ECONOMIC EVALUATION OF VACCINATION PROGRAMS: EXPLORING MULTIPLE METHODS

# Expanding economic analysis for HTA: The fiscal impact of vaccination in the Italian Context

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This study has been supported thanks to an unconditional grant by Sanofi, Pfizer and Merck Sharp & Dhome

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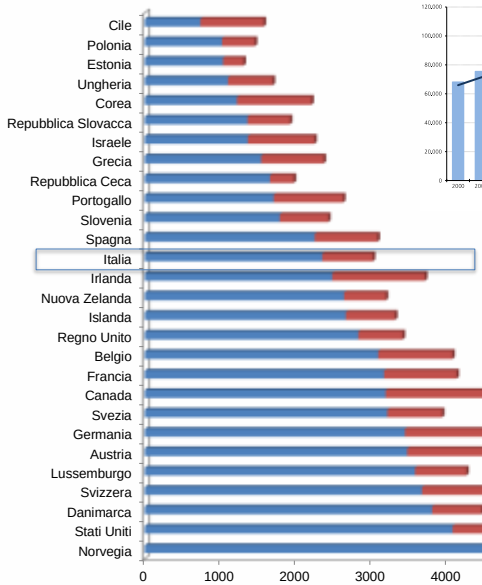
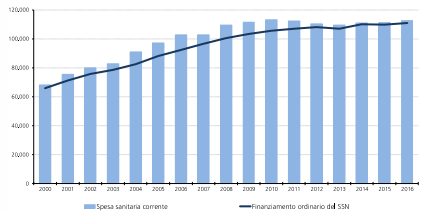
**Public expenditures**
**Private expenditures**




Public health expenditures (2000-2016)




- Three layer system
- Universal coverage
- Regional devolution of power
- 113 Billion euros (70% total health expenditures)
- 60 million people served

Source: www.oecd.org

# Prevention and Vaccination

- 5% of the global NHS (113bln€) budget is devoted to prevention;
- Meanwhile 318mln € (1,4% of the global expenditures) is dedicated to vaccination;
- The recent National Vaccination Plan (2017-19) identifies vaccination calendar to be covered by the NHS budget;
- Multiple HTAs has been developed to support de definition of the vaccination strategies and calendar
- An increase of 186 Mln€ is expected in three years mainly due to the itroduction of new compulsory vaccinations for kids;
- Active political discussion regarding the extension of the coverage of immunization strategies for adults (e.g. flu vaccination) in underway;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# Aims of the researchprogramme

- The objective of the biennial research program is to estimate the value generated for the entire economic and social system by immunization programs in the adult population of working age for three diseases preventable through vaccination:

| Condition | Key words |
|---|---|
| Herpes Zoster | Herpes, Zoster, Varicella Zoster, Post herpetic neuralgia |
| Pneumococco | Streptococcus pneumoniae, Pneumococcal Virus |
| Influenza | Influenza Virus |

- The overall objective was divided into two sub-objectives:
  - realization of a cost-of-illness analysis (direct health costs and indirect costs) related to the three areas of pathology, influenza, shingles, and IPD, completed in 2016;
  - development of the model for estimating the economic and social value of immunization programs (so-called "fiscal impact" model) implemented in 2017.

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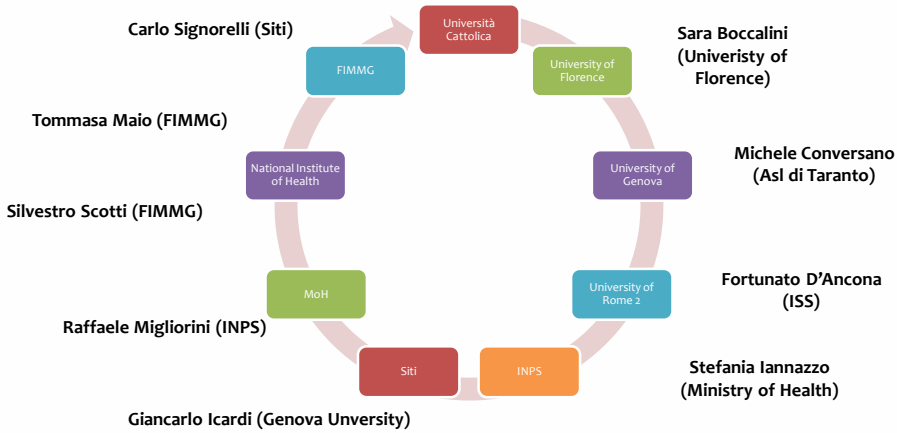


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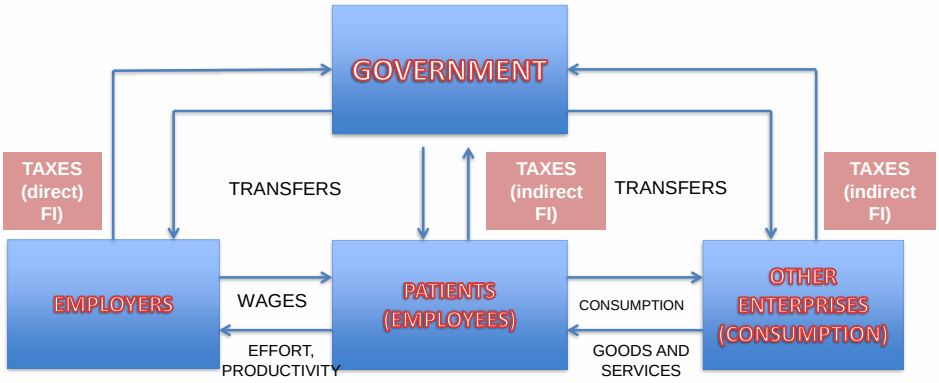
# Fiscal Impact: Conceptual Framework

- Poor health states resulting in premature mortality, disability, early retirement, or reduced labor force participation will reduce taxes paid to governments.
- Health conditions that increase life expectancy will increase tax revenues but also transfer costs for governments.
- Tax revenues forgone and increased transfer payments represent real costs to government.

These aspects are often overlooked in the traditional cost-effectiveness framework

# Basic framework to value the fiscal impact






# Main methodology

- Human capital approach (estimation of the number of days lost);
- Estimated cost of social security (supported by INPS, National Institute for Social Security after the 4th day of illness);
- Estimation of the reduction in taxable income on the part of workers applying income brackets to the average gross salary in Italy;
- Simulations based on reduction of number of infected workers against vaccination extension;
- Probabilistic sensitivity analysis on uncertain parameters

**Table 1. Italian personal income taxation (IRPEF tax rates)**

| Income Brakets | Percentage + fixed |
|---|---|
| € 0-€ 15.000 | 23% |
| € 15.000 - € 28.000 | 27% + € 3.450 |
| € 28.000 - € 55.000 | 38% + € 6.960 |
| € 55.000 - € 75.000 | 41% + € 17.220 |
| > € 75.000 | 43% + € 25.420 |

# Sensitivity analysis

- It studies changes in results with varying key parameters:
  - % sick workers;
  - # of days with disease;
  - Effectiveness vaccine (preliminary linear trend assumption);
  - Compensation on a fixed part;
  - Share flu-like syndromes compared to cases of influenza;
  - Gross hourly wage;
- Probabilistic approach
  - Multi-way probabilistic analysis
  - 1000 MonteCarlo simulations

# INFLUENZA

# Influenza – Results

- Prevalence: 8% of italian workers (net of the unemployment rate 11,2%)
- 4,5 days of absence from work
- Gross hourly wage : € 18,00
- Average compensation by the National Social Secuity: 67% of the gross salary

| N of infected | Total days of absence from work | Fiscal impact | Social costs | Total | Increase in the tax revenues | Decrease of productivity lossess |
|---|---|---|---|---|---|---|
| 2,1MLN | 9,72 MLN | € 159.563.520 | € 839.808.000 | € 999.371.520 | - | - |
| 1,9MLN | 8,64 MLN | € 141.834.240 | € 746.496.000 | € 888.330.240 | € 17.729.280 | € 111.041.280,00 |
| 1,7MLN | 7,56 MLN | € 124.104.960 | € 653.184.000 | € 777.288.960 | € 35.458.560 | € 222.082.560,00 |
| 1,4MLN | 6,48 MLN | € 106.375.680 | € 559.872.000 | € 666.247.680 | € 53.187.840 | € 333.123.840,00 |
| 1,2MLN | 5,4 MLN | € 88.646.400 | € 466.560.000 | € 555.206.400 | € 70.917.120 | € 444.165.120,00 |

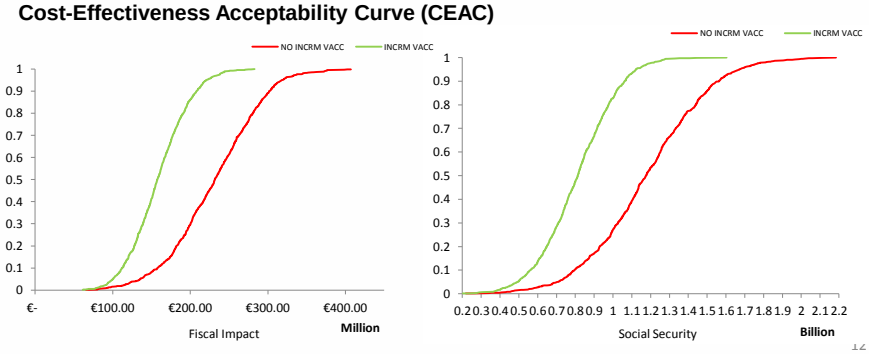
General prevalence 8% (Range 4-12%), 4,8 mln. In 2017-18 764 ICU cases and 173 deths.



# Influenza - sensitivity analysis

| Number of INFECTED | FISCAL IMPACT + SOCIAL COSTS | | INCREASE OF INCOME TAXES + DECREASE OF SOCIAL COSTS | |
|---|---|---|---|---|
| | 25TH PERCENT | 75TH PERCENT | 25TH PERCENT | 75TH PERCENT |
| 1,8-2,2 MLN | € 726.519.622 | € 1.134.184.689 | | |
| 1,7 - 2,1 MLN | € 645.795.219 | € 1.008.164.168 | € 80.724.402 | € 126.020.521 |
| 1,6- 2 MLN | € 565.070.817 | € 882.143.647 | € 161.448.804 | € 252.041.042 |
| 1,5 -1,9 MLN | € 484.346.414 | € 756.123.126 | € 242.173.207 | € 378.061.563 |
| 1,4-1,8 MLN | € 403.622.012 | € 630.102.605 | € 322.897.609 | € 504.082.084 |

**Cost-Effectiveness Acceptability Curve (CEAC)**



# PNEUMOCOCCUS

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## Pneumococcus- Results

- 306/100.000 ( Sterrantino C et al. Eur Respir J 2013; 42:17-37)
- 10 – 31 working days lost (hospitalizations), Weighted mean: 16 (Personne et al.)
- Hourly avarege salary (ISTAT) : € 18,00
- Average compensation given from the National Social Security: 67% of the gross salary

| N of infected | Total days of absence from work | Fiscal impact | Social costs | Total | Increase in the fiscal revenues | Decrease of productivity lossess |
|---|---|---|---|---|---|---|
| 90.000 | 1.440.000 | € 23.639.040 | € 124.416.000 | € 148.055.040 | - | - |
| 81.000 | 1.296.000 | € 21.275.136 | € 111.974.400 | € 133.249.536 | € 2.363.904 | € 12.441.600 |
| 72.000 | 1.152.000 | € 18.911.232 | € 99.532.800 | € 118.444.032 | € 4.727.808 | € 24.883.200 |
| 63.000 | 1.008.000 | € 16.547.328 | € 87.091.200 | € 103.638.528 | € 7.091.712 | € 37.324.800 |
| 54.000 | 864.000 | € 14.183.424 | € 74.649.600 | € 88.833.024 | € 9.455.616 | € 49.766.400 |

## Pneumococcus:10 yrs results projection

| Year | Increase of income taxes | Productivity loss | Total effect |
|---|---|---|---|
| 0 | € 4.727.808 | € 24.883.200 | € 29.611.008 |
| 1 | € 4.590.104 | € 24.158.446 | € 28.748.551 |
| 2 | € 4.326.614 | € 22.771.652 | € 27.098.267 |
| 3 | € 3.959.464 | € 20.839.288 | € 24.798.753 |
| 4 | € 3.517.933 | € 18.515.437 | € 22.033.370 |
| 5 | € 3.034.600 | € 15.971.579 | € 19.006.179 |
| 6 | € 2.541.429 | € 13.375.946 | € 15.917.375 |
| 7 | € 2.066.414 | € 10.875.868 | € 12.942.283 |
| 8 | € 1.631.247 | € 8.585.510 | € 10.216.757 |
| 9 | € 1.250.215 | € 6.580.079 | € 7.830.294 |
| 10 | € 930.277 | € 4.896.196 | € 5.826.474 |
| total | € 32.576.109 | € 171.453.205 | € 204.029.315 |

- Discount rate 3%
- Hp 20.000 less infected from the base case

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# HERPES ZOSTER

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# HZ

- HZ occurs in the most severe forms and gives rise to PHN in individuals aged 50 and over
- Incidence of subjects aged 50-64: 3.95-6.45 per 1000 (Alicino et al., 2017, Gialloreti et al., 2010, Bricout et al., 2010)
- PHN cases 15.29-17.65% of HZ accidents (Alicino et al. 2017)
- Working days lost: 6 days for HZ and 10 for PHN (Panatto et al., Gialloreti et al., Ruggeri et al.,)
- Unemployment rate in Italy 11.2%



# HZ Results

| N of infected | Total days of absence from work | Fiscal impact | Social costs | Total | Increase in the fiscal revenues | Decrease of productivity lossess |
|---|---|---|---|---|---|---|
| 6400 | 38400 | € 630.000 | € 4.147.200 | € 4.777.200 | | |
| 6000 | 36000 | € 590.625 | € 3.888.000 | € 4.478.625 | € 39.375 | € 259.200 |
| 5500 | 33000 | € 541.406 | € 3.564.000 | € 4.105.406 | € 88.593 | € 518.400 |
| 5000 | 30000 | € 492.187 | € 3.240.000 | € 3.732.187 | € 118.125 | € 1.555.200 |

# PHN Results

| N of infected | Total days of absence from work | Fiscal impact | Social costs | Total | Increase in the fiscal revenues | Decrease of productivity lossess |
|---|---|---|---|---|---|---|
| 1050 | 10500 | € 100.000 | € 1.134.000 | € 1.234.000 | | |
| 800 | 8000 | € 76.190 | € 864.000 | € 940.190 | € 23.809 | € 384.000 |
| 500 | 5000 | € 47.619 | € 540.000 | € 587.619 | € 47.619 | € 768.000 |
| 300 | 3000 | € 28.571 | € 324.000 | € 352.571 | € 71.428 | € 1.152.000 |

# HZ /PHN – 10 years results (Projection)

| Year | Increase of income taxes | Productivity loss | Total effect |
|---|---|---|---|
| 0 | € 100.000 | € 600.000 | € 700.000 |
| 1 | € 97.087 | € 582.524 | € 679.611 |
| 2 | € 91.514 | € 549.085 | € 640.599 |
| 3 | € 83.748 | € 502.490 | € 586.238 |
| 4 | € 74.409 | € 446.456 | € 520.865 |
| 5 | € 64.186 | € 385.117 | € 449.303 |
| 6 | € 53.754 | € 322.529 | € 376.284 |
| 7 | € 43.707 | € 262.246 | € 305.953 |
| 8 | € 34.503 | € 207.019 | € 241.522 |
| 9 | € 26.443 | € 158.663 | € 185.107 |
| 10 | € 19.676 | € 118.060 | € 137.737 |
| **Total** | **€ 689.031** | **€ 4.134.191** | **€ 4.823.223** |

- Hp: reduction of 1000 for HZ and 200 for Phn on respect of base case
- Discount rate 3%



# To sum up …

| Per capita impact | INFLUENZA | | PNEUMOCOCCO | | HZ/PHN | | POOLED | |
|---|---|---|---|---|---|---|---|---|
| | FI | PS | FI | PS | FI | PS | FI | PS |
| Benefit | € 90 | € 555 | € 266 | € 1.377 | € 171 | € 2.000 | € 150 | € 1.200 |
| Net Benefit (on cost of vaccination) | € 40 | € 505 | € 181 | € 1.292 | € 74 | € 1.902 | € 78 | € 1.128 |
| Cost/Benefit Ratio | 1,8 | 11,1 | 3,1 | 16,2 | 1,7 | 20,0 | 2,0 | 16,0 |

FI = Fiscal Impact
PS = Social security savings

| Pathologies | Example of policy | Reduction of # of infected | Reduction of # working days lost | Fiscal Impact | Social Security Savings | Total Economic Impact |
|---|---|---|---|---|---|---|
| Influenza | Extension of coverage (age 50-64) | -200.000 | 1.080.000 | 17.729.280 | 111.041.280 | 128.770.560 |
| Pneumococcus | Communication strategies (10 yrs) | -9.000 | 144.000 | 2.363.904 | 12.441.600 | 14.805.504 |
| Herpes Zoster/PHN | Communication strategies (10yrs) | -1.200 | 35.500 | 689.031 | 4.134.191 | 4.823.223 |
| **Total Impact** | | **-210.200** | **1.259.500** | **20.782.215** | **127.617.071** | **148.399.287** |

# Discussion

- To enhance the perspective of the standard cost-effectiveness framework taking into account the wider point of view of the public decision maker.
- To provide an in-depth understanding of the benefit generated by new technologies (particularly in large public health programmes) and analyse a new aspect to be taken into account in multi-criteria decision analysis (MCDA).
- To establish a standardized method to assess the fiscal impact deriving from health gains (i.e. consumption increases, productivity gains) to support decision-making for pricing and reimbursement of new drugs, vaccines, and other health technologies by providing an integrated view of the economic and social impact of new healthcare interventions.

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# Limitations and work in progress

- Enlaring the model to take into consideration:
  - Indirect taxes (VAT)
  - Frinction costs (survey in progress)
  - Businesses taxes
  - Changes in consumption behaviour
- Stratification of results by:
  - Age and sex
  - Geography (Italian Regions)
  - Industrial sectors
- Other
  - Application of the model to chronic conditions and related technologies (IMPACT HTA EU Horizon 2020 project)

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