose** was computed by dividing total facility cost by total number of doses administered at a given facility. **The cost per Fully Immunized Child (FIC)** was computed by dividing a total facility cost by a number of children that received three DPT doses at this facility. **The cost per Infant** was calculated by dividing a total facility cost by a total number of infants in a facility catchment area. Cost per capita was estimated by dividing a total facility cost by a total population in a facility catchment area. Delivery unit costs (cost without vaccines and injection supplies) such as

[6] FIC in our report denotes the number of children who have received three doses of DTP vaccine (DTP3)

delivery cost per dose, delivery cost per FIC, delivery cost per infant and delivery cost per capita were also computed.

Approach to estimating a new vaccine introduction cost

We have estimated economic, financial and cash-based/fiscal incremental cost of a new vaccine introduction whether financed by the government or through other sources. Considering that Moldova introduced Rotavirus vaccine in July 2012 the cost of Rotavirus vaccine introduction was estimated prospectively. The data collection captured all costs (for capital equipment, for surveillance, for trainings, for social mobilization and etc.) incurred six-month prior and six month following the date of vaccine introduction. Obtained costs in local currency were converted to 2011 $US using current exchange rate and annualized.

We used WHO recommended methodology for estimating costs of introducing a new vaccine that entails identifying all inputs required for the introduction along with quantities and unit costs (so called ingredients approach to costing) [25] [26].Resource items required for the Rotavirus vaccine introduction were identified through review of the national plan for Rotavirus vaccine introduction and by interviewing key informants.

Due to the fact that staff does not work exclusively on the Rotavirus vaccine; incremental personnel costs were assessed on the bases of time allocation. The survey tool allowed collecting information about additional time spent by a staff on any stage of the Rotavirus vaccine introduction (planning, social mobilization, vaccine delivery, etc.). Consequently, additional human resource costs were estimated and considered in the economic cost analysis. Additional allowances provided to personnel of the national public health centre and related to the rotavirus vaccine were also included in our estimations[7].

Cost of Rotavirus vaccine was estimated/projected using the following formula:

$$\textbf{Cost}=\textbf{P} \times \textbf{C} \times \textbf{B} \times \textbf{D} \times (1/(1-\textbf{W})) \times (1+\textbf{R});$$

Where **P** denotes costs per vaccine dose (including freight expenses), **C** denotes predicted vaccination coverage rate of the first dose for the Rotavirus vaccine, **B** denotes target population, **D** denotes number of doses per child, **W** denotes wastage rate and **R** denotes the reserve stock. No correction was made for anticipated dropout rates [27]. Considering that Rotavirus vaccine is administered along with the DTP-Hep B-Hib and OPV vaccines, the coverage rate for the first dose of DTP-Hep B-Hib vaccine was used. A birth cohort for 2012 and 25% of reserve stock were applied during cost estimation. A wastage rate of 5% was predicted for a single dose vial of the Rotavirus vaccine per WHO recommendation [28]

Information on cold chain investments necessary for the rotavirus vaccine introduction was obtained from the National EPI manager. An Effective Vaccine Management Assessment Report, undertaken in 2011 was also used for this estimation [7]. Existing cold chain capacity was sufficient to accommodate additional space/volume demand; therefore no additional cold chain equipment was purchased prior to introduction. Although no additional investments were made in the cold chain, for **economic costing** we allocated cold chain cost to the Rotavirus vaccine based on the % of space need for the new vaccine. A two-step method was used for these purposes: firstly, the percentage increase in overall vaccine volume was estimated using the WHO vaccine volume calculator [28]; secondly, percentage generated by the new vaccine volume calculator was used to allocate cold chain equipment cost to the Rotavirus vaccine.

In 2012 new investments related to the new vaccine introduction were made only in office equipment. GAVI funds for the new vaccine introduction were used to purchase server and computers for the National Public Health office. These investments were included in cash flow analysis, while for financial costs the value of this equipment was annualized using straight-line depreciation method and for economic costs using discount rate and ULY (as described earlier).

[7] These allowances were covered by the funds of GAVI Alliance

Incremental transportation costs associated with the Rotavirus vaccine introduction were assessed using the specific question in the survey tool: whether the frequencies of vaccine collection and supervisory visits have changed due to the vaccine introduction and if yes, by how much. Cost of training delivered for the Rotavirus introduction was treated as a capital cost with the useful life of 2 years and 3% discount rate.

Data analysis

Excel database was used to estimate/calculate various cost elements (described earlier in this section). Calculated cost variables were eventually transferred to SPSS version 19.0 for descriptive statistical analysis and to STATA for regression analysis.

The Study Limitations

This study has several limitations. Namely:

Recall bias related to a time spent on immunization activities could affect the study results. Although the survey tool was constructed in a way to minimise such biases, findings of the study may still differ from realities on the ground. The study team used different approaches to minimise recall bias by:

- Developing the survey tool in a manner that all respondents were forced to break down their daily activities and allocate a percentage time spent on each activity with the objective that total sum would equal to 100%;
- Whenever possible (mostly in large facilities) doctors or nurses were asked to sit in small groups and discuss time allocation together and reach group consensus. Data collectors facilitated these discussions to avoid over or underestimation of the time spent on each activity.

Furthermore, by not including maternities, where only the first BCG dose and Hepatitis B is administered, total cost of immunization could be underestimated, although due to very small size of the birth cohort, this underestimation would not be significant.

A comprehensive analysis of surveillance costs was beyond the scope of this study. The study is focused only on a) estimating the value of activities related to case detection and outbreak response; b)estimation of the proportion of time and value of time spent at the facility, district, and national levels on surveillance activities, c) estimation of the transportation/fuel cost for surveillance activities. Costs of laboratory services and the cost of capital equipment for surveillance are not estimated; therefore surveillance costs are underestimated in our study.

Therefore, these limitations should be considered when interpreting the study results.

Ethical Issues

CIF tried to secure the national Institutional Review Board (IRB) approval. However, following preliminary review of the study documentation and according to the current legislation in Moldova, IRB decided that the study did not need such approval.

Results of routine immunization costs

In this section of the report we will initially evaluate obtained results on a facility level and will try to look at total and unit costs of the routine immunization program (financial and economic), we will describe observed variation and its explaining factors with the help of univariate analysis. Then we move onto cost aggregation to estimate district and national level costs of the national routine immunization program. Finally, we will dissect the unit cost of immunization into cost elements to better understand cost of various inputs as well as functions carried out by facilities involved in the immunization service delivery in Moldova.

However, prior to describing obtained results on a provider level it is important to understand taxonomy of health care facilities involved in immunization service provision. Text Box 1 lists all those providers that deliver vaccinations in Moldova. Understanding their nature, size, and principles of their establishment is necessary to understand results of the analysis detailed in this report.

Text Box 1 Taxonomy of Providers Involved in Immunization Service Provision

- **Family medicine centres (FMC)** are established in urban locations or district centres and serve a population ranging from 40 000 to 80 000 inhabitants. The National Health Insurance Company (CNAM) directly contract family medicine centres for the provision of basic and specialized outpatient services to district/city inhabitants. They also serve as methodological and organizational centres for all primary care facilities in a district and collate all health care related statistical data for primary care level in a district.
- **Health centres (HC)** usually serve at least 4500 inhabitants and have at least three family doctors. Health centres can be organized as subordinated unit of a FMC or as autonomous entity (public or private). The autonomous health centres are contracted directly by the CNAM for the provision of basic services in their catchment area.
- **Office of a family doctor (OFD)** serves a population between 900–3000 inhabitants and can employ one or two family doctors.
- **Health offices (HO)** are organized in communities with fewer than 900 inhabitants (mostly found in rural areas) and are staffed with only family medicine nurses.

Total Costs and Cost Variation on a facility level

Total facility level immunization costs in the sample varied broadly, between 565$US and 112,548$US, mean being 11,943 $US and median 3,822 $US. Total cost obviously varied and was strongly correlated with the size and scale of a facility (measured by the total number of doses delivered at the facility in 2011). Figure 1 describes relationship between total facility level costs and facility scale on a facility level. Log transformed variables reveal strong positive linear correlation between these two (r=0.95).

Figure 2 presents variability of these costs by facility type and shows that due to size of a facility and due to number of infants in a catchment population total facility level costs grow from Health Offices (HO that are the smallest) to Family Medicine Centres (FMC – that are the largest). Variability within facility types is not major with the exception of FMCs where total facility level costs vary within a broader range 28,335 – 112,548 $US. There are also two exceptions within HOs and HCs namely facility No.12 and facility No.45 seem to have significantly higher costs when compared to their peers (see Figure 2 and for more details see Figure 18 on page 84). Both these facilities were found to be high performing ones delivering more doses annually and achieving high coverage rates. The figure also shows that most sampled facilities achieve highest DTP3 coverage rate, but due to number of underperforming ones the average DTP3 coverage in the sample was 94.8%. HCs and OFDs showed better performance 98.1-97.8% respectively and HOs have the poorest performance - 90.2% followed by FMCs - 92.7%.

Figure 1 Total Economic cost on a facility level by facility scale (i.e. number of annual doses delivered)

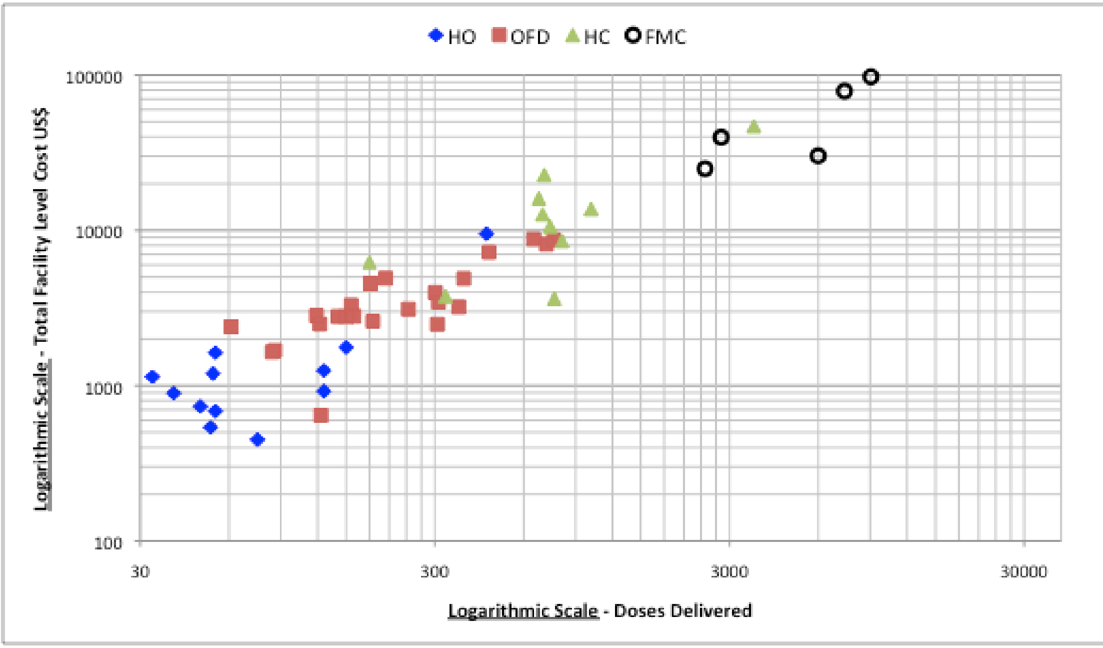
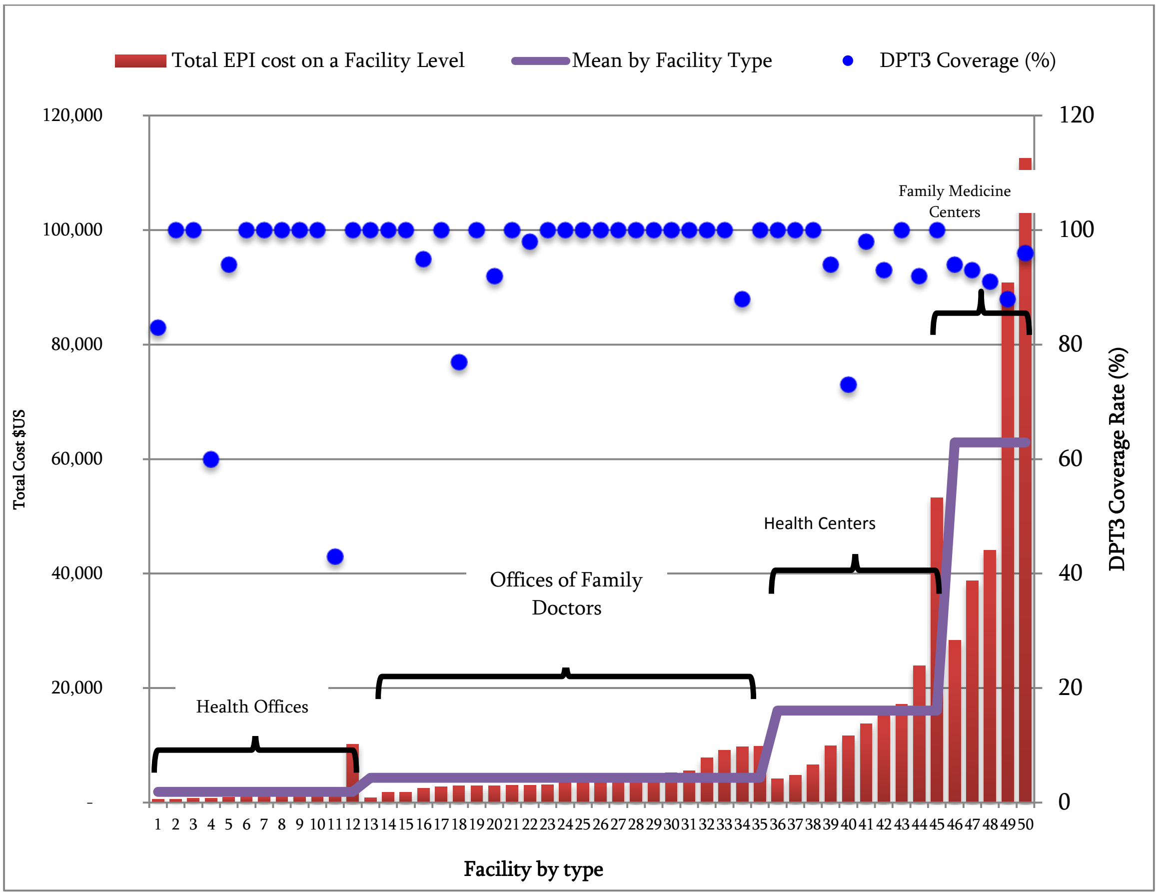


Figure 2: Total economic costs by facility type and DTP3 coverage (%)

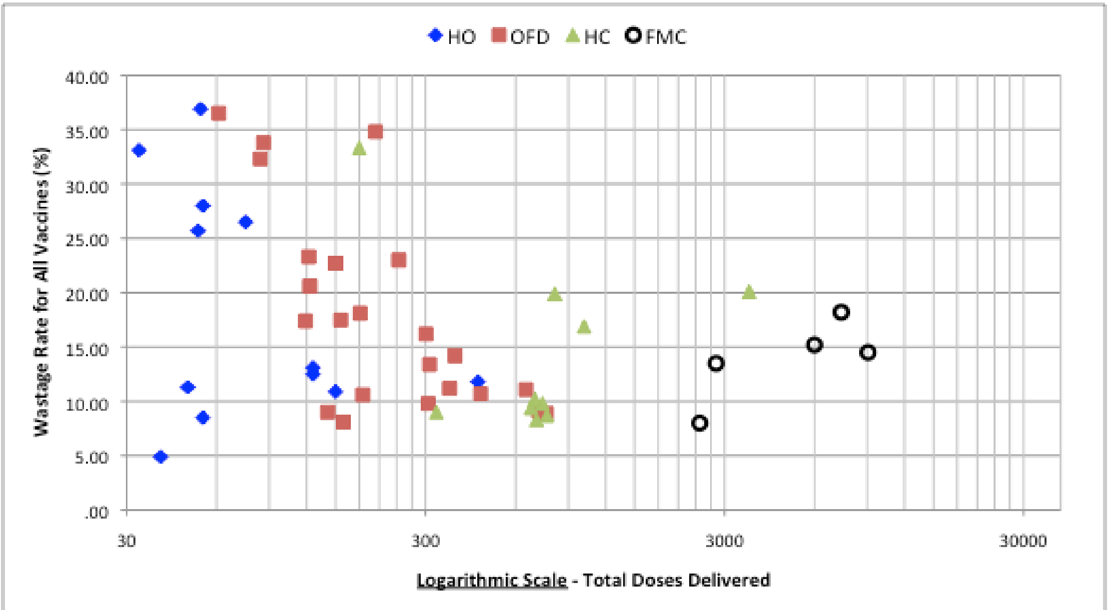


It was interesting to understand what drives these differences in performance. When looked at communities where these facilities operate, OFDs on average have 17.2 infants (95%CI: 16.1 – 18.3) and serve on average a population of 1,555 people; HCs have 47 (95%CI: 39-54) infants and a population of 3,737 and they both are staffed with doctors and nurses. It could be assumed that small size of catchment population with adequate staffing probably allows them to better identify, plan and follow-up infants and consequently achieve higher coverage rates.

Contrary to these facilities, FMCs serve higher number of infants 430 (95%CI: 372-487) in a community with an average population size of 32,616 (95%CI: 28,693 – 36,539). While they also have doctors and nurses they may face challenges in finding, following up and immunizing children due to size of catchment population. Health offices that reveal the poorest performance serve on average 7 infants (95%CI: 6.7-7.9) with 535 inhabitants in catchment area, and should be able to produce better immunization results. However, their DPT3 coverage at 90.2% means that they may not be able to vaccinate with DPT3 only one kid out of seven and DPT3 coverage may not be the best measure for such facilities.

Finally through bi-variate correlation we also looked at overall vaccine wastage rate on a facility level and DPT3 coverage rates. The analysis showed that facilities with higher DPT3 coverage are expected to have lower wastage rate (corr. coefficient = -0.154; $p<0.01$) although the strength of this correlation was weak. We also looked at the relationship between wastage rate and annual doses of immunization delivered by a facility (see Figure 3), which showed that with increasing scale the wastage rate tends to decline, although in a small facilities (HOs and OFDs) we also notice significant variability in a wastage rate, which is not directly related to a scale. Wastage rate could possibly be explained by different factors e.g. by quality of managerial decision-making, by vial size of vaccines delivered, etc. Consequently, influence of staffing patterns, the size of a catchment population and influence of wastage rate on immunization program performance on a facility level has to be thoroughly evaluated using multivariate regression analysis.

Figure 3 Wastage rate for all vaccines by facility scale (i.e. number of annual doses delivered)



We also analysed a) total facility economic and financial costs without labour cost, b) total delivery cost, that is a total cost without costs of vaccine and injection supplies and c) total delivery cost without labour cost. Results of this analysis are presented in Table 11 and Table 12. Total facility economic cost is three times higher compared to the total facility cost without labour, 1.13 times higher compared to the delivery cost with shared labour and 5.5 higher when costs of labour and vaccines are not considered. This indicates that shared labour cost together with the costs of vaccines and injection supplies accounted to almost 82% of the total facility cost.

Table 11: Total facility cost, non-HR facility cost, delivery cost and non-HR delivery cost (economic costs)

Facility Type	Total Cost US$	Total Non-HR Cost US$	Delivery Cost US$	Total Non-HR Delivery Cost US$
FMC	57,869	17,448	49,132	8,711
OFD	4,298	1,264	3,875	841
HC	11,849	3,151	10,715	2,017
HO	1,881	728	1,715	562
Total for all facilities	**6,964**	**2,066**	**6,160**	**1,263**

Table 12: Total facility cost, non-HR facility cost, delivery cost and non-HR delivery cost (financial costs)

Facility Type	Total Cost US$	Total Non-HR Cost US$	Delivery Cost US$	Total Non-HR Delivery Cost US$
FMC	55,877	15,456	47,140	6,719
OFD	4,135	1,101	3,712	678
HC	11,494	2,796	10,359	1,661
HO	1,765	612	1,599	446
Total for all facilities	**6,710**	**1,812**	**5,906**	**1,009**

Total Cost structure on a facility level

Total facility level immunization economic cost structure was analysed by facility type and facility location. (See Table 53 and Table 55 in the Annex 2)

Analysis revealed that the labour cost was a main contributor to the total immunization cost. Average share of labour cost out of the total immunization cost was 70.3% (Figure 4), ranging from 61.3% in HO to 73.4% in HC and from 69.5% in semi-urban facilities to 71. 5% in the facilities located in urban areas. Vaccines and injection supplies were the second largest component of the immunization cost, accounted for 11.5% of the total costs and ranging from 8.8% in HO to 15.1% in FMCs and from 9.7% in rural facilities to 15.4% in semi-urban facilities.

Distribution of the cost by immunization activities shows that the main portion of the cost (47.6%) comes to the facility based service delivery function followed by the Program management (16.9%) and record keeping and HMIS (13%).

Figure 4: Distribution of total routine immunization economic costs by line item

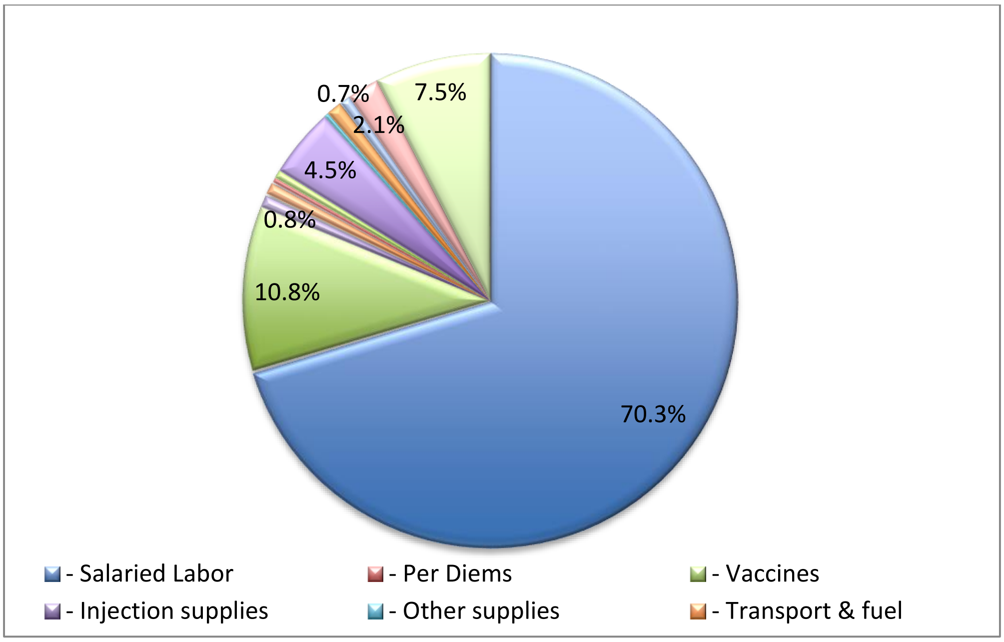


Figure 5: Distribution of total routine immunization economic costs by activity

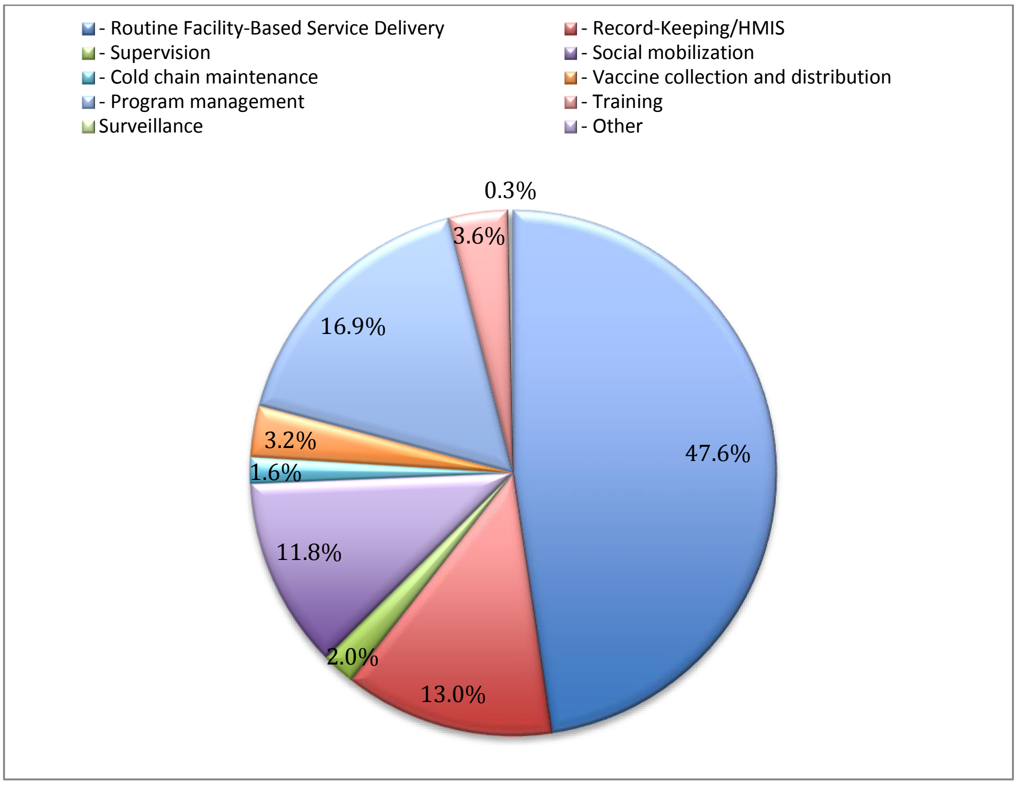


Table 57-Table 60 in the annex 2 present comparisons of the economic and financial costs by cost line items and activities by facility type and facility location.

Unit Costs and Cost Variation on a facility level

As stated earlier, when looking at a unit cost of immunization we used several indicators:

- Cost per dose
- Cost per FIC and
- Cost per infant
- Cost per Capita

We estimated both: financial and economic costs and used t-test for statistical significance. Statistical tests were applied only to un-weighted dataset. Furthermore, when estimating unit costs we looked at *Total Unit Cost* (TUC), which includes salaries for shared labour as well as at *Unit Costs* (UC) without these salaries to see what differences between these two were. We evaluated unit cost variations by looking at three dimensions: a) location i.e. urban-rural differences, b) type of facilities (see details in Text Box 1 above) and c) facility scale (measured by the annual doses delivered at the facility). Delivery cost per dose, per FIC, per Infant and per capita with and without labour costs was also evaluated.

Thorough analysis of financial and economic costs across different dimensions revealed that when TUCs were compared, economic costs were always higher by about 6%, although this percentage was different depending on a dimension used. However, looking at UCs, which does not include cost of shared labour, the difference between financial and economic costs becomes more pronounced around 20%. Therefore, for ease of presentation we primarily concentrate on presenting economic costs in this section, unless otherwise stated. However, detailed presentation of financial and economic costs could be found in Annex 2 to this report.

Table 13 provides unit cost analysis by location, which shows consistent and declining trend of a unit cost from rural to urban facilities; however observed differences did not have statistical significance and point to the fact that location does not have influence on a unit cost of immunization services. Furthermore, TUC comparison with UC, in the same table, shows that on average, when shared labour costs are being considered, unit costs become almost three times higher, and these differences range from 2.8 for rural facilities to 3.7 in semi-urban. This indicates that labour costs have significant contribution to a unit cost and consequently to total cost of the national immunization program. We will try more thoroughly evaluating the impact of shared labour cost later throughout the analysis.

Table 13: Unit Costs by Location on a Facility Level

Unit Cost $US	Rural	Semi-urban	Urban	Total	Sig.
TUC per dose	18.6	14.5	13.1	**18.3**	*n.s.*
TUC per Infant	325	207	165	**317**	*n.s.*
TUC per FIC	340	222	180	**332**	*n.s.*
TUC per capita	3.0	2.3	2.3	**3.0**	*n.s.*
UC per dose	6.6	4.0	3.7	**6.4**	*n.s.*
UC per Infant	116	56	47	**112**	*n.s.*
UC per FIC	122	60	51	**118**	*n.s.*
UC per capita	1.1	0.6	0.6	**1.0**	*n.s.*
TUC/UC ratio per dose	2.8	3.6	3.5	**2.9**	*n.s.*
TUC/UC ratio per infant	2.8	3.7	3.5	**2.8**	*n.s.*
TUC/UC ratio per FIC	2.8	3.7	3.5	**2.8**	*n.s.*
TUC/UC ratio per capita	2.8	3.6	3.5	**2.9**	*n.s.*
N weighted	**1,238**	**54**	**26**	**1,318**	

n.s. = not significant

In Table 14 unit costs are analyzed by facility type. From the table we observe that unit costs increase when facility size declines i.e. when providers start serving less population in a catchment area. However, this trend becomes statistically significant only when shared labour costs are removed and only for UC per dose, UC per capita (at 99% level) and for UC per FIC, but in the latter case the level of statistical significance is low at 90% level only.

When looking at UCs, costs are lowest in FMC, which are largest facilities, mainly located in Chisinau and highest in HOs - located in rural areas. Mean costs in HCs and OFDs are in the same range and are almost two times higher compared to unit costs in FMCs. Based on a literature [9][10][13] observed differences could be explained by numerous factors which include: size of a population served by a facility; scale of a facility itself i.e. number of doses delivered per annum, or by other factors such as education or income level of a catchment population, which could determine demand for services[14][16][18].

Table 14: Unit Costs by Facility Type on a Facility Level

Unit Cost $US	FMC	HC	OFD	HO	Total	Sig.
TUC per dose	10.4	19.4	18.5	18.7	**18.3**	*n.s.*
TUC per Infant	143.9	322.9	338.7	296.5	**316.6**	*n.s.*
TUC per FIC	155.1	328.8	347.2	332.2	**332.3**	*n.s.*
TUC per capita	1.8	3.3	2.9	3.1	**3.0**	*n.s.*
UC per dose	3.1	5.2	5.9	8.5	**6.4**	*p<0.01*
UC per Infant	42.6	88.5	110.6	138.7	**112.3**	*n.s.*
UC per FIC	45.9	89.9	113	152.4	**117.8**	*p<0.1*
UC per capita	0.5	0.9	0.9	1.4	**1.0**	*p<0.1*
TUC/UC ratio per dose	3.4	3.7	3.1	2.2	**2.9**	*p<0.01*
TUC/UC ratio per infant	3.4	3.6	3.1	2.1	**2.8**	*p<0.01*
TUC/UC ratio per FIC	3.4	3.7	3.1	2.2	**2.8**	*p<0.01*
TUC/UC ratio per capita	3.3	3.7	3.2	2.2	**2.9**	*p<0.1*
N weighted	**55**	**190**	**708**	**365**	**1318**	

n.s. = not significant

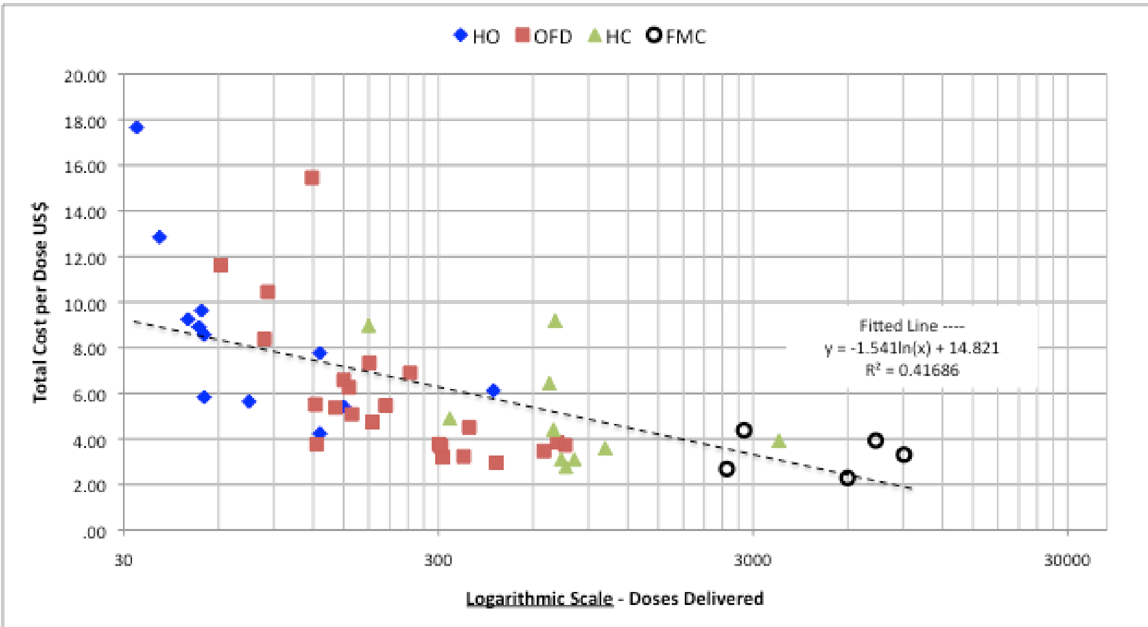
The ratios of TUC/UC costs, presented in Table 14 shows that shared labour costs are relatively higher in HCs and FMCs and their contribution in the unit cost of immunization declines in smaller facilities i.e. OFDs and HOs, and the latter ones have the lowest ratio. The same trend was observed for the delivery unit costs: the ratios of delivery cost/delivery cost without wages are highest in FMCs and decline when facility size decreases. (See Table 15).

Table 15: Total delivery unit costs and delivery unit costs without shared labour costs by facility type

Unit Cost $US	FMC	HC	OFD	HO	Total	Sig.
Delivery cost per dose	8.9	17.8	16.9	17.1	**16.8**	*n.s.*
Delivery cost per Infant	123.1	296.2	309.4	270.7	**289.0**	*n.s.*
Delivery cost per FIC	132.6	301.6	317.1	303.8	**303.5**	*n.s.*
Delivery cost per capita	1.5	3.1	2.6	2.8	**2.7**	*n.s.*
Delivery cost w/o labour per dose	1.6	3.6	4.3	7.0	**4.8**	*p<0.01*
Delivery cost w/o labour per Infant	21.8	61.8	81.3	112.9	**84.7**	*n.s.*
Delivery cost w/o labour per FIC	23.4	62.7	82.9	124.1	**88.9**	*p<0.01*
Delivery cost w/o labour per capita	0.3	0.6	0.6	1.1	**0.8**	*p<0.01*
Delivery cost/ Delivery cost w/o labour ratio per dose	5.6	4.9	3.9	2.4	**3.5**	*p<0.01*
Delivery cost/ Delivery cost w/o labour ratio per infant	5.6	4.8	3.8	2.4	**3.4**	*p<0.01*
Delivery cost/ Delivery cost w/o labour ratio per FIC	5.7	4.8	3.8	2.4	**3.4**	*p<0.01*
Delivery cost/ Delivery cost w/o labour ratio per capita	5.7	5.0	4.1	2.4	**3.5**	*p<0.01*
N weighted	**55**	**190**	**708**	**365**	**1318**	

We also analysed unit costs by the facility scale. Total number of vaccine doses delivered by a facility was used to stratify facilities in three groups. Stratification was done using frequency analysis. Low scale facilities denote facilities where up to 126 doses were delivered in 2011, the facilities where between 127-309 doses were administered were attributed to the medium scale facilities and finally, all facilities with annual doses more than 310 doses were grouped into high scale facilities. Going further and looking at unit costs by facility scale we see that the higher the scale (i.e. more doses a facility delivers a year) the lower the unit cost of immunization (Figure 6). This association is statistically weak for TUC, but when shared labour costs are removed statistical significance of the influence increases up to 99% level

Figure 6: Facility unit costs without shared labour cost by facility scale



From Table 16 it becomes evident that difference in TUC between low and medium scale facilities is marginal and the magnitude of difference increases when shared labour costs are removed. At the same time partial contribution of shared labour costs is highest in a high scale facilities and lowest in low scale ones. All of this leads to a conclusion that labour costs as well as other facility specific factors may play significant role in determining a unit cost of immunization, which requires simultaneous evaluation of various factors with the help of a multivariate regression analysis (described later in the document). Finally, univariate analysis presented in Table 16 proves that scale of a facility (measured in doses delivered) has strong influence on a unit cost and deserves further evaluation in a multivariate model.

Table 16: Unit Costs by Facility scale

Unit Cost $US	Low	Medium	High	Total	Sig.
TUC per dose	20.5	18.3	14.5	**18.3**	*n.s.*
TUC per Infant	331.5	352.8	216.1	**316.6**	*p<0.1*
TUC per FIC	357.5	359.7	231.2	**332.3**	*p<0.1*
TUC per capita	2.8	3.2	2.7	**3.0**	*n.s.*
UC per dose	9.1	5.2	3.9	**6.4**	*p<0.01*
UC per Infant	157.3	99.8	57.4	**112.3**	*p<0.01*
UC per FIC	167.3	101.7	61.6	**117.8**	*p<0.01*
UC per capita	1.3	0.9	0.7	**1.0**	*p<0.01*
TUC/UC ratio per dose	2.3	3.5	3.7	**2.9**	*p<0.01*
TUC/UC ratio per infant	2.1	3.5	3.8	**2.8**	*p<0.01*
TUC/UC ratio per FIC	2.1	3.5	3.8	**2.8**	*p<0.01*
TUC/UC ratio per capita	2.1	3.4	3.7	**2.9**	*p<0.01*
N weighted	**489**	**556**	**273**	**1318**	

n.s. = not significant

Table 17: Correlation Matrix

Variables	Facility Location	Facility type	Scale	Unit Cost per Doze	Unit Cost per FIC	Unit Cost per Infant	DPT3 Coverage rate (%)	Population in catchment area
Facility location (Rural =0)								
Facility Type (HO = 4)	-.232**							
Scale (low =1)	.375**	-.486**						
Unit Cost per Doze	-.131**	.069*	-.263**					
Unit Cost per FIC	-.166**	.027	-.217**	.678**				
Unit Cost per Infant	-.168**	-.034	-.192**	.635**	.962**			
DPT3 Coverage rate (%)	-.067*	-.27**	.083**	-.027	-.040	.214**		
Population in catchment area	.883**	-.322**	.446**	-.213**	-.219**	-.22**	-.057*	

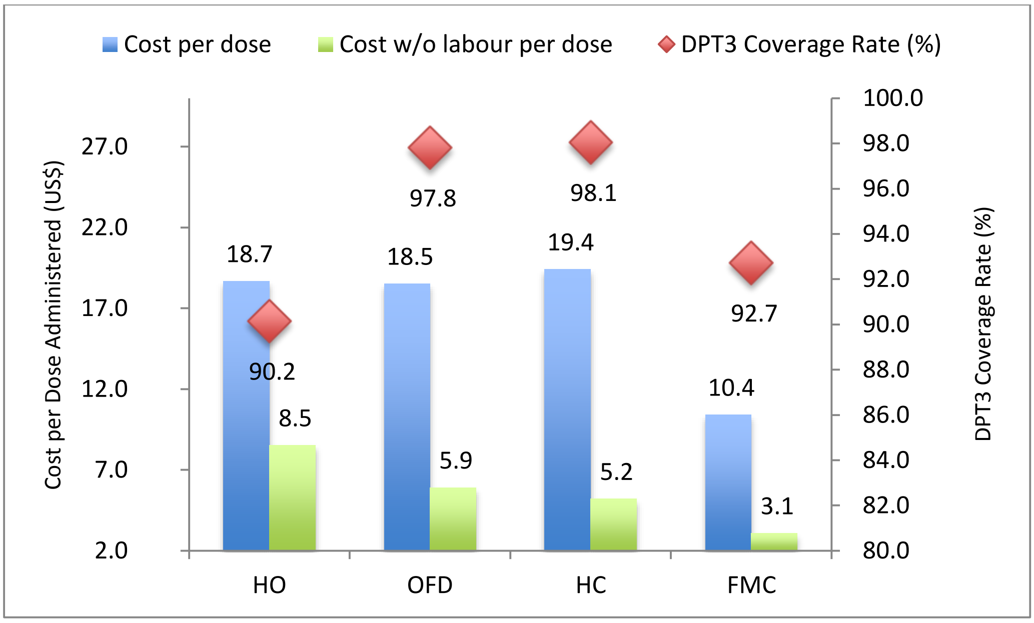
** Correlation significant at the 0.01 level (2-tailed).
* Correlation significant at the 0.05 level (2-tailed).

Finally, Pearson's bi-variate correlation results presented in Table 17 revealed weak relationship between explored influences of facility characteristics on the unit cost. While Pearson's coefficients are weak, statistical significance of most findings are strong and Table 17 shows that facilities located in urban areas could be bigger in size i.e. HCs or FMCs (r=-0.232; p<0.01), could have greater scale (r=0.375; p<0.01), and could be able to deliver immunization services at a relatively lower costs. However, facilities in urban areas are quite likely to serve larger catchment population (r=0.883; p<0.01).

Unit Costs and Immunization Program Performance on a Facility Level

Obtained unit costs were also related to a facility performance measured by facility-specific DPT3 coverage rate. We measured coverage based on a number of children under 1 year of age who have received three doses of DTP vaccine (DTP3), reasoning that DTP3 is a close measure of a routine immunization program performance [29]. For our analysis we grouped facilities by type and tried to evaluate relationship between TUC, UC and DPT3 coverage rates. Results are presented in Figure 7, which shows that HOs that have lowest DPT3 coverage rate (although as mentioned earlier this could be just one child out of seven that missed the third dose of DPT) spend comparable amount per dose delivered with OFDs and HCs, however amount of non-labour inputs are highest in HOs when compared to other facilities. HCs spend highest amount per dose delivered but also achieve highest coverage rates. FMCs seem to be the most efficient facilities being able to deliver immunization at a lowest cost per dose as well as use least amount of labour and non-labour inputs. Finally, while HCs spend highest amount per dose delivered they spend least (after FMCs) on non-labour inputs.

Figure 7 DPT3 Coverage on a facility level and unit costs and delivery unit costs of service provision



Therefore with increased scale, labour and non-labour inputs are more effectively used and smaller facilities are more prone to be more inefficient. However, observed tendency of declining use of non-labour inputs when increasing scale (see Figure 7) as well as variable contribution of labour inputs in achieving high DTP3 coverage points to the fact that labour inputs might be as well important in determining DTP3 coverage rates i.e. facility performance. This hypothesis was further analysed by looking at hours and minutes spent on delivering a dose of immunization or administering three DPT doses to a child.

Results of this analysis are presented in

Figure 8 and Figure 9 and show that health offices use the largest amount of staff time to deliver a dose of immunization (65.6 minutes) or to immunize a child with three doses of DPT vaccine (19 hours). Effectiveness of human resource use improves as the facilities become bigger and scale of immunization services increase. Consequently FMCs spent the least amount i.e. 8 minutes for delivery of a dose and 2 hours for immunizing a child with three doses of DPT vaccine (see Figure 9 for details).

Figure 8 Time spent on immunization services by type of a facility and doses administered

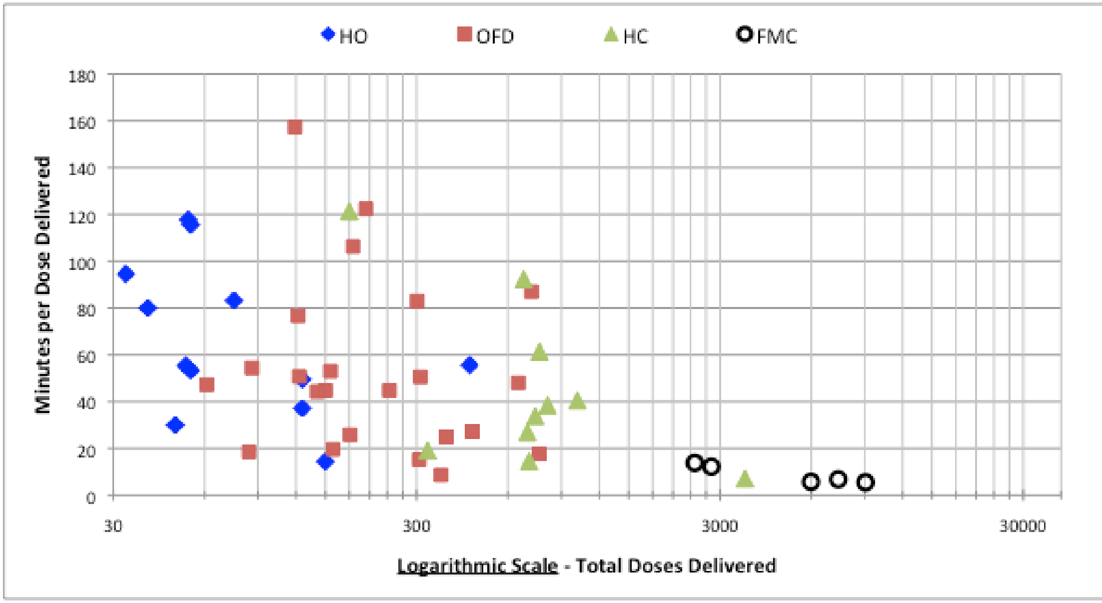
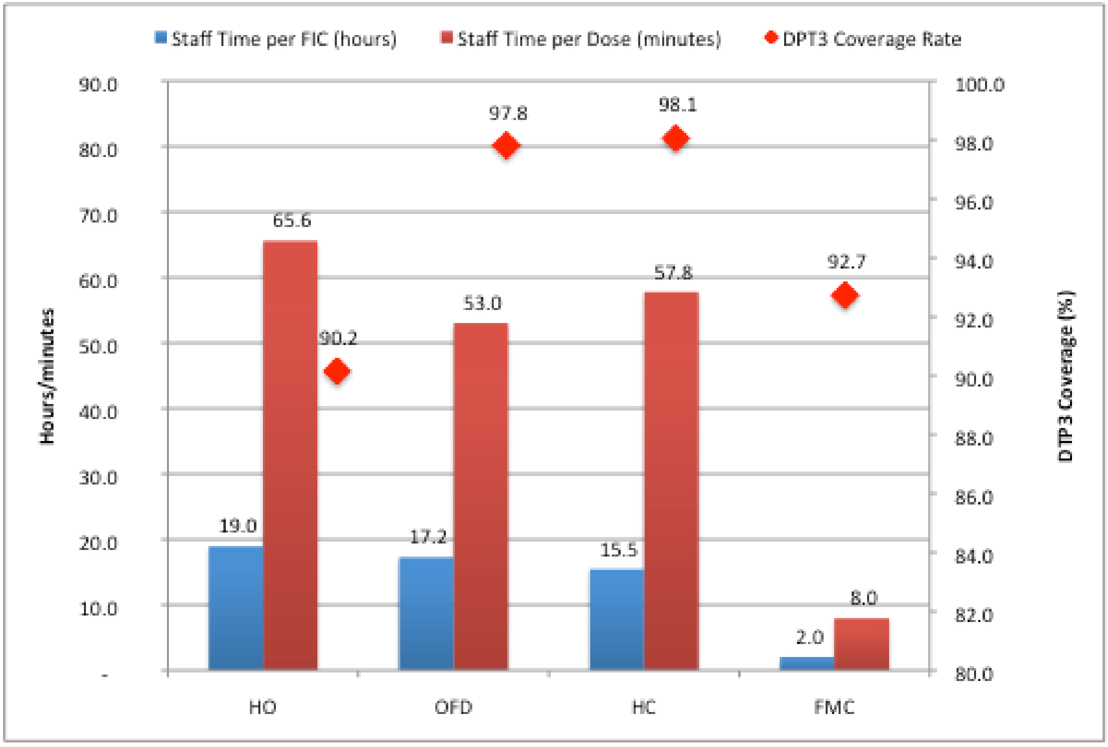


Figure 9 Time spent on immunization services by type of a facility



All of these points to the need that in a multivariate analysis influence of labour related as well as non-labour related factors have to be carefully evaluated. This could help explain, what may be required for improving facility level productivity as well as will help understand what needs to be done, in terms of financing and management on a facility level that will help increase coverage rates.
More detailed data on FTEs and staff time allocation on immunization by facility type is presented in Table 61 in the Annex 2

Unit Cost Structure on a Facility Level

Detailed unit cost structure by a facility type and scale was analyzed and results are reflected in Table 18 and Table 19 below. Analysis of a cost drivers revealed that the labour costs are main contributors to immunization costs on a facility level and their share increases along with increase in facility size and scale. Average share of a labour cost contribution was 65.07% for the sample, ranging from 54.42% in HOs to 70.48% in FMCs and from 55.46% in lower scale to 73.27% in higher scale facilities. Figure 10 provides simplified visualization of observed tendencies by recurrent and capital costs. From the figure it is clear that share of recurrent and capital costs vary across type and scale of providers. Namely, share of capital costs in a unit cost of FMCs is lowest - 10.3% and highest in HOs – 22.8%, which are the smallest facilities in their size and capacity and which deliver lowest number of dozes per year.

Figure 10 Unit Cost Structure by facility type and scale

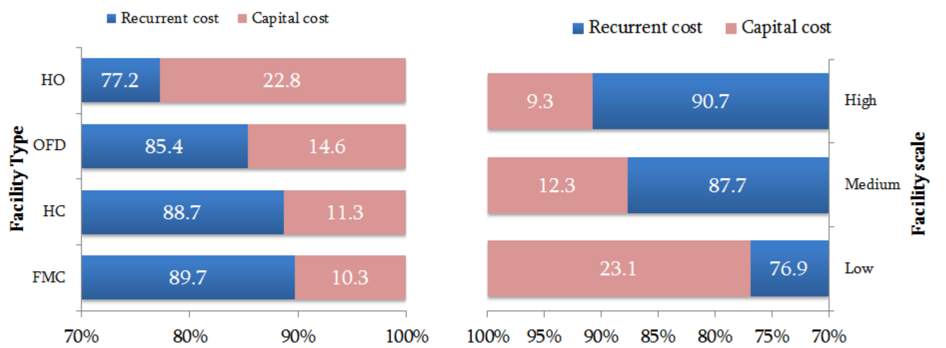
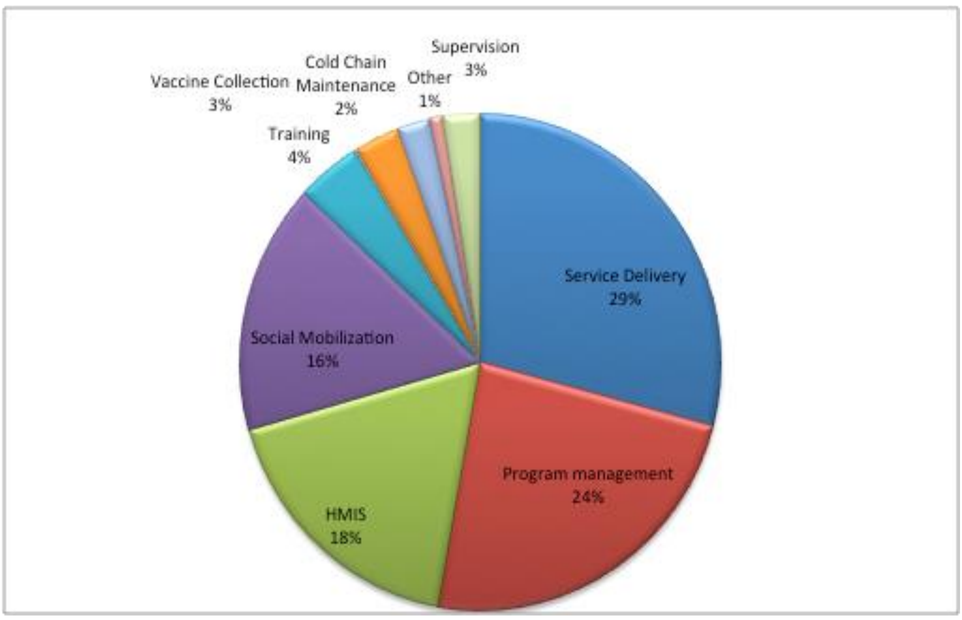


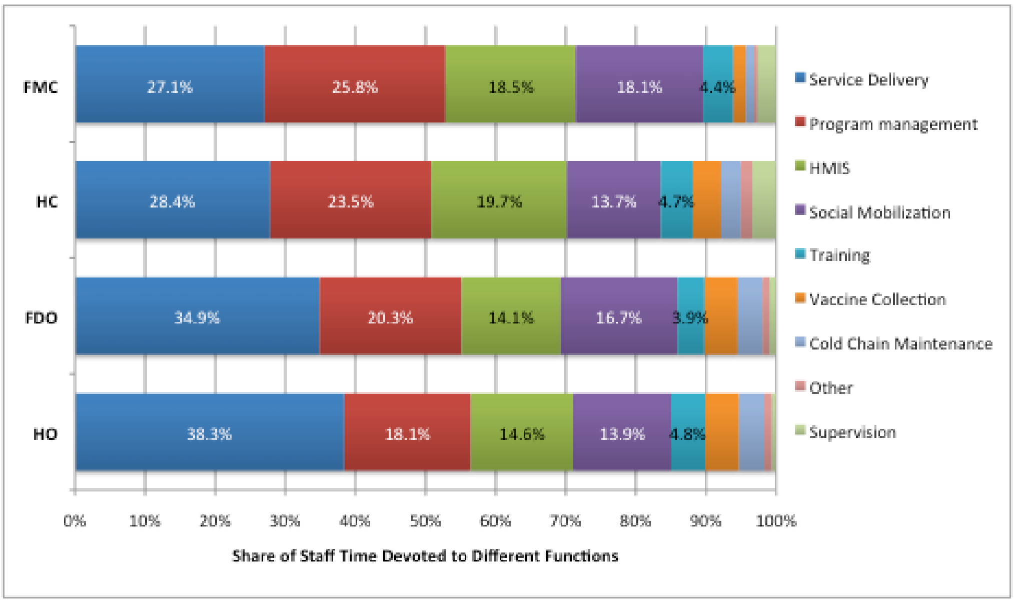
Figure 11 Staff time by immunization specific functions for the sample



Furthermore, in a unit cost of a high scale facility the share of capital costs is around 9.3% while in low scale facility it reaches 23.1%. Higher share of capital in a unit cost is also accompanied by a higher unit cots per dose delivered (see in Table 18 and Table 19 below), which may lead to a conclusion that cost of capital may determine cost of immunization services and more effective use of capital (if this is possible) could help reduce costs. Furthermore, when structure of a recurrent cost is analyzed it becomes obvious that share of a facility related costs (i.e. utilities and communications) do correlate with a facility type as well as with facility scale and consequently with a unit cost of immunization.

Earlier we also presented relationship between labour inputs and facility-specific DTP3 coverage. We have further explored breakdown of staff time by immunization specific functions (see Figure 11) and by type of a facility, which is detailed in Figure 12

Figure 12 Breakdown of staff time by immunization specific functions (unweighted sample)



This analysis shows that largest amount of time is spent on delivering immunization services in a facility and health offices devote the highest share - 38.3% and lowest is in FMCs – 27.1%. However, the time spent on immunization management and planning issues is highest in FMCs and lowest in HOs, 25.8% and 18.1% respectively and it is 24% for the whole sample. Time spent on HMIS and social mobilization is the third and fourth most labour intensive activities in Moldovan PHC facilities.

Weighted average and range of total staff time allocated on different immunization activities by facility type is presented in Table 62 in the Annex 2

In previous section we observed close link between facility type and DPT3 coverage rates, which was also closely associated with the use of labour and non-labour inputs. Therefore, it becomes important to evaluate influence of a facility characteristic (taking into account capital as well as operations related indicators) along with labour inputs in a multivariate model to objectively establish causality between facility characteristics (used as inputs) along with labour use and immunization costs on a facility level and immunization program performance.

Table 18 Unit Cost structure by Facility Type

Item	FMC	HC	OFD	HO	Total
Recurrent cost (%) of Total	**89.7**	**88.7**	**85.4**	**77.2**	**83.71**
Salaried Labor and per-diems	70.48	73.25	68.11	54.42	70.48
Vaccines and injection supplies	14.42	8.14	8.79	8.3	14.42
Utilities and communications	2.69	4.85	5.94	8.46	2.69
Printing	1.06	0.46	0.11	0.00	1.06
Cold chain energy	0.1	0.46	0.49	1.77	0.1
Other recurrent	0.97	1.53	2.01	4.23	0.97
Capital cost (%) of Total	**10.3**	**11.3**	**14.6**	**22.8**	**16.29**
Building	7.12	5.77	9.23	15.32	10.35
Cold chain equipment	0.19	0.77	2.27	4.61	2.67
Other capital costs	2.98	4.74	3.07	2.89	3.27
TOTAL %	**100**	**100**	**100**	**100**	**100**
TUC Cost per Dose US$	**10.4**	**19.4**	**18.5**	**18.7**	**18.4**

Table 19 Unit Cost structure by Facility scale

Item	Low	Medium	High	Total
Recurrent cost(%) of Total	**76.9**	**87.7**	**90.7**	**83.71**
Salaried Labor and per-diems	55.46	71.37	73.27	55.46
Utilities and communications	8.04	8.56	10.63	8.04
Vaccines and injection supplies	8.28	5.13	5.04	8.28
Transportation/fuel	2.44	1.47	0.48	2.44
Cold Chain energy	1.41	0.49	0.21	1.41
Other recurrent	1.22	0.7	1.11	1.22
Capital cost(%) of Total	**23.1**	**12.3**	**9.3**	**16.29**
Building	15.16	7.47	5.66	10.35
Cold chain equipment	4.53	1.64	0.55	2.67
Other equipment	2.83	2.29	1.86	2.45
Vehicles	0.63	0.87	1.17	0.82
TOTAL %	**100**	**100**	**100**	**100**
TUC Cost per Dose US$	**20.5**	**18.3**	**14.5**	**18.4**

In conclusion in Table 20 we summarize financial and economic unit costs as well as financial and economic delivery unit costs on a facility level, which could be used in budget estimation as well as for further analysis. The table also reflects observed differences in economic and financial costs noted by our study, more details could be found in Annex 2.

Table 20 Financial and Economic Unit Costs

Unit costs on a facility level US $	Financial	Economic	Difference (%)
Cost per dose	17.4	18.3	5.17%
Cost per infant	299.5	316.6	5.71%
Cost per FIC	314.3	332.3	5.73%
Cost per capita	2.8	3.0	7.14%
Delivery cost per dose	15.8	16.8	6.33%
Delivery cost per infant	271.8	289.0	6.33%
Delivery cost per FIC	285.5	303.5	6.30%
Delivery cost per capita	2.5	2.7	8.0%
Cost w/o labor per dose	5.5	6.4	16.36%
Cost w/o labor per Infant	95.2	112.3	17.96%
Cost w/o labor per FIC	99.8	117.8	18.04%
Cost w/o labor per capita	0.9	1.0	11.1%
Delivery cost w/o labor per dose	3.9	4.8	23.08%
Delivery cost w/o labor per Infant	67.6	84.7	25.30%
Delivery cost w/o labor per FIC	70.9	88.9	25.39%
Delivery cost w/o labor per capita	0.6	0.8	33.3%

Immunization Cost and Cost Structure at the District level

We also estimated immunization economic and financial costs at the district level-the cost of district public health centers for vaccine storage, managing and supervising immunization activities at the district level.
Table 21 presents total immunization economic cost for each sampled district public health center and district level weighted average cost by cost line items. At the district level average share of the labour cost was 19.6% of total cost and it increases when size of district decreases (ranging from 11% in Chisinau that is the largest district to 35% in Vulkanesti that is the smallest district in our sample).

Table 21: District Public Health Offices' Immunization Economic Costs by Line Item ($2011)

Line Items	Chisinau	Ungheni	Briceni	Calarasi	Leova	Vulcanesti	Weighted Average District N= 37	%
Salaried Labor	30,337	10,870	5,926	5,717	6,909	5,353	8,085	**19.6%**
Per Diems	-	61	269	10	41	-	74	**0.2%**
Vaccines	209,944	33,236	16,089	19,635	14,658	6,421	25,249	**61.3%**
Injection supplies	11,753	1,746	948	1,485	770	392	1,453	**3.5%**
Other supplies	235	237	43	52	20	12	99	**0.2%**
Transport & fuel	290	463	893	120	269	434	437	**1.1%**
Vehicle maintenance	79	439	1,175	849	695	396	665	**1.6%**
Cold chain energy costs	1,416	509	437	414	83	356	410	**1.0%**
Printing	368	-	130	68	115	24	67	**0.2%**
Building overheads	2,469	2,638	1,076	402	252	143	1,175	**2.9%**
Other recurrent	125	-	84	-	-	-	18	**0.0%**
Subtotal recurrent	257,015	50,200	27,069	28,752	23,811	13,530	37,732	**91.6%**
Cold chain equipment	1,671	872	447	368	246	318	539	**1.3%**
Vehicles	58	769	300	233	301	135	395	**1.0%**
Other capital	1,682	758	549	427	356	439	571	**1.4%**
Buildings	6,177	3,872	1,014	1,069	964	751	1,962	**4.8%**
Subtotal capital	9,588	6,270	2,311	2,097	1,866	1,643	3,467	**8.4%**
Total Immunization Economic Cost	**266,604**	**56,471**	**29,381**	**30,849**	**25,677**	**15,172**	**41,199**	**100%**

Total immunization economic cost for each sampled district public health centre desegregated by immunization activities is presented in Table 105 in the Annex 2. Table 106 and Table 107 present district level financial costs by cost line items and activities.

Total Cost and Cost Structure of the National Immunization Program

To calculate total annual costs (financial and economic) of the EPI program on a national level we carried out cost aggregation using bottom-up aggregation approach. Firstly, we calculated a facility mean cost, without cost of vaccines and injection supplies on a facility level where immunization is delivered and multiplied these cost by the total number of facilities in the country. Secondly, we calculated mean district level cost for district public health centres without cost of vaccines and injection supplies and multiplied by the total number of districts in Moldova. Finally we estimated national level costs and cost of vaccines and injection supplies and added up all costs to arrive to the national EPI program cost (see Table 22).

Table 22: Economic and Financial Cost aggregation for the National EPI

Cost Element	Economic Costs	Financial Costs	Difference
Average facility cost without vaccines and injection supplies	$ 6,160	$ 5,906	$ 254
Total number of facilities in the country	1318	1318	
Total facility level immunization program cost without vaccines and injection supplies	**$ 8,119,394**	**$ 7,784,266**	**$ 335,128**
Average district cost without vaccines and injection supplies	$ 14,497	$ 13,360	$ 1,137
Total number of districts	37	37	
Total district cost without vaccines and injection supplies	**$ 536,404**	**$ 494,335**	**$ 42,069**
National cost without vaccines and injection supplies	**$ 142,063**	**$ 132,489**	**$ 9,574**
Cost of vaccines and injection supplies	**$ 1,058,706**	**$ 1,058,706**	-
Total National level immunization economic cost with vaccines and injection supplies	**$ 9,856,567**	**$ 9,469,796**	**$ 386,771**

The bottom-up aggregation approach was used as well to estimate national immunization program economic cost by line items that are presented in Table 23 below.

We also estimated national level unit costs: Cost per dose, Cost per infant, Cost per FIC/DTP3 vaccinated child, Cost per capita and delivery unit costs. National cost per dose was estimated by dividing total national immunization program cost by the total number of doses administered in 2011 in the country, national cost per infant was calculated by dividing total national immunization program cost by the total number of FIC in the country, national cost per infant was estimated by dividing national immunization program cost by the total number of infants in 2011 in Moldova and national cost per capita - by dividing total immunization program cost by the total population in Moldova. The national level unit costs are also presented in Table 23 below

Table 23: Aggregated Immunization Economic Costs and Unit Costs in by Line Item ($2011)

Line Items	Average Facility Level	Average District Level	National Level	Total Routine Immunization Program Cost	Percent Distribution
	N= 1318	N= 37			
- Salaried Labour	4,897	8,085	21,449	6,775,187	68.7%
- Per Diems	8	74	1,372	14,295	0.1%
- Vaccines	750	25,249	1,042,281	988,337	10.0%
- Injection supplies	53	1,453	58,851	70,374	0.7%
- Other supplies	11	99	2,951	20,678	0.2%
- Transport & fuel	51	437	212	84,121	0.9%
- Vehicle maintenance	6	665	1,894	34,509	0.4%
-Cold chain energy costs	22	410	3,270	47,918	0.5%
- Printing	38	67	6,052	58,847	0.6%
- Building overheads	316	1,175	16,892	476,695	4.8%
- Other recurrent	22	18	58,582	87,861	0.9%
Subtotal recurrent	**6,175**	**37,732**	**1,213,805**	**8,658,822**	**87.8%**
- Cold chain equipment	69	539	5,791	117,219	1.2%
- Vehicles	49	395	2,805	82,451	0.8%
- Other capital	145	571	2,336	214,854	2.2%
-Buildings	525	1,962	18,457	783,219	7.9%
Subtotal capital	**789**	**3,467**	**29,389**	**1,197,742**	**12.2%**
Total Immunization Economic Cost	**6,964**	**41,199**	**1,243,194**	**9,856,564**	**100%**
Delivery Economic Cost (minus vaccine and injection)				8,797,853	

- Total child doses administered		680,877	
- Infant population		47,537	
- Total DTP3 Vaccinated Children		44,571	
- Total population		3,809,715	
- Cost per Dose		14.5	
- Cost per child		207.3	
- Cost per DTP3 Vaccinated child		221.1	
- Cost per capita		2.6	
- Delivery cost per Dose		12.9	
- Delivery cost per child		185.1	
- Delivery cost per DTP3 Vaccinated child		197.4	
- Delivery cost per capita		2.3	

Aggregated costs, both financial and economic, show that 82% of costs arise on a facility level (not including cost of vaccines and injection supplies) and around 5% of costs are attributable to district level costs, which includes primarily cost of vaccine storage, supervision-monitoring and program management and also VPD surveillance. And national level costs amount only to 1.4% of the total immunization program costs and vaccines and syringes – 11%. Furthermore, aggregated costs were partitioned separately for a facility, district and national level and are presented in Table 24 and Table 24 below. Further partitioning of the national program costs in a cross tab inputs by activities are detailed in the matrixes provided in Annex 3.

Table 24: Financial cost and cost profile of the national immunization program

Item	**Facility level**		**Facility+District level**		**Facility+District+National level**	
	Total Cost $US	**% of total cost**	**Total Cost $US**	**% of total cost**	**Total Cost $US**	**% of total cost**
Recurrent cost	**8,137,856**	**92.0%**	**408,134**	**82.6%**	**112,674**	**85.0%**
Salaried Labour	6,454,459	73.0%	299,157	60.5%	21,449	16.2%
Per-Dime & Travel Allowances	10,189	0.1%	2,734	0.6%	1,372	1.0%
Vaccines	988,318	11.2%	0	0.0%	0	0.0%
Vaccine Injection & Safety Supplies	70,373	0.8%	0	0.0%	0	0.0%
Other Supplies	14,061	0.2%	3,663	0.7%	2,951	2.2%
Transportation/fuel	67,728	0.8%	16,179	3.3%	212	0.2%
Vehicle maintenance	7,998	0.1%	24,616	5.0%	1,894	1.4%
Cold Chain energy	29,478	0.3%	15,169	3.1%	3,270	2.5%
Printing	50,310	0.6%	2,484	0.5%	6,052	4.6%
Utilities and communications	416,333	4.7%	43,461	8.8%	16,892	12.7%
Other recurrent	28,609	0.3%	670	0.1%	58,582	44.2%
Capital cost	**705,100**	**8.0%**	**86,202**	**17.4%**	**19,815**	**15.0%**
Cold chain equipment	74,951	0.8%	16,356	3.3%	4,725	3.6%
Vehicles	55,437	0.6%	8,540	1.7%	2,298	1.7%
Other equipment	174,734	2.0%	19,360	3.9%	2,127	1.6%
Building	399,971	4.5%	41,954	8.5%	10,665	8.0%
TOTAL	**8,842,957**	**100.0%**	**494,335**	**100.0%**	**132,489**	**100.0%**

Table 25: Economic cost and cost profile of the national immunization program

Item	Facility level		Facility+District level		Facility+District+National level	
	Total Cost $US	% of total cost	Total Cost $US	% of total cost	Total Cost $US	% of total cost
Recurrent cost	**8,137,856**	**88.7%**	**408,134**	**76.1%**	**112,674**	**79.3%**
Salaried Labour	6,454,459	70.3%	299,157	55.8%	21,449	15.1%
Per-Dime & Travel Allowances	10,189	0.1%	2,734	0.5%	1,372	1.0%
Vaccines	988,318	10.8%	0	0.0%	0	0.0%
Vaccine Injection & Safety Supplies	70,373	0.8%	0	0.0%	0	0.0%
Other Supplies	14,061	0.2%	3,663	0.7%	2,951	2.1%
Transportation/fuel	67,728	0.7%	16,179	3.0%	212	0.1%
Vehicle maintenance	7,998	0.1%	24,616	4.6%	1,894	1.3%
Cold Chain energy	29,478	0.3%	15,169	2.8%	3,270	2.3%
Printing	50,310	0.5%	2,484	0.5%	6,052	4.3%
Utilities and communications	416,333	4.5%	43,461	8.1%	16,892	11.9%
Other recurrent	28,609	0.3%	670	0.1%	58,582	41.2%
Capital cost	**1,040,066**	**11.3%**	**128,270**	**23.9%**	**29,389**	**20.7%**
Cold chain equipment	91,483	1.0%	19,946	3.7%	5,792	4.1%
Vehicles	65,047	0.7%	14,598	2.7%	2,804	2.0%
Other equipment	191,377	2.1%	21,137	3.9%	2,336	1.6%
Building	692,158	7.5%	72,590	13.5%	18,457	13.0%
TOTAL	**9,177,922**	**100.0%**	**536,404**	**100.0%**	**142,063**	**100.0%**

Discussion

The study helped estimate average facility level cost per dose delivered in 2011 which amounted to 18.3 $US, cost per infant - 316.6 cost per FIC - 332.3 $US and cost per capita- 2.6 $US. These figures are higher than what has been previously reported in the literature [8],[9][12]. Our study shows that the labour inputs are significant contributor to a unit cost and consequently to the overall immunization program cost. These findings are comparable with the evidence documented elsewhere - immunization program being labour intensive [30],[12][31]. Cost of Vaccines is the second largest component of the immunization program cost,

We also found that total cost as well as unit cost of service provision differs by facility type, by facility scale and by urban-rural location, although in a latter case influence is only obvious when shared human resource costs are not accounted in a unit cost. From all of these factors facility scale (measured by total number of annual doses delivered) have strongest influence on the total unit cost of service provision, which is similar with the available global evidence that scale of immunization services has strong and negative relationship with the unit cost of service provision [9],[32] which means that facilities with a greater scale are able to deliver service more efficiently, by using available inputs more effectively and therefore reducing costs per unit of output. Consequently, increasing scale of a facility (by merging smaller ones into bigger if at all possible) could help reduce the program costs. Although this may as well increase distance to a facility and may negatively affect immunization coverage rates.

Furthermore, unit cost of service provision varies between facility types and mainly due to observed differences in using capital and human resources. Smaller facilities are using capital less effectively compared to larger ones. And amount of staff time spent on delivering a dose of vaccine reveals strong correlation with the type of a facility. Namely in smaller/rural facilities staff tend to spend more time on delivering a dose of a vaccine than in bigger facilities, which is obviously indicative of a variable productivity of employed staff by a facility type. This could be determined by numerous factors, such as size and/or density of a population in a catchment area, staff quality (nurses vs. doctors), management capacity i.e. availability of immunization plans and supervisory visits [33] [34] etc. The recent study conducted by the WHO [35] in Moldova showed that staff in rural PHC facilities could be overstretched serving approximately 16.9 patients a day and spending on average 42.4 hours at work. Consequently, higher amount of time spend by the staff of small facilities on immunization is indicative that with new vaccine introduction it might become necessary to increase number of FTEs on a PHC level, unless staff productivity is increased with the help of different tools. As we observed, close to 33-34% of time spent by the staff on HO and OFD level are taken by HMIS and program management. Moldova currently is designing e-health system for primary health care, which could (or should) include the modules for the immunization. However, this module should be designed in a way that it reduces demand on staff time while collects all necessary data need for adequate management of immunization services on a facility level.

Our study also documented that not only costs are different by facility type but also facility performance, measured with the help of DPT3 rate is different. Based on our analysis we can hypothesize that facility characteristics as well as facility's management performance may have influence on achieved DPT3 coverage rates. However, available literature also proves that immunization coverage rates are also related to socio-economic and education status of the population [36][37][38] proximity to health facility [39][40], etc. Therefore, the factors determined by our bi-variate analysis will not be sufficient to establish causal links with the facility productivity and costs unless other determinants related to the environmental context (e.g. population or geography characteristics) are as well evaluated in a multivariate model.

We have also seen that Moldova achieves high immunization coverage rates compared to other countries in the region [41]. However, differences exist when coverage rates are examined by facility level. Namely, HOs, that are equipped only with nurses and located in rural areas, show the lowest performance – 90.2%. However, due to very small number of infants - 7 (95%CI: 6.7-7.9) in the catchment population of these facilities this low coverage translates into at most one child missing its third dose of DPT, which could be due to numerous objective or subjective reasons. Therefore, trying to increase coverage in rural facilities most likely will be more costly and marginal impact on the overall program performance could be minimal due to low number of children covered by these facilities. Consequently in the Moldovan context it seems more appropriate to place more importance on FMCs, where DPT3 coverage is second lowest after HOs – 92.7%. Improving performance of these facilities seems more feasible due to their staffing patterns and resources available, it could be less costly due to lowest cost per dose delivered and per FIC and overall impact on the national program performance is expected to be greater. However, this strategy may raise equity concerns with regards to rural areas - HOs. To mitigate these concerns it seems possible to mostly focus efforts on significantly underperforming rural facilities, where DPT3 coverage rates are below 80% and provide supportive supervision or other assistance that will be necessary.

Finally the unit costs per dose (without shared labour costs) captured in our study were comparable only with findings from selected countries Columbia (2009) - 3.95$, Morocco (2009) – 7$. Also there were other studies that estimated significantly lower costs per dose delivered e.g. Gambia (1980-1981) – 1.09-1.75$, Peru (2001) 1.5-3.2$, Viet Nam (2005) - 0.7$, Ethiopia – 0.5$, etc. and others higher costs e.g. Mexico -15$. However, lack of details about the costs included in these estimates and for which vaccines makes such comparisons meaningless. Therefore, it would be more informative to compare our findings with those documented by other studies supported by the Bill and Melinda Gates Foundation, which used similar methodology and therefore offer greater potential for meaningful comparisons.

Comparison of Financial Flows with updated cMYP

Estimates of the immunization program costs were compared with the cMYP[8], which shows that in 2011 total immunization program cost was approximately $ US 1.6 million higher than projected in the cMYP. This difference was mainly due to underestimating shared costs, especially shared personnel costs, which drive this difference. Considering the fact that shared personnel costs may have imposed bias in the study we also compared estimated costs without shared personnel costs with those provided in the cMYP for 2011 and difference between study estimates and cMYP projections equalled to $ US 390,641 (see Table 26).

Table 26: The comparison of line items between cMYP and the costing study

Line items	cMYP	Costing study	Variance
Routine Recurrent Cost			
Vaccine costs	1,068,849	988,318	8%
Vaccine Injection & Safety Supplies[9]	158,670	72,333	119%
Salaries of full-time NIP health workers	273,784	320,606	-15%
Per-diems	14,676	14,295	3%
Transportation cost[10]	141,093	42,901	229%
Maintenance and overhead[11]	1,269,942	524,959	142%
Trainings	18,824	29,399	-36%
Social mobilization	23,531	3,981	491%
Disease surveillance	43,044	5,594	669%
Program management	42,355	125,400	-66%
Other cost		692	-100%
Subtotal	**3,054,767**	**2,128,478**	**44%**
Capital Cost			
Vehicles	6,478	66,275	-90%
Cold chain equipment cost	127,173	96,032	32%
Other capital equipment cost	19,760	196,221	-90%
Buildings	163,138	452,590	-64%
Subtotal	**316,549**	**811,118**	**-61%**
Shared Cost			
Shared personnel costs	4,433,533	6,454,459	-31%
Shared transportation cost	34,627	75,727	-54%
Subtotal	**4,468,180**	**6,530,186**	**-32%**
Total immunization program cost with shared health system costs	**7,839,496**	**9,469,781**	**-17%**
Total immunization program cost without shared personnel costs	**3,405,963**	**3,015,322**	**13%**

Personnel cost: In the cMYP facility level personnel costs includes only the salaries of nurses and doctors while salaries of other personnel such as managers of primary health care facilities, drivers and others are not considered. Our costing study revealed that PHC facility managers are in charge of organizing and managing immunization provision, they participate in planning meetings as well as attend immunization related trainings; drivers are involved in vaccine collection and distribution; therefore, we considered costs associated with these personnel in our costing study estimates.

Vaccine and injection supply: In the cMYP cost of vaccines and injection supplies for 2011 were calculated based on projected number of newborns, planned target for immunization coverage and planned wastage targets for each vaccine. We estimated cost of vaccines and injection supplies based on actual number of vaccines and injection supplies used in 2011.

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[8] The cMYP for 2011-2015 was developed in 2010, therefore the cost of the immunization program for 2011 is not actual cost; it is a projection. Cost projection was made based on 2009 data.

[9] Vaccine injection and safety supplies includes also printing cost of vaccination cards

[10] Transportation cost includes both fuel cost and vehicle maintenance cost

[11] Building overhead cost includes cold chain energy and maintenance cost as well

Vehicles: Cost of vehicles for a facility level is not included in the cMYP estimates, although our study considers cost of vehicles for all three levels. If only district and national level vehicle costs were to be considered the difference between cMYP and our study estimates would be 4,340 USD.

Other equipment: Costs of other equipment (desktops, laptops, furniture and etc.) on a facility level are not included in the cMYP calculations, while our costing tools allowed capturing these costs as well.

Cold chain equipment cost: Based on the cMYP, procurement of additional cold room for the national level and 45 new refrigerators for district level was planned in 2011, although no additional cold chain equipment was actually purchased.

Comparison reveals some differences in assumptions used in the cMYP and our costing study: Following differences should be underlined:

Vehicle maintenance: In the cMYP 15% of fuel cost is used to estimate vehicle maintenance. This study estimates vehicle maintenance costs more directly. We estimated total vehicle maintenance costs per facility (per district) and multiplied by the share of km travelled for routine immunization related activities. According to our costing study, vehicle maintenance cost in 2011 was 12% of fuel cost.

Cold chain maintenance: The cMYP Guidelines estimates cold chain operation and maintenance as 5% of the capital cost of equipment. In the costing study the cold chain maintenance cost includes energy costs required to run the cold chain as well as the cost of repairs and spare parts. Our costing study revealed that cold chain maintenance cost in 2011 was only 0.4% of the cold chain costs.

Surveillance cost: a comprehensive analysis of surveillance costs were beyond the scope of this study. The study focused only on: a) estimating the value of activities related to case detection and outbreak response; b) estimating the proportion and value of time spent on a facility, district, and national levels on surveillance activities and c) estimating transportation/fuel costs for surveillance activities. Costs of laboratory services and the cost of capital equipment for surveillance were not estimated; therefore surveillance costs are underestimated in our study.

This comparison reveals weaknesses of the cMYP costing tool, which in some instances significantly underestimates costs and in the other overestimates. Consequently different approach/methodology might be warranted to address these weaknesses on a regional and global level if cMYPs will continue to be a planning tool for immunization services and for GAVI support.

Conclusions

The findings of our study are useful in informing policy discussions within Moldova that are focused on increasing immunization coverage and increasing efficiency of the immunization program performance.

Looking at the costs of immunization on a facility level we could conclude:

1. Due to the fact that facility performance is multidimensional phenomenon it becomes necessary to evaluate influence of different factors on a facility productivity and costs using more complex multivariate regression models and including not only facility specific characteristics and its inputs, but also factors characterizing demand side aspects and related to a population in a catchment area. Only such analysis will permit to better understand drivers of costs and productivity on a facility level and identify those key factors, which could be acted on by a facility and immunization program managers to improve immunization performance and/or to reduce service delivery costs. Furthermore, this knowledge could help inform

global policies aimed at improved immunization program performance in other parts of the world.

2. Financial flow analysis and its comparison with the updated cMYP reveal significant discrepancies, underlying weaknesses and inadequacy of assumptions, used for multi-year financial planning for immunization services. Therefore, it becomes important to enrich current planning tools on a country, regional and global level, with more detailed costing data obtained from a country level and/or with better benchmarks, which could be used for the planning nationally, regionally or globally and which will help achieve better precision in financial estimates needed for scaling-up of immunization services.

3. The government of Moldova is focusing on increasing health system efficiency through various means, including infrastructure optimization. Our study findings confirm that immunization services are labour intensive and significant costs on a facility level arise due to cost of human resources. Reducing staff time spent on immunization could help increase efficiency of the program. This objective could be achieved either through task shifting[12] i.e. delegating certain immunization related tasks from doctors to nurses, or through reducing time spend on management and/or record-keeping functions. The latter could be achieved with the help of information technology, which is currently being developed for the HMIS. Adequate modules for immunization program planning and management along with the modules for record keeping offer potential for reducing staff time spent on these functions, conditioned that PHC modules of the HMIS are developed with this objective in mind.

4. Further increasing DPT3 coverage in Moldova could be challenging task as the coverage levels are already high. But if government decides to further improve program performance, instead of focusing on HOs, the focus could be maintained on FMCs where current coverage rates are relatively lower – 92.7% and potential for increasing DPT3coverage is greater, which could be achieved at a lower cost.

5. Finally, after graduating from the GAVI Moldova is considering reforming its immunization program and decentralizing vaccine procurement responsibilities due to specificity of the national health care financing system and due to rules embedded in the national legislation. Our study shows that the cost of vaccines is critical element of the immunization program. Therefore centralized model for vaccine procurement seems to be more effective and decentralization of this function may drive vaccine prices up and could increase overall program cost.

[12]Task shifting is the name given to a process of delegation whereby tasks are moved, where appropriate, to less specialized health workers. By reorganizing the workforce in this way, task shifting presents a viable solution for improving health care coverage by making more efficient use of the human resources already available.

Analysis of Financial Flows for the Routine Immunization

Background

In this section of the report we describe financial flows for the routine immunization, which looks at sources and uses of funds using health accounting approaches suggested by the OECD, Eurostat and WHO [42]. A *System of Health Accounts* (SHA) provides a framework for the systematic description of financial flows related to health care. The aim of our analysis was to describe the national immunization program from an expenditure perspective both for international and national purposes. Therefore our study looked at a funding flow for immunization services during 2011, which helped estimate amount of funds provided by the different national and external sources; amount of funds managed by the different financing agents within and outside of the country; funds spent on a provider level by a type of a provider, by function and by type of inputs. All amounts were estimated in a current 2011 $US using average annual exchange rates [43] to convert different currencies into $US.

Methods

For the financial flow analysis, the study looked at the overall health care financing system of the country [44] to understand funds flow and key players in the system, which helped understand and describe funding flow for immunization services.

Furthermore in our analysis we only looked from an expenditure perspective and separated funds flow in two broad categories: a) the funding flow, which could be directly attributed to the immunization services and explicitly traced through public finance system, e.g. vaccine and consumable purchase, direct financial support provided by external donors, etc. The information about these flows was sourced from various reports and through in-depth interviews with the key informants and b) a financial flow, which is not explicitly traceable through public finance management system, but is related to immunization services, e.g.: financing shared human resource costs, or paying for utility costs, or paying for cold chain maintenance, etc. These flows were estimated with the help of a facility survey. Using statistical weights, imputed in the survey dataset, the results from sampled facilities were scaled-up on a national level and consequently national level estimates were produced.

All individual expenditure estimates, generated by the study, were computerised in an Excel™ software and coded using internationally provided guidance [42] as well as using common principles developed by the study team. Consequently following classifications were used to code expenditure (for more details see Annex 6)

Classification of types of revenues of health financing schemes (FS) i.e. funding sources;

- Classification of financing schemes (HF);
- Classification of financing agents (FA);
- Classification of health care providers (HP);
- Classification of health care functions (HC);
- Classification of factors for health care provision (FP)

Using pivot table function in Excel™, two dimensional expenditure tables were generated, which are detailed later in this report.

Results

Funds Flow for Immunization Services

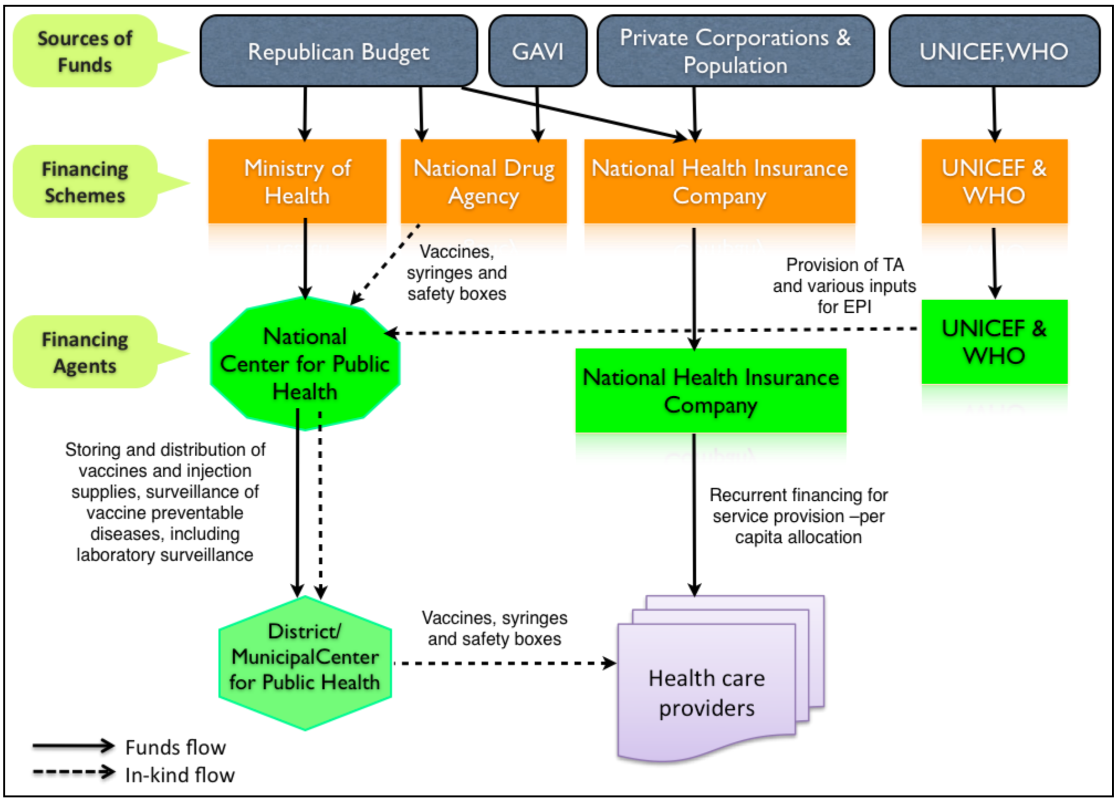
Overall funding for immunization services amounted to 8,814,053 $US during 2011, which is almost 1.15 million[13] more than originally planned (secure and probable funds) by the

[13] For financial flow analysis economic costs, estimated by the study, were excluded from total costs.

government in the *Comprehensive Multi-Year Plan* (cMYP) [2]. The largest share - 94.8% came from national sources (state budget -54% and mandatory health insurance contributions from corporations and households – 46%[14]). External sources collectively contributed only 5.2% and this was shared by GAVI 4.5%, by UNICEF - 0.2% and WHO - 0.5%. These estimates are comparable with projections for 2011 included in the cMYP where 92% of revenues were planned from national sources and 8% were budgeted for external sources.

Out of the total amount spent on immunization in 2011 the *National Health Insurance Company* (CNAM[15]) managed 80.3% of funds and primarily paid for recurrent expenses on a facility/provider level, 18.9% of funds were managed by the National Centre for Public Health and were primarily used for the NIP management, storage and distribution of direct inputs, e.g. vaccines, injection supplies and safety boxes. Portion of these funds also paid for surveillance of vaccine preventable disease and for trainings. The UNICEF and WHO managed only 0.2% and 0.5% of funds, respectively. These funds were primarily used for technical assistance and some other inputs for immunization services (see Figure 13 for schematic presentation of funds flow).

Figure 13 Funds flow for immunization services 2011



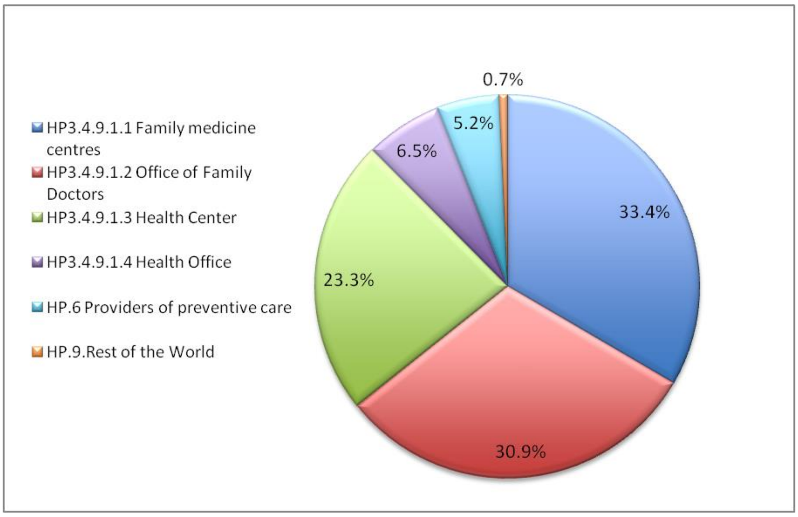
Funds flow on a provider level

Based on the funding flow analysis FMCs consumed the largest amount of funds – 33.4%, followed by offices of family doctors – 30.9% and health centres – 23.3%. The amount of funds spent on health offices was the lowest – 6.5%, because the volume of immunizations services (number of doses administered) offered by these facilities is the lowest. National and municipal/district public health centres spent only 5.2% of immunization funds and amounts administered by the WHO and UNICEF did not exceed 0.7%.

[14] Breakdown of revenues of the National Health Insurance Company received from the state budget and from private contributions were sourced from the National Health Accounts 2011 for Moldova. Similar breakdown was used to apportion revenues for immunization services from public and private sources.

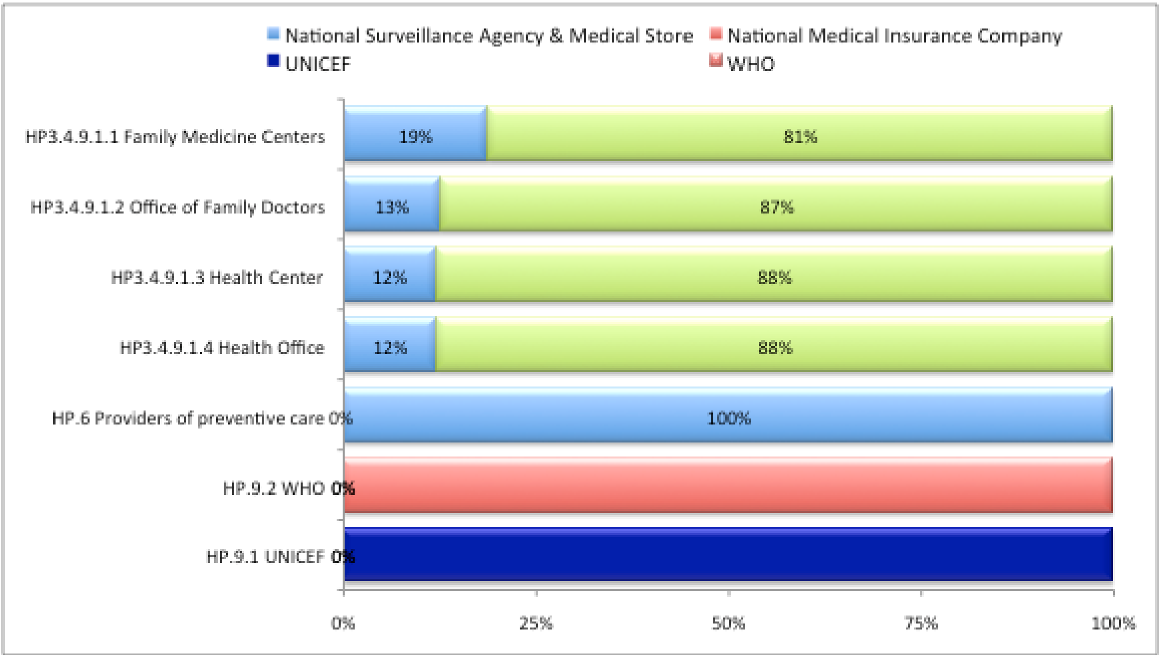
[15] Compania Nationala de Asigurari in Medicina

Figure 14 Funds flow on a provider level



Analysis also showed that major financier of a PHC care provider was CNAM, which provided 81-88% of the funds used for the immunization services. National and municipal/district public health centres solely depended on the funding from the state budget channelled through the MoH and the National Centre for Public Health. And the funds provided by the WHO and UNICEF were mainly used by their offices and did not reach a provider level (see Figure 15), with the exception of in-kind inputs.

Figure 15 Funds flow financing agents by providers



Financing of Immunization Functions

Analysis of funds flow by functions revealed that most funds are being spent on a facility-based immunization service delivery - 41%, followed by the program management – 18%. Record keeping & HMIS[16] and social mobilization have absorbed 14% and 12% respectively. The amount of funds spent on all other functions was 4% or below. For more details please see Table 27.

[16] HMIS denotes health management information system

Table 27 Funding levels for different functions by a provider =100%

Function / Provider	Social mobilization, advocacy	Facility-based routine immunization service delivery	Training	Vaccine collection, storage and distribution	Cold chain maintenance	Program Management	Supervision	Other routine immunization program activity	EPI Surveillance	Record-keeping and HMIS	Not disaggregated	Grand Total	Total $US
FMC	14%	42%	4%	1%	1%	20%	3%	0%	0%	15%	0%	**100%**	**2,948,758**
OFD	14%	47%	4%	4%	3%	17%	1%	0%	0%	11%	0%	**100%**	**2,719,876**
HC	12%	39%	4%	3%	2%	20%	3%	0%	0%	16%	0%	**100%**	**2,053,244**
HO	11%	51%	4%	5%	2%	14%	1%	0%	0%	11%	0%	**100%**	**571,368**
Providers of preventive care	1%	4%	5%	22%	9%	20%	11%	1%	12%	14%	0%	**100%**	**454,427**
UNICEF	22%	0%	0%	0%	0%	0%	0%	0%	0%	0%	78%	**100%**	**18,165**
WHO	0%	0%	3%	0%	0%	0%	0%	0%	9%	0%	88%	**100%**	**48,215**
Grand Total	**12%**	**41%**	**4%**	**4%**	**2%**	**18%**	**3%**	**0%**	**1%**	**14%**	**1%**	**100%**	**8,814,053**

These averages hide marked differences that emerge between types of medical providers. PHC providers spend comparable shares on similar functions and, as expected, providers of preventive care i.e. national and district/municipal centres of public health reveal different spending patterns by functions. Most resources at these facilities are spent on vaccine collection, storage and distribution 22% followed by program management -20% record keeping & HMIS -14% EPI surveillance-12%, supervision 11%, and cold chain maintenance – 9%. The amount of funds spent on all other functions was below 5%. For more details please see Table 27.

Funding inputs for immunization services

Funds spent on various inputs were analyzed in order to understand the level of resource consumption by the immunization services. The analysis revealed that the largest amount is being spent on wages and salaries that have consumed on average 77% of all funds dedicated for immunization or 6.78 million $US out of 8.81 million $US. Vaccines and syringes absorbed 14% of funds and the remaining 9% was spent on other inputs detailed in Table 28. Largest amount of vaccine & syringe inputs were spent on FMC level – 45%, followed by the offices of the family doctors – 28% and the health centres – 20%. Health offices being the smallest providers of immunization services consumed the least amount – 6% (see details in Table 29).

Furthermore, direct inputs related to the immunization program (i.e. vaccines & syringes, transport, maintenance, printing and other inputs) consumed only 25.9% of funds or 2.28 million $US while the rest – 74.1% were used to fund shared health system costs.

While the role of the external funding sources in funding immunization services is marginal – 5.2% (see earlier in this report), when external funding is related to only direct immunization inputs their share increases up to 20% and especially GAVI inputs amount to 17% of direct inputs necessary for the immunization program.

Table 28 Funding levels for different inputs by a provider = 100%

Provider \ Input/Factor	FP.1.1 Wages and salaries	FP.1.3.1 Per diem	FP.3.2 Vaccines & syringes	FP.3.3.1 Transport	FP.3.3.2 Maintenance	FP.3.3.3 Printing	FP.3.4.1 Utilities and communications	FP.3.4.2 Other	FP.9.9 Not disaggregated	Grand Total
HP3.4.9.1.1 Family Medicine Centers	76%	0%	19%	0%	0%	1%	3%	0%	0%	**100%**
HP3.4.9.1.2 Office of Family Doctors	79%	0%	13%	1%	0%	0%	7%	0%	0%	**100%**
HP3.4.9.1.3 Health Center	80%	0%	12%	1%	0%	1%	5%	0%	0%	**100%**
HP3.4.9.1.4 Health Office	74%	0%	12%	3%	0%	0%	10%	0%	0%	**100%**
HP.6 Providers of preventive care	71%	1%	1%	4%	6%	1%	17%	0%	0%	**100%**
HP.9.1 WHO	0%	0%	0%	0%	0%	22%	0%	0%	78%	**100%**
HP.9.2 UNICEF	0%	3%	5%	0%	0%	0%	0%	9%	83%	**100%**
Grand Total	**77%**	**0%**	**14%**	**1%**	**0%**	**1%**	**6%**	**0%**	**1%**	**100%**

Table 29 Funding levels for different inputs =100% by a provider

Provider \ Input/Factor	FP.1.1 Wages and salaries	FP.1.3.1 Per diem	FP.3.2 Vaccines & syringes	FP.3.3.1 Transport	FP.3.3.2 Maintenance	FP.3.3.3 Printing	FP.3.4.1 Utilities and communications	FP.3.4.2 Other	FP.9.9 Not disaggregated	Grand Total
HP3.4.9.1.1 Family Medicine Centers	33%	13%	45%	10%	3%	55%	19%	39%	0%	**33%**
HP3.4.9.1.2 Office of Family Doctors	32%	28%	28%	33%	9%	3%	34%	26%	0%	**31%**
HP3.4.9.1.3 Health Center	24%	18%	20%	17%	11%	28%	21%	16%	0%	**23%**
HP3.4.9.1.4 Health Office	6%	12%	6%	20%	0%	0%	11%	4%	0%	**6%**
HP.6 Providers of preventive care	5%	19%	0%	19%	77%	8%	15%	2%	0%	**5%**
HP.9.1 WHO	0%	0%	0%	0%	0%	7%	0%	0%	26%	**0%**
HP.9.2 UNICEF	0%	10%	0%	0%	0%	0%	0%	13%	74%	**1%**
Grand Total (%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Grand Total $US	**6,775,065**	**14,295**	**1,234,755**	**84,119**	**34,508**	**58,846**	**524,603**	**33,697**	**54,164**	**8,814,053**

Conclusions

Presented analysis shows that funding estimates for the immunization program in Moldova obtained through this study were 8.81 $US million, which amounts to approximately 1.27% of the *Total National Health Expenditure* for 2011 or 2.4% of recurrent public financing for health[45]. This estimate is 15% higher than the secured and probable funds estimated in the cMYP for 2011. The largest difference arises from overestimating "Routine Recurrent Costs" in the cMYP and significant underestimation of the "Shared Health Systems Costs" primarily through undervaluation of human resource inputs on a provider level. With regards to the role of different funding sources in financing national immunization program the cMYP and the study estimates were comparable (see Table 30 for more details).

Table 30 Comparison of study estimates with cMYP projections for 2011[17]

Cost Category	cMYP Estimates for 2011	Study Estimates for 2011	Variance between cMYP and Study Findings
Routine Recurrent Costs	**US$**	**US$**	**US$**
Vaccines & Injection supplies	1,227,519	1,221,937	5,582
Personnel			
Salaries of NIP health workers (immunization specific)	273,784	320,606	(46,822)
Per-diems for supervision and monitoring	14,676	14,295	381
Transportation	141,093	42,901	98,192
Maintenance and overhead	1,269,942	524,959	744,983
Short-term training	18,824	29,399	(10,575)
IEC/social mobilization	23,531	3,981	19,549
Disease surveillance	43,044	5,594	37,450
Program management	42,355	119,504	(77,149)
Subtotal	**3,054,767**	**2,283,176**	**771,591**
Routine Capital Costs			
Vehicles	10,000	0	10,000
Cold chain equipment	65,943	0	65,943
Other capital equipment	57,000	0	17,000
Subtotal	**132,943**	**0**	**132,943**
Shared Health Systems Costs			0
Shared personnel costs	4,433,553	6,454,459	(2,020,906)
Shared transportation costs	34,627	75,727	(41,100)
Other	0	692	(692)
Subtotal Optional	**4,468,180**	**6,530,878**	**(2,062,698)**
GRAND TOTAL	**7,655,889**	**8,814,054**	**(1,158,164)**
Sources of Funds			
National sources	**90.8%**	**94.8%**	(4.0%)
External (secure and probable)	**9.2%**	**5.2%**	4.0%
From GAVI	7.8%	4.5%	3.3%
From WHO	1.3%	0.2%	1.1%
From UNICEF	0.1%	0.5%	(0.4%)

Cost of vaccines estimated through facility survey was 1,058,706 $US while financial flow analysis estimates these costs at 1,221,937 $US, which renders difference of 15.4%, maybe due to the fact that cost of a buffer stock was not captured by the facility level costing study.

Furthermore, while the role of the external sources in the overall funding for the national immunization program is marginal – 5.2%, when external funding is related to only direct immunization inputs their share increases up to 20% and especially for the GAVI inputs they reach 17%. This share is expected to grow significantly during 2012 and 2013 when new vaccines are introduced and are expected to significantly increase pressure on the national budget when Moldova graduates from GAVI in 2016. This pressure will be further

[17] This comparison implies some methodological limitations because cMYP costing tool mixes inputs and functions in a spreadsheet, while SHA approach used in the study separately accounts for inputs and separately for functions. However on major line items the comparison renders valid estimates.

aggravated by concurrent graduation from the Global Fund, which currently provides funding for most TB and HIV/AIDS inputs. Based on preliminary estimates provided in the *Medium Term Budgetary Framework for 2014-2016*, Moldova expects that graduation from the GAVI and the Global Fund will increase demand for national public health budget 2.45 times in 2016 compared to 2011 levels [46]. Due to limited fiscal space and weak economic growth prospects for the same period, this could pose significant challenges for the government during coming years and may put at risk adequate financing of the immunization, TB and HIV/AIDS programs.

In light of this it is thought that when the GAVI and Global Fund boards determine graduation policies, it should not be only linked to a country GNI, as this trigger sudden and simultaneous graduation from donor support and places challenges for fiscally constrained governments to pick up the price tag of donor funded programs. Such graduations run the risk of inadequate financing from national budgets since graduation, and entails risks of negatively affecting public health achievements realised with the help of GAVI and Global Fund. Consequently, it seems more appropriate for the GAVI and Global Fund to develop phasing out plans for each country in a more coordinated manner, considering different factors and not only GNIs, and while implementing these plans helping health and finance sectors of a country to gradually transition towards the national funding. Such approach seems to have better potential for obtaining durable public health impacts.

Cost Analysis of New Vaccine Introduction

Incremental Costs for NUVI on a Facility Level

The study also looked at *New Vaccine Introduction* (NUVI) costs, using the methodology described earlier. Incremental costs were estimated on a facility, district and national level. We looked at financial costs, cash flow/fiscal costs, and economic costs with and without cold chain and staff salaries. Using the total cost of Rotavirus vaccine introduction we derived costs per unit of output, which are detailed in Table 34 below.

On average cash flow per unit of output was 7% higher than financial costs, economic costs that include the cost of additional shared labour were 20% higher when compared to financial cost and economic costs that also accounted for additional cold chain space were 26% higher.

Table 31 Total Incremental Rota virus vaccine introduction costs

Dimension	Financial cost ($US 2012)	Fiscal cost ($US 2012)	Economic cost (without Cold Chain)	Economic cost (including Cold Chain)
Average facility cost without vaccines	3.1	4.8	43.6	56.1
Average Rota vaccine cost per facility	193.4	193.4	193.4	193.4
Shared staff salary costs per facility			38.9	38.9
Average Cold Chain Costs per Facility				12.6
Total number of facilities	1318	1318	1318	1318
Total facility level cost without vaccines	**4,080**	**6,372**	**57,436**	**73,984**
Total facility level cost with vaccines	**258,947**	**261,239**	**312,303**	**328,851**
Mean district cost without vaccines	43.6	66.4	108.1	232.0
Number of districts	37	37	37	37
Total district cost without vaccines	**1,613**	**2,455**	**3,998**	**8,584**
National level cost without vaccines	**118,219**	**142,660**	**138,820**	**140,210**
Total National Rota Introduction Cost	**378,779**	**406,355**	**455,120**	**477,645**

As stated earlier, introduction of Rotavirus vaccine in Moldova did not require purchase of additional cold chain, because the country had spare capacity and neither additional staff was added on a facility level to meet increased service delivery needs. Therefore, financial implication of the Rota virus vaccine introduction in Moldova was marginal and recurrent financial costs of the Rotavirus vaccination resulted only in additional 378.8 thousand $US on top of the routine immunization program costs. Due to investments required in staff training and other systems, start-up cash flow needs were some 27.5 thousand $US more than would be required for routine maintenance of Rotavirus vaccination.

However, had Moldova needed additional cold chain and/or staff to deploy new vaccines in the system, these costs would have increased by almost 26% to pay for additional staff salaries as well as for additional cold chain equipment. Out of total incremental fiscal cost of a rota virus vaccine introduction only 151,489$ (37%) were spent on immunization delivery and the rest 63% were used for vaccine procurement..

New vaccine introduction economic, financial and fiscal costs were also analysed by cost line items and activities. The costs further were desegregated by start-up and on-going costs. (Table 32 and Table 33). Analysis show that 87% of the total incremental economic cost was ongoing cost and start-up cost accounted for only 13%. The proportion was slightly different for fiscal cost where share of the start- up cost increased to 17%.

Table 32: Start-up and Ongoing New Vaccine introduction costs by line items

Line Items	Economic Costs		Financial Costs		Fiscal Costs	
	Start-Up	Ongoing	Start-Up	Ongoing	Start-Up	Ongoing
- Salaried Labor		65,451		12,324		12,324
- Per Diems		2,126		1,525		2,203
- Vaccines		254,867		254,867		254,867
- Transport & fuel		10,893		8,221		11,240
- Printing	2,828	12,511	1,500	12,511	3,000	12,511
- Building overheads		29,771		29,771		29,771
- Other recurrent	38,229	15,805	37,007	15,805	38,387	15,805
Subtotal recurrent	**41,056**	**391,423**	**38,507**	**335,022**	**41,387**	**338,720**
- Cold chain equipment		22,524				
- Other capital	22,641		5,250		26,248	
Subtotal capital	**22,641**	**22,524**	**5,250**		**26,248**	
Total NUVI Cost	**63,697**	**413,947**	**43,757**	**335,022**	**67,635**	**338,720**
Percent Distribution (Start-up and Ongoing)	**13%**	**87%**	**12%**	**88%**	**17%**	**83%**
- Total Doses of New Vaccine administered	78,148	78,148	78,148	78,148	78,148	78,148
- Infant population	39,691	39,691	39,691	39,691	39,691	39,691
- Total population	3,809,715	3,809,715	3,809,715	3,809,715	3,809,715	3,809,715
- Incremental NUVI Cost per Dose	0.8	5.3	0.6	4.3	0.9	4.3
- Incremental NUVI Cost per Child	1.6	10.4	1.1	8.4	1.7	8.5
- Incremental NUVI per Capita	0.02	0.11	0.01	0.09	0.02	0.09

Table 33: Start-up and Ongoing New Vaccine introduction costs by activity

Activity	Economic Costs		Financial Costs		Fiscal Costs	
	Start-Up	Ongoing	Start-Up	Ongoing	Start-Up	Ongoing
Routine Facility-Based Service Delivery		287,647		267,378		267,378
Supervision		5,935		5,935		5,935
Social mobilization	18,842	19,121	18,842	129	18,842	129
Cold chain maintenance		5,840		5,840		5,840
Vaccine collection and distribution		2,915		660		660
Program management	22,641	52,287	5,250	51,382	26,248	51,382
Training	5,429	40,201	2,880	3,698	5,760	7,396
Surveillance	16,785		16,785		16,785	
Other						
Total NUVI Cost	**63,697**	**413,947**	**43,757**	**335,022**	**67,635**	**338,720**
Total NUVI Cost/Month	**5,308**	**34,496**	**3,646**	**27,919**	**5,636**	**28,227**

National level Unit cost analysis showed that incremental financial cost of delivering Rotarix™ was 4.85$US per dose and 9.54$US per infant in the birth cohort. However, close to 67% of these financial costs were due to vaccines and only 33% were pure delivery costs (see Table 34 for details).

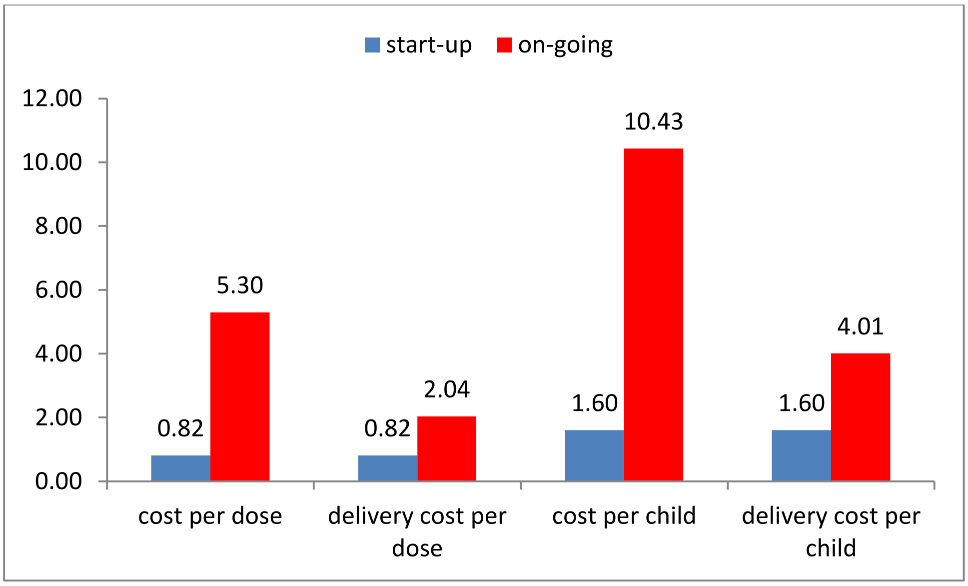
Economic costs per unit of output (with vaccine costs) were 26% higher over comparable financial costs, because they account for annualized costs of additional staff time at the facility district and national levels and cold chain. Namely, cost of delivering a single dose of vaccine increases up to 6.11 $US and cost per infant up to 12.03 $US. Health system related vaccine delivery economic costs were found to be 2.85$ per dose and 5.61$ per infant (see Table 34).

Table 34: Incremental unit costs for a rotavirus vaccine introduction

National level unit costs	Financial cost $US	Fiscal Cost $ US	Economic cost without Cold chain $US	Economic cost including Cold chain $US
Unit costs without vaccines				
Cost per dose delivered	1.59	1.94	2.56	2.85
Cost per infant/child	3.12	3.82	5.05	5.61
Unit costs including vaccines				
Cost per dose delivered	4.85	5.20	5.82	6.11
Cost per infant/child	9.54	10.24	11.47	12.03

Figure 16 below presents distribution of the incremental economic unit costs (with and without vaccine costs) by on-going and start-up costs. Share of the on-going costs in the total incremental unit costs is 86% and decreases to 71% when vaccine costs are not considered.

Figure 16: Start-up and on-going Rota vaccine introduction economic unit costs



These findings are important, for going forward. It is well know that over past three decades number of diseases that have respective vaccines have increased 2.5 times, consequently vaccine doses delivered to a child faced almost three fold increase. Consequently vaccine volumes required to fully immunize child have grown four times and now they require significant additional volumes in cold chain as well as greater logistical complexity [47]. Furthermore, investments currently being made in a new product development are expected to bring more vaccines to the Global market and countries may start introducing more vaccines in their routine immunization calendars. Consequently more and more cold chain capacity as well as staff time on a primary health care level will become necessary to cope with increased vaccine volumes as well as with increased vaccination time demands on a facility level. Therefore, the structure of economic cost estimates arising from this study might be helpful in estimating potential costs of NUVI for the countries in future.

While for Moldova the cost of Rota virus vaccine introduction is marginal because it only amounts to estimated financial costs, if other additional vaccines will be introduced in future the country may face significant additional costs, resulting from additional cold chain capacity and possibly from additional staff to cope with increased workload. It has to be noted that even now in Moldova human resources are thinly stretched on a PHC level, which has been captured by the WHO[18] and recommended increasing staff to cope with the workload. Therefore, any further introduction of a new vaccine will further aggravate relative HR shortages on a PHC level and will obviously demand more staff time and costs. In such a case estimates in this report will become instrumental.

Estimated incremental costs on a national level were further disaggregated by inputs on a facility, district and national level and are presented in Table 35 and Table 36. Further disaggregation by input and activities are provided in Annex 4.

Table 35: Incremental financial cost and cost profile at a facility, district and national levels for NUVI

Item	**Facility level**		**District level**		**National level**	
	Total Cost $US	**% of total cost**	**Total Cost $US**	**% of total cost**	**Total Cost $US**	**% of total cost**
Recurrent cost	**258,947**	**100.0%**	**260,560**	**100.0%**	**373,529**	**98.6%**
Salaried Labour	-		-		12,324	3.3%
Per-Dime & Travel Allowances	-		**117**	0.0%	1,525	0.4%
Vaccines	**254,867**	98.4%	**254,867**	97.8%	254,867	67.3%
Transportation/fuel	**4,080**	1.6%	**5,576**	2.1%	8,221	2.2%
Cold Chain energy	-		-		-	
Printing					14,011	3.7%
Building overhead	-		-		29,771	7.9%
Other recurrent	-		-		52,812	13.9%
Capital cost			-		**5,250**	**1.4%**
Other equipment					5,250	1.4%
TOTAL	**258,947**	**100.0%**	**260,560**	**100.0%**	**378,779**	**100.0%**

Table 36: Incremental economic cost (with cold chain) and cost profile at the facility, district and national levels for NUVI

Item	**Facility level**		**District level**		**National level**	
	Total Cost $US	**% of total cost**	**Total Cost $US**	**% of total cost**	**Total Cost $US**	**% of total cost**
Recurrent cost	**312,303**	**95.0%**	**316,301**	**93.7%**	**432,479**	**90.5%**
Salaried Labor	51,327	15.6%	52,966	15.7%	65,451	13.7%
Per Diem & Travel Allowances	-	0.0%	221	0.1%	2,126	0.4%
Vaccines	254,867	77.5%	254,867	75.5%	254,867	53.4%
Transport/ Fuel	6,109	1.9%	8,247	2.4%	10,893	2.3%

[18] WHO 2012. Evaluation of the structure and provision of primary care in the Republic of Moldova. Republic of Moldova Health Policy Paper Series No. 5, Chisnau, Moldova

Printing	-	0.0%	-	0.0%	15,339	3.2%
Building overhead, Utilities, Communication	-	0.0%	-	0.0%	29,771	6.2%
Other Recurrent	-	0.0%	-	0.0%	54,033	11.3%
Capital costs	**16,548**	**5.0%**	**21,134**	**6.3%**	**45,165**	**9.5%**
Cold Chain Equipment	16,548	5.0%	21,134	6.3%	22,524	4.7%
Other Equipment	-	0.0%	-	0.0%	22,641	4.7%
TOTAL	**328,851**	**100.0%**	**337,435**	**100.0%**	**477,645**	**100.0%**

Finally, Table 37 presents results of sensitivity analysis showing that one-dollar increase in the vaccine price translates into 2.1% increase in the overall cost per infant and doubling the prices results in 24.1% increase.

Table 37: Price influence on financial costs per infant (sensitivity analysis)

Price Change	Price per dose of Rotarix	Cost per Infant (Rotarix)	Price per dose of PCV-13	Cost per Infant (PCV-13)	Incremental cost per Infant (Rotarix + PCV-13)	Percent Change relative to 2011 Prices per Infant
Baseline price	*2.5*	*9.5*	*7*	*32.6*	*42.5*	*13.4%*
1$ increase in price	3.5	12.5	8	36.5	49.0	15.5%
2$ increase in price	4.5	15.1	9	40.4	55.5	17.5%
3$ increase in price	5.5	17.7	10	44.3	62.1	19.6%
4$ increase in price	6.5	20.3	11	48.2	68.6	21.7%
5$ increase in price	7.5	22.9	12	52.2	75.1	23.7%
6$ increase in price	8.5	25.5	13	56.1	81.6	25.8%
Double of the baseline price	**4.9**	**16.3**	**14**	**60.0**	**76.2**	**24.1%**

Funding NUVI

We also used financial flow analysis to understand sources and uses of funds for the NUVI in Moldova. The methodology for financial flow analysis was similar to the one used for the routine immunization program. The analysis showed that 77% of funds, needed for the NUVI came from GAVI, 10.5% from UNICEF and WHO and the government was only responsible for providing 12.5% of the funds necessary for the Rotavirus vaccine introduction (see Table 38). If the role of CNAM in the routine immunization program was significant for the NUVI the role of the National Public Health Centre became more paramount as they administered 96.1% of all resources and CNAM only managed 1.6%.

Table 38 Financial Sources for NUVI

Source / Financing Agent	GAVI	State Budget	UNICEF	WHO	Total $US	Percent
CNAM		6,372			6,372	1.6%
District Public Health Center		2,221			2,221	0.5%
National Public Health Center	312,711	42,307	18,842	16,785	390,645	96.1%
UNICEF			1,760		1,760	0.4%
WHO				5,357	5,357	1.3%
Grand Total $US	**312,711**	**50,900**	**20,602**	**22,142**	**406,355**	**100.0%**
Percent	77.0%	12.5%	5.1%	5.4%	**100%**	

GAVI funds were spent on different immunization activities: 84% of the funds spent on facility based service delivery function and almost 98% of expenses related to the program management were covered by the GAVI. UNICEF mainly supported social mobilization and surveillance function was fully financed by the WHO (Table 39).

Table 39: Financing by activity

Function / Sources	Social mobilization, advocacy	Facility-based routine immunization service delivery	Training	Vaccine collection, storage and distribution	Cold chain maintenance	Program Management	Supervision	EPI Surveillance	Grand Total
GAVI		225,094			5,840	78,307	3,470		**312,711**
State budget	129	42,284	6,039	660		1,788			**50,900**
UNICEF	18,842		1,760						**20,602**
WHO			5,357					16,785	**22,142**
Grand Total	**18,972**	**267,378**	**13,156**	**660**	**5,840**	**80,095**	**3,470**	**16,785**	**406,355**

Similar to the routine immunization, most of resources for the NUVI are being spent on an FMC level, and the least amount on HOs determined by scale of these facilities. As expected CNAM financing for the NUVI is only used on a medical provider level to finance transportation costs related to trainings and program management and resources from the National Public Health Centre are being used by medical providers as well as by providers of a preventive care (see Table 40 for details).

Table 40 Funding flow on a provider level

Providers / Financing Agent	CNAM	District Public Health Center	National Public Health Center	UNICEF	WHO	Total $US	Percent
Family Medicine Center	1,301		128,553			**129,854**	31.96%
Health Center	1,036		49,555			**50,591**	12.45%
Office of Family Doctors	2,816		62,929			**65,745**	16.18%
Health Office	1,219		13,831			**15,049**	3.70%
Providers of preventive care		2,221	135,778			**137,999**	33.96%
WHO					5,357	**5,357**	1.32%
UNICEF				1,760		**1,760**	0.43%
Grand Total $US	**6,372**	**2,221**	**390,645**	**1,760**	**5,357**	**406,355**	**100%**
Percent	1.6%	0.5%	96.1%	0.4%	1.3%	**100%**	

Table 41 below describes use of funds for a different function on a provider level and shows that 92-99% of funds on a medical provider level are being used for facility based services provision and marginal amounts are being spent on trainings. Providers of preventive care i.e. district and national level centres of public health are the ones to assume responsibility for following key functions and spent following amounts out of 137,999$US they received: social mobilization - 14%, cold chain maintenance – 4%, program management 57% and supervision – 3% and surveillance -12%. Finally Table 42 below describes use of funds for various inputs and once again highlights that 92-99% of funds for the NUVI on a medical provider level are being spent on vaccines and little portion 2-7% are used to finance transportation costs to training sites.

Table 41 Use of funds for various functions on a provider level

Provider \ Function	Social mobilization, advocacy	Facility-based routine immunization service delivery	Training	Vaccine collection, storage and distribution	Cold chain maintenance	Program Management	Supervision	EPI Surveillance	**Percent**	**Total $US**
Family Medicine Center	0%	99%	0%	0%	0%	1%	0%	0%	**100%**	**129,854**
Health Center	0%	98%	2%	0%	0%	0%	0%	0%	**100%**	**50,591**
Office of Family Doctors	0%	96%	4%	0%	0%	0%	0%	0%	**100%**	**65,745**
Health Office	0%	92%	7%	0%	0%	1%	0%	0%	**100%**	**15,049**
Providers of preventive care	14%	9%	1%	0%	4%	57%	3%	12%	**100%**	**137,999**
UNICEF	0%	0%	100%	0%	0%	0%	0%	0%	**100%**	**5,357**
WHO	0%	0%	100%	0%	0%	0%	0%	0%	**100%**	**1,760**
Total Percent	**5%**	**66%**	**3%**	**0%**	**1%**	**20%**	**1%**	**4%**	**100%**	**406,355**

Table 42 Use of funds for various inputs on a provider level

Provider \ Inputs	Wages and salaries	Per diem	Vaccines	Transport	Printing	Utilities and communications	Other	Other equipment	**Percent**	**Total $US**
Family Medicine Center	0.0%	0.0%	99.0%	1.0%	0.0%	0.0%	0.0%	0.0%	**100%**	**129,854**
Health Center	0.0%	0.0%	98.0%	2.0%	0.0%	0.0%	0.0%	0.0%	**100%**	**50,591**
Office of Family Doctors	0.0%	0.0%	95.7%	4.3%	0.0%	0.0%	0.0%	0.0%	**100%**	**65,745**
Health Office	0.0%	0.0%	91.9%	8.1%	0.0%	0.0%	0.0%	0.0%	**100%**	**15,049**
Providers of preventive care	8.9%	0.6%	0.0%	3.5%	9.1%	21.6%	37.3%	19.0%	**100%**	**137,999**
UNICEF	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	**100%**	**5,357**
WHO	0.0%	25.3%	0.0%	0.0%	56.0%	0.0%	18.7%	0.0%	**100%**	**1,760**
Total Percent	**3%**	**1%**	**63%**	**3%**	**4%**	**7%**	**13%**	**6%**	**100%**	**406,355**

Discussion of Results

Our study documented that incremental fiscal costs of a rotavirus vaccine introduction (without vaccines) amounted to 151,489$, out of which 100,000 $US was provided through GAVI grant and the rest financed by UNICEF and WHO. The government was only responsible for providing 12.5% of the funds necessary for the Rotavirus vaccine introduction.

These findings may point to the adequacy of GAVI's vaccine introduction grant relative to the financial need of the country in a Moldovan case. However, incremental fiscal cost per infant (without vaccine) was estimated at 3.82$ which is 4.7 times higher than 80 cents established per infant under GAVI vaccine introduction grant policies [48].Consequently, adequacy of the introduction grant from GAVI for Moldova was only determined by small size of the birth cohort. Furthermore, as noted earlier costs in Moldova were low because the country had spare cold chain capacity on the national and district level and was able to meet increased vaccine volume needs without additional investments. It is well known that most countries face cold chain capacity constraints when they introduce new or underutilized vaccines [49]. Therefore it is expected that difference between GAVI established amount per infant – 80c under vaccine introduction grants and actual fiscal costs of delivering new vaccine per infant could be even greater in the countries that have bigger birth cohorts.

Our study estimated economic cost per infant to be 12.03 $, when vaccine costs are considered. This translates into 3.8% increase over the cost per infant under the national immunization schedule, which was estimated at 316.6 $ in 2011. Our estimates for a rotavirus vaccine introduction were based on 2.5$ per dose of Rotarix™, currently being purchased through UNICEF with GAVI co-financing. In 2016 Moldova is scheduled to graduate from GAVI financial support. In the current fiscal context immunization program accounts to only 2.4% of the recurrent public financing for health and is comparable to the levels found elsewhere [50]; [51]. However, after GAVI graduation vaccine prices are expected to increase because of the national public procurement rules, which mandate local tendering[19] and as a consequence for all non-UNICEF supplied vaccines Moldova pays almost double the UNICEF price [6]. Also it is estimated that every dollar increase in vaccine price may result in 2.1% increase of immunization costs and doubling the vaccine price will demand almost 24.1% more from the national budget. Consequently financial sustainability of the immunization program will significantly depend on future vaccine prices, which does not make Moldova much different from many other countries, where cost of new vaccines has been found to drive up to 60% of vaccine introduction costs [52].

Finally, introducing new vaccines and even in case of doubling vaccine prices the share of public health spending that will be required in Moldova will be close to 3% of public financing for health and will be comparable to the levels documented elsewhere [50]. Therefore affordability and financial sustainability of immunization services may look promising. However, looking at financial sustainability of immunization programs in a silo and not taking broader country fiscal context into consideration, may lead to misleading conclusions. Namely, in 2016 Moldova is expected to graduate from GAVI and, due to recently introduced New Funding Model (NFM), will also receive significantly reduced financing from the Global Fund to Fight HIV/AIDS, Tuberculosis and Malaria (GFATM) [53]. Currently both donors contribute significant share of financing for public health programs. Concurrent reduction/graduation of the assistance from the GFATM and GAVI is expected to significantly increase pressure on the national budget. This has been confirmed by the estimates in the Medium Term Budgetary Framework for 2014-2016 [54]. In its budget planning the Ministry of Health expects that graduation from the GAVI and reductions in financing from the GFATM will increase demand on the national budget for public health programs 2.45 times in 2016 compared to 2012 levels. Due to limited fiscal space and weak economic growth prospects for the same period [55][56] this could pose significant challenges for the government and may put at risk adequate financing of the immunization, TB and HIV/AIDS programs in this country.

Comparison with NUVI introduction plan

We also compared cash flow estimates derived from our study with the *New Vaccine Introduction Plan* [57] that was developed by the government of Moldova in 2011.

Before describing findings we have to note significant limitations, which this comparison poses. The new vaccine introduction plan uses cost elements from the cMYP, where some inputs and functions are mixed in a same budget line. In order to derive more meaningful comparison we have made following adjustments for example per-diems that were given to personnel for attending trainings were accounted under the "training" cost category in the study findings, while per-diems given to personnel for supervisory visits were included in the

[19] Due to small market size of Moldova with 3.5 million population and small birth cohort, big vaccine manufacturers are not much interested to bid on local tenders.

line for "human resources". Transportation costs regardless of function (social mobilization, program management and training) were accounted under the "vehicles and transportation" cost category, etc. Nonetheless, comparison on a total cost level shows that total financial requirements for the Rotavirus vaccine introduction in Moldova were estimated at US $227,000, but actual expenditure was less by US $ 75,512 or by 33%. Detailed comparison by cost categories is presented in Table 43 below, although it is not informative due to limitations noted above. Therefore, bottom line comparison is more important and it further confirms that for going forward cMYP approach needs further improvements to help better estimate NUVI costs and help secure financial support from GAVI or other donors.

Table 43: Comparison of full needs and expenses for the new vaccine introduction

Cost Category	Plan	Costing Study	Variance
	Full needs for new vaccine introduction (US$)	Expenses for the New vaccine introduction (US$)	
Training	25,000	7,117	17,883
Social Mobilization, IEC and Advocacy	30,000	18,842	11,158
Cold Chain Equipment & Maintenance	22,000	5,840	16,160
Vehicles and Transportation	45,000	11,240	33,760
Programme Management	20,000	22,475	(2,475)
Surveillance and Monitoring	25,000	16,785	8,215
Human Resources	30,000	13,170	16,830
Technical assistance	30,000		30,000
Overhead		29,771	(29,771)
Office equipment		26,248	(26,248)
Total	**227,000**	**151,488**	**75,512**

Table 44 below presents comparison of new vaccine introduction grant with our costing study.

Table 44: Comparison of new vaccine introduction grant with costing study

Cost Category	NUVI Plan	GAVI Grant	Costing Study
	Full needs for new vaccine introduction (US$)	Funded with new vaccine introduction grant (US$)	Expenses for the New vaccine introduction (US$)
Training	25,000	15,000	7,117
Social Mobilization, IEC and Advocacy	30,000	15,000	18,842
Cold Chain Equipment & Maintenance	22,000	15,000	5,840
Vehicles and Transportation	45,000		11,240
Programme Management	20,000	20,000	22,475
Surveillance and Monitoring	25,000	25,000	16,785
Human Resources	30,000	10,000	13,170
Technical assistance	30,000		
Overhead			29,771
Office equipment			26,248
Total	**227,000**	**100,000**	**151,488**

Conclusions

Our study shows that cMYP in its current form and as the critical toll for financial planning for NUVI may not be appropriate unless further improvements are introduced or alternative approaches to financial planning are developed. The variation, resulting from cMYP are significant and if on a country level (especially for Moldova) they are negligible, on a regional and Global level such weaknesses could result in a significant bias and waste of resources.

This is the first costing study conducted in Moldova and consequently the estimated incremental financial and economic costs for the new vaccine introduction provide useful inputs for the national planning and policymaking.

While graduating from the GAVI support the government may want to use the remaining time till the end of 2016 and identify the best vaccine procurement mechanisms[20], which would allow purchasing vaccines from UNICEF or at a comparable price. This will help minimize vaccine price, materialize savings and reduce the financial pressure on the national budget after GAVI graduation.

Our estimates for the incremental fiscal costs that are necessary to introduce a new vaccine in the immunization program proved to be 4.7 times higher compared to 80c currently paid by GAVI. These findings highlighted possible weaknesses in the GAVI policies and call for thorough re-evaluation in light of emerging new evidence.

We have documented that incremental financial costs are not high, when only a rotavirus vaccine introduction is evaluated. However, with PCV introduction, with possible vaccine price increases after GAVI graduation and with concurrent reduction in the funding from the GFATM, financial sustainability of immunization and other health programs may be put at risk and Moldova may lose the health gains achieved thus far. These challenges do not look unique to Moldova and many countries that are graduating from GAVI assistance and expecting funding reductions from the GFATM could be at similar risk. Consequently, careful evaluation and elaboration of graduation and/or co-financing policies across donors seems to be warranted to assure that achieved health gains are sustained and enhanced after countries graduate from donor assistance. When evaluating these policies not only national fiscal context has to be considered but also expected graduation from other donors' support needs to be as well taken into account.

[20]Allowing for purchases from UNICEF or for pulled procurement under national legislation, etc.

Immunization Cost Determinants and Productivity

Introduction

Cost-effectiveness of immunization programs are well documented worldwide within developed and developing country settings. Consequently, investing public financial resources on activities aimed at enhancing vaccination activities reveal to be a priority [10][58] [59][60][61][62].

Although strong steps have been taken globally to expand immunization coverage rates, the progress is not sufficient in many countries and several issues are still pending on the international agenda, namely: how to identify and to reach out to non-served population? Which new vaccines need to be considered in an improved vaccination calendar? What are the costs of including them (both non-served population and new vaccines) in the current immunization plans? etc.

As in many other health care services, strategies of immunization programs and their cost structures cannot be replicated from one country to another. Population density, their location and accessibility along a territory, geographic particularities and distribution of health care services and population characteristics (health habits, education) among others, have strong influence on costs of delivering vaccination services [14] [16].

Beyond that, vaccine procurement mechanisms, status of cold chains and managerial issues on a facility and on an immunization program level also has significant influence on success of vaccination initiatives. Global evidence on what actually determines cost of immunization and how much is necessary for developing countries to deliver these services is still inconclusive. Our study aims at contributing additional evidence around the topic of immunization costs and productivity determinants, by using the facility level costing data from Moldova.

Particular studies on cost determinants for immunization programs provide rich insights about relevance of particular factors under specific scenarios. Bishai et al. [32] analyzes average costs and DTP3 coverage, by using a fifty-country panel from 2000 to 2003 arising from WHO and GAVI sources. They prove the presence of strong economies of scale in the provision of immunization coverage, leaving room for increasing coverage and closing the immunization gap. Also using facility data, Robertson et al [63] calculated average costs per FIC in Gambia which further contributed to the argument of decreasing costs with scale. In the same direction, Kahn et al. [31] based on immunization centers in Dhaka, Bangladesh, calculated average cost of FIC during the year 1999. Results prove decreasing costs with population scale, and identified the relevance of community support in reaching higher coverage.

Creese et al [64] looked at costs per fully immunized child (FIC) in Indonesia, Philippines and Thailand, analyzing 1978/79 facility level data. Bi-variate analysis across institutions and countries found significant rural-urban differences in input prices as well as in population accessibility to the services. Walker et al. [9] looked at disaggregated immunization costs per budgetary line in three Peruvian districts and calculated average expenses per FIC. Findings show significant differences across urban and rural locations, as well among type of facilities, particularly between urban and rural health centers, suggesting the presence of geographical access barriers in reaching immunization. All of these findings from other parts of the world resonate well with the findings of our study presented in earlier sections.

Particular goal of this chapter is to identify productivity indicators by human and capital factors in the Moldavian immunization program, analyzing production and costs determinants. Ordinary least square (OLS) method was applied to a traditional cost function structure, recognizing a multivariate influence different factors on immunization costs, where production variables as well as population and health system characteristics participate in the definition of average costs.

Estimations were performed on a facility level as well as on a district and the national level. And in all three cases, cost determinants were studied including and excluding costs related to wages for shared staff, which is covered by the national purchaser - CNAM.

Results confirm the presence of economies of scale in the production of immunized population. The share of time spent by staff at health centers is a driving component in explaining immunization coverage, followed by infrastructure indicators, although the former is more important with 3:1 ratio. In addition to production factors, socio-economic variables are relevant in defining average immunization costs, showing the interaction between demand characteristics with supply structure in the design of a vaccination program.

Methodology and Major Research Questions

Out of 1,318 health care facilities in charge of delivering immunization services in Moldova across 37 districts, the research team sampled 50 institutions, combining districts with urban and rural locations, as well as capturing diversity of health service providers (see Table 114 in the Annex 5 for sampling criteria).

The survey allowed capturing facility performance indicators (fully immunized child and number of total doses administered), human resource characteristics and their participation in the immunization activity (hours worked on immunization activities, presence of doctor in the health center), as well as a facility specific scale factors (total square meters per facility, cold chain capital index, etc.).

Beyond this information, the facility-based dataset was enriched with information about input prices, socio-economic characteristics of a population sourced from the national statistical office, such as number of infants in a catchment area, average household income, education level of families living in a given area, etc. These variables were evaluated with the help of bi-variate correlations, and appropriate ones also tested in the regression model (described later) to see their influence on productivity as well as on the cost of delivering immunization services in Moldova.

Table 45 below and Table 115 in the Annex 5; summarize descriptive statistics for un-weighted and weighted sample of facilities, respectively. These variables were used in the econometric analysis described later in the report.

The estimation strategy used in the study considers a sequence of two steps. The first step analyzes determinants of main production indicators/outputs: i.e. what explains the number of *Fully Immunized Child* (FIC) and the total number of doses administered on a facility level? In order to answer these questions, we looked at variables related to inputs i.e. human resources and facility capacity/specification. Production determinants are also corrected by scale variables (number of infants in catchment area), as well as by wastage rates, which could be seen as a proxy for a facility management practices. Applying a linear production function, immunization outputs take the form:

$$Q\_\mathrm{i} = A\_\mathrm{i} + \alpha\_1\, L\_\mathrm{i} + \alpha\_2\, K\_\mathrm{i} - \alpha\_3 W\_\mathrm{i} \qquad (1)$$

Where Q is the output indicator (FIC or number of doses administered) for facility “i”, L and K are multiplicative vectors of production factors, with participation α1 and α2 respectively and A is the scale of infants present in the catchment area. The production function also depends on the wastage rate (W), which weighted the productivity of each factor.

Applying natural logarithms on the left side of the equation (1) facilitates the use of ordinary least square estimations techniques and the calculus of semi-elasticities in production with respect to a relevant input indicator(s). They allow identifying how output production changes (in percentages) when input each factor is modified by one unit (keeping constant all other factors)[21] [22]:

$$lnQ\_i = A\_i + \alpha\_1\ L\_i + \alpha\_2\ K\_i + \alpha\_3\ W\_i \quad (2)$$

The second estimation step proposes to answer the question: what determines the cost of immunization services? For this purposes we use the Total Economic Cost at a facility level as well as at district and national levels as a dependent variable.

The costs model implemented is based on a traditional cost structure $CQ\_i = w\_i.K\_i + r\_i.L\_i$, expressed in natural logs, adding contributions from the literature on hybrid costs models, where prices, quality-driver and demand side characteristics interact [65]; [66]in the form:.

This type of specification allows combining pure structural cost function characteristics with potentially relevant ad-hoc variables. In this case, the scale factor is defined by the output indicator measured in the first step (FIC). The cost function may also need to consider the influence of the demand side (population characteristics) on immunization. Therefore, the cost equation will take the form:

$$\text{Ln}\ CQ\_i = \ln FIC\_i + \alpha\_1 \ln w\_i + \alpha\_2 \ln r\_i + \alpha\_3 \ln W\_i + \alpha\_4 \ln P\_i \quad (3)$$

Where CQ is the total economic cost for the facility i (i=1…50), w and r are input prices for labor force and infrastructure (as it will be detail in the next section), FIC captures the effect of the size of the objective population (scale factor) which incorporates the level of inputs involved[23]. W is a proxy of managerial quality (wastage rate) and P introduces the relevance of demand-side variable in the cost structure (i.e. education and income of the population affected by the program).

Table 45: Summary statistics, unweighted sample

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Fully Immunized Child (FIC)	50	60,88	135,16	1	714
Total number of doses administered	50	895,20	1844,43	33	9060
Total Economic Cost, Facility Level	50	11942	21743	565	112548
Total Economic Cost, Facility + District Level	50	12502,23	22404,94	627,75	115062
Total Economic Cost, Facility + District + National Level	50	12663,11	22723,92	641,27	116657
Share of staff time spent in the facility for immunization in % (FTE)	50	1,32	2,01	0,2	10,20
Total working hours	50	51,22	12,12	8	71
Total facility square meters	50	577,76	1173,18	20	5820
Cold chain capital index (cold chain economic cost at facility level)	50	72,86	22,20	7,79	136,14

[21] Originally, a Cobb-Douglas functional form was considered as a potential specification for the production function, given its relative straightforward reading of coefficients within a log linear equation. However, it assumes constant elasticity of substitution, which imposes a constraint to the estimation. In addition, histograms of both dependent variables used in the econometric implementation (Fully immunized children and total number of doses administered) suggest the presence of a semi-log specification. For more details see [14].

[22] Although Poisson and Negative Binomial estimation forms are useful in studying health care related issues (visits to doctors, number of inpatient days, etc.), in our case the dependent variables do not fit into those alternatives: although integer and positive, observations are not concentrated on values 0, 1, 2, etc., and there are not zero values involved (see Table 35 in the chapter).

[23] A production function shows the technological relation of inputs to produce a good or service (immunized children, in this case), while cost function is triggered by input prices, given a technological production structure. As the former is an antecedent of the latter, the econometrical implementation instruments a two-step estimation, where the result of the first step is incorporated in the second.

Hourly wage, mid career nurse (USD)	50	1,82	0,16	1,45	2,28
Refrigerator unit price (USD)	50	0,76	0,36	0,01	2,13
Total number of infants in the facility catchment area	50	66,06	149,98	1	810
Share of population with university education in %	50	6,46	5,38	2,90	24,40
Dummy Facility Type (=1 if FMC)	50	0,10	0	0	1
Dummy Doctor at the facility (=1 Yes)	50	0,88	0,33	0	1
Dummy Facility Location (=1 if Urban)	50	0,06	0,24	0	1
Distance from the facility to the vaccine collection point	50	19,60	13,14	0	50
Overall Wastage Rate in % (from total number of doses administered)	50	17,01	8,89	4,90	36,90

Results

Productivity

The issue about productivity and how it can be measured and compared across alternative definitions of output can be addressed with the help of two Tables presented below. They help understand observed differences in performance between types of facility. First, Table 46 looks at FIC related outputs by using FIC to human resource ratios (i.e. FIC per immunization working hour and total working hours per FIC), and FIC to infrastructure ratios (i.e. FIC per thousand outpatient visits and facility's square meters per FIC). Each indicator is presented by a facility type (FMC, OFD, HC and HO), and for the total average. The last three columns on the right hand-side present T-tests of comparing OFDs with other facilities. Table 47 repeats the same exercise using same indicators but related to total doses administered instead of FIC.

Table 46: FIC: Performance Indicators by Facility Type; Weighted sample.

	Facility Type					T-test		
Annual Indicators	FMC	OFD	HC	HO	Mean	OFD vs. FMC	OFD vs. HC	OFD vs. HO
FIC/Immunization working hours	2.488	1.194	1.362	1.500	1.636	-1.294***	-0.168***	-0.306***
FIC/Total working hours	0.127	0.006	0.017	0.003	0.039	-0.121***	-0.011***	0.003***
FIC/Outpatient visits	0.001	0.005	0.004	0.008	0.005	0.003***	0.001***	-0.003***
FIC/Facility Sq. Meters	0.113	0.135	0.100	0.119	0.116	0,022	0.038***	0.016**

Notes: Significance levels: *** p<0.01, ** p<0.05,* p<0.1.

Table 46 shows that an additional working hour spent on immunization is associated with about 1.6 fully immunized child in Moldova, with a minimum at OFDs - 1.194 FIC per hour and a maximum at FMCs with 2.5 additional fully immunized child. Contrary increasing ***total working hours*** clearly has lower correlation with immunization outputs across types of facilities.

On the other hand, infrastructure has no strong linkages with immunization performance. One thousand outpatient visits relates to one to eight more children fully immunized, while increasing facility physical space in the same proportion is associated in average with 116 new FIC. All observed differences across facilities are statistically significant, with the exception of one.

Table 47 reproduces the same indicators using the total number of administered doses as the output variable and shows that FMCs delivers 37.4 doses per immunization hour and 1.86 doses per working hour as opposed to OFDs with the lowest number of doses-20.5 per immunization hour.

In terms of variables used as proxy of capital measures, Table 47 shows that, on average, Moldavian health facilities present a mean value of 1.8 new doses administered per square meter. Such indicator has its lowest value in FMCs with 1.161 dose administered per each square meter, while the highest productivity is reached at OFD with 2.3 FICs.

Nevertheless, this bi-variate analysis still hides valuable information having potential to explain immunization performance. Each type of facility is associated to certain geographical environment (rural, urban, with different levels of population density), as well as medical and support personnel structure and capacity, among other issues. Deeper look with the help of multivariate estimations may allow understanding production and costs determinants much better. Therefore, we now move onto multivariate analysis.

Table 47: Total Dose Adm.: Performance Indicators by Facility Type; Weighted sample

	Facility Type					T-test		
Annual Indicators	FMC	OFD	HC	HO	Mean	OFD vs. FMC	OFD vs. HC	OFD vs. HO
Total Dose Adm./Immunization working hours	37.419	20.478	21.471	22.810	25.545	-16.940***	-0,992	-2.332***
Total Dose Adm./ Total working hours	1.8553	0.107	0.275	0.058	0.574	-1.749***	-0.169***	0.049***
Total Dose Adm./ Outpatient visits	0.024	0.086	0.065	0.119	0.074	0.061***	0.021***	-0.032***
Total Dose Adm./ Facility Sq. Meters	1.161	2.308	1.526	1.760	1.801	0.697***	0.782***	0.548***

Notes: Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

First Step: Production Determinants

The Moldova uses only fixed strategy for immunization delivery, therefore we regressed two production indicators following the specification in equation (2): "*Number of Fully Immunized Children*" and "*Total Number of Doses Administered*" per facility, against explanatory variables from Table 46. Although both dependant variable relate to the service production capacity of a facility, the "*Total Number of Doses Administered*" could be seen as a facility-specific scale factor and the "*Number of Fully Immunized Children*" also involves quality dimension of the services rendered, because in order to achieve higher number of FICs several things have to occur: children that need vaccination have to be identified, they need to be followed by the staff and vaccination schedule has to be completed on time.

Explanatory variables used in the regression were facility level inputs (human resources and infrastructure), proxy explaining logistics required for vaccine distribution i.e. distance to vaccine collection site, size of population in a facility catchment area and facility type, and ability of a population to reach immunization site (by urban or rural location). In addition, the variable "*wastage rate*" was included in the regression as a proxy for managerial effectiveness of a service provider.

The analysis of the histograms on the dependent variable (Figure 19 and Figure 20 in the Annex 5) suggested using semi-log functions in the econometric implementation for production analysis. In addition, and following Manning and Mullahy [67], the final set of estimation techniques includes the use of robust standard errors given the presence of heteroscedasticity under basic OLS specifications[24.]

[24] One of the main assumptions for OLS regression is that the variance of the error term is constant (there is not heteroscedasticity). Otherwise, OLS does not provide estimates with the smallest variances. The Breusch-Pagan / Cook-Weisberg test is designed to detect any linear form of heteroscedasticity. One way to deal with the problem of heteroscedasticity is the use of robust standard errors. The use of robust standard errors does not

Results of regression bring particular learning for our analysis. Firstly, the impact of human resources on facility outputs is positive and significant at 99% in all specifications. Coefficients can be read as productivity indicators, and show that increasing working hours devoted to immunization by one per cent (measured as total working hours per 10,000 populations) would result on three additional child being fully immunized (seeTable 48)

Devoting more staff time towards immunization has comparable impact on total number of doses administered, not only in terms of magnitude of impact but also in statistical significance[25].

Furthermore, two alternative measures of capital were included in the analysis: facility square meters and the cold chain capital index[26], intending both to capture productivity issues related to infrastructure. In the case of total number of doses administered coefficients of both variables (square meters and cold chain) show to be significant at 95% level, although their effects on productivity are significantly smaller than those of human resources. On the other hand the cold chain capital index does not affect FIC but has positive and statistically significant influence on the total doses delivered by a facility, and its influence is greater that of square meters.

The difference between centers and –particularly- number of infants in a catchment population, show to have positive relationship in explaining higher immunization outputs, but the magnitude of their impact is lower when their coefficients are compared with those which relates to human resources.

change coefficient estimates, but (because the standard errors are changed) the test statistics give reasonably accurate p-values.

[25] Nevertheless, the analysis may involve potential issues related to endogeneity. Claiming that the share of staff at the health center spent on immunization affects the number of fully immunized children does not reveal that it is possible that health care personnel are responding to demand requirements.

[26] One possible measure of capital in immunization activities is the cold chain available capacity at the health care center level. As cold chain devices varies in capacity across facility types, one potential way of capturing the scale of this factor is to know the share of total costs at the facility level, under the assumption that higher capacity is linked with higher economic costs. The cold chain capital index captures this proportion.

Table 48: Determinants of Production

	Ln Fully Immunized Children (FIC)									Ln Total Dose								
	(1)			(2)			(3)			(4)			(5)			(6)		
	b	se	p	b	se	p	b	se	P	b	se	p	b	se	p	b	se	p
Total working hours	0.0311*	0.012	0.014	0.0330**	0.011	0.006	0.0315**	0.011	0.008	0.0249**	0.009	0.006	0.0269***	0.007	0.001	0.0254**	0.007	0.001
Total facility square meters	0.000507*	0	0.026	-	-	-	0.000461*	0	0.04	0.000523*	0	0.017	-	-	-	0.000459*	0	0.03
Cold chain capital index	-	-	-	0.0109	0.007	0.135	0.00955	0.007	0.183	-	-	-	0.0147*	0.006	0.014	0.0133*	0.006	0.021
Total number of infants in the facility catchment area	0.00636**	0.002	0.005	0.00577*	0.003	0.041	0.00547*	0.002	0.017	0.00538**	0.002	0.003	0.00444	0.002	0.06	0.00413*	0.002	0.021
Dummy Facility Type (=1 if FMC)	-1.708	1.123	0.136	-0.0152	1.04	0.988	-1.62	1.152	0.167	-1.529	0.944	0.113	0.192	0.884	0.829	-1.407	0.968	0.153
Dummy Doctor at the facility (=1 Yes)	0.585**	0.209	0.008	0.676**	0.239	0.007	0.627*	0.235	0.011	0.702**	0.213	0.002	0.809***	0.219	0.001	0.760**	0.22	0.001
Distance from the facility to the vaccine collection point	0.0036	0.009	0.685	0.00553	0.009	0.562	0.00583	0.009	0.532	-0.000313	0.007	0.962	0.0025	0.007	0.726	0.0028	0.007	0.678
Overal Wastage Rate	-0.0387***	0.011	0.001	-0.0399***	0.01	0	-0.0402***	0.01	0	-0.0460***	0.01	0	-0.0478***	0.01	0	-0.0481***	0.009	0
Constant	0.703	0.823	0.398	-0.119	1.147	0.918	0.0121	1.135	0.992	3.982***	0.663	0	2.888***	0.796	0.001	3.018***	0.779	0
R2	0.721			0.714			0.735			0.779			0.787			0.811		
Degrees of freedom	42			42			41			42			42			41		
F test model	17.63			18.18			15.18			21.7			26.78			20.92		
Prob > F	0.000			0.000			0.000			0.000			0.000			0.000		

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

If uni-variate analysis showed that distance from a health care facility and type of medical facility were closely associated with the facility outputs, the multivariate analysis indicates that these two factors do not have statistically significant influence on productivity in a multivariate model. On the other hand, the econometric analysis proves that presence of doctors in the facility has strongest influence on the number of doses delivered and number of FICs produced. All specifications show this influence to be statistically significant at 99% level[27].

Finally, wastage rate, which had statistically significant influence in a bi-variate analysis, retains its significance and negative coefficients on both output indicators, although with slightly stronger implications for the total number of doses administered[28].

Beyond the predictive capacity of the model implemented, the obtained R2 might be also the result of the small size of the sample available to pursue the analysis. The same consideration applies to the results reached at the second estimation step.

Second Step: Cost Determinants

For evaluating determinants of costs we used Equation (3) described earlier and we used two alternative approaches.

The first approach for explaining total cost on a facility level used facility-specific scale variable and prices of inputs in the production function -see specifications (1) through (4) in Table 49. In the second approach in addition to price variables we used a hybrid specification where other variables were considered, as wastage rate and share of the population with university education –see specifications (5) to (8) in Table 49.

In both cases, the scale factor is the total number of FIC and/or FIC estimated [29] with the help of Table 48.

Based on the available evidence, the expectation is that higher scale will require more resources to deliver immunization services and therefore the total facility costs will be higher. However due to economies of scale, we also expect cost per FIC to decline as the scale increases.

When we evaluated input prices they do not show strong differences across facilities. Probably centralized purchase of equipment (i.e. cold boxes, freezers, ice packs, thermometers, refrigerators), as well as uniform national regulation of labor inputs affecting salaries and incentives for personnel, explain limited variability in inputs costs across facilities. Table 117, Table 118 and Table 119 in Annex 5 were developed to present information about units and their prices on a facility level. Table 117 describes hours spent on immunization by different staff categories showing clearly that nurses the most involved with vaccination, followed by doctors and managers/directors. Within nurses Table 118 presents minimum, maximum and their average remuneration per hour, as well as the rates of variations with each group, which is relatively low due to uniform national regulations for

[27] The facilities studied do not show the presence of correlation between experience (seniority) of the nurses participating in the vaccination team and immunization performance.

[28] Table 9 shows the results of applying the same model under a log-log specification. In general, findings are similar to the ones introduced under the log normal setup: labor factor has stronger and significant effects on production than capital inputs; infants in the catchment area are also significant, although facility type, and distance from the distribution point are not. Wastage rates are negative and significant, and the dummy variable capturing the relevance of doctors supplying services at the health center level in this case is not statistically relevant.

[29] Due to the fact that FIC strongly correlated with the demand and supply side variables used in the regression and to avoid multi-collinearity we used FIC estimated as well. The variable is built based on the estimation of FIC arisen from step one of the model. Replacing coefficients obtained in specification (3) of FIC into the original database leads to a new variable, FIC estimated, allowing to link production decisions with the cost structure.

wages. Consequently, in the regression analysis we used mid-career nurse hourly wage as a proxy for prices of human resources.

For prices of capital Table 119 describes differences observed across capital items. As in the case of human resources, the table summarizes minimum, maximum and average prices for an array of five different devices used in the immunization program. Three of them show low coefficients of variation, while two others (cold boxes and refrigerators) the variation is more prominent. Therefore in the econometric analysis unit prices of cold boxes and refrigerators were used as a proxy for capital.

To account for supply and demand side characteristics in the regression model we used two variables, which could provide information about impact of various inputs on immunization costs.

The first one relates to a facility management practices associated to efficiency in the use of resources (wastage rates). The second variable accounted for demand-side factors-characteristics of households (i.e. income, educational level) which may affect demand for health services [68] [69]. As these variables were strongly cross-correlated we only retained the share of population with university education in the model.

Results of both approaches are presented in Table 49. The first four columns of the table (specifications (1) through (4)) show the dependent variable “Total Facility Specific Economic Costs” explained by the scale and price specification, but using alternatively FIC and estimated FIC from Table 48.

In all cases, coefficients of FIC and estimated FIC show to be positive and significant at 99% level. Using natural logarithms on both sides of the equation allow identifying the decreasing effect of scale on a unit cost of immunization. Increasing the number of FIC by one percent results in total cost increase by 0.74% or less-than-one proportion. Consequently, the coefficients presented in Table 49 show that average cost per FIC declines with increasing number of FICs per facility. Replacing the original variable for FIC for its estimated specification (see column (2) and (4)) does not change either the significance or the weight of the variable influence on the total cost, which assures robustness of our findings.

Prices of human resources and capital do not show conclusive and strong influence on the total cost of immunization. Only labor prices reveal statistically significant influence when FIC estimated is used in the regression. Similarly price of refrigerators reveals statistically significant influence only with FIC estimated specification. On the other hand, ice pack unit prices are not significant under any specification of the model. One potential explanation is that the estimated FIC is showing a stylized behavior of the scale variable, which provides room for additional effects to arise, probably associated to particular characteristics at the health center level. These effects may compensate the clear centralized patterns of procurement and payment at the national level.

Specifications (5) to (8) in Table 49 introduce supply and demand characteristics in addition to input prices[30]. Coefficients related to production factor variables show positive and significant influence on explaining immunization costs on a facility level. However, the relevance of each input is different. Human resources show a higher coefficient in explaining costs, five times higher than infrastructure indicators, supporting the argument of vaccination is a labor-intensive intervention. At the same time infrastructure related supply-side variables do not present statistical significance in the model.

The regression analysis shows low efficiency gaps across facilities: the variable distance from the distribution point to the vaccine collection site is not significant in explaining costs,

[30] The approach combines supply and demand characteristics into a single reduced-form regression. Nevertheless, additional information, not available at this stage, may allow estimating a system of equations, in order to capture separately both vectors of determinants.

which could refer to lack of logistic challenges across the immunization system in Moldavia. In addition, the dummy variable capturing rural/urban differences in immunization costs is not statistically significant ,which may refer to a low equity gap in access to immunization services between urban-rural facilities.

Table 49: Determinants of Total Economic Cost, Facility Level

	Dep. Var.: Ln Total Economic Cost, Facility Level																							
	(1)			(2)			(3)			(4)			(5)			(6)			(7)			(8)		
	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p
Ln Fully Immunized Children (FIC)	0.743***	0.06	0	-	-	-	0.743***	0.055	0	-	-	-	0.615***	0.075	0	-	-	-	0.616***	0.164	0.001	-	-	-
Ln FIC Est.	-	-	-	0.815***	0.107	0	-	-	-	0.813***	0.109	0	-	-	-	0.694***	0.15	0	-	-	-	1.720***	0.218	0
Ln FIC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.000218	0.03	0.994	-	-	-
Ln FIC2 Est.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.139***	0.027	0
Ln Hourly wage, mid career nurse	1.122	0.981	0.261	1.442*	0.532	0.01	0.991	1.024	0.34	1.409*	0.569	0.019	1.05	0.986	0.295	1.395*	0.593	0.025	1.05	0.999	0.301	1.628*	0.619	0.013
Ln Refrigerator unit price	0.0502	0.082	0.546	0.183***	0.036	0	-0.0745	0.165	0.654	0.152	0.133	0.262	-0.0651	0.137	0.638	0.132	0.133	0.328	-0.0651	0.139	0.644	0.132	0.112	0.251
Ln Ice pack unit price	-	-	-	-	-	-	-1.033	1.127	0.366	-0.261	1.086	0.812	-1.468	0.947	0.131	-0.667	1.111	0.553	-1.469	1.007	0.155	-0.934	0.904	0.31
Ln Share of population with university education	-	-	-	-	-	-	-	-	-	-	-	-	0.618**	0.186	0.002	0.447	0.229	0.059	0.619*	0.264	0.026	0.692***	0.174	0
Ln Overal Wastage Rate	-	-	-	-	-	-	-	-	-	-	-	-	-0.00933	0.175	0.958	-0.0188	0.2	0.925	-0.00945	0.181	0.959	0.21	0.156	0.189
Constant	5.526***	0.661	0	5.303***	0.512	0	2.649	3.309	0.429	4.581	2.993	0.135	0.842	2.924	0.775	3.13	3.279	0.347	0.837	3.187	0.795	-0.283	2.839	0.921
R2		0.815			0.795			0.821			0.795			0.859			0.811			0.859			0.891	
Degrees of freedom		34			34			33			33			31			31			30			30	
F test model		53.99			41.11			47.36			30.2			68.14			29.66			60.08			56.54	
Prob > F		0.000			0.000			0.000			0.000			0.000			0.000			0.000			0.000	

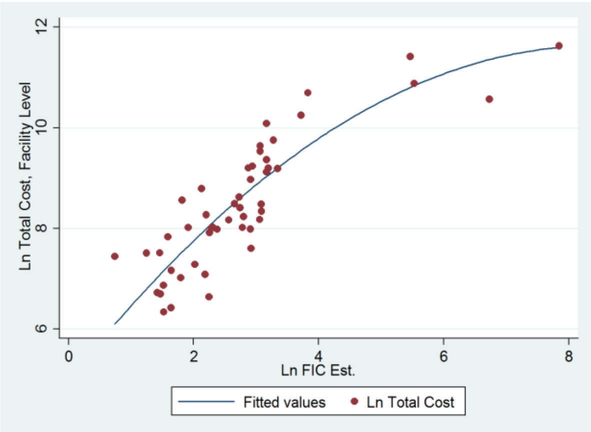
Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Demand side variables show their explanatory power (positive and significant at 99% of confidence) over immunization costs on a facility level under any specification: higher education levels allow demanding for more immunization, triggering vaccination costs. Wastage rate proved not to be significant influence over costs in any specification.

Finally, specifications (7) and (8) introduce the variable FIC2 and FIC2-est, which are the second power of the scale variables used in our cost estimations. The goal of these variables is to explicitly check the hypothesis of decreasing costs with scale, as shown in the literature. Although with FIC the new variable does not have significant power, it shows 99% of significance with FIC estimated. Its sign is negative, supporting the argument of lower costs once quantities produced are higher. As Figure 17 shows, total immunization costs increase with scale (FIC or FIC-estimated). However, the slope of the curve provides an argument about potential decreasing costs as long as the number of FIC increases (i.e., total costs' growth rate is decreasing with scale).

Table 120 in the Annex 5, shows exactly the same specifications provided in Table 49, but using un-weighted sample, in order to check the explanatory power of the sample selection. One-to-one comparisons across different alternative econometric specifications confirm robustness of our findings.

Figure 17: Total Costs by FIC. Estimation at Facility Level



Immunization program in Moldavia is strongly centralized. Central Government assumes responsibility for cold chain, vaccine and syringe procurement and distribution, payment to providers is managed through the single purchaser - CNAM, etc. All of this leaves limited responsibility over cost management to a lower level, which mainly is responsible for organizing and managing immunization program at a facility level only. Therefore, cost determinants are expected to be mainly dependent on health care provider characteristics, where decentralized responsibilities and social factors interact.

Table 50: Total Economic Cost, Facility + District, and Facility + District + National Level

	Dep. Var.: Ln Total Economic Cost																							
	Facility + District Level												Facility + District + National Level											
	(1)			(2)			(3)			(4)			(5)			(6)			(7)			(8)		
	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p	b	se	p
Ln Fully Immunized Children (FIC)	0.749***	0.053	0	-	-	-	0.609***	0.16	0.001	-	-	-	0.750***	0.052	0	-	-	-	0.608***	0.159	0.001	-	-	-
Ln FIC Est.	-	-	-	0.818***	0.106	0	-	-	-	1.719***	0.204	0	-	-	-	0.819***	0.105	0	-	-	-	1.717***	0.202	0
Ln FIC2	-	-	-	-	-	-	0.00274	0.029	0.924	-	-	-	-	-	-	-	-	-	0.00329	0.028	0.909	-	-	-
Ln FIC2 Est.	-	-	-	-	-	-	-	-	-	-0.138***	0.025	0	-	-	-	-	-	-	-	-	-	-0.137***	0.025	0
Ln Hourly wage, mid career nurse	0.919	0.989	0.359	1.339*	0.553	0.021	0.979	0.964	0.318	1.561*	0.61	0.016	0.91	0.981	0.36	1.331*	0.551	0.021	0.971	0.956	0.318	1.553*	0.608	0.016
Ln Refrigerator unit price	-0.0612	0.155	0.695	0.167	0.127	0.199	-0.049	0.132	0.712	0.151	0.106	0.166	-0.0597	0.154	0.7	0.169	0.127	0.192	-0.0471	0.131	0.721	0.153	0.105	0.156
Ln Ice pack unit price	-0.973	1.075	0.372	-0.197	1.049	0.852	-1.355	0.958	0.168	-0.817	0.87	0.355	-0.967	1.067	0.371	-0.19	1.045	0.857	-1.342	0.951	0.168	-0.804	0.866	0.361
Ln Share of population with university education	-	-	-	-	-	-	0.579*	0.256	0.031	0.661***	0.168	0	-	-	-	-	-	-	0.574*	0.254	0.032	0.658***	0.167	0
Ln Overal Wastage Rate	-	-	-	-	-	-	-0.0205	0.182	0.911	0.195	0.15	0.203	-	-	-	-	-	-	-0.0216	0.182	0.906	0.193	0.149	0.205
Constant	2.914	3.151	0.362	4.859	2.886	0.102	1.35	3.048	0.661	0.234	2.723	0.932	2.944	3.127	0.353	4.893	2.873	0.098	1.413	3.025	0.644	0.302	2.707	0.912
R2		0.835			0.806			0.869			0.899			0.838			0.808			0.871			0.9	
Degrees of freedom		33			33			30			30			33			33			30			30	
F test model		52.33			35.83			67.88			62.38			53.24			36.67			69.72			63.5	
Prob > F		0.000			0.000			0.000			0.000			0.000			0.000			0.000			0.000	

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

To evaluate this assumption, costs arising on a district and national level were allocated to the facility level costs and regressed in the model described earlier. Findings of this analysis are presented in Table 50, which presents similar results to those described in Table 49 specifications (3) and (4). Columns (1) to (4) in Table 50 include district level costs along with costs on a facility level. The last four columns also add national level expenditures to those presented for a district level. The results are consistent with findings presented for a facility level in Table 49. Coefficients and significance levels vary only marginally, supporting the hypothesis that average costs per fully immunized child is mainly affected by performance at a local facility level factors.

Finally, because salaries constitute a main source of expenditures paid at the national level, it was decided to conduct similar econometric analysis but excluding the wages from the dependent variable. These results are presented in Table 121 (at the facility level) and Table 122 (at District and National levels) in the Annex 5.

Results confirm prior findings about economies of scale affecting cost of immunization service provision. In addition relative explanatory power of human resources related variable is obviously reduced, giving more room for infrastructure characteristics. As a result, the variable related to wages of health staff loses statistically significance and its coefficients are smaller.

Conclusions and Discussions

As we have seen in this section traditional bi-variate productivity indicators, such as FIC per hour devoted to vaccination, or total number of doses administrated per unit of capital used for immunization allows overall comparisons across facility types. However, they do not help in defining the significance and impact of each potential driver over production outputs and costs.

By using a representative sample of health care facilities and the econometric model, elaborated in this section, our analyses of **production determinants** show particular importance of human resources in producing higher outputs (measured as FIC or as total doses administered). In comparison to facility infrastructure, such as cold chain equipment or square meters of a facility, regression estimations reveal strong labor-intensive character of immunization programs. If in univariate analysis facility size (measured in square meters) had strong influence in producing more FICs or delivering more doses, in the multivariate model it retains statistical significance, but the power of its influence is 48 to 68 times less that of working hours devoted to immunization by the staff.

While labor inputs (hours spent on immunization) are critical for increasing the outputs, the quality of such labor inputs seems to be more important in achieving higher production levels. Our model showed that having a doctor in the facility has more significant influence on the volume of outputs (FICs and doses administered) than having just nurses. In all cases, labor related inputs bring positive and significant coefficients at 99% of significance, while relevance of proxies for capital have less revealing results, particularly when FIC is used as an output measure.

Production estimations also point to the importance of the population size in the catchment area, increasing of which allows for cost savings at the same level of production. The distance of health centers from a vaccine distribution point does not affect production levels significantly. Particularly, dummy variables for facility type, which seemed to have significant influence in a bi-variate analysis, does not reveal significant effects on production, showing higher importance of other production drivers beyond the general characteristics of health care facilities. Finally facilities with lower wastage rates, when all other factors are kept constant, are more able to produce higher outputs.

Our econometric analysis of ***total economic cost determinants*** on a facility level strongly supports the presence of economies of scale in immunization programs. These findings once again re-confirm similar arguments, provided by others [16].

Moreover, the econometric model for evaluating immunization costs contributes to the discussion about centralized health systems that subject providers to uniform rules and its influence on immunization costs. Namely, we found that input prices for labor and capital reveal non-conclusive influence on the immunization costs. Considering that in Moldova central government regulates wages, as well as centrally procures and delivers immunization inputs: vaccines, cold boxes, syringes and safety boxes etc. such inconclusive influence of the prices is not surprising. Furthermore, the analysis showed that costs arising on a district and national level are not that important and mostly facility level costs determine overall variability seen among facilities. Therefore, factors operating on a facility level seem to have most influence on the cost of immunization. It will be most interesting to compare our results with those obtained from decentralized systems, where decision making for labour remuneration and/or purchase of inputs are decentralized to sub-national entities and/or facilities. It is expected that predictability of immunization costs would be higher in the centralized models compared to decentralized ones, although this assumption has not been yet validated. Although the set of similar studies supported by the Gates Foundation offer opportunity for such comparisons. All of this attracts the interest as after graduation from GAVI Moldova may introduce greater decentralization in its immunization programs. In some quarters[31] there are discussions to allow facilities to purchase immunization inputs on their own while CNAM will only reimburse for the volume of services delivered. In light of our findings such decisions, if implemented, could pose risks of resulting in greater variability in input prices. Therefore, before acting on such decisions thorough evaluation of their impact on the national immunization costs is warranted.

The next important finding of the econometric model is importance of the staff time devoted to immunization in determining costs. The specification (4) in Table 49 proves that increasing average nurse wage by one unit would cause total immunization cost increase by 1.4, which re-confirms labour intensity of immunization services and therefore price changes in labour inputs would have significant impact on the overall cost of the program. Consequently, when making decisions and trying to expand coverage and/or add new vaccines, which may require additional staff, the discussions should center on seniority and diversity of health care personnel involved in immunization and how this may affect labour costs. In the earlier section we argued for increasing DPT3 coverage by focusing on FMCs, which at a relatively lower costs offer greater potential for increasing national DPT3 rates. This argument is strongly supported by outcomes of the econometric model, which show that FMC that have higher number of population in their catchment area, have greater capacity and better-qualified staff and are more capable of managing their wastage rates, therefore they have greater ability to increase coverage at a lower cost.

These arguments are further supported by regression analysis that shows that the distance between the immunization center and the distribution point (as a proxy for vaccine logistics), urban-rural dummy and size of the facility are not statistically significant factors in explaining immunization costs.

Furthermore, differences between urban/rural locations are not relevant variables in explaining immunization costs on a facility level. Therefore, the econometric analysis did not identify strong equity issues across providers in Moldova, which is expected as the resource flow from center to urban and rural facilities are comparable in Moldova, which probably explains their ability in delivering comparable services to the population. Therefore, focus on FMCs is not expected to have negative equity outcomes.

[31] Based on interviews conducted by authors with national stakeholders

Finally, demand side variables show their explanatory power (positive and significant at 99% of confidence) over immunization costs on a facility level under any specification: higher education levels allow demanding for more immunization, triggering vaccination costs..

In conclusion, presented analysis of production and costs determinants allows separating the effect of four different factors on immunization outputs: operative capacity at the facility level largely related to human resources, managerial efficiency for vaccine and program management, population scale in the catchment and educational level are seem to have the most explanatory power on the productivity and immunization costs.

We also perform a sensitivity analysis of the obtained results, identifying 5%-10%-15% and 20% increase in three main variables. Those variables are: total wages devoted to immunization, vaccines costs and building costs, as a proxy of infrastructure, which are the three main accounting items based on the information collected in the fieldwork. The calculations were implemented not only at the overall total costs level, as well as at the unit costs level (defined both as number of doses administered and FIC). Results show the mayor participation of human resources in the overall costs function, followed by vaccines and building costs. Increasing 5% wages affects total costs in 3,5%, while triggers 7%, 11%, 14% respectively, when the increments were 10, 15 and 20% of input costs. Both building and vaccines cost increments do not affect total disbursements in more than 2.2 % in the more inflationary scenario (See annex 8). It will be most interesting to compare our results with those obtained from decentralized systems, where decision making for labor remuneration and/or purchase of inputs is decentralized to sub-national entities and/or facilities.

Annex 1: Sampling frame of rural and urban facilities by districts

Table 51: Sampling frame of rural facilities by districts, selected and visited facilities

Facility ID	No	District Name	Facility	Facility Type	sampled/ replacement	Actually visited
1	1	Briceni	OFD Criva	OFD	Replacement	
2	2	Briceni	Drepcauti	OFD		
3	3	Briceni	Sireuti	OFD		
4	4	Briceni	Hlina	OFD		
5	5	Briceni	Colicauti	OFD	Sampled	visited
6	6	Briceni	Tabani	OFD	Replacement	
7	7	Briceni	Halahora de Sus	OFD		
8	8	Briceni	Trebisauti	OFD		
9	9	Briceni	Bulboaca	OFD	Sampled	visited
10	10	Briceni	Medicalpoint Caracusenii Noi	HO	Replacement	
11	11	Briceni	Larga	HC		
12	12	Briceni	Cotelea	OFD		
13	13	Briceni	Medjeva	OFD	Sampled	visited
14	14	Briceni	Corjeuti	HC	Replacement	
15	15	Briceni	Balasinesti	OFD		
16	16	Briceni	Pererita	OFD		
17	17	Briceni	Sl. Sireuti	OFD	Sampled	visited
18	18	Briceni	Beleavinet	OFD	Replacement	
19	19	Briceni	Berlinet	OFD		
20	20	Briceni	Tetcani	OFD		
21	21	Briceni	Bezeda	OFD		
22	22	Briceni	Bogdanesti	OFD	Sampled	visited
23	23	Briceni	Grimesti	OFD	Replacement	
24	24	Briceni	Marcauti	OFD		
25	25	Briceni	Balcauti	OFD		
26	26	Briceni	Mihaileni	OFD	Sampled	visited
27	27	Briceni	Medical point Groznita	HO	Replacement	
28	28	Briceni	Grimancauti	OFD		
29	29	Briceni	Cotiujeni	OFD		
30	30	Briceni	Caracusenii Vechi	OFD	Sampled	visited
31	31	Briceni	Medical point Trestieni	HO	Replacement	
32	32	Călărași	Raciula	OFD		
33	33	Călărași	Niscani	OFD		
34	34	Călărași	Paulesti	OFD		
35	35	Călărași	Frumoasa	OFD	Sampled	visited
36	36	Călărași	Parcani	OFD	Replacement	
37	37	Călărași	Temeleuti	OFD		
38	38	Călărași	Peticeni	OFD		
39	39	Călărași	Novaci	OFD	Sampled	visited
40	40	Călărași	Tuzara-Seliste	OFD	Replacement	
41	41	Călărași	Pitusca	OFD		
42	42	Călărași	Varzarestii Noi	OFD		
43	43	Călărași	Radeni	OFD	Sampled	visited
44	44	Călărași	Dereneu	OFD	Replacement	
45	45	Călărași	Tiberica	OFD		
46	46	Călărași	Meleseni	OFD		
47	47	Călărași	Hirjauca	OFD		
48	48	Călărași	Leordoaia	HO	Sampled	visited

Facility ID	No	District Name	Facility	Facility Type	sampled/ replacement	Actually visited
49	49	Călărași	Palanca	HO	Replacement	
50	50	Călărași	Mindra	HO		
51	51	Călărași	Sadova	OFD		
52	52	Călărași	Oniscani	HC	Sampled	visited
53	53	Călărași	Hirbovat	OFD	Replacement	
54	54	Călărași	Hirbova	OFD		
55	55	Călărași	Hoginesti	OFD		
56	56	Călărași	Bravicea	HC	Sampled	visited
57	57	Călărași	Saseni	OFD	Replacement	
58	58	Călărași	Bahu	OFD		
59	59	Călărași	Pirjolteni	HC		
60	60	Călărași	Horodiste	OFD	Sampled	visited
61	61	Călărași	Buda	OFD	Replacement	
62	62	Călărași	Cabaiesti	OFD		
63	63	Călărași	Valcinet	HC		
64	64	Călărași	Sipoteni	HC		
65	65	Călărași	Bahmut	OFD	Sampled	visited
66	66	Călărași	Gara Bahmut	OFD	Replacement	
67	67	Chișinău	Bacioi	HC		
68	68	Chișinău	Truseni	HC		
69	69	Chișinău	Ghidighici	HC	Sampled	visited
70	70	Chișinău	Ciorescu	HC	Replacement	
71	71	Chișinău	Bubuieci	HC		
72	72	Chișinău	Budesti	HC		
73	73	Chișinău	Colonita	HC	Sampled	visited
74	74	Chișinău	Stauceni	HC	Replacement	
75	75	Chișinău	Gratiesti	HC		
76	76	Leova	Sirma	OFD		
77	77	Leova	Hanasenii Noi	OFD		
78	78	Leova	Sarata Noua	HC	Sampled	visited
79	79	Leova	Cupcui	OFD	Replacement	
80	80	Leova	Cazangic	OFD		
81	81	Leova	Seliste	HO		
82	82	Leova	Frumusica	HO	Sampled	visited
83	83	Leova	Tomai	HC	Replacement	
84	84	Leova	Tochile-Raducani	OFD		
85	85	Leova	Sarata- Razesi	OFD		
86	86	Leova	Filipeni	HC	Sampled	visited
87	87	Leova	Romanovca	HO	Replacement	
88	88	Leova	Borogani	HC		
89	89	Leova	Sarateni	HC		
90	90	Leova	Cneazevca	OFD		
91	91	Leova	Victoria	HO	Sampled	replaced
92	92	Leova	Vozneseni	OFD	Replacement	visited
93	93	Leova	Saratica Veche	HO		
94	94	Leova	Cazlar	HO		
95	95	Leova	Bestemac	OFD	Sampled	visited
96	96	Leova	Tomaiul Nou	HO	Replacement	
97	97	Leova	Troita	HO		
98	98	Leova	Troian	HO		
99	99	Leova	Covurlui	OFD	Sampled	visited
100	100	Leova	Saratica Noua	HO	Replacement	
101	101	Leova	Cimpul drept	HO		
102	102	Leova	Colibabovca	OFD		

Facility ID	No	District Name	Facility	Facility Type	sampled/ replacement	Actually visited
103	103	Leova	Ceadar	OFD	Sampled	visited
104	104	Leova	Orac	OFD	Replacement	
105	105	Leova	Tigheci	OFD		
106	106	Leova	Cuporani	HO		
107	107	Leova	Baius	OFD		
108	108	Ungheni	Nicolaevca Noua	HO	Sampled	replaced
109	109	Ungheni	Costuleni	OFD	Replacement	visited
110	110	Ungheni	Zagarancea	OFD		
111	111	Ungheni	Manoioesti	OFD		
112	112	Ungheni	Rezina	OFD	Sampled	visited
113	113	Ungheni	Vulpesti	HO	Replacement	
114	114	Ungheni	Romanovca	HO		
115	115	Ungheni	Poiana	HO		
116	116	Ungheni	Cornesti	OFD	Sampled	visited
117	117	Ungheni	Bumbata	OFD	Replacement	
118	118	Ungheni	Boghenii Noi	OFD		
119	119	Ungheni	Izvoreni	HO		
120	120	Ungheni	Boghenii Vechi	HO		
121	121	Ungheni	Micresti	HO	Sampled	visited
122	122	Ungheni	Magurele	OFD	Replacement	
123	123	Ungheni	Drujba	OFD		
124	124	Ungheni	Hirnesti	HO		
125	125	Ungheni	Minzatesti	HO	Sampled	visited
126	126	Ungheni	Veverita	HO	Replacement	
127	127	Ungheni	Sinestii Noi	OFD		
128	128	Ungheni	Leordoaia	HO		
129	129	Ungheni	Sculeni	HC		
130	130	Ungheni	Blindesti	HO	Sampled	visited
131	131	Ungheni	Floreni	HO	Replacement	
132	132	Ungheni	Gherman	OFD		
133	133	Ungheni	Petresti	HC		
134	134	Ungheni	Medeleni	HO	Sampled	visited
135	135	Ungheni	Semeni	OFD	Replacement	
136	136	Ungheni	Cioropcanii Vechi	HC		
137	137	Ungheni	Stolniceni	OFD		
138	138	Ungheni	Bulhac	HO	Sampled	visited
139	139	Ungheni	Floresti	OFD	Replacement	
140	140	Ungheni	Buciumeni	HO		
141	141	Ungheni	Pirlita	HC		
142	142	Ungheni	Nicolaevca Veche	HO		
143	143	Ungheni	Todiresti	OFD	Sampled	visited
144	144	Ungheni	Graseni	HO	Replacement	
145	145	Ungheni	Tescureni	OFD		
146	146	Ungheni	Hristoforovca	HO		
147	147	Ungheni	Agromonovca	OFD	Sampled	visited
148	148	Ungheni	Zazulenii Vechi	HO	Replacement	
149	149	Ungheni	Cetireni	HC		
150	150	Ungheni	Untesti	OFD		
151	151	Ungheni	Floritoaia Veche	OFD	Sampled	visited
152	152	Ungheni	Floritoaia Noua	HO	Replacement	
153	153	Ungheni	Grozasca	HO		
154	154	Ungheni	Napadeni	HO		
155	155	Ungheni	Cornova	OFD	Sampled	visited
156	156	Ungheni	Condratesti	OFD	Replacement	

Facility ID	No	District Name	Facility	Facility Type	sampled/ replacement	Actually visited
157	157	Ungheni	Curtoaia	HO		
158	158	Ungheni	Radenii Vechi	HC		
159	159	Ungheni	Alexeevca	OFD		
160	160	Ungheni	Saghieni	HO	Sampled	replaced
161	161	Ungheni	Busila	HO	Replacement	visited
162	162	Ungheni	Lidovca	HO		
163	163	Ungheni	Negurenii Vechi	OFD		
164	164	Ungheni	Zazulenii Noi	HO	Sampled	visited
165	165	Ungheni	Tighira	OFD	Replacement	
166	166	Ungheni	Coseni	HO		
167	167	Ungheni	Valea Mare	HC		
168	168	Ungheni	Buzduganii de Sus	HO	Sampled	visited
169	169	Ungheni	Buzduganii de Jos	HO	Replacement	
170	170	Ungheni	Morenii Noi	OFD		
171	171	Ungheni	Sicovet	HO		
172	172	Ungheni	Danuteni	HC		
173	173	Ungheni	Negurenii NOI	HO	Sampled	replaced
174	174	Ungheni	Chirileni	OFD	Replacement	visited
175	175	Ungheni	Frasinesti	OFD		
176	176	Ungheni	Elizavetovca	HO		
177	177	Ungheni	Costuleni-Macaresti	HC	Sampled	visited
178	178	Vulcanesti (Găgăuzia)	Cismicioi	HC	Replacement	
179	179	Vulcanesti (Găgăuzia)	Etulia	HC		
180	180	Vulcanesti (Găgăuzia)	Vulcanesti	OFD		
181	181	Vulcanesti (Găgăuzia)	Carbolia	OFD	Sampled	visited

Table 52: Sampling frame of urban/peri-urban facilities by districts, selected and visited facilities

No	Facility ID	District name	Facility	Facility type	selected/ replacement	Actually visited
1	182	Briceni	Lipcani	HC	Selected	Visited
2	183	Briceni	Briceni	HC	replacement	
3	184	Călărași	Calarasi	HO	Selected	Visited
4	185	Chișinău	CFD-1	CFD	replacement	
5	186	Chișinău	CFD-2	CFD		
6	187	Chișinău	CFD-3	CFD	Selected	Visited
7	188	Chișinău	Sîngera	HC	replacement	
8	189	Chișinău	Medical Centre of civil aviation	MC		
9	190	Chișinău	Medical Center	MC		
10	191	Chișinău	Buiucani	DCC	replacement	
11	192	Chișinău	CFD-4	CFD		
12	193	Chișinău	CFD-5	CFD		
13	194	Chișinău	CFD-6	CFD		
14	195	Chișinău	HC Durlesti	HC	Selected	Visited
15	196	Chișinău	HC Vatra	HC	replacement	
16	197	Chișinău	Centru	DCC		
17	198	Chișinău	CFD-7	CFD		
18	199	Chișinău	University Clinic	UC		
19	200	Chișinău	Cricova	HC		
20	201	Chișinău	Vadu-lui-Voda	HC		
21	202	Chișinău	Ciocana	DCC		
22	203	Chișinău	CFD-8	CFD	Selected	Visited
23	204	Chișinău	CFD-9	CFD	replacement	
24	205	Chișinău	Riscani	DCC		
25	206	Chișinău	CFD-10	CFD		
26	207	Chișinău	CFD-11	CFD		
27	208	Chișinău	CFD-12	CFD		
28	209	Chișinău	Galaxia			
29	210	Chișinău	Sancos			
30	211	Leova	Leova	CFD	replacement	
31	212	Leova	Iargara	HC	Selected	Visited
32	213	Ungheni	Ungheni CFD	CFD	Selected	Visited
33	214	Ungheni	Corbesti	HC	replacement	
34	215	Vulcanesti (Găgăuzia)	Vulcanesti	HC	Selected	Visited

Annex 2: Unit Costs Analysis for Immunization Services

Figure 18Total cost of immunization by facility type

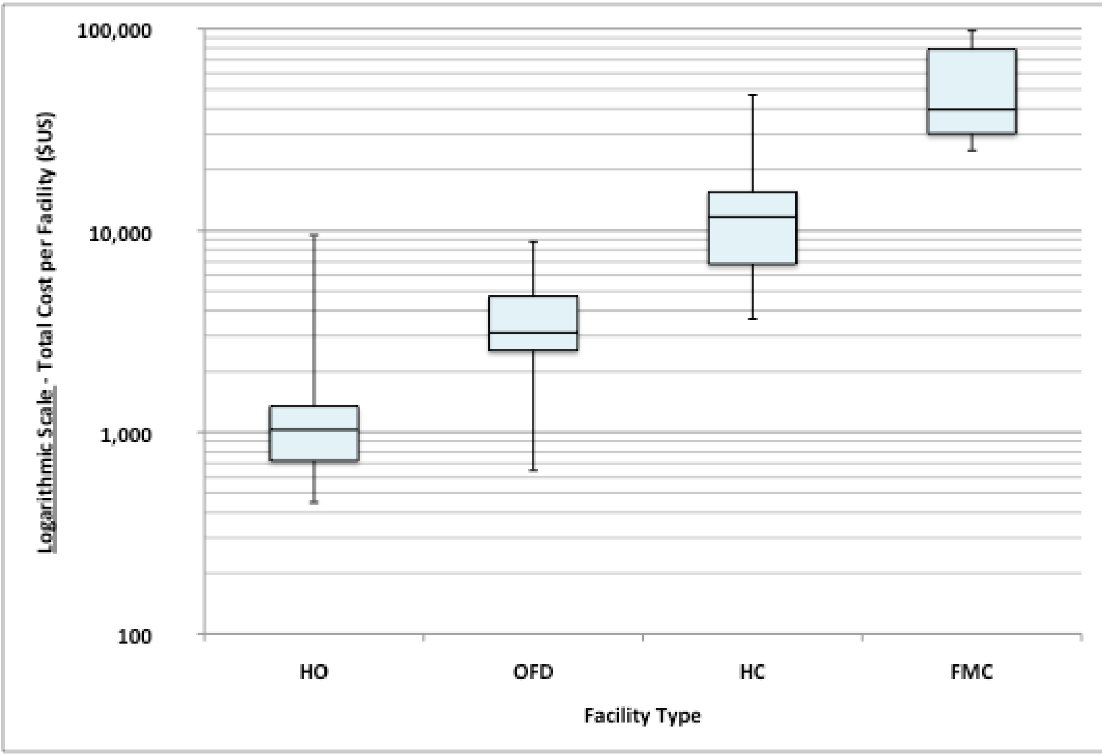


Table 53: Total Routine Immunization Economic Costs and Unit Costs by Line Item by Facility Type ($2011, Weighted Average and Range)

	FMC				OFD				HC				HO				Total Facility			
			Range				Range				Range				Range				Range	
Line Items	Total Cost	%	Min	Max	Total Cost	%	Min	Max	Total Cost	%	Min	Max	Total Cost	%	Min	Max	Total Cost	%	Min	Max
Sample (n)	**55**				**708**				**190**				**365**				**1318**			
Salaried Labour	40,421	69.8%	21,714	82,618	3,034	70.6%	369	7,586	8,698	73.4%	2,595	39,045	1,153	61.3%	142	7,494	4,897	70.3%	142	82,618
Per Diems	35	0.1%	-	162	6	0.1%	-	26	14	0.1%	-	59	5	0.2%	0	42	8	0.1%	-	162
Vaccines	8,127	14.0%	3,207	13,945	397	9.2%	110	1,015	1,062	9.0%	324	5,824	155	8.2%	42	690	750	10.8%	42	13,945
Injection supplies	610	1.1%	186	1,031	27	0.6%	7	70	73	0.6%	14	419	11	0.6%	4	49	53	0.8%	4	1,031
Other supplies	55	0.1%	9	172	7	0.2%	1	43	24	0.2%	1	253	3	0.2%	0	13	11	0.2%	0	253
Transport & fuel	147	0.3%	-	233	40	0.9%	4	119	78	0.7%	18	208	46	2.4%	10	191	51	0.7%	-	233
Vehicle maintenance	20	0.0%	-	49	5	0.1%	-	40	19	0.2%	-	71	-	0.0%	0	-	6	0.1%	-	71
Cold chain energy costs	45	0.1%	18	111	16	0.4%	5	31	36	0.3%	16	56	23	1.2%	1	58	22	0.3%	1	111
Printing	582	1.0%	-	1,904	3	0.1%	-	29	86	0.7%	-	1,146	-	0.0%	0	-	38	0.5%	-	1,904
Building overheads	1,731	3.0%	447	4,187	235	5.5%	19	814	542	4.6%	231	3,138	141	7.5%	25	744	316	4.5%	19	4,187
Other recurrent	236	0.4%	120	355	12	0.3%	-	103	29	0.2%	-	251	4	0.2%	0	16	22	0.3%	-	355
Subtotal recurrent	52,010	89.9%			3,780	88.0%			10,660	90.0%			1,540	81.9%			6,175	88.7%		
Cold chain equipment	117	0.2%	76	133	74	1.7%	43	84	68	0.6%	53	97	54	2.9%	8	76	69	1.0%	8	133
Vehicles	111	0.2%	62	191	35	0.8%	-	377	170	1.4%	38	399	6	0.3%	0	70	49	0.7%	-	399
Other capital	1,265	2.2%	385	2,635	86	2.0%	28	439	239	2.0%	93	508	42	2.2%	11	106	145	2.1%	11	2,635
Buildings	4,366	7.5%	1,533	8,636	323	7.5%	88	863	711	6.0%	322	4,639	239	12.7%	70	778	525	7.5%	70	8,636
Subtotal capital	5,859	10.1%			517	12.0%			1,189	10.0%			340	18.1%			789	11.3%	565	112,548
Total Facility Immunization Cost	57,869	100%	28,355	112,548	4,298	100%	831	9,834	11,849	100%	4,190	53,263	1,881	100%	565	10,242	6,964	100%		
Total Child Doses	5,724		2,478	9,060	271		61	760	709		180	3,627	104		33	449	517		33	9,060
Total DTP3 Vaccinated Children	394		154	714	17		4	61	45		12	255	7		1	21	34		1	714
Infant population	430		166	810	17		4	62	47		12	271	7		1	21	36		1	810
Total population	32,616		14,696	59,995	1,555		452	3,906	3,737		1,347	18,909	536		212	1,917	2,891		212	59,995
Cost per Dose	10		6	16	19		7	41	19		6	37	19		8	36	18		6	41
Cost per child	144		101	248	339		128	757	323		85	548	297		93	806	317		85	806
Cost per DTP3 Vaccinated child	155		95	237	347		128	757	329		85	548	332		93	806	332		85	806
Cost per capita	2		1	2	3		1	4	3		1	5	3		1	5	3		1	5

Total Delivery Cost	49,132	24,946	97,572	3,875	643	8,789	10,715	3,644	47,021	1,715	449	9,502	6,160	449	97,572
Delivery Cost per Dose	9	5	14	17	5	39	18	5	35	17	6	35	17	5	39
Delivery Cost per child	123	74	214	309	108	706	296	64	520	271	75	735	289	64	735
Delivery Cost per DTP3 Vaccinated child	133	79	223	317	108	706	302	64	520	304	77	735	303	64	735
Delivery Cost per capita	2	1	2	3	1	4	3	1	5	3	1	5	3	1	5

Table 54: Total Routine Immunization Economic Costs and Unit Costs by Activity by Facility Type ($2011)

	FMC				OFD				HC				HO				Total Facility			
Line Items			Range				Range				Range				Range				Range	
	Total Cost	%	Min	Max	Total Cost	%	Min	Max	Total Cost	%	Min	Max	Total Cost	%	Min	Max	Total Cost	%	Min	Max
Sample (n)	55				708				190				365				1318			
Routine Facility-Based Service Delivery	26,591	46.0%	12,654	49,168	2,201	51.2%	535	5,872	4,979	42.0%	1,936	23,350	1,093	58.1%	419	5,818	3,318	47.6%	419	49,168
Record-Keeping/HMIS	8,414	14.5%	4,019	17,000	452	10.5%	80	1,080	1,781	15.0%	450	9,099	179	9.5%	32	860	902	13.0%	32	17,000
Supervision	1,504	2.6%	1,044	1,905	43	1.0%	-	239	334	2.8%	19	1,500	22	1.2%	-	127	140	2.0%	-	1,905
Social mobilization	7,195	12.4%	3,373	15,990	520	12.1%	37	1,537	1,329	11.2%	456	3,153	166	8.8%	-	1,154	819	11.8%	-	15,990
Cold chain maintenance	388	0.7%	119	861	101	2.3%	18	246	211	1.8%	68	742	39	2.1%	7	110	112	1.6%	7	861
Vaccine collection and distribution	683	1.2%	187	1,384	178	4.1%	49	651	503	4.2%	223	1,084	85	4.5%	29	369	220	3.2%	29	1,384
Program management	10,761	18.6%	4,599	23,992	648	15.1%	57	1,930	2,188	18.5%	601	11,979	224	11.9%	22	1,389	1,177	16.9%	22	23,992
Training	2,138	3.7%	1,304	3,249	145	3.4%	22	404	466	3.9%	103	2,634	69	3.7%	9	386	253	3.6%	9	3,249
Surveillance	65	0.1%	-	186	-	0.0%	-	-	12	0.1%	-	103	-	0.0%	-	-	4	0.1%	-	186
- Other	129	0.2%	40	196	10	0.2%	-	110	46	0.4%	-	297	4	0.2%	-	46	18	0.3%	-	297
Total Facility Immunization Cost	57,869	100%			4,298	100%			11,849	100%			1,881	100%			6,964	100%		
Total Child Doses	5,724		2,478	9,060	271		61	760	709		180	3,627	104		33	449	517		33	9,060
Total DTP3 Vaccinated Children	394		154	714	17		4	61	45		12	255	7		1	21	34		1	714
Infant population	430		166	810	17		4	62	47		12	271	7		1	21	36		1	810
Total population	32,616		14,696	59,995	1,555		452	3,906	3,737		1,347	18,909	536		212	1,917	2,891		212	59,995
Cost per Dose	10		6	16	19		7	41	19		6	37	19		8	36	18		6	41
Cost per child	144		95	237	339		128	757	323		85	548	297		93	806	317		85	806
Cost per DTP3 Vaccinated child	155		101	248	347		128	757	329		85	548	332		93	806	332		85	806
Cost per capita	2		1	2	3		1	4	3		1	5	3		1	5	3		1	5
Total Delivery Cost (Total – vaccines and injection supplies)	49,132		24,946	97,572	3,875		643	8,789	10,715		3,644	47,021	1,715		449	9,502	6,160		449	97,572
Delivery Cost per Dose	9		5	14	17		5	39	18		5	35	17		6	35	17		5	39
Delivery Cost per child	123		74	214	309		108	706	296		64	520	271		75	735	289		64	735
Delivery Cost per DTP3 Vaccinated child	133		79	223	317		108	706	302		64	520	304		77	735	303		64	735
Delivery Cost per capita	2		1	2	3		1	4	3		1	5	3		1	5	3		1	5

Table 55: Total Routine Immunization Economic Costs by Line Item by Location ($2011)

Line Items	Urban Facility Weighted Average	%	Rural Facility Weighted Average	%	Semi-Urban Weighted Average	%	Weighted Average	%
Sample (n)	26		1238		54		1318	
Salaried Labor	61,168	71.5%	2,954	70.1%	22,344	69%	4,897	70.3%
Per Diems	0.00	0.0%	6	0.1%	46	0.1%	7.73	0.1%
Vaccines	10,250	12.0%	381	9.0%	4,637	14.4%	750	10.8%
Injection supplies	788	0.9%	26	0.6%	328	1.0%	53	0.8%
Other supplies	161	0.2%	7	0.2%	25	0.1%	11	0.2%
Transport & fuel	71	0.1%	46	1.1%	169	0.5%	51	0.7%
Vehicle maintenance	36	0.0%	5.3	0.1%	10	0.0%	6	0.1%
Cold chain energy costs	22	0.0%	21	0.5%	46	0.1%	22	0.3%
Printing	1,265	1.5%	5	0.1%	218	0.7%	38	0.5%
Building overheads	2,941	3.4%	231	5.5%	1,009	3.1%	316	4.5%
Other recurrent	261	0.3%	10	0.2%	172	0.5%	22	0.3%
Subtotal recurrent	76,962	90.0%	3,692	87.6%	29,004	90.2%	6,175	88.7%
Cold chain equipment	120	0.1%	67	1.6%	99	0.3%	69	1.0%
Vehicles	59	0.1%	44	1.0%	174	0.5%	49	0.7%
Other capital	1,320	1.5%	91	2.2%	817	2.5%	145	2.1%
Buildings	7,062	8.3%	321	7.6%	2,065	6.4%	525	7.5%
Subtotal capital	8,562	10.0%	523	12.4%	3,155	9.8%	789	11.3%
Total Facility Immunization Cost	**85,524**	**100%**	**4,215**	**100%**	**32,160**	**100%**	**6,964**	**100%**

Table 56: Total Routine Immunization Economic Costs by Activity by Location ($2011)

Activities	Urban Weighted Average	%	Rural Weighted Average	%	Semiurban Weighted Average	%	Total Weighted Average	%
Sample (n)	26		1238		54			
Routine Facility-Based Service Delivery	37,075	43.4%	2,087	49.5%	15,277	47.5%	3,318	47.6%
Record-Keeping/HMIS	13,638	15.9%	487	11.6%	4,282	13.3%	902	13.0%
Supervision	1,214	1.4%	65	1.5%	1,350	4.2%	140	2.0%
Social mobilization	10,621	12.4%	496	11.8%	3,497	10.9%	819	11.8%
Cold chain maintenance	751	0.9%	91	2.2%	278	0.9%	112	1.6%
Vaccine collection and distribution	1,099	1.3%	188	4.5%	540	1.7%	220	3.2%
Program management	17,914	20.9%	640	15.2%	5,414	16.8%	1,177	16.9%
Training	3,004	3.5%	146	3.5%	1,389	4.3%	253	3.6%
Surveillance	139	0.2%	0.8	0.0%	24	0.1%	4	0.1%
Other	69	0.1%	13	0.3%	107	0.3%	18	0.3%
Total Facility Immunization Cost	85,524	100%	4,215	100%	32,160	100%	6,964	100%

Table 57: Comparison of Economic and Financing Costs by Line Item by Facility Type ($2011)

Line Items	Economic Costs					Financial Costs				
	FMC	OFD	HC	HO	Weighted Average	FMC	OFD	HC	HO	Weighted Average
Salaried Labor	40,421	3,034	8,698	1,153	4,897	40,421	3,034	8,698	1,153	4,897
Per Diems	35	6	14	5	8	35	6	14	5	8
Vaccines	8,127	397	1,062	155	750	8,127	397	1,062	155	750
Injection supplies	610	27	73	11	53	610	27	73	11	53
Other supplies	55	7	24	3	11	55	7	24	3	11
Transport & fuel	147	40	78	46	51	147	40	78	46	51
Vehicle maintenance	20	5	19	0	6	20	5	19	0	6
Cold chain energy costs	45	16	36	23	22	45	16	36	23	22
Printing	582	3	86	0	38	582	3	86	0	38
Building overheads	1,731	235	542	141	316	1,731	235	542	141	316
Other recurrent	236	12	29	4	22	236	12	29	3.53	22
Subtotal recurrent	**52,010**	**3,780**	**10,660**	**1,540**	**6,175**	**52,010**	**3,780**	**10,660**	**1,540**	**6,175**
Cold chain equipment	117	74	68	54	69	95	60	59	44	57
Vehicles	111	35	170	6	49	94	30	145	5	42
Other capital	1,265	86	239	42	145	1,155	78	218	38	133
Buildings	4,366	323	711	239	525	2,523	187	411	138	303
Subtotal capital	**5,859**	**517**	**1,189**	**340**	**789**	**3,867**	**355**	**833**	**225**	**535**
Total Facility Immunization Cost	**57,869**	**4,298**	**11,849**	**1,881**	**6,964**	**55,877**	**4,135**	**11,494**	**1,765**	**6,710**

Table 58: Comparison of Economic and Financing Costs by Activity by Facility Type ($2011)

Activities	Economic Costs					Financial Costs				
	FMC	OFD	HC	HO	Weighted Average	FMC	OFD	HC	HO	Weighted Average
Routine Facility-Based Service Delivery	26,591	2,201	4,979	1,093	3,318	24,643	2,045	4,654	979	3,074
Record-Keeping/HMIS	8,414	452	1,781	179	902	8,394	451	1,778	179	900
Supervision	1,504	43	334	22	140	1,504	43	333	22	140
Social mobilization	7,195	520	1,329	166	819	7,195	520	1,329	166	819
Cold chain maintenance	388	101	211	39	112	388	101	211	39	112
Vaccine collection and distribution	683	178	503	85	220	677	174	482	84	214
Program management	10,761	648	2,188	224	1,177	10,749	647	2,185	224	1,175
Training	2,138	145	466	69	253	2,134	144	464	69	253
Surveillance	65	-	12	-	4	63	-	11	-	4
Other	129	10	46	4	18	129	10	46	4	18
Total Facility Immunization Cost	**57,869**	**4,298**	**11,849**	**1,881**	**6,964**	**55,877**	**4,135**	**11,494**	**1,765**	**6,710**

Table 59: Comparison of Economic and Financing Costs by Line Item by Location ($2011)

Line Items	Economic Costs				Financial Costs			
	Urban	Rural	Semi urban	Weighted Average	Urban	Rural	Semi urban	Weighted Average
Salaried Labor	61,168	2,954	22,344	4,897	61,168	2,954	22,344	4,897
Per Diems	-	6	46	8	-	6	46	8
Vaccines	10,250	381	4,637	750	10,250	381	4,637	750
Injection supplies	788	26	328	53	788	26	328	53
Other supplies	161	7	25	11	161	7	25	11
Transport & fuel	71	46	169	51	71	46	169	51
Vehicle maintenance	36	5	10	6	36	5	10	6
Cold chain energy costs	22	21	46	22	22	21	46	22
Printing	1,265	5	218	38	1,265	5	218	38
Building overheads	2,941	231	1,009	316	2,941	231	1,009	316
Other recurrent	261	10	172	22	261	10	172	22
Subtotal recurrent	76,962	3,692	29,004	6,175	76,962	3,692	29,004	6,175
Cold chain equipment	120	67	99	69	98	55	81	57
Vehicles	59	44	174	49	51	37	147	42
Other capital	1,320	91	817	145	1,202	83	748	133
Buildings	7,062	321	2,065	525	4,081	185	1,193	303
Subtotal capital	8,562	523	3,155	789	5,432	361	2,168	535
Total Facility Immunization Cost	**85,524**	**4,215**	**32,160**	**6,964**	**82,394**	**4,053**	**31,173**	**6,710**

Table 60: Comparison of Economic and Financing Costs by Activity by location ($2011)

Activities	Economic Costs				Financial Costs			
	Urban	Rural	Other Location	Weighted Average	Urban	Rural	Other Location	Weighted Average
Routine Facility-Based Service Delivery	37,075	2,087	15,277	3,318	33,989	1,934	14,332	3,074
Record-Keeping/HMIS	13,638	487	4,282	902	13,615	486	4,270	900
Supervision	1,214	65	1,350	140	1,214	65	1,348	140
Social mobilization	10,621	496	3,497	819	10,621	496	3,497	819
Cold chain maintenance	751	91	278	112	751	91	278	112
Vaccine collection and distribution	1,099	188	540	220	1,085	182	528	214
Program management	17,914	640	5,414	1,177	17,913	639	5,401	1,175
Training	3,004	146	1,389	253	3,004	146	1,389	253
Surveillance	139	1	24	4	132	1	23	4
Other	69	13	107	18	69	13	107	18
Total Facility Immunization Cost	**85,524**	**4,215**	**32,160**	**6,964**	**82,394**	**4,053**	**31,173**	**6,710**

Table 61: Total FTEs and staff time allocation by type of facility by line item (weighted averages and range)

Line Items	FMC			OFD			HC			HO			All Facilities		
		Range			Range			Range			Range			Range	
Sample (n)	**55**	**Min**	**Max**	**708**	**Min**	**Max**	**190**	**Min**	**Max**	**365**	**Min**	**Max**	**1318**	**Min**	**Max**
Total FTEs	5	3	10	1	.1	1.3	1	.6	5	0.3	.02	1	1	.0	10
Doses/FTE	1,186	610	1820	493	188	1289	543	214	1278	799	83	2912	614	83	2912
Time spent per dose delivered (hr)	0.13			0.88			0.96			1.09			0.92		
Share of time spent on immunization by physicians	18%	16%	24%	16%	0%	30%	21%	15%	28%	7%	0%	25%	14%	0%	30%
Share of time spent on immunization by vaccinator	100%	100%	100%	13%	0%	50%	41%	0%	100%				17%	0%	100%
Share of time spent on immunization by nursing staff	22%	18%	24%	22%	10%	44%	20%	12%	35%	19%	5%	34%	21%	5%	44%
Share of time spent on immunization by administrative staff	12%	3%	23%	0.1%	0%	3%	4%	0%	20%	-	0%	0%	1.1%	0%	23%
Share of time spent on immunization by other (specify)	4%	3%	10%	1%	0%	10%	3%	3%	5%	0.2%	0%	3%	1%	0%	10%
Share of time spent on immunization by infectionist	2%	0%	6%										0.1%	0%	6%

Table 62: Total Staff time by type of facility and activity (weighted averages and range)

	FMC				OFD				HC				HO				Total Facility			
			Range				Range				Range				Range				Range	
Line Items		**%**	**Min**	**Max**		**%**	**Min**	**Max**		**%**	**Min**	**Max**		**%**	**Min**	**Max**		**%**	**Min**	**Max**
Sample (n)	**55**				**708**				**190**				**365**				**1318**			
Routine Facility-Based Service Delivery	94	27.9%	64	174	11	34.7%	1.5	34	23	27.2%	7	99	4	38.3%	0.3	33	14	30.9%	0.3	174
Record-Keeping/HMIS	63	18.6%	39	127	4	14.1%	0.7	12	15	18.2%	4	58	2	14.6%	0.2	9	8	16.6%	0.2	127
Supervision	10	3.0%	6	13	0.3	1.0%	0.0	2	2	2.7%	0.1	8	0.1	0.6%	0.0	0.6	0.9	2.0%	0.0	13
Social mobilization	59	17.3%	30	129	5.1	16.7%	0.4	14	13	15.3%	4	29	2	14.0%	0.0	11	8	16.3%	0.0	129
Cold chain maintenance	4	1.1%	1	8	1.1	3.5%	0.2	2	2	2.7%	1	7	0.4	3.6%	0.1	1	1	2.6%	0.1	8
Vaccine collection and distribution	6	1.9%	2	11	1.5	4.8%	0.4	6	4	4.9%	3	8	0.6	4.9%	0.2	3	2	3.9%	0.2	11
Program management	85	25.2%	44	190	6.2	20.3%	0.6	20	19	22.8%	6	82	2	18.1%	0.2	13	10	22.4%	0.2	190
Training	15	4.5%	11	23	1.18	3.9%	0.2	3	4	4.4%	1	16	1	4.8%	0.1	4	2	4.3%	0.1	23
Surveillance	0.03	0.0%	0.0	0.11	.31	1.0%	0.0	0.0	.02	0.0%	0.0	0.1	.14	1.2%	0.0	0.0	0.0	0.0%	0.0	0.1
Other	2	0.5%	0.7	3	0.3	1.0%	0.0	2	1.4	1.7%	0.0	4	0.1	1.2%	0.0	2	0.5	1.0%	0.0	4
Total Staff time	339	100%	217	671	30	100%	4.2	78	85	100%	30	302	12	100%	1.0	77	46	100%	1.0	671
Total Facility Immunization Cost	**57,869**				**4,298**				**11,849**				**1,881**				**6,964**			

Table 63: Facility specific mean cost per dose, cost per FIC and cost per infant by location

By location		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Financial cost per dose	Rural	17.4	17.6	1238	0.596
	Semi-urban	17.0	14.1	54	
	Urban	12.7	12.7	26	
	Total	**17.1**	**17.4**	**1318**	
Economic cost per dose	Rural	18.4	18.6	1238	0.561
	Semi-urban	17.5	14.5	54	
	Urban	13.1	13.1	26	
	Total	**18.0**	**18.3**	**1318**	
Financial cost per FIC	Rural	316.4	321.6	1238	0.309
	Semi-urban	257.5	215.9	54	
	Urban	173.4	173.4	26	
	Total	**301.9**	**314.3**	**1318**	
Economic cost per FIC	Rural	334.5	340.3	1238	0.290
	Semi-urban	264.5	222.1	54	
	Urban	180.1	180.1	26	
	Total	**318.2**	**332.3**	**1318**	
Financial cost per Infant	Rural	300.5	306.7	1238	0.294
	Semi-urban	239.6	201.2	54	
	Urban	158.6	158.6	26	
	Total	**285.9**	**299.5**	**1318**	
Economic cost per Infant	Rural	317.6	324.6	1238	0.279
	Semi-urban	246.2	207.0	54	
	Urban	164.8	164.8	26	
	Total	**301.3**	**316.6**	**1318**	

Table 64: Facility specific mean cost per dose, cost per FIC and cost per infant without wages by location

By location		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Financial cost per dose without wages	Rural	5.5	5.6	1238	0.253
	Semi-urban	4.1	3.6	54	
	Urban	3.2	3.2	26	
	Total	**5.2**	**5.5**	**1318**	
Economic cost per dose without wages	Rural	6.4	6.6	1238	0.226
	Semi-urban	4.6	4.0	54	
	Urban	3.7	3.7	26	
	Total	**6.1**	**6.4**	**1318**	
Financial cost per FIC without wages	Rural	100.4	103.0	1238	0.210
	Semi-urban	61.8	54.0	54	
	Urban	44.3	44.3	26	
	Total	**93.2**	**99.8**	**1318**	
Economic cost per FIC without wages	Rural	118.4	121.7	1238	0.216
	Semi-urban	68.8	60.1	54	
	Urban	51.0	51.0	26	
	Total	**109.4**	**117.8**	**1318**	
Financial cost per Infant without wages	Rural	95.6	98.3	1238	0.224
	Semi-urban	57.6	50.3	54	
	Urban	40.5	40.5	26	
	Total	**88.5**	**95.2**	**1318**	
Economic cost per Infant without wages	Rural	112.7	116.2	1238	0.232
	Semi-urban	64.1	56.1	54	
	Urban	46.7	46.7	26	
	Total	**103.9**	**112.3**	**1318**	

Table 65: Facility specific mean cost per dose cost per FIC and cost per infant by type of facility

By facility type		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Financial cost per dose	FMC	11.3	10.1	55	0.346
	HC	18.7	18.8	190	
	OFD	17.6	17.7	708	
	HO	17.2	17.3	365	
	Total	**17.1**	**17.4**	**1318**	
Economic cost per dose	FMC	11.7	10.4	55	0.338
	HC	19.3	19.4	190	
	OFD	18.5	18.5	708	
	HO	18.6	18.7	365	
	Total	**18.0**	**18.3**	**1318**	
Financial cost per FIC	FMC	167.2	149.9	55	0.288
	HC	302.4	318.1	190	
	OFD	329.9	330.4	708	
	HO	304.0	306.2	365	
	Total	**301.9**	**314.3**	**1318**	
Economic cost per FIC	FMC	172.9	155.1	55	0.285
	HC	311.6	328.8	190	
	OFD	346.6	347.2	708	
	HO	329.6	332.2	365	
	Total	**318.2**	**332.3**	**1318**	
Financial cost per infant	FMC	154.9	139.1	55	0.233
	HC	287.8	312.3	190	
	OFD	321.7	322.2	708	
	HO	270.1	272.9	365	
	Total	**285.9**	**299.5**	**1318**	
Economic cost per infant	FMC	160.1	143.9	55	0.249
	HC	296.7	322.9	190	
	OFD	338.2	338.7	708	
	HO	293.4	296.5	365	
	Total	**301.3**	**316.6**	**1318**	

Table 66: Facility specific mean cost per dose, cost per FIC and cost per infant without wages by type of facility

By facility type		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Financial cost per dose without wages	FMC	2.9	2.7	55	0.014
	HC	4.5	4.6	190	
	OFD	5.0	5.0	708	
	HO	7.1	7.1	365	
	Total	**5.2**	**5.5**	**1318**	
Economic cost per dose without wages	FMC	3.3	3.1	55	0.009
	HC	5.0	5.2	190	
	OFD	5.9	5.9	708	
	HO	8.5	8.5	365	
	Total	**6.1**	**6.4**	**1318**	
Financial cost per FIC without wages	FMC	43.4	40.7	55	0.091
	HC	73.1	79.2	190	
	OFD	96.0	96.2	708	
	HO	125.2	126.4	365	
	Total	**93.2**	**99.8**	**1318**	
Economic cost per FIC without wages	FMC	49.0	45.9	55	0.083
	HC	82.3	89.9	190	
	OFD	112.7	113.0	708	
	HO	150.9	152.4	365	
	Total	**109.4**	**117.8**	**1318**	
Financial cost per infant without wages	FMC	40.2	37.8	55	0.162
	HC	69.8	77.9	190	
	OFD	93.9	94.1	708	
	HO	113.7	115.1	365	
	Total	**88.5**	**95.2**	**1318**	
Economic cost per infant without wages	FMC	45.4	42.6	55	0.152
	HC	78.7	88.5	190	
	OFD	110.4	110.6	708	
	HO	136.9	138.7	365	
	Total	**103.9**	**112.3**	**1318**	

Table 67: Facility specific mean cost per dose, cost per FIC and cost per infant by facility scale

By facility scale		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Financial cost per dose	Low	18.8	19.0	489	0.311
	Medium	17.7	17.6	556	
	High	14.7	14.1	273	
	Total	**17.1**	**17.4**	**1318**	
Economic cost per dose	Low	20.4	20.5	489	0.190
	Medium	18.4	18.3	556	
	High	15.2	14.5	273	
	Total	**18.0**	**18.3**	**1318**	
Financial cost per FIC	Low	324.9	328.2	489	0.096
	Medium	347.2	346.0	556	
	High	228.0	224.8	273	
	Total	**301.9**	**314.3**	**1318**	
Economic cost per FIC	Low	353.8	357.5	489	0.078
	Medium	360.9	359.7	556	
	High	234.4	231.2	273	
	Total	**318.2**	**332.3**	**1318**	
Financial cost per infant	Low	300.0	303.9	489	0.064
	Medium	340.5	339.3	556	
	High	210.2	210.0	273	
	Total	**285.9**	**299.5**	**1318**	
Economic cost per infant	Low	327.2	331.5	489	0.059
	Medium	354.0	352.8	556	
	High	216.2	216.1	273	
	Total	**301.3**	**316.6**	**1318**	

Table 68: Facility specific mean cost per dose, cost per FIC and cost per infant without wages by facility scale

By facility scale		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Financial cost per dose without wages	Low	7.5	7.6	489	p<0.01
	Medium	4.6	4.5	556	
	High	3.6	3.5	273	
	Total	**5.2**	**5.5**	**1318**	
Economic cost per dose without wages	Low	9.1	9.1	489	p<0.01
	Medium	5.2	5.2	556	
	High	4.0	3.9	273	
	Total	**6.1**	**6.4**	**1318**	
Financial cost per FIC without wages	Low	136.7	138.0	489	p<0.01
	Medium	88.2	88.1	556	
	High	55.2	55.1	273	
	Total	**93.2**	**99.8**	**1318**	
Economic cost per FIC without wages	Low	165.7	167.3	489	p<0.01
	Medium	101.9	101.7	556	
	High	61.6	61.6	273	
	Total	**109.4**	**117.8**	**1318**	
Financial cost per infant without wages	Low	128.3	129.7	489	p<0.01
	Medium	86.5	86.3	556	
	High	50.9	51.4	273	
	Total	**88.5**	**95.2**	**1318**	
Economic cost per infant without wages	Low	155.5	157.3	489	p<0.01
	Medium	99.9	99.8	556	
	High	56.8	57.4	273	
	Total	**103.9**	**112.3**	**1318**	

Table 69: Breakdown of the weighted facility specific mean economic cost per dose by location

Item	Rural		Semi-Urban		Urban		Total	
	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost
Recurrent cost	**15.53**	**83.4**	**13.22**	**91.0**	**11.81**	**89.9**	**15.36**	**83.71**
Salaried Labour	12.06	64.71	10.56	73.61	9.43	72.31	11.94	65.07
Per-Dime & Travel Allowances	0.04	0.00	0.03	0.00	0.00	0.00	0.04	0.22
Vaccines	1.49	8.02	1.39	9.72	1.54	12.31	1.49	8.12
Vaccine Injection & Safety Supplies	0.11	0.53	0.09	0.69	0.12	0.77	0.11	0.60
Other Supplies	0.04	0.00	0.01	0.00	0.03	0.00	0.04	0.22
Transportation/fuel	0.33	1.60	0.09	0.69	0.01	0.00	0.31	1.69
Vehicle maintenance	0.02	0.00	0.01	0.00	0.01	0.00	0.02	0.11
Cold Chain energy	0.16	1.07	0.02	0.00	0.00	0.00	0.15	0.82
Printing	0.02	0.00	0.13	0.69	0.22	1.54	0.03	0.16
Building overhead	1.21	6.42	0.83	5.56	0.41	3.08	1.18	6.43
Other recurrent	0.05	0.53	0.06	0.69	0.04	0.00	0.05	0.27
Capital cost	**3.10**	**16.6**	**1.31**	**9.00**	**1.33**	**10.1**	**2.99**	**16.29**
Cold chain equipment	0.52	2.67	0.05	0.00	0.02	0.00	0.49	2.67
Vehicles	0.15	1.07	0.14	0.69	0.01	0.00	0.15	0.82
Other equipment	0.46	2.67	0.33	2.08	0.19	1.54	0.45	2.45
Building	1.97	10.70	0.79	5.56	1.11	8.46	1.90	10.35
TOTAL	**18.63**	**100.00**	**14.53**	**100.00**	**13.14**	**100.00**	**18.35**	**100.00**

Table 70: Breakdown of the weighted facility specific mean economic cost per dose by facility type

Item	FMC		HC		OFD		HO		Total	
	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost
Recurrent cost	**9.33**	**89.7**	**17.21**	**88.7**	**15.83**	**85.4**	**14.41**	**77.2**	**15.36**	**83.71**
Salaried Labour	7.33	70.48	14.21	73.25	12.62	68.11	10.16	54.42	11.94	65.07
Per-Dime & Travel Allowances	0.01	0.10	0.02	0.10	0.02	0.11	0.10	0.54	0.04	0.22
Vaccines	1.40	13.46	1.49	7.68	1.52	8.20	1.44	7.71	1.49	8.12
Vaccine Injection & Safety supplies	0.10	0.96	0.09	0.46	0.11	0.59	0.11	0.59	0.11	0.60
Other Supplies	0.01	0.10	0.03	0.15	0.04	0.22	0.04	0.21	0.04	0.22
Transportation/fuel	0.03	0.29	0.19	0.98	0.24	1.30	0.57	3.05	0.31	1.69
Vehicle maintenance	0.00	0.00	0.03	0.15	0.03	0.16	0.00	0.00	0.02	0.11
Cold Chain energy	0.01	0.10	0.09	0.46	0.09	0.49	0.33	1.77	0.15	0.82
Printing	0.11	1.06	0.09	0.46	0.02	0.11	0.00	0.00	0.03	0.16
Building overhead	0.28	2.69	0.94	4.85	1.10	5.94	1.58	8.46	1.18	6.43
Other recurrent	0.05	0.48	0.03	0.15	0.04	0.22	0.08	0.43	0.05	0.27
Capital cost	**1.07**	**10.3**	**2.19**	**11.3**	**2.70**	**14.6**	**4.26**	**22.8**	**2.99**	**16.29**
Cold chain equipment	0.02	0.19	0.15	0.77	0.42	2.27	0.86	4.61	0.49	2.67
Vehicles	0.03	0.29	0.41	2.11	0.16	0.86	0.01	0.05	0.15	0.82
Other equipment	0.28	2.69	0.51	2.63	0.41	2.21	0.53	2.84	0.45	2.45
Building	0.74	7.12	1.12	5.77	1.71	9.23	2.86	15.32	1.90	10.35
TOTAL	**10.40**	**100.00**	**19.4**	**100.00**	**18.53**	**100.00**	**18.67**	**100.00**	**18.35**	**100.00**

Table 71: Breakdown of the weighted facility specific mean economic cost per dose by facility scale

Item	Low		Medium		High		Total	
	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost	Cost per dose $US	% of total cost
Recurrent cost	**15.77**	**76.9**	**16.09**	**87.7**	**13.14**	**90.70**	**15.36**	**83.71**
Salaried Labour	11.38	55.46	13.09	71.37	10.61	73.27	11.94	65.07
Per-Dime & Travel Allowances	0.08	0.39	0.03	0.16	0.02	0.14	0.04	0.22
Vaccines	1.53	7.46	1.48	8.07	1.44	9.94	1.49	8.12
Vaccine Injection & Safety Supplies	0.12	0.58	0.09	0.49	0.10	0.69	0.11	0.60
Other Supplies	0.07	0.34	0.02	0.11	0.02	0.14	0.04	0.22
Transportation/fuel	0.50	2.44	0.27	1.47	0.07	0.48	0.31	1.69
Vehicle maintenance	0.03	0.15	0.01	0.05	0.02	0.14	0.02	0.11
Cold Chain energy	0.29	1.41	0.09	0.49	0.03	0.21	0.15	0.82
Printing	0.01	0.05	0.02	0.11	0.06	0.41	0.03	0.16
Building overhead	1.70	8.28	0.94	5.13	0.73	5.04	1.18	6.43
Other recurrent	0.06	0.29	0.05	0.27	0.04	0.28	0.05	0.27
Capital cost	**4.75**	**23.1**	**2.25**	**12.3**	**1.34**	**9.30**	**2.99**	**16.29**
Cold chain equipment	0.93	4.53	0.30	1.64	0.08	0.55	0.49	2.67
Vehicles	0.13	0.63	0.16	0.87	0.17	1.17	0.15	0.82
Other equipment	0.58	2.83	0.42	2.29	0.27	1.86	0.45	2.45
Building	3.11	15.16	1.37	7.47	0.82	5.66	1.90	10.35
TOTAL	**20.52**	**100.00**	**18.34**	**100.00**	**14.48**	**100.00**	**18.35**	**100.00**

Table 72: Breakdown of the weighted facility specific mean economic cost per infant by location

Item	Rural		Semi-Urban		Urban		Total	
	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost
Recurrent cost	**269.59**	**83.06**	**187.94**	**90.80**	**148.14**	**89.87**	**263.83**	**83.34**
Salaried Labour	208.38	64.20	150.89	72.90	118.13	71.67	204.24	64.52
Per-Dime & Travel Allowances	0.56	0.17	0.37	0.18	0.00	0.00	0.54	0.17
Vaccines	26.18	8.07	20.46	9.89	19.31	11.72	25.81	8.15
Vaccine Injection & Safety Supplies	1.83	0.56	1.26	0.61	1.47	0.89	1.80	0.57
Other Supplies	0.80	0.25	0.16	0.08	0.44	0.27	0.76	0.24
Transportation/fuel	5.17	1.59	1.29	0.62	0.12	0.07	4.91	1.55
Vehicle maintenance	0.27	0.08	0.12	0.06	0.07	0.04	0.26	0.08
Cold Chain energy	2.88	0.89	0.28	0.14	0.06	0.04	2.72	0.86
Printing	0.26	0.08	1.69	0.82	2.83	1.72	0.37	0.12
Building overhead	22.55	6.95	10.53	5.09	5.15	3.12	21.71	6.86
Other recurrent	0.71	0.22	0.89	0.43	0.56	0.34	0.71	0.22
Capital cost	**54.98**	**16.94**	**19.04**	**9.20**	**16.69**	**10.13**	**52.74**	**16.66**
Cold chain equipment	8.98	2.77	0.72	0.35	0.25	0.15	8.47	2.68
Vehicles	2.41	0.74	1.93	0.93	0.12	0.07	2.34	0.74
Other equipment	7.66	2.36	4.70	2.27	2.32	1.41	7.43	2.35
Building	35.93	11.07	11.69	5.65	14.00	8.49	34.50	10.90
TOTAL	**324.57**	**100.00**	**206.98**	**100.00**	**164.83**	**100.00**	**316.57**	**100.00**

Table 73: Breakdown of the weighted facility specific mean economic cost per infant by facility type

Item	FMC		HC		OFD		HO		Total	
	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost
Recurrent cost	**129.07**	**89.70**	**284.58**	**88.14**	**284.14**	**84.86**	**226.6**	**76.42**	**263.83**	**83.34**
Salaried Labour	101.30	70.40	234.38	72.59	228.14	68.13	157.86	53.24	204.24	64.52
Per-Dime & Travel Allowances	0.17	0.12	0.39	0.12	0.34	0.10	1.08	0.36	0.54	0.17
Vaccines	19.46	13.52	25.15	7.79	27.39	8.18	24.05	8.11	25.81	8.15
Vaccine Injection & Safety supplies	1.38	0.96	1.59	0.49	1.92	0.57	1.76	0.59	1.80	0.57
Other Supplies	0.13	0.09	0.46	0.14	0.87	0.26	0.81	0.27	0.76	0.24
Transportation/fuel	0.43	0.30	3.25	1.01	0.43	0.13	7.57	2.55	4.91	1.55
Vehicle maintenance	0.06	0.04	0.55	0.17	0.34	0.10	0.00	0.00	0.26	0.08
Cold Chain energy	0.18	0.13	1.47	0.46	1.74	0.52	5.65	1.91	2.72	0.86
Printing	1.56	1.08	1.30	0.40	0.21	0.06	0.00	0.00	0.37	0.12
Building overhead	3.75	2.61	15.59	4.83	22.08	6.59	26.90	9.07	21.71	6.86
Other recurrent	0.65	0.45	0.45	0.14	0.68	0.20	0.92	0.31	0.71	0.22
Capital cost	**14.82**	**10.30**	**38.31**	**11.86**	**50.71**	**15.14**	**69.93**	**23.58**	**52.74**	**16.66**
Cold chain equipment	0.33	0.23	2.76	0.85	7.74	2.31	14.07	4.74	8.47	2.68
Vehicles	0.38	0.26	7.35	2.28	2.22	0.66	0.27	0.09	2.34	0.74
Other equipment	3.94	2.74	8.44	2.61	7.21	2.15	7.87	2.65	7.43	2.35
Building	10.17	7.07	19.76	6.12	33.54	10.02	47.72	16.09	34.50	10.90
TOTAL	**143.89**	**100.00**	**322.89**	**100.00**	**334.85**	**100.00**	**296.53**	**100.00**	**316.57**	**100.00**

Table 74: Breakdown of the weighted facility specific mean economic cost per infant by facility scale

Item	Low		Medium		High		Total	
	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost	Cost per infant $US	% of total cost
Recurrent cost	**249.43**	**75.24**	**309.83**	**87.83**	**195.91**	**90.67**	**263.83**	**83.34**
Salaried Labour	174.19	52.54	253.01	71.72	158.64	73.42	204.24	64.52
Per-Dime & Travel Allowances	0.81	0.24	0.46	0.13	0.25	0.12	0.54	0.17
Vaccines	26.27	7.92	27.65	7.84	21.24	9.83	25.81	8.15
Vaccine Injection & Safety Supplies	2.05	0.62	1.76	0.50	1.46	0.68	1.80	0.57
Other Supplies	1.47	0.44	0.37	0.10	0.30	0.14	0.76	0.24
Transportation/fuel	6.77	2.04	5.15	1.46	1.10	0.51	4.91	1.55
Vehicle maintenance	0.31	0.09	0.15	0.04	0.40	0.19	0.26	0.08
Cold Chain energy	5.02	1.51	1.79	0.51	0.49	0.23	2.72	0.86
Printing	0.13	0.04	0.34	0.10	0.85	0.39	0.37	0.12
Building overhead	31.72	9.57	18.35	5.20	10.62	4.92	21.71	6.86
Other recurrent	0.69	0.21	0.80	0.23	0.56	0.26	0.71	0.22
Capital cost	**82.08**	**24.76**	**42.94**	**12.17**	**20.16**	**9.33**	**52.74**	**16.66**
Cold chain equipment	15.56	4.69	5.79	1.64	1.20	0.56	8.47	2.68
Vehicles	1.41	0.43	2.91	0.82	2.88	1.33	2.34	0.74
Other equipment	9.05	2.73	7.66	2.17	4.08	1.89	7.43	2.35
Building	56.06	16.91	26.58	7.53	12.00	5.55	34.50	10.90
TOTAL	**331.51**	**100.00**	**352.77**	**100.00**	**216.07**	**100.00**	**316.57**	**100.00**

Table 75: Breakdown of the weighted facility specific mean economic cost per FIC by location

Item	Rural		Semi-Urban		Urban		Total	
	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost
Recurrent cost	**282.48**	**83.00**	**201.71**	**90.83**	**161.9**	**89.88**	**276.79**	**83.29**
Salaried Labour	218.64	64.25	161.93	72.92	129.10	71.67	214.55	64.56
Per-Dime & Travel Allowances	0.71	0.21	0.40	0.18	0.00	0.00	0.68	0.20
Vaccines	27.30	8.02	21.87	9.85	21.13	11.73	26.96	8.11
Vaccine Injection & Safety Supplies	1.93	0.57	1.34	0.60	1.61	0.89	1.90	0.57
Other Supplies	0.81	0.24	0.18	0.08	0.47	0.26	0.78	0.23
Transportation/fuel	5.37	1.58	1.40	0.63	0.14	0.08	5.11	1.54
Vehicle maintenance	0.28	0.08	0.13	0.06	0.07	0.04	0.27	0.08
Cold Chain energy	3.07	0.90	0.30	0.14	0.06	0.03	2.89	0.87
Printing	0.26	0.08	1.81	0.82	3.06	1.70	0.38	0.11
Building overhead	23.33	6.86	11.39	5.13	5.65	3.14	22.49	6.77
Other recurrent	0.78	0.23	0.96	0.43	0.61	0.34	0.78	0.23
Capital cost	**57.84**	**17.00**	**20.36**	**9.17**	**18.22**	**10.12**	**55.52**	**16.71**
Cold chain equipment	9.68	2.84	0.77	0.35	0.27	0.15	9.13	2.75
Vehicles	2.48	0.73	2.08	0.94	0.13	0.07	2.42	0.73
Other equipment	8.14	2.39	5.00	2.25	2.55	1.42	7.90	2.38
Building	37.54	11.03	12.51	5.63	15.27	8.48	36.07	10.85
TOTAL	**340.32**	**100.00**	**222.07**	**100.00**	**180.12**	**100.00**	**332.31**	**100.00**

Table 76: Breakdown of the weighted facility specific mean economic cost per FIC by facility type

Item	FMC		HC		OFD		HO		Total	
	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost
Recurrent cost	**139.11**	**89.73**	**290.04**	**88.21**	**295.6**	**85.14**	**254.34**	**76.57**	**276.79**	**83.29**
Salaried Labour	109.19	70.43	238.87	72.65	234.22	67.46	179.77	54.12	214.55	64.56
Per-Dime & Travel Allowances	0.17	0.11	0.40	0.12	0.36	0.10	1.54	0.46	0.68	0.20
Vaccines	20.97	13.53	25.62	7.79	28.11	8.10	26.32	7.92	26.96	8.11
Vaccine Injection & Safety supplies	1.49	0.96	1.62	0.49	1.96	0.56	1.99	0.60	1.90	0.57
Other Supplies	0.14	0.09	0.48	0.15	0.87	0.25	0.85	0.26	0.78	0.23
Transportation/fuel	0.46	0.30	3.29	1.00	4.43	1.28	8.07	2.43	5.11	1.54
Vehicle maintenance	0.06	0.04	0.55	0.17	0.35	0.10	0.00	0.00	0.27	0.08
Cold Chain energy	0.20	0.13	1.47	0.45	1.76	0.51	6.24	1.88	2.89	0.87
Printing	1.67	1.08	1.33	0.40	0.21	0.06	0.00	0.00	0.38	0.11
Building overhead	4.06	2.62	15.93	4.85	22.62	6.52	28.46	8.57	22.49	6.77
Other recurrent	0.70	0.45	0.48	0.15	0.71	0.20	1.10	0.33	0.78	0.23
Capital cost	**15.93**	**10.27**	**38.75**	**11.79**	**51.59**	**14.86**	**77.82**	**23.43**	**55.52**	**16.71**
Cold chain equipment	0.35	0.23	2.78	0.85	7.84	2.26	16.24	4.89	9.13	2.75
Vehicles	0.40	0.26	7.40	2.25	2.35	0.68	0.27	0.08	2.42	0.73
Other equipment	4.20	2.71	8.52	2.59	7.35	2.12	9.20	2.77	7.90	2.38
Building	10.98	7.08	20.05	6.10	34.05	9.81	52.11	15.69	36.07	10.85
TOTAL	**155.04**	**100.00**	**328.79**	**100.00**	**347.19**	**100.00**	**332.16**	**100.00**	**332.31**	**100.00**

Table 77: Breakdown of the weighted facility specific mean economic cost per FIC by facility scale

Item	Low		Medium		High		Total	
	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost	Cost per FIC $US	% of total cost
Recurrent cost	**269.66**	**75.42**	**315.98**	**87.85**	**209.61**	**90.65**	**276.79**	**83.29**
Salaried Labour	190.23	53.21	257.94	71.72	169.65	73.37	214.55	64.56
Per-Dime & Travel Allowances	1.15	0.32	0.47	0.13	0.27	0.12	0.68	0.20
Vaccines	27.90	7.80	28.17	7.83	22.78	9.85	26.96	8.11
Vaccine Injection & Safety Supplies	2.22	0.62	1.79	0.50	1.55	0.67	1.90	0.57
Other Supplies	1.50	0.42	0.37	0.10	0.31	0.13	0.78	0.23
Transportation/fuel	7.12	1.99	5.27	1.47	1.17	0.51	5.11	1.54
Vehicle maintenance	0.31	0.09	0.15	0.04	0.44	0.19	0.27	0.08
Cold Chain energy	5.45	1.52	1.81	0.50	0.51	0.22	2.89	0.87
Printing	0.13	0.04	0.34	0.09	0.89	0.38	0.38	0.11
Building overhead	32.83	9.18	18.85	5.24	11.39	4.93	22.49	6.77
Other recurrent	0.82	0.23	0.82	0.23	0.65	0.28	0.78	0.23
Capital cost	**87.87**	**24.58**	**43.69**	**12.15**	**21.63**	**9.35**	**55.52**	**16.71**
Cold chain equipment	17.17	4.80	5.90	1.64	1.29	0.56	9.13	2.75
Vehicles	1.41	0.39	2.91	0.81	3.25	1.41	2.42	0.73
Other equipment	10.02	2.80	7.81	2.17	4.27	1.85	7.90	2.38
Building	59.27	16.58	27.07	7.53	12.82	5.54	36.07	10.85
TOTAL	**357.53**	**100.00**	**359.67**	**100.00**	**231.24**	**100.00**	**332.31**	**100.00**

Table 78: Total facility specific Financial and Economic mean cost with and without wages by location

By location		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Total Financial cost	Rural	4,398	4,053	1238	0.000
	Semi-urban	28,924	31,173	54	
	Urban	82,394	82,394	26	
	Total	**11,530**	**6,710**	**1318**	
Total Financial Cost without wages	Rural	1,168	1,098	1238	0.000
	Semi-urban	7,575	8,829	54	
	Urban	21,226	21,226	26	
	Total	**3,013**	**1,812**	**1318**	
Total Economic Cost	Rural	4,563	4,215	1238	0.000
	Semi-urban	29,781	32,160	54	
	Urban	85,524	85,524	26	
	Total	**11,943**	**6,964**	**1318**	
Total Economic Cost without wages	Rural	1,334	1,260	1238	0.000
	Semi-urban	8,433	9,816	54	
	Urban	24,356	24,356	26	
	Total	**3,425**	**2,066**	**1318**	

Table 79: Total facility specific Financial and Economic mean cost with and without wages by facility type

By facility type		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Total Financial cost	FMC	60,744	55,877	55	0.000
	HC	15,610	11,494	708	
	OFD	4,147	4,135	190	
	HO	1,777	1,765	365	
	Total	**11,530**	**6,710**	**1318**	
Total Financial cost without wages	FMC	16,136	15,456	55	0.000
	HC	3,721	2,796	708	
	OFD	1,103	1,101	190	
	HO	615	612	365	
	Total	**3,013**	**1,812**	**1318**	
Total Economic cost	FMC	62,902	57,869	55	0.000
	HC	16,079	11,849	708	
	OFD	4,310	4,298	190	
	HO	1,893	1,881	365	
	Total	**11,943**	**6,964**	**1318**	
Total Economic cost Without wages	FMC	18,294	17,448	55	0.000
	HC	4,189	3,151	708	
	OFD	1,266	1,264	190	
	HO	731	728	365	
	Total	**3,425**	**2,066**	**1318**	

Table 80: Total facility specific Financial and Economic mean cost with and without wages by facility scale

By facility scale		Unweighted Mean $US	Weighted Mean $US	N	Unweighted P Value
Total Financial cost	Low	1,337	1,343	489	0.000
	Medium	4,316	4,303	556	
	High	29,840	21,247	273	
	Total	**11,530**	**6,710**	**1318**	
Total Financial cost Without wages	Low	542	543	489	0.000
	Medium	1,103	1,102	556	
	High	7,631	5,538	273	
	Total	**3,013**	**1,812**	**1318**	
Total Economic cost	Low	1,451	1,457	489	0.000
	Medium	4,477	4,465	556	
	High	30,833	21,942	273	
	Total	**11,943**	**6,964**	**1318**	
Total Economic cost Without wages	Low	656	658	489	0.000
	Medium	1,264	1,263	556	
	High	8,624	6,232	273	
	Total	**3,425**	**2,066**	**1318**	

Table 81: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Chisinau district)

Line Items	N 69	N 73	N 187	N 195	N 203	Weighted Average
Salaried Labor	11,737	7,406	82,618	39,045	61,840	40,529
Per Diems	-	-	-	-	-	-
Vaccines	1,512	1,260	13,945	5,824	10,981	6,704
Injection supplies	117	89	1,031	419	913	514
Other supplies	54	13	59	253	172	110
Transport & fuel	76	71	143	36	33	72
Vehicle maintenance	13	10	49	22	37	26
Cold chain energy costs	16	16	18	30	19	20
Printing	-	-	746	1,146	1,904	759
Building overheads	767	329	3,664	971	4,187	1,983
Other recurrent	125	79	355	251	176	197
Subtotal recurrent	14,417	9,272	102,628	47,997	80,261	50,915
Cold chain equipment	74	78	130	97	133	102
Vehicles	38	39	62	38	78	51
Other capital	199	208	1,817	492	1,653	874
Buildings	668	322	7,911	4,639	8,636	4,435
Subtotal capital	978	647	9,920	5,266	10,500	5,462
Total Facility Immunization Cost	**15,394**	**9,919**	**112,548**	**53,263**	**90,761**	**56,377**
Total Delivery Cost	**13,765**	**8,570**	**97,572**	**47,021**	**78,867**	**49,159**
Total Child Doses	1,017	811	9,060	3,627	7,369	4,377
Total DTP3 Vaccinated Children	60	56	714	255	522	321
Infant population	82	56	810	271	571	358
Total population	5,160	3,552	59,995	18,909	42,469	26,017
Cost per Dose	15	12	12	15	12	13
Cost per DTP3 Vaccinated child	257	177	158	209	174	195
Cost per child	188	177	139	197	159	172
Cost per capita	3	3	2	3	2	3
Delivery cost per dose	14	11	11	13	11	12
Delivery cost per DTP3 vaccinated child	229	153	137	184	151	171
Delivery cost per child	168	153	120	174	138	151
Delivery cost per capita	3	2	2	2	2	2

Table 82: Total Routine Facility Immunization Economic Costs (Percent of total distribution) (Facilities in Chisinau district)

Line Items	N 69	N 73	N 187	N 195	N 203	Weighted Average
Salaried Labor	76.2%	74.7%	73.4%	73.3%	68.1%	73.2%
Per Diems	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vaccines	9.8%	12.7%	12.4%	10.9%	12.1%	11.6%
Injection supplies	0.8%	0.9%	0.9%	0.8%	1.0%	0.9%
Other supplies	0.3%	0.1%	0.1%	0.5%	0.2%	0.2%
Transport & fuel	0.5%	0.7%	0.1%	0.1%	0.0%	0.3%
Vehicle maintenance	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
Cold chain energy costs	0.1%	0.2%	0.0%	0.1%	0.0%	0.1%
Printing	0.0%	0.0%	0.7%	2.2%	2.1%	1.0%
Building overheads	5.0%	3.3%	3.3%	1.8%	4.6%	3.6%
Other recurrent	0.8%	0.8%	0.3%	0.5%	0.2%	0.5%
Subtotal recurrent	93.7%	93.5%	91.2%	90.1%	88.4%	91.4%
Cold chain equipment	0.5%	0.8%	0.1%	0.2%	0.1%	0.3%
Vehicles	0.2%	0.4%	0.1%	0.1%	0.1%	0.2%
Other capital	1.3%	2.1%	1.6%	0.9%	1.8%	1.5%
Buildings	4.3%	3.2%	7.0%	8.7%	9.5%	6.6%
Subtotal capital	6.3%	6.5%	8.8%	9.9%	11.6%	8.6%
Total Facility Immunization Cost	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 83: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Briceni district)

Line Items	**N 5**	**N 9**	**N 13**	**N 17**	**N 22**	**N 26**	**N 30**	**N 182**	**Weighted Average**
Salaried Labor	6,501	2,065	2,565	3,534	1,186	604	6,944	10,698	4,262
Per Diems	14	-	-	14	-	14	20	17	10
Vaccines	610	252	224	300	225	42	1,015	1,023	461
Injection supplies	33	12	10	14	10	4	50	45	22
Other supplies	1	1	5	1	0	0	2	1	1
Transport & fuel	15	30	119	91	89	82	48	110	73
Vehicle maintenance	-	-	5	-	-	-	40	22	8
Cold chain energy costs	16	16	16	17	1	5	16	17	13
Printing	3	1	3	-	-	-	5	6	2
Building overheads	251	328	126	370	183	211	530	375	297
Other recurrent	26	-	-	15	-	15	63	75	24
Subtotal recurrent	7,469	2,705	3,075	4,357	1,694	976	8,733	12,391	5,175
Cold chain equipment	75	76	84	76	8	15	72	74	60
Vehicles	-	-	58	-	-	-	377	173	76
Other capital	76	63	63	52	61	20	89	166	74
Buildings	236	207	262	377	236	176	504	962	370
Subtotal capital	387	346	467	505	304	210	1,042	1,375	580
Total Facility Immunization Cost	**7,856**	**3,051**	**3,541**	**4,862**	**1,998**	**1,186**	**9,775**	**13,766**	**5,754**
Total Delivery Cost	**7,213**	**2,787**	**3,307**	**4,547**	**1,763**	**1,141**	**8,710**	**12,698**	**5,271**
Total Child Doses	458	150	156	181	150	33	760	696	323
Total DTP3 Vaccinated Children	22	5	8	7	15	3	30	38	16
Infant population	22	5	8	8	16	3	39	41	18
Total population	2,317	920	1,162	1,101	461	357	3,906	4,970	1,899
Cost per Dose	17	20	23	27	13	36	13	20	21
Cost per DTP3 Vaccinated child	357	610	443	695	133	395	326	362	415
Cost per child	357	610	443	608	125	395	251	336	391
Cost per capita	3	3	3	4	4	3	3	3	3
Delivery cost per dose	16	19	21	25	12	35	11	18	20
Delivery cost per DTP3 vaccinated child	328	557	413	650	118	380	290	334	384
Delivery cost per child	328	557	413	568	110	380	223	310	361
Delivery cost per capita	3	3	3	4	4	3	2	3	3

Table 84: Total Routine Facility Immunization Economic Costs (Percent of total distribution) (Facilities in Briceni district)

Line Items	N 5	N 9	N 13	N 17	N 22	N 26	N 30	N 182	Weighted Average
Salaried Labor	82.8%	67.7%	72.4%	72.7%	59.3%	50.9%	71.0%	77.7%	69.3%
Per Diems	0.2%	0.0%	0.0%	0.3%	0.0%	1.2%	0.2%	0.1%	0.2%
Vaccines	7.8%	8.3%	6.3%	6.2%	11.3%	3.5%	10.4%	7.4%	7.6%
Injection supplies	0.4%	0.4%	0.3%	0.3%	0.5%	0.3%	0.5%	0.3%	0.4%
Other supplies	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Transport & fuel	0.2%	1.0%	3.4%	1.9%	4.5%	6.9%	0.5%	0.8%	2.4%
Vehicle maintenance	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.4%	0.2%	0.1%
Cold chain energy costs	0.2%	0.5%	0.5%	0.4%	0.0%	0.4%	0.2%	0.1%	0.3%
Printing	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Building overheads	3.2%	10.7%	3.6%	7.6%	9.2%	17.8%	5.4%	2.7%	7.5%
Other recurrent	0.3%	0.0%	0.0%	0.3%	0.0%	1.2%	0.6%	0.5%	0.4%
Subtotal recurrent	95.1%	88.7%	86.8%	89.6%	84.8%	82.3%	89.3%	90.0%	88.3%
Cold chain equipment	1.0%	2.5%	2.4%	1.6%	0.4%	1.2%	0.7%	0.5%	1.3%
Vehicles	0.0%	0.0%	1.6%	0.0%	0.0%	0.0%	3.9%	1.3%	0.8%
Other capital	1.0%	2.1%	1.8%	1.1%	3.0%	1.7%	0.9%	1.2%	1.6%
Buildings	3.0%	6.8%	7.4%	7.8%	11.8%	14.8%	5.2%	7.0%	8.0%
Subtotal capital	4.9%	11.3%	13.2%	10.4%	15.2%	17.7%	10.7%	10.0%	11.7%
Total Facility Immunization Cost	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 85: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Calarasi district)

Line Items	N 35	N 39	N 43	N 48	N 52	N 56	N 60	N 65	N 184	Weighted Average
Salaried Labor	929	1,190	1,837	1,113	4,960	12,854	3,834	4,095	31,800	6,957
Per Diems	-	-	8	-	-	23	-	-	162	22
Vaccines	139	186	399	161	324	1,058	588	266	4,165	810
Injection supplies	7	18	18	8	14	100	50	32	186	48
Other supplies	7	43	13	8	5	25	4	2	52	18
Transport & fuel	76	4	85	54	97	103	23	34	-	53
Vehicle maintenance	32	-	19	8	11	71	-	-	33	19
Cold chain energy costs	16	16	16	16	55	55	16	16	55	29
Printing	12	-	29	4	27	84	-	-	1,086	138
Building overheads	84	564	255	81	231	956	340	70	995	397
Other recurrent	-	-	103	-	-	6	-	4	120	26
Subtotal recurrent	1,303	2,022	2,782	1,453	5,724	15,335	4,855	4,519	38,654	8,516
Cold chain equipment	71	78	73	72	56	53	75	72	76	70
Vehicles	107	-	189	62	173	385	-	-	75	110
Other capital	66	66	91	60	261	508	439	48	2,635	464
Buildings	281	863	384	169	360	926	159	572	2,650	707
Subtotal capital	525	1,007	738	364	850	1,872	673	691	5,436	1,351
Total Facility Immunization Cost	**1,828**	**3,029**	**3,520**	**1,817**	**6,574**	**17,207**	**5,529**	**5,211**	**44,090**	**9,867**
Total Delivery Cost	**1,682**	**2,824**	**3,103**	**1,648**	**6,236**	**16,049**	**4,891**	**4,913**	**39,740**	**9,009**
Total Child Doses	86	119	244	84	180	676	376	204	2,810	531
Total DTP3 Vaccinated Children	9	4	16	6	12	42	24	10	178	33
Infant population	9	4	16	6	12	42	26	10	186	35
Total population	712	949	1,762	452	1,347	3,765	2,776	1,202	19,266	3,581
Cost per Dose	21	25	14	22	37	25	15	26	16	22
Cost per DTP3 Vaccinated child	203	757	220	303	548	410	230	521	248	382
Cost per child	203	757	220	303	548	410	213	521	237	379
Cost per capita	3	3	2	4	5	5	2	4	2	3
Delivery cost per dose	20	24	13	20	35	24	13	24	14	21
Delivery cost per DTP3 vaccinated child	187	706	194	275	520	382	204	491	223	354
Delivery cost per child	187	706	194	275	520	382	188	491	214	351
Delivery cost per capita	2	3	2	4	5	4	2	4	2	3

Table 86: Total Routine Facility Immunization Economic Costs (Percent of total distribution) (Facilities in Calarasi district)

Line Items	**N 35**	**N 39**	**N 43**	**N 48**	**N 52**	**N 56**	**N 60**	**N 65**	**N 184**	**Weighted Average**
Salaried Labor	50.8%	39.3%	52.2%	61.2%	75.4%	74.7%	69.4%	78.6%	72.1%	63.8%
Per Diems	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%	0.4%	0.1%
Vaccines	7.6%	6.2%	11.3%	8.9%	4.9%	6.1%	10.6%	5.1%	9.4%	7.8%
Injection supplies	0.4%	0.6%	0.5%	0.4%	0.2%	0.6%	0.9%	0.6%	0.4%	0.5%
Other supplies	0.4%	1.4%	0.4%	0.5%	0.1%	0.1%	0.1%	0.0%	0.1%	0.3%
Transport & fuel	4.1%	0.1%	2.4%	3.0%	1.5%	0.6%	0.4%	0.6%	0.0%	1.4%
Vehicle maintenance	1.7%	0.0%	0.5%	0.4%	0.2%	0.4%	0.0%	0.0%	0.1%	0.4%
Cold chain energy costs	0.9%	0.5%	0.5%	0.9%	0.8%	0.3%	0.3%	0.3%	0.1%	0.5%
Printing	0.7%	0.0%	0.8%	0.2%	0.4%	0.5%	0.0%	0.0%	2.5%	0.6%
Building overheads	4.6%	18.6%	7.2%	4.4%	3.5%	5.6%	6.2%	1.3%	2.3%	6.0%
Other recurrent	0.0%	0.0%	2.9%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%
Subtotal recurrent	71.3%	66.8%	79.0%	80.0%	87.1%	89.1%	87.8%	86.7%	87.7%	81.7%
Cold chain equipment	3.9%	2.6%	2.1%	4.0%	0.8%	0.3%	1.4%	1.4%	0.2%	1.8%
Vehicles	5.8%	0.0%	5.4%	3.4%	2.6%	2.2%	0.0%	0.0%	0.2%	2.2%
Other capital	3.6%	2.2%	2.6%	3.3%	4.0%	3.0%	7.9%	0.9%	6.0%	3.7%
Buildings	15.4%	28.5%	10.9%	9.3%	5.5%	5.4%	2.9%	11.0%	6.0%	10.5%
Subtotal capital	28.7%	33.2%	21.0%	20.0%	12.9%	10.9%	12.2%	13.3%	12.3%	18.3%
Total Facility Immunization Cost	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 87: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Ungheni district)

Line Items	N 112	N 116	N 121	N 125	N 130	N 134	N 138	N 143	N 147
Salaried Labor	2,047	2,911	153	1,247	583	448	461	6,424	369
Per Diems	9	-	42	-	-	-	-	-	-
Vaccines	299	425	70	73	180	72	62	988	175
Injection supplies	24	35	7	8	15	6	5	70	13
Other supplies	8	5	2	1	6	4	2	42	3
Transport & fuel	19	17	18	14	24	10	36	30	46
Vehicle maintenance	-	-	-	-	-	-	-	-	-
Cold chain energy costs	16	16	16	16	16	35	31	16	16
Printing	-	-	-	-	-	-	-	-	-
Building overheads	71	187	88	30	40	59	72	814	19
Other recurrent	5	-	16	-	-	-	-	-	-
Subtotal recurrent	2,498	3,597	411	1,388	864	633	668	8,384	640
Cold chain equipment	75	73	72	76	49	49	65	75	75
Vehicles	-	-	-	-	-	-	-	-	-
Other capital	37	41	54	44	58	11	13	153	28
Buildings	314	188	80	202	145	70	216	567	88
Subtotal capital	426	301	205	321	252	130	293	795	191
Total Facility Immunization Cost	**2,924**	**3,898**	**616**	**1,709**	**1,116**	**762**	**962**	**9,180**	**831**
Total Delivery Cost	**2,601**	**3,438**	**539**	**1,629**	**922**	**684**	**895**	**8,122**	**643**
Total Child Doses	185	309	52	54	126	54	39	717	123
Total DTP3 Vacc. Children	10	18	3	3	12	2	4	51	4
Infant population	10	19	5	7	12	2	4	51	4
Total population	878	2,125	342	455	570	521	212	3,290	708
Cost per Dose	16	13	12	32	9	14	25	13	7
Cost per DTP3 Vacc. child	292	217	205	570	93	381	240	180	208
Cost per child	292	205	123	244	93	381	240	180	208
Cost per capita	3	2	2	4	2	1	5	3	1
Delivery cost per dose	14	11	10	30	7	13	23	11	5
Delivery cost per DTP3 vaccinated child	260	191	180	543	77	342	224	159	161
Delivery cost per child	260	181	108	233	77	342	224	159	161
Delivery cost per capita	3	2	2	4	2	1	4	2	1

Line Items	N 151	N 155	N 162	N 164	N 168	N 173	N 174	N 176	N 213	Weighted Average
Salaried Labor	2,060	2,227	7,494	142	481	9,420	7,586	3,365	25,067	4,027
Per Diems	-	-	-	-	-	1	-	-	18	4
Vaccines	216	183	690	109	198	1,005	975	490	7,919	785
Injection supplies	23	16	49	8	11	79	70	38	629	61
Other supplies	1	5	13	2	6	7	6	2	25	8
Transport & fuel	17	75	191	23	15	86	25	31	233	50
Vehicle maintenance	-	-	-	-	-	23	-	-	-	1
Cold chain energy costs	16	31	55	58	16	16	16	16	40	25
Printing	-	-	-	-	-	-	-	-	-	-
Building overheads	86	63	744	25	94	300	333	119	725	215
Other recurrent	-	-	-	-	-	7	-	-	261	16
Subtotal recurrent	2,419	2,600	9,235	367	822	10,944	9,012	4,061	34,919	5,192
Cold chain equipment	78	43	52	75	72	78	78	75	127	71
Vehicles	-	-	70	-	-	87	-	-	130	16
Other capital	63	104	106	15	31	175	115	51	665	98
Buildings	171	237	778	108	535	429	628	314	2,915	444
Subtotal capital	312	383	1,007	198	637	768	821	440	3,838	629
Total Facility Immunization Cost	**2,732**	**2,984**	**10,242**	**565**	**1,460**	**11,712**	**9,834**	**4,502**	**38,756**	**5,821**
Total Delivery Cost	**2,493**	**2,784**	**9,502**	**449**	**1,251**	**10,629**	**8,789**	**3,974**	**30,209**	**4,975**
Total Child Doses	122	141	449	75	126	738	649	301	5,993	570
Total DTP3 Vacc. Children	12	5	21	5	7	40	61	18	384	37
Infant population	12	5	21	6	7	41	62	18	409	39
Total population	884	1,050	1,917	370	497	3,380	3,321	1,810	29,217	2,864
Cost per Dose	22	21	23	8	12	16	15	15	6	15
Cost per DTP3 Vacc. child	228	597	488	113	209	293	161	250	101	268
Cost per child	228	597	488	94	209	286	159	250	95	243
Cost per capita	3	3	5	2	3	3	3	2	1	3
Delivery cost per dose	20	20	21	6	10	14	14	13	5	14
Delivery cost per DTP3 vaccinated child	208	557	452	90	179	266	144	221	79	241
Delivery cost per child	208	557	452	75	179	259	142	221	74	217
Delivery cost per capita	3	3	5	1	3	3	3	2	1	2

Table 88: Total Routine Facility Immunization Economic Costs (Percent of total distribution) (Facilities in Ungheni district)

Line Items	N 112	N116	N 121	N 125	N 130	N 134	N 138	N 143	N 147	N 151	N 155	N 162	N 164	N 168	N 173	N 174	N 176	N 213	Weighted Average
Salaried Labor	70.0%	74.7%	24.8%	72.9%	52.2%	58.7%	47.9%	70.0%	44.4%	75.4%	74.6%	73.2%	25.2%	33.0%	80.4%	77.1%	74.8%	64.7%	60.8%
Per Diems	0.3%	0.0%	6.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Vaccines	10.2%	10.9%	11.3%	4.2%	16.1%	9.4%	6.4%	10.8%	21.1%	7.9%	6.1%	6.7%	19.2%	13.6%	8.6%	9.9%	10.9%	20.4%	11.3%
Injection supplies	0.8%	0.9%	1.2%	0.5%	1.3%	0.8%	0.5%	0.8%	1.6%	0.8%	0.5%	0.5%	1.4%	0.8%	0.7%	0.7%	0.8%	1.6%	0.9%
Other supplies	0.3%	0.1%	0.2%	0.1%	0.6%	0.5%	0.2%	0.5%	0.4%	0.1%	0.2%	0.1%	0.4%	0.4%	0.1%	0.1%	0.0%	0.1%	0%
Transport & fuel	0.6%	0.4%	2.9%	0.8%	2.2%	1.3%	3.7%	0.3%	5.5%	0.6%	2.5%	1.9%	4.0%	1.0%	0.7%	0.3%	0.7%	0.6%	1.7%
Vehicle maintenance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0%
Cold chain energy costs	0.6%	0.4%	2.6%	0.9%	1.5%	4.5%	3.2%	0.2%	2.0%	0.6%	1.0%	0.5%	10.2%	1.1%	0.1%	0.2%	0.4%	0.1%	1.7%
Printing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%
Building overheads	2.4%	4.8%	14.2%	1.8%	3.6%	7.8%	7.5%	8.9%	2.2%	3.2%	2.1%	7.3%	4.5%	6.5%	2.6%	3.4%	2.6%	1.9%	4.8%
Other recurrent	0.2%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.7%	0.2%
Subtotal recurrent	85.4%	92.3%	66.7%	81.2%	77.4%	83.0%	69.5%	91.3%	77.1%	88.6%	87.1%	90.2%	64.9%	56.3%	93.4%	91.6%	90.2%	90.1%	82%
Cold chain equipment	2.6%	1.9%	11.7%	4.4%	4.4%	6.4%	6.7%	0.8%	9.0%	2.8%	1.4%	0.5%	13.3%	4.9%	0.7%	0.8%	1.7%	0.3%	4.1%
Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.7%	0.0%	0.0%	0.3%	0%
Other capital	1.3%	1.0%	8.7%	2.6%	5.2%	1.4%	1.3%	1.7%	3.3%	2.3%	3.5%	1.0%	2.7%	2.1%	1.5%	1.2%	1.1%	1.7%	2.4%
Buildings	10.7%	4.8%	12.9%	11.8%	13.0%	9.2%	22.4%	6.2%	10.6%	6.3%	7.9%	7.6%	19.1%	36.6%	3.7%	6.4%	7.0%	7.5%	11.3%
Subtotal capital	14.6%	7.7%	33.3%	18.8%	22.6%	17.0%	30.5%	8.7%	22.9%	11.4%	12.9%	9.8%	35.1%	43.7%	6.6%	8.4%	9.8%	9.9%	18.0%
Total Facility Immunization Cost	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 89: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Leova district)

Line Items	N 78	N 82	N 86	N 95	N 96	N 99	N 103	N 212	Weighted Average
Salaried Labor	2,595	362	2,714	2,212	1,803	2,582	1,821	17,464	3,944
Per Diems	12	-	27	14	-	26	22	59	20
Vaccines	401	68	1,123	209	110	505	437	1,072	491
Injection supplies	22	4	56	12	11	24	26	57	26
Other supplies	11	4	9	2	2	2	2	36	8
Transport & fuel	59	11	18	17	4	31	26	208	47
Vehicle maintenance	-	-	-	-	-	-	-	-	-
Cold chain energy costs	16	15	56	16	5	16	16	16	20
Printing	14	-	-	-	-	-	-	330	43
Building overheads	274	97	254	194	209	207	108	3,138	560
Other recurrent	7	-	31	14	-	10	39	24	16
Subtotal recurrent	3,411	560	4,289	2,690	2,144	3,404	2,497	22,405	5,175
Cold chain equipment	78	48	65	72	72	84	72	70	70
Vehicles	180	-	48	-	-	-	-	399	78
Other capital	93	23	93	73	51	86	58	375	107
Buildings	428	175	328	184	244	172	316	690	317
Subtotal capital	779	246	534	330	367	343	447	1,534	572
Total Facility Immunization Cost	**4,190**	**806**	**4,823**	**3,020**	**2,511**	**3,747**	**2,944**	**23,939**	**5,748**
Total Delivery Cost	**3,767**	**735**	**3,644**	**2,800**	**2,390**	**3,217**	**2,481**	**22,810**	**5,230**
Total Child Doses	326	48	763	159	61	361	306	705	341
Total DTP3 Vaccinated Children	12	1	57	11	4	26	23	56	24
Infant population	12	1	57	11	4	26	23	61	24
Total population	1,609	217	3,643	1,061	676	1,538	1,285	4,745	1,847
Cost per Dose	13	17	6	19	41	10	10	34	19
Cost per DTP3 Vaccinated child	349	806	85	275	628	144	128	427	355
Cost per child	349	806	85	275	628	144	128	392	351
Cost per capita	3	4	1	3	4	2	2	5	3
Delivery cost per dose	12	15	5	18	39	9	8	32	17
Delivery cost per DTP3 vaccinated child	314	735	64	255	598	124	108	407	325
Delivery cost per child	314	735	64	255	598	124	108	374	321
Delivery cost per capita	2	3	1	3	4	2	2	5	3

Table 90: Total Routine Facility Immunization Economic Costs (Percent of total distribution) (Facilities in Leova district)

Line Items	N78	N82	N86	N95	N96	N99	N103	N212	Weighted Average
Salaried Labor	61.9%	45.0%	56.3%	73.2%	71.8%	68.9%	61.8%	73.0%	64.0%
Per Diems	0.3%	0.0%	0.6%	0.5%	0.0%	0.7%	0.7%	0.2%	0.4%
Vaccines	9.6%	8.4%	23.3%	6.9%	4.4%	13.5%	14.8%	4.5%	10.7%
Injection supplies	0.5%	0.5%	1.2%	0.4%	0.4%	0.6%	0.9%	0.2%	0.6%
Other supplies	0.3%	0.5%	0.2%	0.1%	0.1%	0.0%	0.1%	0.2%	0.2%
Transport & fuel	1.4%	1.3%	0.4%	0.6%	0.2%	0.8%	0.9%	0.9%	0.8%
Vehicle maintenance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cold chain energy costs	0.4%	1.9%	1.2%	0.5%	0.2%	0.4%	0.6%	0.1%	0.7%
Printing	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.2%
Building overheads	6.5%	12.0%	5.3%	6.4%	8.3%	5.5%	3.7%	13.1%	7.6%
Other recurrent	0.2%	0.0%	0.6%	0.5%	0.0%	0.3%	1.3%	0.1%	0.4%
Subtotal recurrent	81.4%	69.5%	88.9%	89.1%	85.4%	90.9%	84.8%	93.6%	85.4%
Cold chain equipment	1.9%	6.0%	1.3%	2.4%	2.9%	2.2%	2.5%	0.3%	2.4%
Vehicles	4.3%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	1.7%	0.9%
Other capital	2.2%	2.8%	1.9%	2.4%	2.0%	2.3%	2.0%	1.6%	2.2%
Buildings	10.2%	21.7%	6.8%	6.1%	9.7%	4.6%	10.8%	2.9%	9.1%
Subtotal capital	18.6%	30.5%	11.1%	10.9%	14.6%	9.1%	15.2%	6.4%	14.6%
Total Facility Immunization Cost	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 91: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Vulkanesti district)

Line Items	N 180	N 215	Weighted Average
Salaried Labor	778	21,714	11,246
Per Diems	-	17	9
Vaccines	84	3,207	1,645
Injection supplies	8	202	105
Other supplies	2	9.00	5
Transport & fuel	39	200	120
Vehicle maintenance	-	12	6
Cold chain energy costs	16	111	64
Printing	-	-	-
Building overheads	53	447	250
Other recurrent	11	226	119
Subtotal recurrent	991	26,146	13,568
Cold chain equipment	72	101	86
Vehicles	-	191	95
Other capital	69	385	227
Buildings	157	1,533	845
Subtotal capital	298	2,209	1,254
Total Facility Immunization Cost	**1,289**	**28,355**	**14,822**
Total Delivery Cost	**1,197**	**24,946**	**13,072**
Total Child Doses	53	2,478	1,266
Total DTP3 Vaccinated Children	4	154	79
Infant population	4	166	85
Total population	540	14,696	7,618
Cost per Dose	24	11	18
Cost per DTP3 Vaccinated child	322	184	253
Cost per child	322	171	246
Cost per capita	2	2	2
Delivery cost per dose	23	10	16
Delivery cost per DTP3 vaccinated child	299	162	231
Delivery cost per child	299	150	225
Delivery cost per capita	2	2	2

Table 92: Total Routine Facility Immunization Economic and Unit Costs by Line Item (USD) (Facilities in Vulkanesti district)

Line Items	**N 180**	**N 215**	**Weighted Average**
Salaried Labor	60.4%	76.6%	68.5%
Per Diems	0.0%	0.1%	0.0%
Vaccines	6.5%	11.3%	8.9%
Injection supplies	0.6%	0.7%	0.7%
Other supplies	0.1%	0.0%	0.1%
Transport & fuel	3.0%	0.7%	1.9%
Vehicle maintenance	0.0%	0.0%	0.0%
Cold chain energy costs	1.3%	0.4%	0.8%
Printing	0.0%	0.0%	0.0%
Building overheads	4.1%	1.6%	2.8%
Other recurrent	0.9%	0.8%	0.8%
Subtotal recurrent	76.9%	92.2%	84.5%
Cold chain equipment	5.6%	0.4%	3.0%
Vehicles	0.0%	0.7%	0.3%
Other capital	5.4%	1.4%	3.4%
Buildings	12.2%	5.4%	8.8%
Subtotal capital	23.1%	7.8%	15.5%
Total Facility Immunization Cost	**100%**	**100%**	**100%**

Table 93: Total Routine Facility Immunization Economic Costs by Activity (USD) (Facilities in Chisinau district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
69	5,901	4,417	572	1,425	-	389	389	1,560	690	51	**15,394**
73	4,743	677	972	456	-	225	342	1,760	448	297	**9,919**
187	49,168	17,000	1,099	15,990	182	861	1,030	23,992	3,130	97	**112,548**
195	23,350	9,099	1,500	3,153	50	617	882	11,979	2,634	-	**53,263**
203	38,707	14,814	1,044	12,722	186	776	1,384	17,771	3,249	108	**90,761**
Weighted Average	**24,374**	**9,201**	**1,037**	**6,749**	**83**	**574**	**805**	**11,412**	**2,030**	**111**	**56,377**

Table 94: Total Routine Facility Immunization Economic Costs (Percent of Total Distribution) (Facilities in Chisinau district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
69	38.3%	28.7%	3.7%	9.3%	0.0%	2.5%	2.5%	10.1%	4.5%	0.3%	**100%**
73	47.8%	6.8%	9.8%	4.6%	0.0%	2.3%	3.5%	17.7%	4.5%	3.0%	**100%**
187	43.7%	15.1%	1.0%	14.2%	0.2%	0.8%	0.9%	21.3%	2.8%	0.1%	**100%**
195	43.8%	17.1%	2.8%	5.9%	0.1%	1.2%	1.7%	22.5%	4.9%	0.0%	**100%**
203	42.6%	16.3%	1.2%	14%	0.2%	0.9%	1.5%	19.6%	3.6%	0.1%	**100%**
Weighted Average	**43.3%**	**16.8%**	**3.7%**	**9.6%**	**0.1%**	**1.5%**	**2.0%**	**18.3%**	**4.1%**	**0.7%**	**100%**

Table 95: Total Routine Facility Immunization Economic Costs by Activity (USD) (Facilities in Briceni district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
5	2,995	1,059	68	1,177	-	246	234	1,749	327	-	**7,856**
9	1,537	345	31	349	-	107	95	506	81	-	**3,051**
13	1,479	416	32	468	-	67	293	677	111	-	**3,541**
17	2,203	456	45	655	-	163	246	914	180	-	**4,862**
22	1,007	196	12	237	-	39	112	331	65	-	**1,998**
26	615	105	11	83	-	38	106	168	60	-	**1,186**
30	4,122	1,080	112	1,330	-	146	651	1,930	404	-	**9,775**
182	4,895	1,948	704	1,923	103	253	487	2,857	595	-	**13,766**
Weighted Average	**2,357**	**701**	**127**	**778**	**13**	**132**	**278**	**1,142**	**228**	**-**	**5,754**

Table 96: Total Routine Facility Immunization Economic Costs (Percent of Total Distribution) (Facilities in Briceni district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
5	38.1%	13.5%	0.9%	15.0%	0.0%	3.1%	3.0%	22.3%	4.2%	0.0%	**100%**
9	50.4%	11.3%	1.0%	11.5%	0.0%	3.5%	3.1%	16.6%	2.6%	0.0%	**100%**
13	41.8%	11.8%	0.9%	13.2%	0.0%	1.9%	8.3%	19.1%	3.1%	0.0%	**100%**
17	45.3%	9.4%	0.9%	13.5%	0.0%	3.4%	5.1%	18.8%	3.7%	0.0%	**100%**
22	50.4%	9.8%	0.6%	11.9%	0.0%	1.9%	5.6%	16.6%	3.3%	0.0%	**100%**
26	51.9%	8.9%	0.9%	7.0%	0.0%	3.2%	8.9%	14.2%	5.0%	0.0%	**100%**
30	42.2%	11.0%	1.1%	13.6%	0.0%	1.5%	6.7%	19.7%	4.1%	0.0%	**100%**
182	35.6%	14.2%	5.1%	14.0%	0.7%	1.8%	3.5%	20.8%	4.3%	0.0%	**100%**
Weighted Average	**44.4%**	**11.2%**	**1.4%**	**12.4%**	**0.1%**	**2.5%**	**5.5%**	**18.5%**	**3.8%**	**0.0%**	**100%**

Table 97: Total Routine Facility Immunization Economic Costs by Activity (USD) (Facilities in Calarasi district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
35	934	163	-	186	-	46	267	194	37	-	**1,828**
39	2,363	131	32	59	-	59	72	249	63	-	**3,029**
43	1,729	300	7	185	-	156	530	438	175	-	**3,520**
48	892	182	3	129	-	97	162	312	40	-	**1,817**
52	2,559	914	84	858	-	251	562	1,144	203	-	**6,574**
56	6,782	2,500	381	2,229	-	222	902	3,500	635	57	**17,207**
60	3,000	871	239	517	-	49	58	513	171	110	**5,529**
65	2,378	829	73	825	-	86	183	623	210	4	**5,211**
184	17,858	6,567	1,905	5,542	-	444	691	8,691	2,197	196	**44,090**
Weighted Average	**4,277**	**1,384**	**303**	**1,170**	**-**	**157**	**381**	**1,740**	**415**	**41**	**9,867**

Table 98: Total Routine Facility Immunization Economic Costs (Percent of Total Distribution) (Facilities in Calarasi district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
35	51.1%	8.9%	0.0%	10.2%	0.0%	2.5%	14.6%	10.6%	2.0%	0.0%	**100%**
39	78.0%	4.3%	1.1%	2.0%	0.0%	2.0%	2.4%	8.2%	2.1%	0.0%	**100%**
43	49.1%	8.5%	0.2%	5.2%	0.0%	4.4%	15.1%	12.4%	5.0%	0.0%	**100%**
48	49.1%	10.0%	0.2%	7.1%	0.0%	5.4%	8.9%	17.2%	2.2%	0.0%	**100%**
52	38.9%	13.9%	1.3%	13.0%	0.0%	3.8%	8.5%	17.4%	3.1%	0.0%	**100%**
56	39.4%	14.5%	2.2%	13.0%	0.0%	1.3%	5.2%	20.3%	3.7%	0.3%	**100%**
60	54.3%	15.8%	4.3%	9.3%	0.0%	0.9%	1.1%	9.3%	3.1%	2.0%	**100%**
65	45.6%	15.9%	1.4%	15.8%	0.0%	1.7%	3.5%	12.0%	4.0%	0.1%	**100%**
184	40.5%	14.9%	4.3%	12.6%	0.0%	1.0%	1.6%	19.7%	5.0%	0.4%	**100%**
Weighted Average	**49.6%**	**11.9%**	**1.7%**	**9.8%**	**0.0%**	**2.6%**	**6.8%**	**14.1%**	**3.3%**	**0.3%**	**100%**

Table 99: Total Routine Facility Immunization Economic Costs by Activity (USD) (Facilities in Ungheni district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
112	1,802	209	11	279	-	50	64	383	125	-	**2,924**
116	1,972	710	44	291	-	90	221	442	128	-	**3,898**
121	419	42	-	-	-	23	36	24	73	-	**616**
125	754	296	127	63	-	77	80	243	70	-	**1,709**
130	695	130	-	87	-	29	51	90	34	-	**1,116**
134	454	93	3	73	-	19	29	70	21	-	**762**
138	619	95	-	92	-	23	53	49	30	-	**962**
143	5,872	615	42	772	-	143	167	1,194	330	44	**9,180**
147	535	80	-	37	-	18	81	57	22	-	**831**
151	1,415	210	15	477	-	37	49	395	110	24	**2,732**
155	1,692	234	9	332	-	61	106	408	142	-	**2,984**
162	5,818	860	110	1,154	-	110	369	1,389	386	46	**10,242**
164	442	32	-	14	-	7	38	22	9	-	**565**
168	1,145	78	-	72	-	24	40	74	27	-	**1,460**
173	4,751	2,002	621	1,672	-	68	248	1,808	491	52	**11,712**
174	5,636	860	118	1,537	-	77	101	1,380	80	46	**9,834**
176	2,373	424	54	731	-	68	94	629	130	-	**4,502**
213	21,050	4,721	1,624	3,373	20	119	437	5,687	1,571	154	**38,756**
Weighted Average	**3,191**	**649**	**154**	**614**	**1**	**58**	**126**	**797**	**210**	**20**	**5,821**

Table 100: Total Routine Facility Immunization Economic Costs (Percent of Total Distribution) (Facilities in Ungheni district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
112	61.6%	7.2%	0.4%	9.6%	0.0%	1.7%	2.2%	13.1%	4.3%	0.0%	**100%**
116	50.6%	18.2%	1.1%	7.5%	0.0%	2.3%	5.7%	11.3%	3.3%	0.0%	**100%**
121	67.9%	6.8%	0.0%	0.0%	0.0%	3.7%	5.8%	3.9%	11.8%	0.0%	**100%**
125	44.1%	17.3%	7.4%	3.7%	0.0%	4.5%	4.7%	14.2%	4.1%	0.0%	**100%**
130	62.2%	11.6%	0.0%	7.8%	0.0%	2.6%	4.6%	8.1%	3.1%	0.0%	**100%**
134	59.6%	12.2%	0.4%	9.6%	0.0%	2.5%	3.8%	9.2%	2.8%	0.0%	**100%**
138	64.4%	9.9%	0.0%	9.6%	0.0%	2.4%	5.5%	5.1%	3.1%	0.0%	**100%**
143	64.0%	6.7%	0.5%	8.4%	0.0%	1.6%	1.8%	13.0%	3.6%	0.5%	**100%**
147	64.4%	9.6%	0.0%	4.4%	0.0%	2.2%	9.8%	6.9%	2.7%	0.0%	**100%**
151	51.8%	7.7%	0.6%	17.5%	0.0%	1.4%	1.8%	14.5%	4.0%	0.9%	**100%**
155	56.7%	7.8%	0.3%	11.1%	0.0%	2.1%	3.5%	13.7%	4.8%	0.0%	**100%**
162	56.8%	8.4%	1.1%	11.3%	0.0%	1.1%	3.6%	13.6%	3.8%	0.4%	**100%**
164	78.3%	5.7%	0.0%	2.5%	0.0%	1.3%	6.7%	4.0%	1.6%	0.0%	**100%**
168	78.4%	5.3%	0.0%	4.9%	0.0%	1.6%	2.7%	5.1%	1.8%	0.0%	**100%**
173	40.6%	17.1%	5.3%	14.3%	0.0%	0.6%	2.1%	15.4%	4.2%	0.4%	**100%**
174	57.3%	8.7%	1.2%	15.6%	0.0%	0.8%	1.0%	14.0%	0.8%	0.5%	**100%**
176	52.7%	9.4%	1.2%	16.2%	0.0%	1.5%	2.1%	14.0%	2.9%	0.0%	**100%**
213	54.3%	12.2%	4.2%	8.7%	0.1%	0.3%	1.1%	14.7%	4.1%	0.4%	**100%**
Weighted Average	**59.2%**	**10.1%**	**1.3%**	**9.0%**	**0.0%**	**1.9%**	**3.8%**	**10.8%**	**3.7%**	**0.2%**	**100%**

Table 101: Total Routine Facility Immunization Economic Costs by Activity (USD) (Facilities in Leova district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
78	1,936	450	50	457	30	121	381	601	103	59	**4,190**
82	529	62	3	39	-	30	40	88	15	-	**806**
86	2,670	458	19	518	-	116	223	635	139	45	**4,823**
95	1,328	304	10	458	-	189	112	504	116	-	**3,020**
96	1,290	222	14	319	-	117	116	366	68	-	**2,511**
99	1,830	373	19	561	-	107	122	600	135	-	**3,747**
103	1,478	338	14	321	-	124	69	456	142	-	**2,944**
212	9,811	3,310	303	3,093	-	742	1,084	4,614	926	55	**23,939**
Weighted Average	**2,609**	**690**	**54**	**721**	**4**	**193**	**268**	**983**	**206**	**20**	**5,748**

Table 102: Total Routine Facility Immunization Economic Costs (Percent of Total Distribution) (Facilities in Leova district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
78	46.2%	10.7%	1.2%	10.9%	0.7%	2.9%	9.1%	14.4%	2.5%	1.4%	**100%**
82	65.7%	7.7%	0.4%	4.9%	0.0%	3.8%	5.0%	10.9%	1.8%	0.0%	**100%**
86	55.4%	9.5%	0.4%	10.7%	0.0%	2.4%	4.6%	13.2%	2.9%	0.9%	**100%**
95	44.0%	10.1%	0.3%	15.2%	0.0%	6.3%	3.7%	16.7%	3.8%	0.0%	**100%**
96	51.3%	8.8%	0.6%	12.7%	0.0%	4.7%	4.6%	14.6%	2.7%	0.0%	**100%**
99	48.8%	10.0%	0.5%	15.0%	0.0%	2.8%	3.2%	16.0%	3.6%	0.0%	**100%**
103	50.2%	11.5%	0.5%	10.9%	0.0%	4.2%	2.4%	15.5%	4.8%	0.0%	**100%**
212	41.0%	13.8%	1.3%	12.9%	0.0%	3.1%	4.5%	19.3%	3.9%	0.2%	**100%**
Weighted Average	**50.3%**	**10.3%**	**0.6%**	**11.6%**	**0.1%**	**3.8%**	**4.6%**	**15.1%**	**3.3%**	**0.3%**	**100%**

Table 103: Total Routine Facility Immunization Economic Costs by Activity (USD) (Facilities in Vulkanesti district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
180	710	170	2	88	-	48	70	157	44	-	**1,289**
215	12,654	4,019	1,699	3,731	-	121	187	4,599	1,304	40	**28,355**
Weighted Average	**6,682**	**2,095**	**851**	**1,909**	**-**	**84**	**129**	**2,378**	**674**	**20**	**14,822**

Table 104: Total Routine Facility Immunization Economic Costs (Percent of Total Distribution) (Facilities in Vulkanesti district)

Facility ID	Routine Facility Based Service Delivery	Record Keeping & HMIS	Supervision	Social Mobilization	Surveillance	Cold Chain Maintenance	Vaccine Collect & Dist	Program Mgmt	Training	Other	Total
180	55.1%	13.2%	0.2%	6.8%	0.0%	3.7%	5.5%	12.2%	3.4%	0.0%	**100%**
215	44.6%	14.2%	6.0%	13.2%	0.0%	0.4%	0.7%	16.2%	4.6%	0.1%	**100%**
Weighted Average	**49.9%**	**13.7%**	**3.1%**	**10.0%**	**0.0%**	**2.1%**	**3.1%**	**14.2%**	**4.0%**	**0.1%**	**100%**

Table 105: Total Routine Immunization District and National Level Economic Costs by Activity ($2011)

Line Items	Chisinau	Briceni	Calarasi	Ungheni	Leova	Vulcanesti	Weighted Average District	National Level EPI Administration
Routine Facility-Based Service Delivery	224,683	17,819	21,825	36,282	15,714	7,445	27,579	1,111,829
Record-Keeping/HMIS	12,304	1,393	1,980	1,938	859	835	1,776	4,063
Supervision	3,624	1,216	747	1,717	2,268	443	1,393	6,003
Social mobilization	-	-	131	145	-	184	96	4,718
Cold chain maintenance	1,118	1,585	654	1,537	111	521	983	3,505
Vaccine collection and distribution	1,164	2,792	1,312	5,177	2,658	1,433	2,955	3,035
Program management	11,930	3,066	2,505	7,259	2,259	1,702	4,102	34,332
Training	4,131	438	457	613	175	434	550	3,108
Surveillance	7,521	993	735	1,723	1,485	2,059	1,594	15,710
Other	128	78	502	80	149	117	172	56,892
Total Immunization Economic Cost	**266,604**	**29,381**	**30,849**	**56,471**	**25,677**	**15,172**	**41,199**	**1,243,194**

Table 106: Total Routine Immunization District and National Health Office Financial Costs by Line Item ($2011)

Line Items	Chisinau	Briceni	Calarasi	Ungheni	Leova	Vulcanesti	Weighted Average District N= 37	National Level EPI Administration
Salaried Labor	30,337	5,926	5,717	10,870	6,909	5,353	8,085	21,449
Per Diems	-	269	10	61	41	-	74	1,372
Vaccines	209,944	16,089	19,635	33,236	14,658	6,421	25,249	1,042,281
Injection supplies	11,753	948	1,485	1,746	770	392	1,453	58,851
Other supplies	235	43	52	237	20	12	99	2,951
Transport & fuel	290	893	120	463	269	434	437	212
Vehicle maintenance	79	1,175	849	439	695	396	665	1,894
Cold chain energy costs	1,416	437	414	509	83	356	410	3,270
Printing	368	130	68	-	115	24	67	6,052
Building overheads	2,469	1,076	402	2,638	252	143	1,175	16,892
Other recurrent	125	84	-	-	-	-	18	58,582
Subtotal recurrent	**257,015**	**27,069**	**28,752**	**50,200**	**23,811**	**13,530**	**37,732**	**1,213,805**
Cold chain equipment	1,338	363	298	726	198	256	442	4,725
Vehicles	48	252	200	306	250	115	231	2,298
Other capital	1,541	503	391	695	326	402	523	2,127
Buildings	3,570	586	618	2,237	557	434	1,134	10,666
Subtotal capital	**6,496**	**1,704**	**1,506**	**3,963**	**1,331**	**1,207**	**2,330**	**19,815**
Total Immunization Financial Cost	**263,511**	**28,774**	**30,258**	**54,164**	**25,142**	**14,737**	**40,062**	**1,233,620**

Table 107: Total Routine Immunization District and National Level Financial Costs by Activity ($2011)

Line Items	Chisinau	Briceni	Calarasi	Ungheni	Leova	Vulcanesti	Weighted Average District	National Level EPI Administration
Routine Facility-Based Service Delivery	224,369	17,749	21,766	36,148	15,672	7,389	27,492	1,123,473
Record-Keeping/HMIS	12,252	1,384	1,969	1,928	856	829	1,767	4,029
Supervision	3,488	1,063	723	1,391	2,235	421	1,252	5,562
Social mobilization	-	-	131	145	-	184	96	4,718
Cold chain maintenance	1,118	1,585	654	1,537	111	521	983	3,505
Vaccine collection and distribution	1,135	2,744	1,282	4,959	2,617	1,411	2,865	2,921
Program management	9,730	2,647	2,070	5,664	1,891	1,459	3,319	27,874
Training	4,131	438	455	611	175	434	549	3,108
Surveillance	7,024	939	689	1,568	1,409	1,951	1,487	14,201
Other	265	223	519	212	176	137	251	56,892
Total Immunization Financial Cost	**263,511**	**28,774**	**30,258**	**54,164**	**25,142**	**14,737**	**40,062**	**1,233,620**

Annex 3: Cost Matrix of Routine Immunization

Table 108: Matrix of facility level economic costs of routine immunization (USD)

Line Item/ Activity	Routine Facility-based Service Delivery	Record-Keeping & HMIS	Super-vision	Training	Social Mobilization & Advocacy	Surveillance	Cold Chain Maintenance	Vaccine Collection, Distribution Storage	Program Management	Other	TOTAL
Salaried Labour	1,924,379	1,102,743	182,308	286,448	1,079,058	4,188	146,817	186,047	1,519,124	23,349	**6,454,459**
Per Diem & Travel Allowances				10,189							**10,189**
Vaccines	988,318										**988,318**
Vaccine Injection & Safety Supplies	70,373										**70,373**
Other Supplies	5,896	3,039		860		13			4,253		**14,061**
Transport/ Fuel	3,791		472	7,815		299		42,697	12,654		**67,728**
Vehicle Maintenance			387	476		140		5,717	1,278		**7,998**
Cold Chain Energy Costs	29,478										**29,478**
Printing		50,310									**50,310**
Building overhead, Utilities, Communication	416,069					263					**416,333**
Other Recurrent				27,561			356			692	**28,609**
Cold Chain Equipment	83,937							7,546			**91,483**
Vehicles			1,941	748		351		48,287	13,720		**65,047**
Other Equipment	158,735	32,550				92					**191,377**
Buildings	691,608					550					**692,158**
TOTAL	**4,372,584**	**1,188,642**	**185,108**	**334,097**	**1,079,058**	**5,633**	**147,173**	**290,294**	**1,551,292**	**24,041**	**9,177,922**

Table 109: Matrix of district level economic costs of routine immunization (USD)

Line Item/ Activity	Routine Facility-based Service Delivery	Record-Keeping & HMIS	Super-vision	Training	Social Mobilization & Advocacy	Surveillance	Cold Chain Maintenance	Vaccine Collection, Distribution Storage	Program Management	Other	TOTAL
Salaried Labour	1,924,379	1,160,210	222,526	297,452	1,082,491	45,592	183,197	262,349	1,545,696	29,724	**6,753,616**
Per Diem & Travel Allowances				12,426				443	53		**12,923**
Vaccines	988,318										**988,318**
Vaccine Injection & Safety Supplies	70,373										**70,373**
Other Supplies	5,896	4,793		1,110		1,037			4,887		**17,724**
Transport/ Fuel	3,791		3,402	10,356	65	435		51,141	14,718		**83,907**
Vehicle Maintenance			4,483	3,700		150		19,455	4,825		**32,614**
Cold Chain Energy Costs	44,647										**44,647**
Printing		52,739			55						**52,794**
Building overhead, Utilities, Communication	416,069					4,932			38,793		**459,794**
Other Recurrent				28,231			356			692	**29,279**
Cold Chain Equipment	101,224							10,205			**111,429**
Vehicles			6,229	1,168		355		56,030	15,863		**79,645**
Other Equipment	158,735	36,602				3,009			14,168		**212,514**
Buildings	691,608					9,355			63,785		**764,748**
TOTAL	**4,405,040**	**1,254,344**	**236,640**	**354,444**	**1,082,611**	**64,865**	**183,553**	**399,623**	**1,702,788**	**30,417**	**9,714,325**

Table 110: Matrix of national level economic costs of routine immunization (USD)

Line Item/ Activity	Routine Facility-based Service Delivery	Record-Keeping & HMIS	Super-vision	Training	Social Mobilization & Advocacy	Surveillance	Cold Chain Maintenance	Vaccine Collection, Distribution Storage	Program Management	Other	TOTAL
Salaried Labour	1,924,379	1,163,618	224,258	299,131	1,083,283	49,637	186,701	264,420	1,549,686	29,952	**6,775,065**
Per Diem & Travel Allowances				13,798				443	53		**14,295**
Vaccines	988,318										**988,318**
Vaccine Injection & Safety Supplies	70,373										**70,373**
Other Supplies	5,896	4,910		1,168		1,176			5,024	2,500	**20,675**
Transport/ Fuel	3,791		3,586	10,356	65	435		51,169	14,718		**84,119**
Vehicle Maintenance			6,130	3,700		150		19,702	4,825		**34,508**
Cold Chain Energy Costs	47,917										**47,917**
Printing	1,960	52,905			3,981						**52,846**
Building overhead, Utilities, Communication	416,070					8,118			52,499		**476,687**
Other Recurrent				28,231		4,418	356			54,856	**87,861**
Cold Chain Equipment	106,692							10,529			**117,221**
Vehicles			8,668	1,168		355		56,396	15,863		**82,449**
Other Equipment	158,735	36,973				3,450			15,692		**214,850**
Buildings	691,608					12,836			78,760		**783,205**
TOTAL	**4,415,738**	**1,258,407**	**242,643**	**357,552**	**1,087,329**	**80,575**	**187,057**	**402,658**	**1,737,121**	**87,309**	**9,856,389**

Annex 4: Cost Matrix for Incremental NUVI costs

Table 111: Matrix of a facility level incremental Economic Costs for NUVI (US $)

Line Item/ Activity	Routine Facility-based Service Delivery	Record-Keeping & HMIS	Super-vision	Training	Social Mobilization & Advocacy	Surveillance	Cold Chain Maintenance	Vaccine Collection, Distribution Storage	Program Management	Other	TOTAL
Salaried Labour				32,335	18,992						**51,327**
Per Diem & Travel Allowances											
Vaccines	254,867										**254,867**
Transport/ Fuel				4,321					1,788		**6,109**
Cold Chain Equipment	14,978							1,570			**16,548**
TOTAL	**269,845**			**36,656**	**18,992**			**1,570**	**1,788**		**328,851**

Table 112: Matrix of a district level incremental Economic Costs for NUVI (US $)

Line Item/ Activity	Routine Facility-based Service Delivery	Record-Keeping & HMIS	Super-vision	Training	Social Mobilization & Advocacy	Surveillance	Cold Chain Maintenance	Vaccine Collection, Distribution Storage	Program Management	Other	TOTAL
Salaried Labour				33,100	18,992				875		**52,966**
Per Diem & Travel Allowances				221							**221**
Vaccines	254,867										**254,867**
Transport/ Fuel				5,688	129			641	1,788		**8,247**
Vehicle Maintenance											
Cold Chain Equipment	18,957							2,177			**21,134**
TOTAL	**273,824**			**39,008**	**19,121**			**2,819**	**2,663**		**337,435**

Table 113: Matrix of a National level incremental Economic Costs for NUVI (US $)

Line Item/ Activity	Routine Facility-based Service Delivery	Record-Keeping & HMIS	Super-vision	Training	Social Mobilization & Advocacy	Surveillance	Cold Chain Maintenance	Vaccine Collection, Distribution Storage	Program Management	Other	TOTAL
Salaried Labour			2,465	33,230	18,992				10,764		**65,451**
Per Diem & Travel Allowances			846	1,279							**2,126**
Vaccines	254,867										**254,867**
Transport/ Fuel			2,624	5,692	129			660	1,788		**10,893**
Printing	12,511			2,828							**15,339**
Building overhead, Utilities, Communication									29,771		**29,771**
Other Recurrent				2,602	18,842	16,785	5,840		9,964		**54,033**
Cold Chain Equipment	20,269							2,255			**22,524**
Other Equipment									22,641		**22,641**
TOTAL	**287,647**		**5,935**	**45,631**	**37,964**	**16,785**	**5,840**	**2,915**	**74,928**		**477,645**

Annex 5:

Table 114: Sample definition

Center Characteristics A	B	No. of Facilities C	Sample D	Ratio E=C:D
Low Doses Administered	Rural	257	8	32.5
	Semi-Urban	15	2	7.5
Medium Doses Administered	Rural	464	15	30.9
	Semi-Urban	17	2	8.5
High Doses Administered	Rural	508	17	29.9
	Semi-Urban	22	1	22
Capital City	Rural	9	2	4.5
	Semi-Urban	26	3	8.7

Table 115: Summary statistics; weighted sample

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Fully Immunized Children (FIC)	50	33,82	88,77	1	714
Total number of doses administered	50	516,61	1245,69	33	9060
Total Economic Cost, Facility Level	50	6963	13682	565	112548
Total Economic Cost, Facility + District Level	50	7341,4	14207,3	627,7	115062
Total Economic Cost, Facility + District + National Level	50	7434,6	14419,6	641,2	116657
Share of staff time spent in the facility for immunization in % (FTE)	50	0,82	1,28	0,2	10,20
Total working hours	50	50,43	12,67	8	71
Total facility square meters	50	349,22	898,37	20	5820
Cold chain capital index (% of the cold chain cost from the total cost)	50	69,45	19,64	7,79	136,14
Hourly wage, mid career nurse (USD)	50	1,82	0,16	1,45	2,28
Refrigerator unit price (USD)	50	0,74	0,34	0,01	2,13
Total number of infants in the facility catchment area	50	36,07	97,66	1	810
Share of population with university education in %	50	4,96	3,40	2,90	24,40
Dummy Facility Type (=1 if FMC)	50	0,04	0,20	0	1
Dummy Doctor at the facility (=1 Yes)	50	0,86	0,35	0	1
Dummy Facility Location (=1 if Urban)	50	0,02	0,14	0	1
Distance from the facility to the vaccine collection point	50	20,64	13,35	0	50
Overall Wastage Rate in % (from total number of doses administered)	50	17,45	9,41	4,90	36,90

Note: each observation represents 1317.97 facilities.

Table 116: Production Determinants - in natural logarithms

	Ln FIC		Ln Total Dose Adm.	
VARIABLES	(1)	(2)	(3)	(4)
Ln Total working hours	0.265***	0.265**	0.296**	0.296**
	(0.0520)	(0.110)	(0.133)	(0.124)
Ln Total facility square meters	0.0564**	0.0564**	0.211***	0.211***
	(0.0273)	(0.0251)	(0.0700)	(0.0568)
Ln Total number of infants in the facility catchment area	0.909***	0.909***	0.619***	0.619***
	(0.0280)	(0.0319)	(0.0718)	(0.0596)
Dummy Facility Type (=1 if FMC)	-0.0514	-0.0514	0.206	0.206
	(0.129)	(0.0800)	(0.330)	(0.265)
Dummy Doctor at the facility (=1 Yes)	0.0681	0.0681	0.269*	0.269
	(0.0542)	(0.0785)	(0.139)	(0.194)
Ln Distance from the facility to the vaccine collection point	-0.0351	-0.0351*	-0.0663	-0.0663
	(0.0250)	(0.0185)	(0.0642)	(0.0507)
Ln Overal Wastage Rate	-0.117***	-0.117**	-0.383***	-0.383***
	(0.0373)	(0.0481)	(0.0958)	(0.118)
Constant	-0.767***	-0.767**	2.563***	2.563***
	(0.242)	(0.352)	(0.620)	(0.767)
R-squared	0.992	0.992	0.939	0.939

Notes: (1) Standard errors in parentheses. Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. Ho: Constant variance. Chi2(1) = 2.24, Prob > chi2 = 0.1347. (2) Robust standard errors in parentheses. (3) Standard errors in parentheses. Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. Ho: Constant variance. Chi2(1) = 6.93, Prob > chi2 = 0.0085. (4) Robust standard errors in parentheses.
Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Figure 19: Histogram of FIC

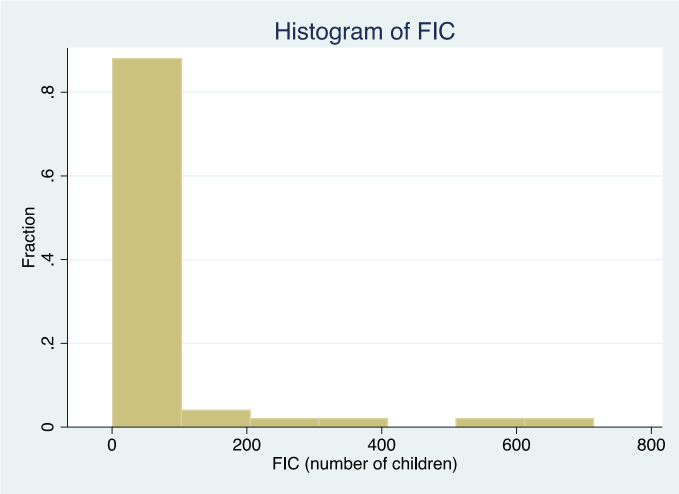


Figure 20: Histogram of total doses administered

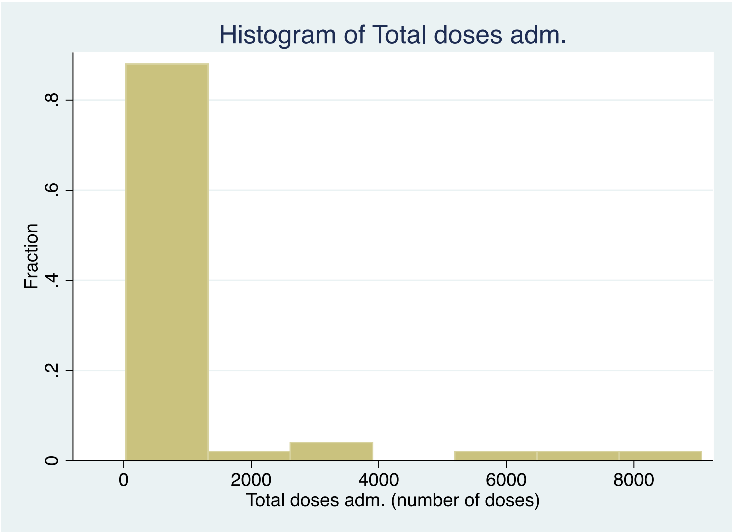


Table 117: Immunization working hours per week, by type of Human Resources

Position	Obs.	Mean
Director	13	6,18
Family doctor	144	6,94
Chief Nurse	18	10,22
Nurse vaccination	20	24,62
General Nurse	214	8,44

Table 118: Input Prices: Labour; Positions and hourly wage (USD); Summary statistics and coefficient of variation (CV).

Position	Obs.	Mean	SD	Min.	Max.	CV
Chief Nurse	18	2,48	0,43	1,63	3,19	0,17
Nurse vaccination	20	1,94	0,35	1,39	2,64	0,18
Nurse	214	1,91	0,49	0,54	4,72	0,26

Young	22	1,08	0,2	0,54	1,31	0,19
Mid-career	153	1,85	0,22	1,4	2,29	0,12
Experienced	39	2,63	0,42	2,31	4,72	0,16

Table 119: Input Prices: Capital; Type of equipment in the facility and unit prices corrected by volume; Summary statistics and coefficient of variation (CV).

Type	Obs.	Mean	SD	Min.	Max.	CV
Freeze Indicators	22	2,9	0,02	2,8	2,95	0,01
Ice Packs	50	0,06	0,01	0,05	0,1	0,17
Thermometers	48	3,04	0,53	2,9	5,5	0,17
Cold box	58	0,7	0,33	0,21	1,12	0,47
Refrigerator	52	0,68	0,41	0,01	2,12	0,60

Table 120: Total Economic Cost, Facility Level (Unweighted Sample)

	Dep. Var.: Ln Total Economic Cost, Facility Level			
VARIABLES	(1)	(2)	(3)	(4)
Ln Fully Immunized Children (FIC)	0.810***		0.625***	
	(0.0449)		(0.0664)	
Ln FIC Est.		0.806***		0.525***
		(0.103)		(0.124)
Ln Hourly wage, mid career nurse	0.685	1.252*	0.706	1.178*
	(1.028)	(0.733)	(0.980)	(0.671)
Ln Refrigerator unit price	-0.0993	0.126	-0.0857	0.0961
	(0.166)	(0.195)	(0.125)	(0.165)
Ln Ice pack unit price	-1.268	-0.800	-1.633*	-1.275
	(1.185)	(1.536)	(0.893)	(1.380)
Ln Share of population with university education			0.572***	0.800***
			(0.144)	(0.197)
Ln Overal Wastage Rate			-0.0221	-0.173
			(0.158)	(0.212)
Constant	2.026	3.269	0.646	1.881
	(3.420)	(4.234)	(2.667)	(3.996)
R-squared	0.890	0.813	0.918	0.863

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 121: Total Economic Cost without Wages, Facility Level

	Dep. Var.: Ln Total Economic Cost Without Wages, Facility Level					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln Fully Immunized Children (FIC)	0.629***		0.629***		0.480***	
	(0.0594)		(0.0586)		(0.0578)	
Ln FIC Est.		0.703***		0.705***		0.564***
		(0.0631)		(0.0650)		(0.0805)
Ln Hourly wage, mid career nurse	0.165	0.441	0.136	0.497	0.219	0.489
	(0.827)	(0.462)	(0.858)	(0.487)	(0.763)	(0.441)
Ln Refrigerator unit price	0.0423	0.154***	0.0145	0.207**	0.0366	0.189**
	(0.0560)	(0.0226)	(0.111)	(0.0904)	(0.0742)	(0.0880)
Ln Ice pack unit price			-0.230	0.439	-0.634	0.0116
			(0.932)	(0.769)	(0.633)	(0.700)
Ln Share of pop. with university education					0.692***	0.515***
					(0.124)	(0.153)
Ln Overal Wastage Rate					-0.0557	-0.0450
					(0.103)	(0.113)
Constant	5.339***	5.113***	4.698*	6.329***	3.043	4.841**
	(0.549)	(0.347)	(2.600)	(2.064)	(1.824)	(2.049)
R-squared	0.847	0.855	0.847	0.857	0.912	0.885

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 122: Total Economic Cost without Wages, Facility + District + National Level

	Dep. Var.: Ln Total Economic Cost Without Wages			
	Facility + District Level		Facility + District + National Level	
VARIABLES	(1)	(2)	(3)	(4)
Ln Fully Immunized Children (FIC)	0.658***	0.518***	0.665***	0.526***
	(0.0560)	(0.0605)	(0.0559)	(0.0610)
Ln Hourly wage, mid career nurse	0.0641	0.154	0.0682	0.159
	(0.797)	(0.725)	(0.786)	(0.715)
Ln Refrigerator unit price	0.0338	0.0645	0.0339	0.0653
	(0.0997)	(0.0694)	(0.0990)	(0.0694)
Ln Ice pack unit price	-0.189	-0.473	-0.198	-0.473
	(0.875)	(0.622)	(0.872)	(0.624)
Ln Share of population with university education		0.622***		0.617***
		(0.123)		(0.123)

Ln Overal Wastage Rate		-0.0925		-0.0956
		(0.113)		(0.114)
Constant	4.956**	3.814**	4.940**	3.840**
	(2.418)	(1.808)	(2.407)	(1.814)
R-squared	0.876	0.924	0.880	0.926

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05,
* p<0.1.

Table 123: Correlation Matrix I

Correlation Matrix I

	lnFic	lnTotDosesAdm	workinghours	sqmeter	costo_ch	infants	Dfacilitytype	Ddoctor	distance	wastage
lnFic	1									
lnTotDosesAdm	0,97	1								
workinghours	0,51	0,49	1							
sqmeter	0,72	0,74	0,31	1						
costo_ch	0,62	0,65	0,24	0,62	1					
infants	0,76	0,76	0,32	0,76	0,72	1				
Dfacilitytype	0,67	0,68	0,27	0,87	0,63	0,81	1			
Ddoctor	0,31	0,34	0,15	0,16	0,08	0,15	0,12	1		
distance	-0,35	-0,39	-0,28	-0,41	-0,35	-0,32	-0,39	-0,23	1	
wastage	-0,32	-0,38	-0,03	-0,1	-0,02	-0,1	-0,12	-0,01	0,09	1

Table 124: Correlation Matrix II

Correlation Matrix II

	lnb1totalcost	lnb2totalcost	lnb3totalcost	lnFic	lnFicHat	lnWageHour	lnPriceRefrig	lnPriceIcePack	lnFte	lnSqMetx10k	lnUnivEduc	DFacilityType	LnDistance	lnWastage	Ddoctor	Durban
lnb1totalcost	1															
lnb2totalcost	1	1														
lnb3totalcost	1	1	1													
lnFic	0,94	0,94	0,94	1												
lnFicHat	0,89	0,89	0,89	0,9	1											
lnWageHour	0,11	0,1	0,1	0,06	-0,01	1										
lnPriceRefrig	0,3	0,31	0,31	0,26	0,11	0,21	1									
lnPriceIcePack	-0,25	-0,25	-0,25	-0,19	-0,1	-0,24	-0,86	1								
lnFte	0,98	0,98	0,98	0,89	0,83	0,13	0,36	-0,33	1							
lnSqMetx10k	-0,29	-0,29	-0,29	-0,43	-0,35	0,06	0,22	-0,2	-0,22	1						
lnUnivEduc	0,8	0,8	0,8	0,74	0,76	0	0,04	0,03	0,77	-0,11	1					
DFacilityType	0,69	0,69	0,69	0,69	0,76	-0,02	0,18	-0,1	0,65	-0,04	0,66	1				
LnDistance	-0,37	-0,38	-0,38	-0,38	-0,37	-0,12	-0,37	0,25	-0,32	-0,12	-0,19	-0,53	1			
lnWastage	-0,11	-0,12	-0,12	-0,19	-0,17	0,1	-0,03	0,11	-0,15	0,38	0,1	-0,07	-0,08	1		
Ddoctor	0,43	0,42	0,42	0,29	0,29	0,18	0,08	-0,13	0,46	-0,11	0,18	0,13	-0,22	0,19	1	
Durban	0,67	0,66	0,66	0,62	0,72	0,02	0,07	-0,09	0,63	-0,19	0,72	0,53	-0,17	0,1	0,11	1

Glossary

Variable	Description
Fully Immunized Children (FIC)	Number of children < 1 received DTP3 dose.
Total number of doses administered	Total number of doses administered for all vaccines in the facility in 2011.
Total Economic Cost, Facility Level	Total facility specific-related-to-immunization economic cost.
Total Economic Cost, Facility + District Level	Immunization economic cost, which includes facility specific expenditures and districts expenditures on public health centers.
Total Economic Cost, Facility + District + National Level	Immunization economic cost, which includes facility specific expenditures, plus national and districts expenditures for immunization services
Share of staff time spent in the facility for immunization in % (FTE)	Total staff time spent in the facility for immunization per week divided by the number of working hours per week, expressed in percentages.
Total working hours	Total working hours per week.
Total facility square meters	Total facility Square Meters.
Cold chain capital index	Cold chain economic cost in the facility, expressed in USD. Formula: (Share of the cold chain cost from the total cost (%)*Total Economic Cost, Facility Level)/100.
Hourly wage, mid career nurse (USD)	Hourly wage of midcareer nurse, expressed in USD.
Refrigerator unit price corrected by volume (USD)	Refrigerator unit price corrected by volume, expressed in USD. Formula: Total refrigerator economic cost/(Refrigerator quantity*Net volume).
Infants in the facility catchment area	Total number of infants in the facility catchment area.
Share of population with university education in %	Share of population with University education among 15-49 year old, expressed in percentages.
Dummy Facility Type (=1 if FMC)	Dummy =1 if FMC, 0= if Other.
Dummy Doctor at the facility (=1 Yes)	Dummy =1 if Yes, 0= if No.
Dummy Facility Location (=1 if Urban)	Dummy =1 if Urban, 0= if Other.
Distance from the facility to the vaccine collection point	Distance from the facility to the vaccine collection point.
Overall Wastage Rate in %	Overall vaccine wastage rate, expressed in percentages: (Total number of doses provided in 2011 - total number of doses administered in 2011)*100/total number of doses provided in 2011)

Annex 6:

Graphical analysis of facilities

Figure 21: Scatter plot: Total Economic Cost vs Total Child Doses

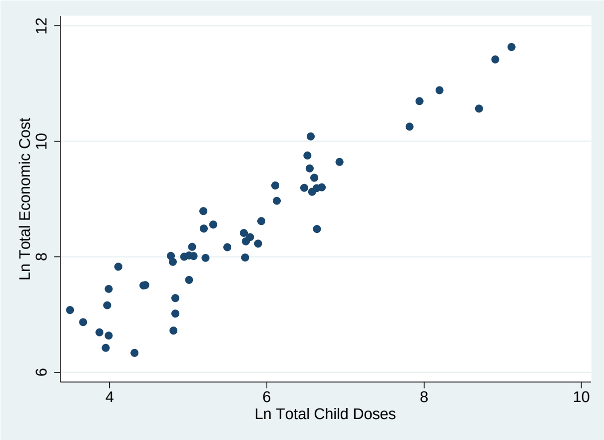


Figure 22: Scatter plot: Total Economic Cost vs DTP3 Vaccinated Children

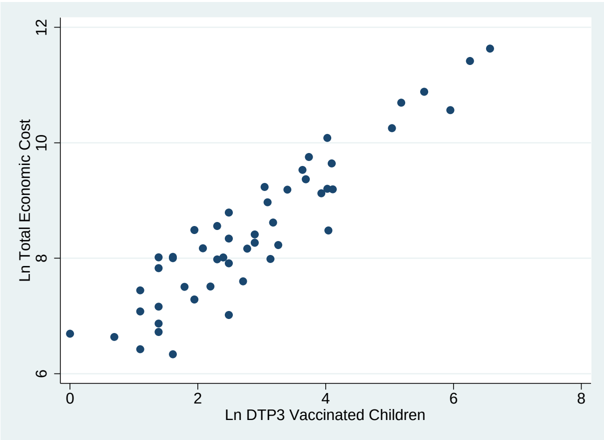


Figure 23: Scatter plot: Total Economic Cost vs Total Infants

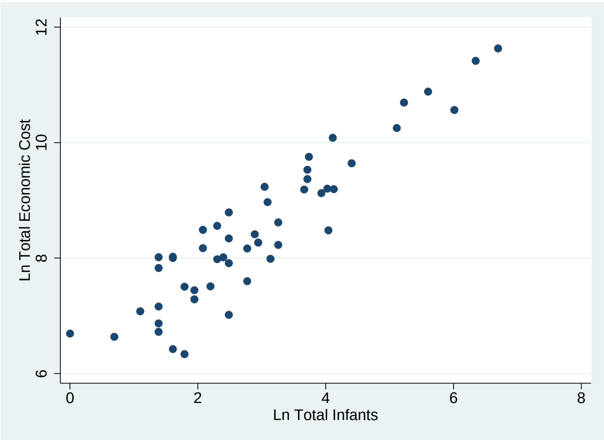


Figure 24: Box plot of Total Economic Cost. District level

Figure 25: Box plot of Total Economic Cost. Facility type level

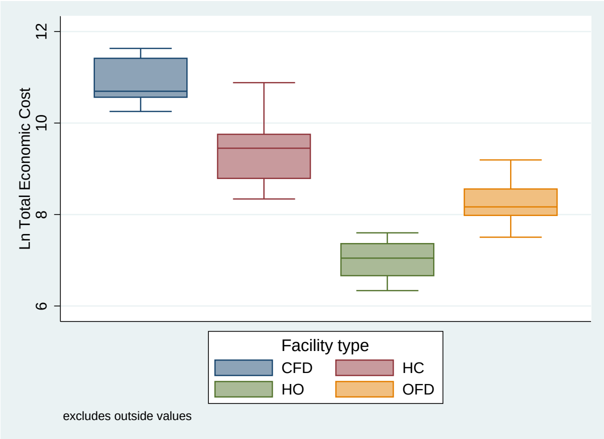


Figure 26: Scatter plot: Unit Cost per dose vs Total Child Doses

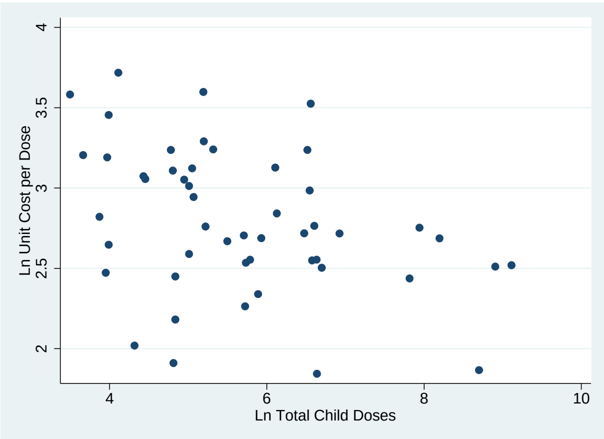


Figure 27: Scatter plot: Unit Cost per FIC vs Total Child Doses

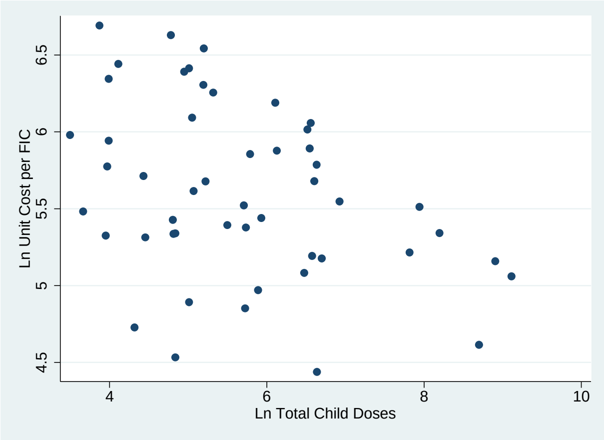


Figure 28: Scatter plot: Unit Cost per dose vs DTP3 Vaccinated Children

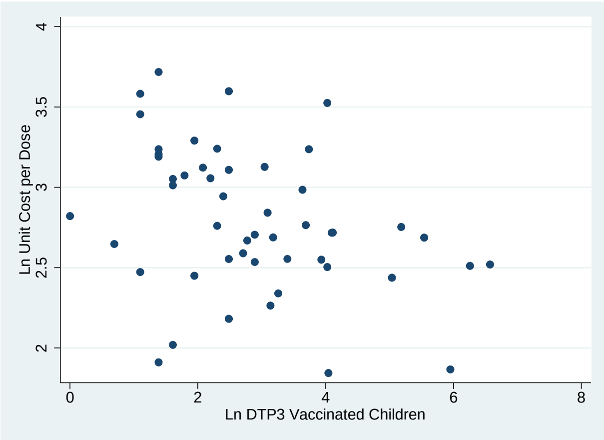


Figure 29: Scatter plot: Unit Cost per FIC vs DTP3 Vaccinated Children

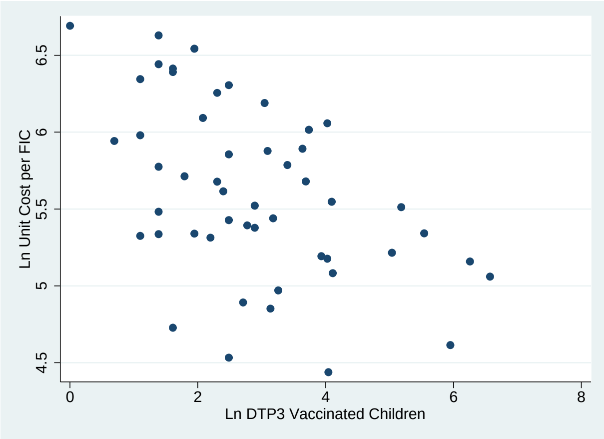


Figure 30: Scatter plot: Unit Cost per dose vs Total children

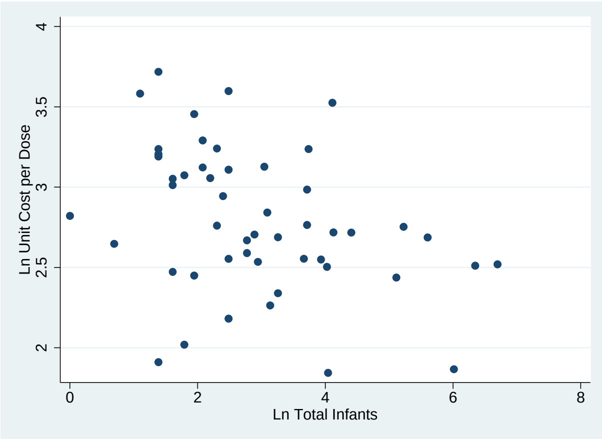


Figure 31: Unit Cost per FIC vs Total children

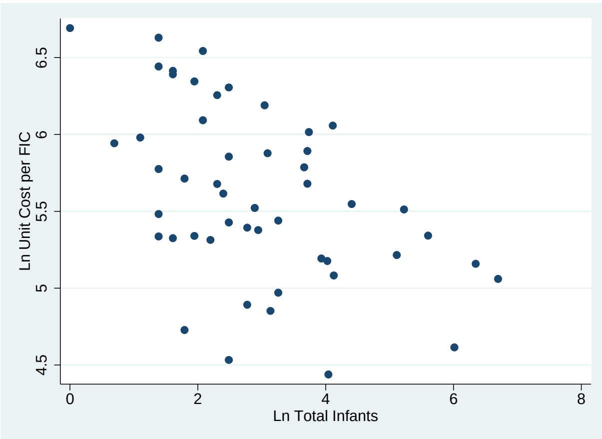


Figure 32: Quadrant analysis of Total Economic Cost vs Total Child Doses

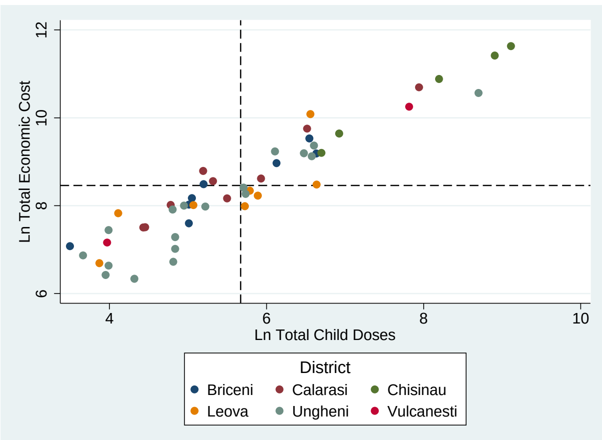


Figure 33: Quadrant analysis of Unit Cost per dose vs Child Doses

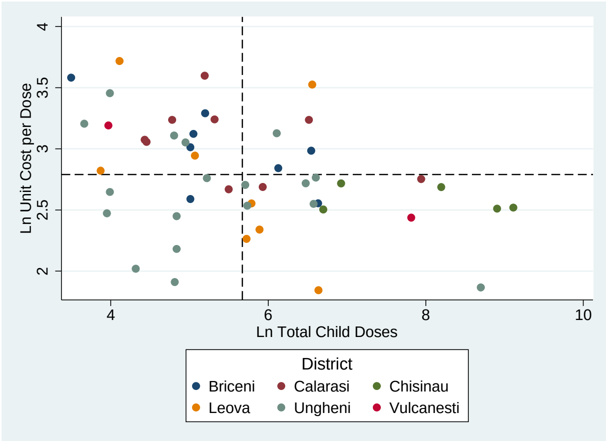
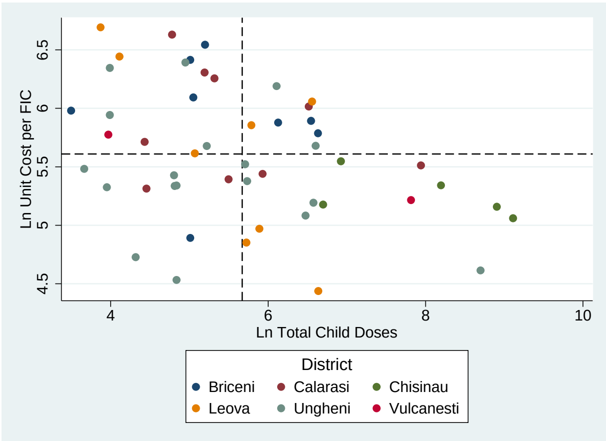


Figure 34: Quadrant analysis of Unit Cost per FIC vs Child Doses



Annex 7: Basic Regression Diagnostics

Table 125: Determinants of Production, Specification (3)

a) Outliers and influential data
Cook's D
Cook's D values range between zero and the cut-off point 4/n. We can list any observation above the cut-off, without identifying influential data problems.

	Ln FIC	Working hours	Square meters	Cold chain	Infants	D Type	D Doctor	Distance	Wastage	d
3	2.08	71	154	83.93	8	0	1	30	17.5	0.08
6	1.10	66	25	14.59	3	0	1	25	33.1	0.09
19	0.00	18	28	48.44	1	0	1	10	11.3	0.21
30	0.69	40	20	48.62	2	0	1	5	8.5	0.09
44	5.18	55	3697	74.95	186	1	1	0	13.5	0.17
45	6.57	66	3139	135.06	810	1	1	7	14.5	0.67
46	5.54	56	2992	95.87	271	0	1	10	20.1	0.16
47	6.26	58	2196	136.14	571	1	1	10	18.2	0.11
49	5.95	70	5820	127.90	409	1	1	2	15.2	0.65

b) Normality of residuals
Shapiro-Wilk W test

Test available: swilk test. The p-value is based on the assumption that the distribution is normal. In our case, it is small, but indicate that we cannot reject that r is normal distributed.

Variable	Obs	W	V	Z	Prob>z
r	50	0.96	1.85	1.31	0.10

c) Heteroskedasticity
Breusch-Pagan/Cook-Weisberg test

Null hypothesis support that variance of the residuals is homogeneous. Therefore, if the p-value is very small, we would reject the hypothesis and accept the alternative hypothesis that the variance is not homogeneous. In our case, we cannot reject the null hypothesis.

Ho: Constant variance
Variables: fitted values of Ln FIC

chi2(1) = 0.78
Prob > chi2 = 0.38

d) Multicollinearity
Variance inflation factor

The term collinearity implies that two variables are near perfect linear combinations of one other. As a rule, a variable whose VIF values are greater than 10 may merit further investigation. The VIF do not show multicollinearity according to the rule.

Variable	VIF	1/VIF
D Type	5.58	0.18
Square meters	4.52	0.22
Infants	3.93	0.25
Cold chain	2.23	0.45
Distance	1.33	0.75
Working hours	1.18	0.85
D Doctor	1.08	0.92
Wastage	1.03	0.98
Mean VIF	2.61	

e) Model specification
Ramsey RESET test

It performs a regression specification error test for omitted variables. This test creates new variables based on the predictors and refits the model using those new variables to see if any of them would be significant. Ramsey RESET test indicates that there are omitted variables in our full model.

Ho: model has no omitted variables
F(3, 38) = 10.27
Prob > F = 0.00

f) Non-linearity
Graphical tests

Performing linear regressions assumes that the relationship between the response variable and the predictors are linear. We use a scatter plot between the response variable and the predictors to see if nonlinearity is present, such as curved band. The adjustments are satisfactory, with reduced nonlinearity in the cases of Total working hours, Total facility square meters and total number of infants, and almost perfect linearity in all other variables.

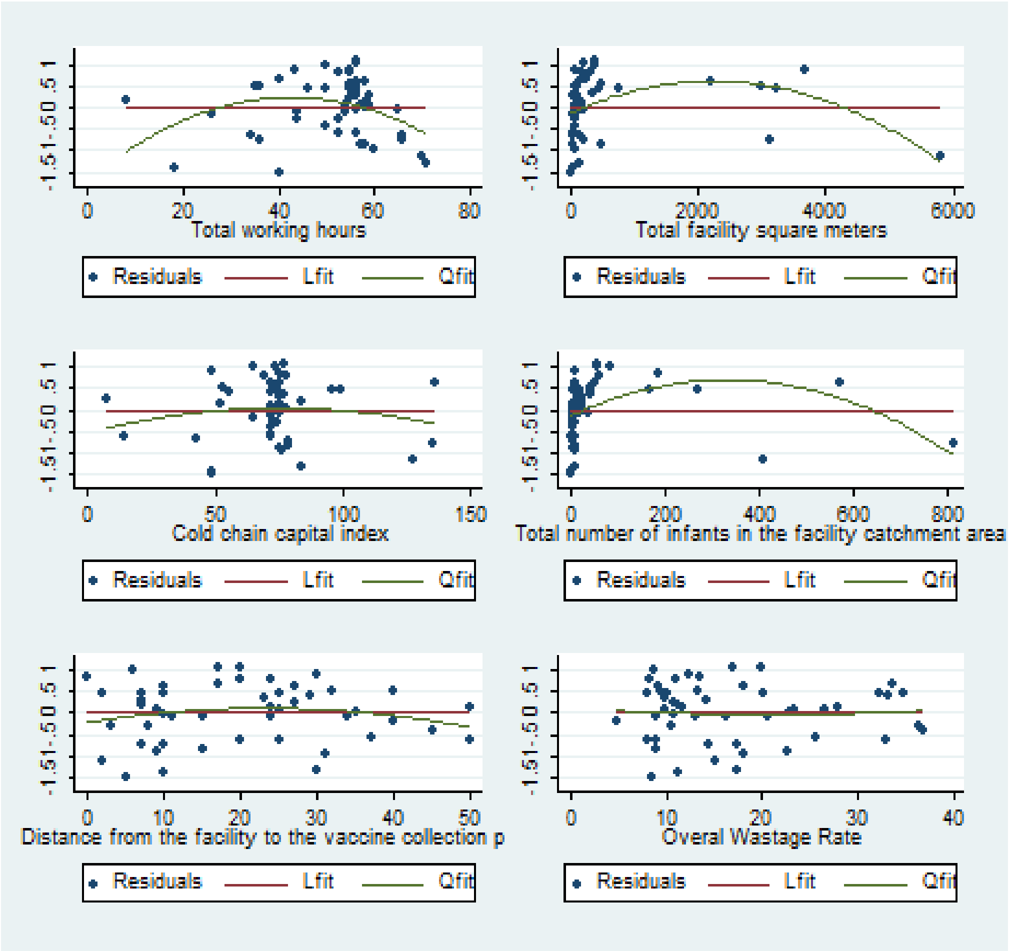

-1.5 -1 -.5 0 .5 1
0 20 40 60 80
Total working hours
Residuals Lfit Qfit
-1.5 -1 -.5 0 .5 1
0 2000 4000 6000
Total facility square meters
Residuals Lfit Qfit
-1.5 -1 -.5 0 .5 1
0 50 100 150
Cold chain capital index
Residuals Lfit Qfit
-1.5 -1 -.5 0 .5 1
0 200 400 600 800
Total number of infants in the facility catchment area
Residuals Lfit Qfit
-1.5 -1 -.5 0 .5 1
0 10 20 30 40 50
Distance from the facility to the vaccine collection p
Residuals Lfit Qfit
-1.5 -1 -.5 0 .5 1
0 10 20 30 40
Overal Wastage Rate
Residuals Lfit Qfit

Table 126: Determinants of Total Economic Cost, Facility Level, Specification (8)

a) Outliers and influential data
Cook's D

We do not see influential data problem.

	Ln Total Cost	Ln FIC Est.	Ln FIC2 Est.	Ln Hourly wage	Ln Refrigerator Unit price	Ln Ice pack Unit price	Ln pop. with university educ.	Wastage	d
15	8.56	1.82	3.30	0.54	-0.26	-2.86	1.46	3.55	0.13
24	7.99	2.91	8.47	0.59	-0.26	-3.00	1.06	2.28	0.08
44	10.69	3.83	14.66	0.58	-0.70	-2.89	2.30	2.60	0.09
45	11.63	7.85	61.56	0.60	-0.26	-2.83	3.19	2.67	0.86
49	10.57	6.73	45.32	0.62	-0.26	-2.82	2.56	2.72	0.11

b) Normality of residuals
Shapiro-Wilk W test

The p-value is very large, indicating that we can not reject that r is normally distributed.

Variable	Obs	W	V	Z	Prob>z
r	38	0.98	0.60	-1.06	0.86

c) Heteroskedasticity
Breusch-Pagan/Cook-Weisberg test

The test indicates that we can not reject the null hypothesis that variance is homogeneous.

Ho: Constant variance
Variables: fitted values of Ln Total Cost

chi2(1) = 0.09
Prob > chi2 = 0.76

d) Multicollinearity
Variance inflation factor

VIFs tests support no presence of multicollinearity, with the exception of Ln FIC Est. and Ln FIC 2 Est., as expected.

Variable	VIF	1/VIF
Ln FIC Est.	24.71	0.040477
Ln FIC2 Est.	20.52	0.048732
Ln Ice pack Unit price	3.67	0.272524
Ln Refrigerator Unit price	3.48	0.287329
Ln pop. with university educ.	2.82	0.354617
Wastage	1.47	0.682364
Ln Hourly wage	1.08	0.926955
Mean VIF	8.25	

e) Model specification
Ramsey RESET test

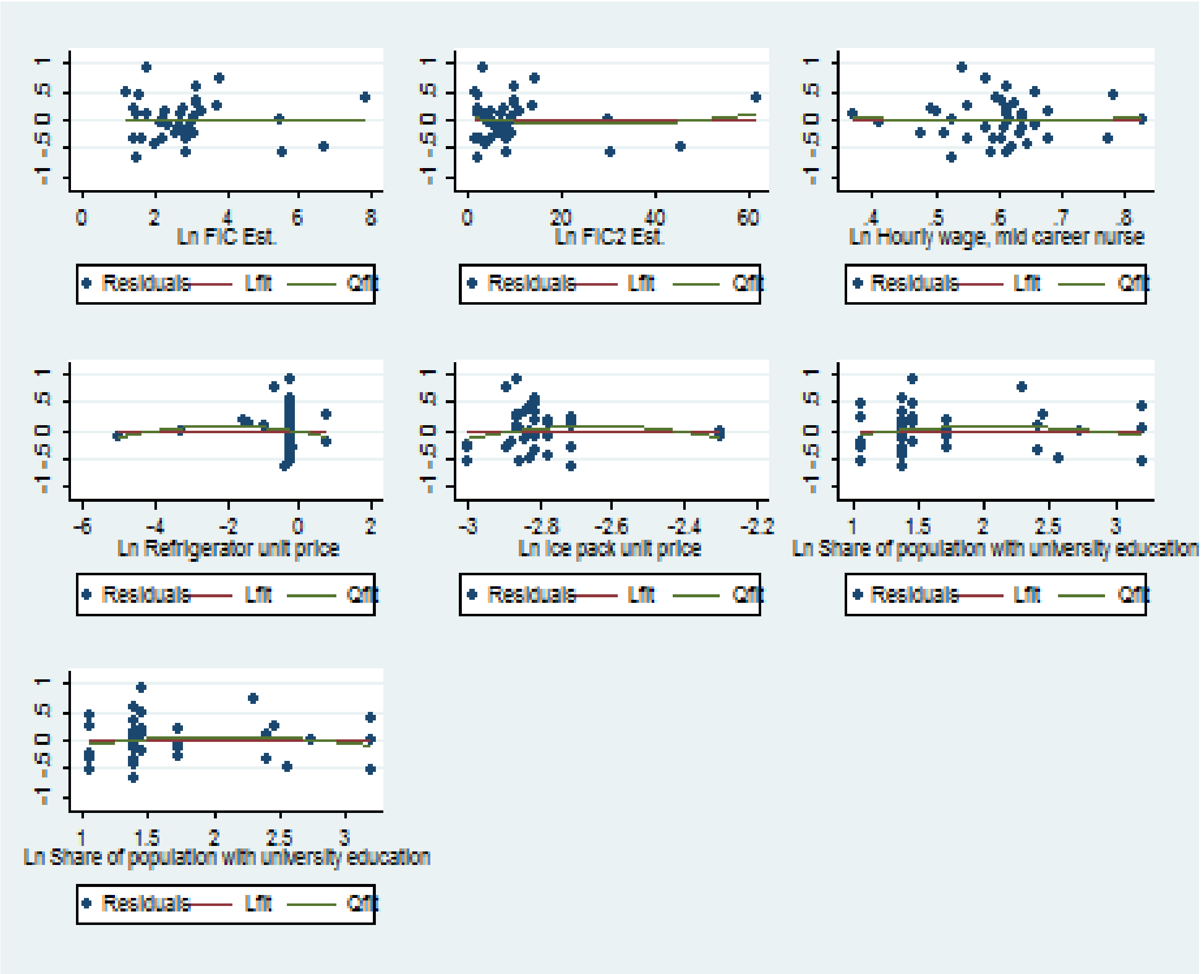
The p-value is large, indicating that we can not reject the null hypothesis that there are not omitted variables in our full model.

Ho: model has no omitted variables

F(3, 27) = 0.8
Prob > F = 0.51

f) Non-linearity
Graphical tests

We do not see evidence of nonlinearity between the response variable and the predictors.



Annex 8: Sensitivity analysis

Table 127: Sensitivity analysis of Total Economic Cost (Unweighted sample)

Scenarios		Unweighted Average ($)	Change from Baseline $	Change from Baseline %
Baseline		11942.66	-	-
Salary (% increase)				
	5	12368.55	425.89	3.57
	10	12794.44	851.77	7.13
	15	13220.32	1277.66	10.70
	20	13646.21	1703.54	14.26
Vaccine (% increase)				
	5	12008.51	65.84	0.55
	10	12074.35	131.69	1.10
	15	12140.19	197.53	1.65
	20	12206.04	263.37	2.21
Building (% increase)				
	5	11986.38	43.71	0.37
	10	12030.09	87.42	0.73
	15	12073.80	131.14	1.10
	20	12117.52	174.85	1.46

Table 128: Sensitivity analysis of Total Economic Cost (Weighted sample)

Scenarios		Weighted Average ($)	Change from Baseline $	%
Baseline		6963.66	-	-
Salary (% increase)				
	5	7208.52	244.86	3.52
	10	7453.38	489.73	7.03
	15	7698.25	734.59	10.55
	20	7943.11	979.45	14.07
Vaccine (% increase)				
	5	7001.15	37.49	0.54
	10	7038.65	74.99	1.08
	15	7076.14	112.48	1.62
	20	7113.63	149.98	2.15
Building (% increase)				
	5	6989.92	26.26	0.38
	10	7016.17	52.52	0.75
	15	7042.43	78.78	1.13
	20	7068.69	105.03	1.51

Table 129: Sensitivity analysis of Unit Cost per Dose Adm. (Unweighted sample)

Scenarios		Unweighted Average ($)	Change from Baseline $	%
Baseline		17.99	-	-
Salary (% increase)				
	5	18.58	0.60	3.31
	10	19.18	1.19	6.62
	15	19.77	1.79	9.93
	20	20.37	2.38	13.24
Vaccine (% increase)				
	5	18.06	0.07	0.41
	10	18.14	0.15	0.83
	15	18.21	0.22	1.24
	20	18.28	0.30	1.66
Building (% increase)				
	5	18.07	0.09	0.49
	10	18.16	0.18	0.98
	15	18.25	0.26	1.47
	20	18.34	0.35	1.95

Table 130: Sensitivity analysis of Unit Cost per Dose Adm. (Weighted sample)

Scenarios		Weighted Average ($)	Change from Baseline	
			$	%
Baseline		18.35	-	-
Salary (% increase)				
	5	18.95	0.60	3.25
	10	19.54	1.19	6.51
	15	20.14	1.79	9.76
	20	20.74	2.39	13.02
Vaccine (% increase)				
	5	18.42	0.07	0.41
	10	18.50	0.15	0.81
	15	18.57	0.22	1.22
	20	18.65	0.30	1.63
Building (% increase)				
	5	18.44	0.10	0.52
	10	18.54	0.19	1.04
	15	18.63	0.29	1.56
	20	18.73	0.38	2.07

Table 131: Sensitivity analysis of Unit Cost per FIC. (Unweighted sample)

Scenarios		Unweighted Average ($)	Change from Baseline	
			$	%
Baseline		318.16	-	-
Salary (% increase)				
	5	328.60	10.44	3.28
	10	339.04	20.87	6.56
	15	349.47	31.31	9.84
	20	359.91	41.75	13.12
Vaccine (% increase)				
	5	319.48	1.31	0.41
	10	320.79	2.63	0.83
	15	322.11	3.94	1.24
	20	323.42	5.26	1.65
Building (% increase)				
	5	319.80	1.64	0.51
	10	321.44	3.27	1.03
	15	323.07	4.91	1.54
	20	324.71	6.54	2.06

Table 132: Sensitivity analysis of Unit Cost per FIC (Unweighted sample)

			Change from Baseline	
Scenarios		Weighted Average ($)	$	%
Baseline		332.31	-	-
Salary (% increase)				
	5	343.04	10.73	3.23
	10	353.77	21.46	6.46
	15	364.49	32.18	9.68
	20	375.22	42.91	12.91
Vaccine (% increase)				
	5	333.66	1.35	0.41
	10	335.01	2.70	0.81
	15	336.35	4.04	1.22
	20	337.70	5.39	1.62
Building (% increase)				
	5	334.11	1.80	0.54
	10	335.92	3.61	1.09
	15	337.72	5.41	1.63
	20	339.53	7.21	2.17

Annex 9: Data Coding for Financial Flow Analysis

Codes used for financial flow analysis:

Classification of types of revenues of health financing schemes (FS)

Code	Description
FS.1	Transfers from government domestic revenue
FS.1.1	Internal transfers and grants
FS.1.1.1	Internal transfers within central government
FS.2	Transfers distributed by government from foreign origin
FS.2.2	Commodity transfers
FS.2.2.3	GAVI
FS.7	Direct foreign transfers
FS.7.2	Direct foreign aid in-kind
FS.7.2.2	Direct foreign aid in kind: services (including TA)
FS.7.2.2.2	Direct multilateral foreign aid in kind
FS.7.2.2.2.1	UNICEF
FS.7.2.2.2.2	WHO

Classification of financing schemes (HF)

Code	Description
HF.1	Government schemes and compulsory contributory health care financing schemes
HF.1.1	Government schemes
HF.1.1.1	Central government schemes
HF.1.2	Compulsory contributory health insurance schemes
HF.4	The Rest of the World
HF.4.1	UNICEF
HF.4.2	WHO

Classification of financing agents (FA)

Code	Description
FA.1	**General Government**
FA.1.1	Central Government Agencies
FA.1.1.1	Central Ministry of Health:
FA.1.1.1.3/5	National Surveillance Agency & Medical Store[32]
FA.1.1.4	National Medical Insurance Company
FA.6	**Rest of the World**
FA.6.1	International Organisations (Multilaterals)
FA.6.1.1	UNICEF
FA.6.1.2	WHO

Classification of health care providers (HP)

Code	Description
HP.3	**Providers of ambulatory health care**
HP.3.4	Ambulatory health care centres
HP.3.4.9	All other ambulatory centres

[32] In Moldova both functions are performed by the same institution, therefore in these codes were used interchangeable to denote role of the Centre for Public Health.

Code	Description
HP3.4.9.1	*Government facilities*
HP3.4.9.1.1	Center of Family Doctors
HP3.4.9.1.2	Office of Family Doctors
HP3.4.9.1.3	Health Center
HP3.4.9.1.4	Health Office
HP.6	**Providers of preventive care**
HP.9	**Rest of the world**
HP.9.1	UNICEF
HP.9.2	WHO

Classification of health care functions (HC)

Code	Description
HC.6	**Preventive care**
HC.6.1	Information, education and counselling programmes
HC.6.1.1	Social mobilization, advocacy
HC.6.2	Immunization programmes
HC.6.2.1	Facility-based routine immunization service delivery
HC.6.2.3	Training
HC.6.2.4	Vaccine collection, storage and distribution
HC.6.2.5	Cold chain maintenance
HC.6.2.6	Supervision/Program management
HC.6.2.7	Other routine immunization program activity
HC.6.5	Surveillance
HC.6.5.1	EPI Surveillance
HC.6.5.2	Record-keeping and HMIS
HC.99	**Not disaggregated**

Classification of factors for health care provision (FP)

Code	Description
FP.1	**Compensation of employees**
FP.1.1	Wages and salaries
FP.1.3	All other costs relating to employees
FP.1.3.1	Per diem
FP.3	**Materials and services used**
FP.3.2	Vaccines & syringes
FP.3.3	Non-health care services
FP.3.3.1	Transport
FP.3.3.2	Maintenance
FP.3.3.3	Printing
FP.3.3.4	Utilities and communications
FP.3.4	Non-health care goods
FP.3.4.2	Other
FP.9.9	**Not disaggregated**

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