Appendix. Method of calculation of cost items

Direct medical costs

Reconstructed by analyzing the Proceedings leading to the "Fincantieri/Italian Naval Shipyards judgment", in which the Veneto Region was asked to list the medical care provided and the hospitalization costs for each worker victim of asbestos, whose surviving relatives were the claimants. The 11 cases of mesothelioma under litigation were examined, their hospital stays and diagnostic/therapeutic interventions were extracted from the claim proceedings and for each of them the costs of in-patient and day-hospital treatment were calculated using regional DRG-based tariffs in force at that time, set out in Veneto Region Resolution no. 916 dated 28/03/2006. For our analysis these amounts were recalculated, updating them to the latest tariffs, covered by Veneto Region Resolution no. 1805 dated 8/11/2011. The average cost of the 11 cases in claim was taken as an estimate of the direct medical cost for each mesothelioma case.

Compensation insurance costs

Direct annuity for occupational diseases was calculated as required by law, starting from the following items:

a. Indemnity for biological damage: annual benefit by degree of disability, as reported in tables attached to the Ministry of Labor and Social Policy Decree 12/07/2000, periodically updated;
b. Indemnity for loss of income: worker's average annual wages corrected by a coefficient for the degree of disability (article no. 13, Legislative Decree no. 38 of 23/02/2000);
c. Inflation adjustment for the indemnity for biological damage, amounting to 8.68% according to current law (Ministerial Decree 27/03/2009).

The number of annuities for disability payable at 31/12/2011 for all-site mesotheliomas acknowledged by INAIL as of occupational origin was retrieved, separately by sex and degree of

permanent disability. The total expenditure for direct annuities updated to 2012 was therefore estimated using the following formula:

$$\sum_i \sum_n \left[\left(R \cdot C_i \right) \cdot \frac{i}{100} + B_i + A_i \right] \cdot P$$

where:

- *i* denotes the degree of disability as a percentage;
- *n* the number of annuities;
- *R* the worker's average annual earnings;
- C_i the coefficient based on the degree of permanent disability;
- B_i indemnity for biological damage;
- A_i inflation adjustment of the indemnity for biological damage;
- *P* the probability of survival for 2012.

For the workers' average annual earnings, we referred to the figures for annual per-capita retribution provided by the Italian National Statistics Institute (ISTAT) for “blue-collar" workers, by sex; this was because workers exposed to asbestos in the various sectors of industry are at most qualified as “specialized workers" (25). The per-capita annual earnings were then corrected for the worker's degree of disability, to obtain the indemnity for income loss. The indemnity for biological damage was derived for each worker from the law tables based on the degree of disability, and the corresponding inflation adjustment was computed.

The amount of each annuity was then multiplied by the probability of being paid in 2012, based on the mean length of survival for the total number of compensated cases of occupational-origin mesothelioma. The insurance costs for direct annuities were calculated by summing up the figures obtained as outlined above for all the current annuities, sorted by degree of disability, and the mean annuity was calculated per disabled person.

All the survivor annuities payable to relatives at 31/12/2011 by site of mesothelioma were taken for analysis. The individual survival annuity was computed starting from the worker's annual earnings and varied by degree of kinship to the dead worker and by the percentage of disability due to the occupational disease. For instance, the survival annuity for a 100% disabled worker payable to each family member for the year 2012 was calculated as follows:

$$(R \cdot a_c)(P+3M)$$

where:

- *R* denotes the worker's total annual earnings (for 100% disability);
- a_c the coefficient based on the degree of kinship;
- *P* the probability of not dying or of re-marrying (for the spouse only);
- *M* the probability of re-marrying (for the spouse only);
- *3* the annuity due in case of re-marriage.

The annual per-capita earnings for a "blue-collar" worker, according to the ISTAT figures (12) were taken for the annual income for worker *n* and the percentage based on degree of kinship with the surviving relative was computed. For surviving spouses these amounts were adjusted for the probability of them not dying, or remarrying, as payment ceases in either of these cases. Three annuities are paid at one time, however, to the remarried partner. Because the age distribution of surviving spouses was not known, probability was based on the average age when the worker started receiving the annuity: 67 years for pleural mesothelioma and 65 for peritoneal mesothelioma.

Tax and benefit costs

The European Community Household Panel (ECHP) is a survey conducted by the Statistics Offices of the European countries from 1994 to 2001, and was replaced in 2003 by the Community Statistics

on Income and Living Conditions (EU-SILC). Data on labor income taxes and old-age benefits were provided by both these surveys and were available in the corresponding dataset, as averages per year and country. For the missing years (*s* = 2001-2003), variables were estimated with an ordinary least squares (OLS) regression model, with quadratic trend and including age, sector, and sex as independent variables.

The ratio of mean consumption (conditional on year, age and sex) to net labor income was extrapolated from the Bank of Italy Survey of Household Income and Wealth (SHIW) dataset. As the average consumption tax rate we took the total direct tax revenue divided by the final consumption expenditure from the National Accounts, which amounted to 14.24 for the time covered in this analysis. Finally, we used a constant discount rate equal to the average long-term nominal interest rate on ten-year government bonds, 6.04% at the time.

Starting from the total of 15,845 incident MM registered by ReNaM, mostly pleural site (93%) and affecting men (11,342: 71.6%), we extracted those of occupational origin (8,367), corresponding to 69.3% of those defined as exposure, for analysis. For each individual *i* diagnosed with mesothelioma at time *s* recorded in the ReNaM dataset, the sum of discounted transfers (income tax, consumption tax or old-age benefit) was calculated with the following formula:

$$V_i(s) = \sum_{t=s}^{+\infty} \frac{v_i(t) sur_i(t)}{(1+r)^{t-s}}$$

where v_i(t) denotes a given expected monetary quantity at time $t \geq s$, $sur_i(t)$ the conditional probability of survival, and *r* an appropriate discount rate. Variables considered for estimates were sex, age at diagnosis, sector of employment and year of diagnosis (Table I). The corresponding aggregate component of the total population of mesothelioma patients *I* at time s then was:

$$X(s) = \sum_i V_i(s)$$

Social costs (loss of productivity)

Two approaches were available to measure the overall economic impact of a reduction in the labor force. First, one can estimate how much production changes if the number of workers decreases by *n* units. Given *Y*(*L*) denoting real yearly GDP and *L* the available labor force the social cost per year is:

$$\text{Product Loss}=Y(L) - Y(L-n) \simeq n \frac{\partial Y}{\partial L}$$

where $\frac{\partial Y}{\partial L}$ is marginal labor productivity.

Alternatively, one can assess the monetary value of the labor force, for instance with Jorgensen and Fraumeni's standardized method. This approach is designed to measure human capital like any other physical capital, at its market price, namely gross earnings. Mathematically, yearly human capital loss generated by an individual with gross earnings *w* is equal to:

$$\text{Human capital loss} = n \cdot w$$

While the two measures coincide, as long as $w=\frac{\partial Y}{\partial L}$ (a common assumption in the main economic theories), we used the second approach since available data permitted more accurate (and computationally simpler) estimates. Because the labor force reduction caused by mesothelioma is permanent, human capital loss is measured by the discounted sum of present future earnings:

$$HC_i(s) = \sum_{t=s}^{\infty} \frac{y_i(t)}{(1+r)^t}$$

where $y_i(t)$ is the earnings at time $t \geq s$ and r an appropriate discount rate. The aggregate human capital loss was therefore:

$$HC\ (s) = \sum_{i \in I} HC_i(s)$$

where *I* is the set of individuals with mesothelioma. In detail, potential incomes the subjects with mesothelioma would have earned if they had not died were estimated on the basis of the

information available from ReNaM. Taking *X* as all observed variables affecting potential earnings, they were calculated for each mesothelioma case as follows:

$$y_i(s) = e(s|X_i)p(s|X_i)q(s|X_i)$$

where $e(s|X)$, $p(s|X)$, and $q(s|X)$ denote respectively the average gross labor income, the average probability of being alive and the average probability of being employed at time *s* for an individual with characteristics *X*.