THE REVISION OF PENNSYLVANIA COMPENSATION INSURANCE RATES, 1918.

BY

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The revision of Pennsylvania compensation insurance rates in October, 1918, is notable for several innovations which had been approved, officially or unofficially, by many actuaries and underwriters, but had not theretofore found practical application in rate making. The more important of these innovations are:

1. The deliberate limitation of experience, in point both of time and of geographical distribution, for the sake of greater homogeneity.

2. The emphasis upon industry-group experience as the basis of classification rates.

3. The combination of experience from different states by means of (*a*) *partial reduction factors* corresponding to the "law differential" for each nature of loss (death, permanent total, permanent partial, temporary and medical); (*b*) *experience differentials* for temporary disability and medical losses, and (*c*) *average values* for deaths and permanent totals.

4. The introduction of accident severity rates as an element in rate making.

5. The incorporation of a "wage level" factor for the modification of the rate level.

6. The use of a graded expense loading.[1]

7. The presentation of statistical experience in a form convenient for committee use.

8. The printing of the manual by industry groups.

None of these departures from traditional practice was strictly new; yet, taken in the aggregate, they constitute a somewhat novel rate revision.

[1] A graded expense loading was suggested by Mr. Woodward to the Actuarial Committee of the Augmented Standing Committee, 1917, and was adopted by the Pennsylvania Compensation Rating & Inspection Bureau in the revision of August, 1917.

I.

Pure premium experience, as every associate knows, is dependable for rate projection only in so far as the exposure is adequate in volume and homogeneous in composition. Roughly it may be said that the volume of losses should be such that the addition or subtraction of a single death would not affect the total by more than one or two per cent.[2] But adequate volume alone is not sufficient: the experience relied upon should represent the same or similar conditions with respect to wage level, business activity, character of working personnel, industrial methods and processes—in fine, so nearly as may be, the same accident frequency and severity as the period and State for which the rates are to be projected. These two criteria mutually limit each other. The shorter the time and the narrower the area from which the experience is taken, the more homogeneous will be its composition, but also the less adequate will be the volume of exposure. Conversely, the longer the period and the wider the area covered by the experience data, the less homogeneous, and thereby the less dependable, will be the statistical average. In practice some compromise of these conflicting requirements is usually necessary.

The Actuarial Committee[3] of the Pennsylvania Compensation Rating & Inspection Bureau, having regard to the above-mentioned criteria, decided to limit the review of experience to Pennsylvania, New York, Massachusetts and New Jersey Schedule "Z" for the policy year 1916. This limitation assured a high degree of homogeneity as respects general industrial conditions, while it brought the whole experience within the initial period of war activity. The four states in question have a wide range and huge volume of

[2] For practical purposes, $100,000 of losses under Pennsylvania 1915 scale of benefits may be accepted as a reasonably adequate exposure for classification rate making. This volume of losses, according to the aggregate of Schedule Z experience of 1916, would "normally" be distributed as follows:

Nature of Loss. 1	No. of Accidents. 2	Amount. 3
Death	15	$26,000
Permanent total disability	1	3,000
Major permanent partial disability	15	15,000
Temporary disabilities (over two weeks)	640	36,000
Medical, all cases	—	20,000

This distribution will, of course, vary from industry to industry.

[3] Messrs. Mowbray, Black, Moore, Scheitlin, Nicholas, Mullaney, Pennock and Kime.

industry, they are presumably not dissimilar in the processes and products covered by the same industry classifications, their recorded experience was susceptible of loss analysis by nature of injury, and it was believed that the reported classifications and losses had been more carefully ascertained than is the case in non-Schedule "Z" states.[4] In short, the committee believed that the gain in volume from the inclusion of other experience would be more than offset by the loss of comparability.

Unfortunately the results of New Jersey's Schedule "Z" were not received in time for utilization. Nevertheless, the aggregate exposure presented to the Classification Committee represented $3,000,000,000 of audited payroll, whereof approximately one third was Pennsylvania experience. This is exclusive of $150,000,000 of Pennsylvania coal mine payroll. The total experience so obtained was distributed into 280 industry-groups, treated as rate-making units. An exposure amounting to at least $100,000 of "reduced" losses was obtained on 34 of these groups, to at least $50,000 on 71 groups, and to at least $25,000 on 120 groups.[5] The remaining 160 groups represented less than 15 per cent. of total losses. On these minor classifications the former "selected pure premium" was re-affirmed on the ground that the exposure was insufficient to warrant change.

With respect to homogeneity, the Pennsylvania pure premium was almost identical with the combined reduced pure premium on

[4] On the same general grounds, the Massachusetts, New York, New Jersey, and Pennsylvania Insurance Departments have recommended to the National Council on Workmen's Compensation Insurance that in future rate revisions for these states only "Schedule Z" experience shall be considered.

[5] FREQUENCY DISTRIBUTION OF INDUSTRY GROUPS BY VOLUME OF LOSSES—PENNSYLVANIA, NEW YORK AND MASSACHUSETTS EXPERIENCE, 1916.
Pennsylvania Rate Revision, 1918.

Volume of Losses.	No. of Groups.
All groups	280
Under $10,000	80
$10,000 and under $25,000	80
$25,000 and under $50,000	49
$50,000 and under $75,000	26
$75,000 and under $100,000	11
$100,000 and over	34

The 120 groups with losses over $25,000 each represented 85 per cent. of the total losses and the 71 groups with losses over $50,000 each represented 70 per cent. of the total losses.

practically every classification for which there was substantial experience both in Pennsylvania and in the other states whose experience was utilized.[6] The marked exceptions were those classifications in which the payroll of one state greatly predominated.

II.

The grouping of industry classifications by analogy of hazard for rate-making purposes is older than workmen's compensation insurance in the United States. The earliest systematic attempt at such grouping, however, was that utilized by the Augmented Standing Committee of 1917.[7] Subsequently to that date the grouping then used was revised and systematized by the so-called "Informal Committee,"[8] which reported jointly to the National Reference Committee on Compensation Insurance Rates and to the Association of Industrial Accident Boards and Commissions. The grouping so evolved by the Informal Committee was used, with few exceptions, in the Pennsylvania rate revision.

The end proposed by the Informal Committee was to bring together, so far as possible, those industries which are closely similar in kind and degree of accident hazard. Within the broad divi-

[6] The close correspondence of Pennsylvania with combined pure premiums will be apparent from the following table:

PENNSYLVANIA, NEW YORK AND MASSACHUSETTS "SCHEDULE Z" EXPERIENCE POLICY YEAR 1916.

Industry. 1.	Payroll (000 Omitted).		Pure Premium.	
	Pennsylvania. 2.	Combined. 3.	Pennsylvania. 4.	Combined. 5.
Iron foundries	$17,277	$26,209	$.63	$.64
Stove foundries	4,608	11,695	.62	.60
Forging	7,204	11,999	.78	.79
Cutlery and tools	5,931	19,070	.31	.32
Machine shops	42,337	88,922	.56	.55
Brick	11,633	14,772	.78	.79
Glassware	9,834	13,536	.192	.198
House construction	15,850	33,056	.78	.81

[7] The grouping used by the Augmented Standing Committee was developed largely upon the basis of a preliminary grouping by Dr. I. M. Rubinow by the joint labors of the Statistical Committees of the International Association of Industrial Accident Boards and Commissions and of the National Workmen's Compensation Service Bureau.

[8] Messrs. Hatch, Verrill, Magoun, Michelbacher and Downey. Messrs. Duffy, Meltzer, Alberti and Kelly attended certain sessions.

sions—agriculture, mining, manufacturing, construction, transportation, trade—the committee sought to arrange industrial enterprises, first by kind of materials worked with, and second by processes used. In this way the 1,500 manual classifications were thrown into some 300 ultimate groups, each more or less homogeneous within itself. The grouping so attained still leaves much to be desired, owing both to insufficient knowledge on the part of the committee, and to difficulties inherent in the disparate bases of the manual classifications themselves.[9] Nevertheless, it is believed that a majority of the committee's groups are reasonably homogeneous; a belief which was well substantiated by the results of compiling New York, Pennsylvania and Massachusetts Schedule "Z" experience in accordance with these groups.

The purposes served by grouping classification experience in the manner above described are: (*a*) to secure a more adequate exposure, particularly for minor classifications, and (*b*) to avoid inconsistencies in rates for classifications of substantially similar hazard. There is no reason to suppose, *e.g.*, that "stair building," "window strip installation" or "parquet floor laying" differs essentially, in point of hazard, from other branches of interior carpentry, or that a pure premium divergence as between "printing press manufacturing" and "machine shops" signifies anything but insufficient volume of exposure. Even where there are significant differences of pure premium between related industries, as between "cement quarrying" and "slate quarrying," it is advantageous to compare the two experiences.

For the reasons just recited, the Classification Committee of the Pennsylvania Bureau relied more upon group experience than upon the experience of individual classifications. In a majority of instances the group pure premium was adopted for all classifications within the group; in other cases the group death and permanent pure premium was combined with the medical and temporary pure premium of specific classifications. In a few cases, however, the group result was ignored, and the pure premium of the predominant classification applied to the entire group.

[9] See Downey, "Classification of Industries for Compensation Insurance," *Proceedings*, II, 10–24.

III.

The weaknesses of the "flat" or average "law differential" have been so fully expounded in the *Proceedings* of this society[10] that further animadversion upon that head would be out of place. Whatever may once have been the case, actuaries now recognize that the ratio of deaths to permanent disabilities and of both to temporary disabilities varies widely from industry to industry, and, consequently, that an average differential between unlike scales of benefits is erroneous for every industry that departs from the average in relative frequency of death and permanent disability.[11] If, indeed, compensation scales differed by a uniform percentage, the

[10] See, especially, Rubinow, "Theory and Practice of Law Differentials," *Proceedings*, IV, 8–44, and discussion, IV, 366–382.

What has been said here or elsewhere in criticism of the flat law differential implies no aspersion upon the *Standard Accident Table* nor upon the methods which are necessarily used in the early attempts to combine the experience of different jurisdictions. The Standard Table is more than a magnified piece of pioneer statistical work, accomplished under great difficulties and with meagre materials: it retains a high permanent value for all students of accident experience. The flat law differential also represented a great advance in its day. Only, with the accumulation of statistical experience and the increase of actuarial knowledge, more refined and more accurate methods have become feasible.

[11] The following exhibit from Pennsylvania Schedule Z, 1916, will sufficiently illustrate the point:

Industry.	Payroll (000 Omitted).	Losses.	No. of Comp. Accidents.			Pure Premium.		
			D. and P. T.	All.	Ratio.	D. and P.	All.	Per Cent. D. and P.
1.	2.	3.	4.	5.	6.	7.	8.	9.
ALL INDUSTRIES	$1,234,045	$7,734,202	1,340	46,543	1:35	$ .34	$ .63	54
Anth. coal mining	18,686	516,282	131	1,819	1:14	1.96	2.77	70
Bit. coal mining.	125,176	2,026,611	384	9,858	1:26	.96	1.62	59
Quarrying	13,338	219,632	46	980	1:22	1.07	1.65	65
All manufacturing.....	542,784	2,655,472	337	20,561	1:61	.22	.49	45
Textiles	89,421	148,194	16	1,328	1:83	.06	.17	35
Blast furnaces ..	4,521	87,063	20	324	1:16	1.20	1.92	65
Iron foundries ..	13,410	93,031	13	900	1:69	.26	.70	40
Machine shops ..	33,158	192,717	17	1,397	1:82	.21	.56	38
Building construction	69,417	814,708	132	4,077	1:31	.57	1.17	49
Carpentry N.O.C.	4,190	86,689	8	525	1:66	.42	2.07	33
Masonry N. O. C.	4,293	81,156	16	283	1:11	.72	1.88	59
Stores	123,256	337,963	59	2,793	1:47	.12	.27	45
Clerical office ...	124,874	25,370	6	101	1:17	.01	.02	50

average differential would be universally valid. Such, however, is far from being the case. Pennsylvania death benefits, *e.g.*, are to those of New York approximately as 4 to 7; permanent total disability benefits as 1 to 3; major permanent disability benefits as 1 to 2; temporary disability benefits as 2 to 3; and medical benefits as 3 to 5. In face of such diverse ratios a basic pure premium is meaningless and the combination of experience or projection of rates by means of flat reduction factors is misleading.[12]

Accepting these premises, the Actuarial Committee of the Pennsylvania Compensation Rating and Inspection Bureau directed that losses be analyzed into death, permanent total, permanent partial, temporary and medical benefits, and that the losses of other states be reduced to the Pennsylvania 1916 level by applying separate reduction factors to each type of loss. The "reduced" losses were then divided by the combined payroll and the resultant fractional pure premiums added to a total. The "reduced" pure premiums so obtained bore, of course, a varying ratio to the reported New York and Massachusetts pure premiums, dependent upon the accident-severity composition of New York and Massachusetts losses.

In practice the method projected by the Actuarial Committee was not fully realized because it was not possible to analyze the losses of the several states upon a strictly comparable basis. The methods actually employed are more fully set out below.

Three methods have at different times been projected or employed for reducing losses experienced under dissimilar scales of

[12] The National Actuarial Committee has voted to convert the experience of all states to the level of New York benefits for a combined total. Such total would be extremely useful for comparing the level of benefits in different states, and as a convenient comparative measure of industrial hazard. It would also, of course, be available for rate making in New York. The basic pure premiums so obtained could not, however, be used for rate making in any state other than New York. It would be necessary to reconvert these pure premiums by separate reduction factors applied to each fractional pure premium. The double operation of conversion from the reporting state to New York and from New York to the state for which rates to be projected, would simply multiply the error inherent in any method of arriving at differentials or reduction factors. The acceptance of the principle of partial law differentials—or of less analyses by nature of injury—carries with it the abandonment of the whole theory and practice of basis pure premiums. This fact has latterly been recognized by the Insurance Departments of New York, New Jersey, Massachusetts and Pennsylvania in a memorandum submitted to the National Council on Workmen's Compensation Insurance.

benefit to a common denominator. (*a*) The so-called "actuarial" or "theoretical" method computes the cost of compensation under any given act by applying the legal scale of benefits to a standard frequency-distribution of accidents by severity of injury. The total cost so calculated is divided by the total calculated cost of the same accidents under a standard or "basic" act to obtain the "law differential," which is then used to convert the reported losses under the given act to the level of the basic act.[13] This method has hitherto been employed in conjunction with a flat "law differential," but it is equally applicable to the development of partial or fractional differentials. (*b*) The "loss experience" method consists in comparing realized pure premiums for a large number of classifications and arriving thereby at an average ratio which is then applied to the reported losses of each classification in turn.[14] This method has been advocated only in connection with partial differentials. (*c*) Lastly, the reported monetary losses may be ignored and the projected losses for a given jurisdiction arrived at by applying to the reported accidents of each jurisdiction the experienced average cost of similar injuries in the given jurisdiction.[15] For brevity's sake this *modus operandi* may be styled the "accident experience," in contra-distinction from the "loss experience" method. Each of these methods has its own weaknesses and its own field of peculiar applicability.

The *à priori* ("theoretical") cost calculation must perforce be used for projecting losses under an untried scale of benefits, but it has the defect of all *à priori* reasoning—that the hypotheses may not fully cover the facts. The compensation of work accidents depends upon many circumstances besides the bare legal provisions: *e.g.*, upon administrative and judicial interpretation, supervision of claim settlements, and the opportunities for reëmployment after injury. Further, the actually realized death and permanent total disability losses in a particular classification are not an indication of probable losses even within the same jurisdiction, unless the number of such accidents is large enough to establish a dependable

[13] This was the method employed for all "law differentials" calculated prior to 1918.

[14] The use of an experience differential was proposed by Messrs. Mowbray and Black to the Actuarial Committee of the Augmented Standing Committee, 1917. Credit for further development of the idea is due especially to Messrs. Greene and Moore.

[15] For discussion of this proposal see *Proceedings*, IV, pp. 372–376.

average cost.[16] Whence it happens that the combination of these losses by means of a "reduction factor," whether "theoretical" or derived from experience, gives erratic and sometimes absurd results.

The "loss experience" differential has the very great advantage that it combines within itself all the causes, known or unknown, of pure premium divergence: benefit scales, wage levels, industrial activity, age of act, or inherent hazard. It is, however, subject to the same weakness as any other loss differential in respect to deaths and permanent total disabilities. Temporary and medical losses are its special province. It is, indeed, the only available method of combining medical losses. Medical costs vary not only with statutory requirements, but with the practice of insurance carriers in respect to voluntary medical care, with the prevalence of plant hospitals, with the fee, contract and salary systems of medical payment, and with the availability of free treatment in state-aided institutions.[17] Any calculation of these manifold cost elements in advance of experience is, at best, highly conjectural.

The "accident experience" method, finally, is especially appropriate for the projection of death and permanent disability losses. A death under the Pennsylvania Act may cost anything from $100 to $8,500, according to wages and number of dependents; a per-

[16] The frequency distribution of deaths by manual classifications in Pennsylvania Schedule Z experience, 1916, is shown below:

No. of Deaths in Each Classification.	No. of Classifications.	Aggregate No. of Deaths.
Total	1,203	1,276
0	934	0
1	141	141
2 and under 5	82	225
5 and under 10	29	195
10 and under 100	15	225
Over 100	2	490

It will be seen that more than three fourths of the classifications for which losses were reported showed no deaths, that two thirds of the remainder showed fewer than five deaths each, and that only 17 classifications out of 1,200 had enough deaths to indicate a dependable classification average cost. Seven twelfths of all the deaths occurred in these 17 classifications—40 per cent. of the total in two classifications.

[17] The low cost of medical benefits under the Pennsylvania Compensation Act, particularly in the coal mining industry, is due in part to free treatment in the state-aided hospitals. Twenty-eight such hospitals incurred costs of $60,000 in one year over and above the sums paid in pursuance of the Compensation Act.

manent total disability under the New York Act may cost a few hundred dollars in the event of early death, or $20,000 if the victim be young and long-lived. That thesingle death in the classification "jewelry stores" actually cost $5,500, while two deaths in "grease manufacturing" cost $170; that a permanent total disability in "woolen and worsted spinning" was reported at $565, and a like injury in "cutlery manufacturing" at $18,000—signifies nothing for the projected pure premium of any of these classifications. The like observation would hold true of serious permanent partial disabilities if compensated—as in all equity they should be—by life pensions. Wherever the number of occurrences is small and the fortuitous range of cost extreme, the average cost of accident method is indicated. For other classes of injury, the "loss experience" differential will give more dependable results with less labor.

In practice, the actuarial committee adopted a combination of the "accident experience" and "loss experience" methods. To project death and permanent total disability losses on the basis of Pennsylvania benefits, the reported number of such accidents in each state was multiplied by the average cost in Pennsylvania, without regard to the reported monetary losses in the particular classification. It was recognized, of course, that a general average for all industries is not valid for each industry: high or low average wages and high or low average dependency are characteristic of certain employments.[18] In a few very important industries—bituminous and anthracite mining, stone quarrying, iron and steel manufacturing, building construction—the number of deaths was great enough to establish a dependable specific average cost, which was accordingly used. For other industries, however, the general average was thought to be more dependable than any conjectural deviation. Permanent total disabilities were taken at the uniform average value of $3,000 for all classifications. Probably the method since adopted by the National Actuarial Committee, of combining deaths with permanent totals and applying the resultant average value to both, is preferable to the procedure followed by the Pennsylvania Committee. Losses other than death and permanent total disability were reduced to the Pennsylvania level by means of "loss experience" differentials.

Adequate handling of permanent partial disabilities would require their separation into major and minor. In most American

[18] The following table shows the average weekly earnings and dependency distribution for death cases in certain leading industries as disclosed by Pennsylvania Schedule Z, 1916.

It will be seen from Column 9 that the number of dependents per fatality, which was 1.70 for all industries, ranged from 1.21 in "Construction, Not Building"—a "floater's" occupation—to 2.11 in coal mining.

Column 11 shows how the combined effect of relative dependency and wage level affects the average death cost.

Industry Schedule.	No. of Deaths.	No. with Specified Number of Dependents.					No. of Dependents.	Av. No. of Dependents.	Average Weekly Wage.	Average Cost of Death.
		None.	One.	Two.	Three.	Four or More.				
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
ALL SCHEDULES	1,276	387	376	144	118	251	2,173	1.70	$16	$2,025
All manufacturing	316	84	106	45	32	49	538	1.70	15	2,000
Iron and steel manufacturing	70	27*	17	8	9	9	106	1.51	18	2,000
Metal working and machinery manufacturing	91	14	36	14	12	15	175	1.92	18	2,200
Coal mining	490	159	105	55	40	131	1,034	2.11	21	2,500
Quarrying	44	15	14	2	3	10	75	1.70	15	2,200
Construction—not building	65	28	15	12	4	6	79	1.21	19	1,850
Building erection	125	41	38	10	12	24	202	1.61	19	2,200
Cartage and trucking	50	15	12	8	7	8	85	1.70	14	1,800

* Of these 27 cases, 10 had unascertained alien dependents. For blast furnaces and open hearths the number of dependents per fatality was 1.89 and the average cost $2,500.

jurisdictions disabilities of this class are compensated for limited periods under "specific indemnity schedules." But these schedules differ both in respect to the injuries covered and in respect to relative, as well as absolue, compensation for the same injury. Wisconsin, *e.g.*, awards relatively large amounts for serious and relatively small amounts for minor dismemberments. In New Jersey the precise reverse is the case. In Pennsylvania the enumerated injuries include only loss or complete loss of use of arm, hand, leg, foot or eye; minor injuries, in general, are compensated only as temporary disabilities during the healing period. In New York the specific schedule includes nearly every conceivable injury of a permanent character and compensation thereunder is practically exclusive. In Massachusetts the list is somewhat comprehensive, but has little to do with the compensation paid.

All these variations are susceptible of intelligent treatment if only the number and cost of these accidents are reported in sufficient detail. For the major disabilities enumerated in the Pennsylvania Act, *e.g.*, a sufficiently accurate reduction factor as between New York and Pennsylvania or Pennsylvania and New Jersey could be calculated *à priori* or derived from loss experience. Since, however, the ratio of compensation, as between Pennsylvania and New York or New York is not the same for major and minor permanent injuries; since, moreover, the frequency distribution of such injuries is not the same for all industries—arm and leg injuries predominating in the building trades, eye injuries in stone, glass and clay working, hard and arm injuries in the textile trades, finger injuries in metal stamping[19]—a flat reduction factor for

[19] The following table compiled from unpublished reports of the Pennsylvania Department of Labor and Industry shows the relative frequency of major permanent partial disabilities in Pennsylvania:

	Loss of					
	All.	Eye.	Hand.	Arm.	Foot.	Leg.
ALL	100	52	23	7	10	8
Mines	100	54	14	6	14	12
Food	100	25	58	5	10	2
Testiles	100	19	52	24	5	—
Paper	100	17	69	11	3	—
Wood	100	44	48	5		3
Metal	100	55	23	7	9	6
Clay, glass, stone	100	59	18	9	12	2
Public service	100	41	13	5	17	14

permanent partial disabilities taken in the lump is necessarily fallacious.

Unfortunately for the realization of these principles, the requisite analysis had not been made in the reported experience. New York Schedule "Z" gave the number and cost of permanent partials in one lump; Pennsylvania Schedule "Z" gave the number and cost of *major*, but not of minor permanents; Massachusetts Schedule "Z" gave neither the number nor the cost of permanent, as distinguished from temporary disabilities.[20] Nothing remained, therefore, but to lump permanent partial with temporary disabilities for the purpose of combining experience.

Two sets of experience differentials, accordingly, were calculated for each state whose experience was to be utilized: (1) "permanent partial and temporary" and (2) "medical." The method of calculation was:

(*a*) Determine for each representative classification—

1. Pennsylvania losses,
2. Pennsylvania pure premium (π),
3. Massachusetts losses,
4. Massachusetts pure premium (π),
5. Pennsylvania pure premium $\times$ Massachusetts payroll,
6. Massachusetts pure premium $\times$ Pennsylvania payroll;

(*b*) Add the products of Pennsylvania pure premiums by Massachusetts payrolls and of Massachusetts pure premiums by Pennsylvania payrolls to schedule and grand totals;

(*c*) Then—

$$\text{Reduction factor} = \tfrac{1}{2}\left(\frac{\pi_M \times \text{Mass. Payroll}}{\text{Penna. Losses}} + \frac{\pi_P \times \text{Mass. Payroll}}{\text{Mass. Losses}}\right)$$

The process is illustrated by Table II. Table III shows the results of the calculations exhibited in Table II.

This calculation was made for every classification which had developed as much as $1,000,000 of payroll in each state. The mean Pennsylvania reduction factors so obtained were .52 for New York and .60 for Massachusetts permanent partial and temporary losses, .60 for New York and .65 for Massachusetts medical losses.

[20] Massachusetts losses are analyzed by "kind of benefit"—a wholly irrelevant category—not by "nature and severity of injury." The amounts appearing in the "specific indemnity" column are the benefits paid *eo nomine;* the bulk of the compensation for permanent partial disabilities is combined with temporary disability benefits under the caption "weekly indemnity."

This method proved extremely laborious and the results not wholly satisfactory. Thus the Pennsylvania reduction factor for Massachusetts medical losses was .58 by the direct, .71 by the inverse calculation; the range by industry schedules was from .44 to .85, and the extreme divergence between the direct and inverse calculations for any one schedule was .16 (see Table III). These marked divergences are due in great part to dissimilar payroll distribution by industries. Some striking instances of such dissimilarity are shown below (Table I). Obviously the multiplication of the Massachusetts "small arms" or "cotton spinning" payroll by the Pennsylvania pure premium will produce a widely different result in the schedule total from the reverse process. To avoid the effect of such undue weighting care should be had to exclude classi-

TABLE I.

CONTRASTING INDUSTRY DISTRIBUTION IN PENNSYLVANIA AND MASSACHUSETTS.

Industry.	Massachusetts.		Pennsylvania.	
	Payroll (000 Omitted).	Medical Pure Premium.	Payroll (000 Omitted).	Medical Pure Premium.
1.	2.	3.	4.	5.
Boot and shoe manufacturing	$57,900	$.063	$8,439	$.031
Cotton spinning and weaving	59,361	.092	4,965	.038
Iron foundries	4,305	.247	13,410	.195
Machine shops	15,683	.255	33,158	.182
Small arms manufacturing	10,134	.138	629	.213

fications which show a large payroll in one state and a petty exposure in the other—a point not sufficiently regarded by the present writers when computing the Pennsylvania-Massachusetts experience differentials. The inverse calculation was, in fact, biased by the coincidence of large Massachusetts payrolls with high Pennsylvania pure premiums for classifications nowise characteristic of Pennsylvania industry. Errors of sampling apart, payroll weighting gives full effect to undetected misreporting of losses. An error of this class is strongly indicated by the exhibit in Table IV. That the same industry, under like conditions and upon substantial exposures, show show a divergence of 1,000 per cent. in medical cost is more difficult to credit than that some insurance carrier reported cents for dollars or assigned the medical losses to another classi-

TABLE II.

COMPUTATION OF PENNSYLVANIA-MASSACHUSETTS MEDICAL DIFFERENTIAL.

Industries.	Penna. 1916 Policy Year.				Mass. 1916 Policy Year.				Differentials.	
	Payroll (000 Omitted.	Med. Losses.	Penna. π 3÷2.	Mass. $\pi \times$ Penna. Payroll. 2x8.	Payroll (000 Omitted.	Med. Losses.	Mass. π 7÷6.	Penna. $\pi \times$ Mass. Payroll. 6x4.	Direct 3÷5.	Inverse 9÷7.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
ALL INDUSTRIES	$460,942	$470,037	$.102	$811,287	$443,007	$611,982	$.139	$435,751	.58	.71
Foods, beverages, tobacco	18,244	24,744	.138	36,279	10,251	17,940	.179	12,763	.68	.71
Bakeries	6,506	7,215	.111	11,255	3,336	5,766	.173	3,703	.64	.64
Sugar refining	1,772	1,736	.098	2,180	1,135	1,401	.123	1,113	.79	.79
Confectionery manufacturing	3,255	3,286	.101	3,873	8,495	4,161	.119	3,529	.85	.85
Packing houses	986	2,816	.287	3,916	455	1,807	.397	1,307	.71	.71
Breweries	5,724	9,671	.169	15,055	1,830	4,805	.263	3,111	.64	.64
Textiles	56,361	26,440	.047	45,281	112,548	101,344	.090	68,742	.58	.68
Yarn manufacturing	4,205	2,615	.062	6,613	3,703	5,297	.143	2,296	.43	.43
Cotton spinning and weaving	4,345	1,756	.040	4,002	59,361	54,680	.092	23,745	.44	.44
Wool spinning and weaving	10,383	9,477	.091	7,787	36,407	27,174	.075	33,130	1.21	1.21
Silk manufacturing	24,506	5,529	.023	14,213	3,092	1,807	.058	680	.40	.40
Knit goods manufacturing	5,006	1,916	.038	3,404	1,985	1,353	.068	754	.56	.56
Carpet manufacturing	5,176	1,836	.035	5,176	3,328	3,339	.100	1,165	.35	.35
Textile finishing	1,579	2,573	.163	2,558	4,041	6,529	.162	6,587	1.00	1.00
Bleaching	1,156	738	.061	2,128	632	1,165	.184	385	.35	.35
Care and custody	26,550	13,213	.050	25,490	18,401	18,099	.100	9,148	.52	.51
Office buildings	5,768	2,835	.049	5,075	4,241	3,739	.088	1,654	.56	.56
Hotels	12,535	5,920	.047	12,410	7,209	7,137	.099	3,388	.48	.48
Restaurants	5,951	3,987	.067	6,904	5,754	6,652	.116	3,855	.58	.58
Clubs	2,296	471	.021	1,101	1,196	571	.048	251	.43	.43
Leather	12,380	6,510	.054	10,834	65,125	46,790	.072	25,029	.60	.53
Tanning	3,941	3,879	.098	5,518	7,224	10,115	.140	7,080	.70	.70
Boot and shoe manufacturing	8,439	2,331	.031	5,316	57,901	36,675	.063	17,949	.50	.50
Printing	20,502	10,201	.050	11,917	11,225	6,919	.063	5,387	.85	.78
Printing, N.O.C.	12,531	6,839	.055	6,767	5,479	2,952	.054	3,014	1.01	1.01
Newspaper publishing	5,008	2,388	.048	3,606	3,184	2,297	.072	1,528	.66	.66
Publishing, N.O.C.	2,232	731	.033	1,005	1,155	516	.045	381	.73	.73
Bookbinding	8,301	243	.033	599	1,407	1,154	.082	464	.41	.41

fication.[21] Notwithstanding these and perhaps other sources of error, the mean differentials calculated in the manner above described are probably not wide of the mark.

TABLE III.

PENNSYLVANIA-MASSACHUSETTS MEDICAL DIFFERENTIAL.

Schedule. 1.	Simple Average of Pure Premiums. 2.	Weighted Differential. Mean. 3.	Direct. 4.	Inverse. 5.	Divergences. Simple. 6.	Mean W. 7.
ALL CLASSIFICATIONS.....	.67	.65	.58	.71		
5. Food.....	.73	.69	.68	.71	.06	.06
6. Textiles.....	.60	.63	.58	.68	.07	.02
7. Clothing.....	.64	.68	.68	.67	.03	.03
9. Leather.....	.60	.67	.60	.53	.07	.02
11. Paper.....	.73	.82	.78	.86	.06	.17
13. Printing.....	.71	.82	.85	.78	.04	.17
17. Metal goods.....	.62	.70	.68	.71	.05	.05
18. Machine manufacturing...	.74	.77	.69	.85	.07	.12
27. Construction.....	.53	.47	.44	.50	.14	.18
32. Drivers and chauffeurs....	.60	.53	.53	.52	.07	.12
34. Commercial.....	.67	.64	.63	.64	.00	.01
36. Care, custody, maintenance	.61	.52	.52	.51	.06	.09

TABLE IV.

CLASSIFICATION 6042. ROAD OR STREET MAKING.

State. 1.	Payroll. 2.	Medical Losses. 3.	Pure Premium. 4.	Reduction Factor. 5.
Pennsylvania.....	$5,325,400	$ 3,831	$.072	$1.00
New York.....	5,478,000	17,167	.313	.23
Massachusetts.....	1,602,800	11,582	.723	.10

It is likely that a simpler procedure would yield better results, and with far less labor. Obviously, for any one classification,

$$\frac{\text{Penna. losses}}{\text{Mass. pure premium} \times \text{Penna. payroll}} = \frac{\text{Penna. pure premium}}{\text{Mass. pure premium}}.$$

For any one classification, moreover, the inverse calculation necessarily gives the same quotient as the direct. For particular clas-

[21] An error in pointing off was responsible for a discrepancy of $3,000,000 in the reported Logging payroll for Pennsylvania. Errors in punching code numbers transferred nineteen fatalities from anthracite to bituminous mining and produced Pennsylvania payrolls in "gold mining" and "cotton compressing."

sifications, in other words, the ratios sought are ratios of pure premiums under the two scales of benefit. If then the pure premium ratios are computed for a sufficient number of classifications—care being had to exclude classifications which developed either a small exposure or a clearly abnormal pure premium in one or the other state—the simple average of these ratios will probably represent the true law differential.[22] This method avoids the laborious multiplication of the classification payrolls of each state by the classification pure premiums of the other. That it gives more dependable results than the method used in the Pennsylvania rate revision is indicated by Table III, whereby it will be seen that the simple averages of pure premium ratios (Column 2) for industry schedules deviates less widely from the grand average than do the weighted averages (Columns 3, 4 and 5). The same table shows a fairly close agreement between the grand average of pure premium ratios (.67) and the mean of the grand weighted averages (.65)—a fact which again confirms the general accuracy of the method.

TABLE V.

PENNSYLVANIA-MASSACHUSETTS MEDICAL REDUCTION FACTOR
SCHEDULE 27—BUILDING ERECTION.

Classification. 1.	Penna. Medical Losses. 2.	$\pi_M \times$ Penna. Payroll. 3.	Reduction Factor, 2 ÷ 3. 4.
SCHEDULE TOTAL	$111,067	$209,562	.53
5190. Electrical equip.—instal.	2,206	4,977	.44
5602. Additions	3,012	6,720	.45
5643. Residences—carpentry	8,695	13,840	.63
5401. Carpentry—N.O.C.	12,287	22,946	.54
5002. Masonry—N.O.C.	9,767	14,977	.65
5204. Concrete construction	5,715	13,131	.44
5209–10. Concrete foundations	7,128	13,249	.54
5183. Plumbing	5,226	8,551	.61
5461–90. Painting	3,811	8,958	.43
5480. Plastering	2,358	3,956	.60

The rather wide divergencies of schedule averages from the grand average, exhibited by Table III, are probably due in most instances to chance fluctuations in pure premiums. Medical aid for a single serious accident may easily cost $500—enough to cause a variation of fifty per cent. in the medical pure premium on $1,000,000 of

[22] This is Mr. Kelly's suggestion.

machine shop payroll. When it is added that the number of classifications in any given schedule which developed $1,000,000 of payroll in both Massachusetts and Pennsylvania was quite small, it will be seen that one or two serious injuries in either state might markedly affect the medical differential for the entire schedule. For this reason the grand average is probably more to be depended upon than any schedule deviation therefrom. Table V, however, appears to show a consistently lower ratio of Pennsylvania to Massachusetts pure premiums for the building industry than for industry at large.

All law differential calculations heretofore have proceeded upon an assumed normal distribution of accidents by severity of injury as ultimately developed in a mature experience. Practical exigencies shall be considered in rate making. In an immature experience, as is well known, a large proportion of major permanent disabilities have not disclosed themselves as such and are commonly carried on the books of the insurer as "temporary disabilities."[23] It is on this class of undeveloped permanents and deferred deaths

TABLE VI.

REPORTED AND EXPECTED FREQUENCY DISTRIBUTION OF ACCIDENTS BY SEVERITY OF INJURY—PENNSYLVANIA SCHEDULE "Z," 1916.

Severity of Injury 1	No. Reported. 2	No. Expected. 3
1. ALL ACCIDENTS	46,543	46,543
2. Deaths	1,276	1,276
3. Permanent totals	64	85
4. Major permanent partials	853	1,200
5. Temporaries	43,460	43,982
6. Indeterminates	890	

that underestimates of outstandings commonly occur. Known deaths and permanent disabilities can, under most compensation acts, be valued in accordance with definite rules. Closed cases of temporary disability require no reserves. Medical outstandings can be ascertained with approximate accuracy at a date three months after the close of the policy year. But the incurable opti-

[23] Investigation disclosed that several permanent totals in Pennsylvania Schedule Z, 1916, were grossly underestimated by the insurance carrier from failure to revise the "temporary" reserve when the severity of the accident was finally discovered. In the reporting of individual risk experience for experience rating "temporary disabilities" have not infrequently been set down at such impossible values as $2,000.

mism of claim adjusters produces a persistent underestimate of ultimate liability on injuries of indeterminate severity.

For this reason the Pennsylvania Insurance Department called for a separate statement of "indeterminates"—*i. e.*, injuries the ultimate severity of which was unascertained at the date of reporting. The result is exhibited below (Table VI).

From the Rubinow Standard Accident Table and from mature American experience there is reason to expect at least one permanent total for every fifteen deaths,[24] and about the same number of major permanents as of deaths. Upon this assumption about forty per cent. (368) of the indeterminates in the above exhibit will ultimately develop into permanent disabilities while the remainder will prove to be temporary in character. Reasoning from these premises, the Actuarial Committee of the Pennsylvania Bureau calculated the ultimate value of the reported indeterminates and found a deficit of $180,000 in the reported, as compared with the calculated indeterminate losses. They accordingly directed the addition of $200 to the reported value of each indeterminate disability. This procedure introduced a loading for underestimate of outstanding upon a more definite basis than that heretofore used, and distributed this loading to those classifications only in which the occurrence of indeterminates gave reason to suspect an underestimate.

For the current year the Pennsylvania Insurance Department has asked that indeterminate disabilities be individually reported and valued upon the Department table. In this way it is believed that the necessity for an underestimate factor will be avoided.

IV.

Accident severity rates are not directly convertible into pure premiums, on which account, probably, this phase of accident expe-

[24] The Rubinow Table, based upon European experience, gives one permanent total to ten deaths. But this proportion has not been realized in American experience apparently because accidents which in the United States are treated as partial or even temporary disabilities are in Europe compensated as permanent totals. To some extent this is a matter of defective statistics on both sides of the ocean. Thus the Austrian statistics give, not the number of permanent total disabilities, but the number of cases for which the maximum pension was allowed. The maximum being small, it is sometimes awarded, *e.g.*, for loss of thumb.

rience hitherto has been little regarded by insurance rate makers.[25] Yet pure premiums express industrial hazard only at the second remove; they vary with every change in wage levels as with every divergence in compensation benefits and so call for all sorts of qualifications in any comparative study. Accident severity rates[26] are the best, because the most stable and uniform, measures of relative hazard as between different industries at different times and under different benefit scales. The uses of such a measure of industrial hazard, for the purposes of compensation insurance, are manifold. Severity rates by cause of accident are the only satisfactory statistical basis for schedule rating and the only scientific basis of industry grouping for rate making. The number of accidents, also, and not the volume of monetary losses—much less the volume of payroll—is the ultimate criterion of the adequacy of exposure.[27]

The considerations just recounted led the Insurance Departments of New York, Massachusetts, New Jersey, Pennsylvania and Wisconsin to include number of accidents in the next ensuing call

[25] Mr. Scattergood presented an interesting study of accident frequency to the Actuarial Committee of the Augmented Standing Committee, 1917. But his results, being based upon accident notices without analysis of severity, were inconclusive and the whole subject was allowed to drop.

[26] By accident severity rate is meant the number of accidents, weighted for severity, per unit of exposure—technically, the accident time-loss per 1,000 full-time workmen per annum. A standard system of severity weighting has been proposed by the Committee on Statistics of the International Association of Industrial Accident Boards and Commissions—see Bulletin 201 of the U. S. Bureau of Labor.

[27] This point is rather implied than clearly brought out in Mr. Mowbray's very able paper "A New Criterion of Adequacy of Exposure," *Proceedings*, IV, 263–273. A direct statement of the criterion in terms of accident numbers would be both clearer and more convenient for practical use than the awkward double conversion from average cost per accident to volume of loss and from volume of loss through pure premium to payroll.

Volume of losses, in fact, is a measure of exposure only for a given class of injuries and only under a given benefit scale. Ten permanent partial disabilities under the existing Pennsylvania scale correspond to $10,000 of losses. But the same accidents, if compensated by life pensions, would cost $50,000, which volume of losses would, accordingly, represent no greater exposure than $10,000 under the present Pennsylvania law. This point has been consistently overlooked in fixing the "constants" and the earned premium qualifications for experience rating.

Payroll, again, is a measure of exposure only for a given classification under a given scale of benefits.

for pure premium experience. A like call was included in Pennsylvania and New Jersey Schedule "Z," 1916, and in New York Schedule "Z," 1915. The use made of this data, in the Pennsylvania rate revision, for the projection of death and permanent total disability losses and for the valuation of indeterminate disabilities was adverted to above. The number of permanent partial and temporary disabilities was used only as a rough *indicium* of the credibility of limited exposures. A permanent partial disability loss, *e.g.*, of $5,000 from one accident tells nothing of inherent hazard. But a loss of like magnitude from a score of minor dismemberments points to a characteristic of the industry and helps to fix its place in a definite rate group. In like manner a given volume of temporary disability losses will have a different meaning if derived from numerous accidents of low average cost than if produced by a few expensive accidents. The completeness of an experience—in comprising or failing to comprise accidents of each degree of severity—and the numerical proportion of deaths and permanents to temporary disabilities are likewise important criteria of dependability. A loss of even $15,000 which includes two deaths, two permanent partials and a hundred or more temporary compensatable accidents affords a fairly reliable indication of pure premium; a loss of the same magnitude made up, as in the case of Pennsylvania clay mining experience, 1916, of four deaths, one permanent partial and only nineteen temporary disabilities is an utterly unsure guide to rate making.[28]

The whole subject of accident rates is inchoate; no competent studies have been made in the United States such as would serve to develop the characteristics of different industries in point either of accident occurrence per unit of exposure or of frequency distribution of accidents by severity of injury. But it is the belief of the present writers, at least, that data of this character, when assembled in volume and analyzed upon a systematic basis, will be found increasingly significant for rate projection.

V.

Pure premiums, for compensation insurance, are invariably expressed in per cent. of payroll, and are thereby subject to fluctua-

[28] The limited Pennsylvania exposure—$381,000 of payroll—gave one death to every $95,000 of payroll. That this fatality rate is wholly abnormal is indicated by an experience of $3,372,000 of payroll from Ohio with ten deaths —one to $337,000 of payroll.

tion from changes in wage level. If, indeed, compensation for work accidents bore a fixed relation to wages, pure premiums would be little affected by wage rates. In the United States, however—as

TABLE VII.

RATIO OF COMPENSATION TO WAGES.[30]

FREQUENCY DISTRIBUTION OF COMP. ACCIDENTS BY WEEKLY EARNINGS OF INJURED—BITUMINOUS COAL MINING.

Weekly Wage Groups.	1916.		1917.		1918.	
	No. of Cases.	Ratio of Comp. to Wages.	No. of Cases.	Ratio of Comp. to Wages.	No. of Cases.	Ratio of Comp. to Wages.
1.	2.	3.	4.	5.	6.	7.
ALL WAGE GROUPS	842	.47*	1587	.41*	554	.37
Under $10	30	.67	17	.63	2	.56
$10 and under $12	33	.50	18	.50	2	.50
$12 and under $14	109	.50	51	.50	3	.50
$14 and under $16	131	.50	113	.50	13	.50
$16 and under $18	126	.50	124	.50	15	.50
$18 and under $20	145	.50	216	.50	51	.50
$20 and under $25	205	.45	541	.45	152	.45
$25 and under $30	47	.37	275	.37	144	.37
$30 and over	16	.30	232	.29	172	.29

* Aggregate weekly compensation to aggregate weekly wages.

Schedule Z experience comprised 59 per cent. of 1916 and 41 per cent. of 1917 payroll. Applying these percentages to Columns 3 and 5 above we obtain .445 as the effective average ratio of compensation to wages during the period covered by Schedule Z. The "wage level factor" is then: .368 ÷ .445 = .85.

All Industries Except Coal Mining.	1916.	1917.	1918 (First Half).
1.	2.	3.	4.
Effective ratio of compensation to wages ...	.474	.457	.438
Average weekly compensation	$ 7.12	$ 8.10	$ 8.64
Average weekly wages	$15.00	$17.71	$19.73
BITUMINOUS COAL MINING.			
Effective ratio of compensation to wages....	.47	.41	.37
Average weekly compensation	$ 8.49	$ 9.42	$ 9.78
Average weekly wages.....	$18.06	$22.91	$26.57

[30] The effective ratio of compensation to wages was, of course, computed from the frequency distribution of weekly earnings, in the manner illustrated below.

also in European countries—the rate of compensation is subject to arbitrary maxima; insomuch that at the higher ranges of weekly earnings the percentages stated in the Compensation Act become fictitious. In Pennsylvania, *e.g.*, compensation is fifty per cent. of wages, *but not more than $10 per week*—which comes to some twenty-five per cent. of the wages of a skilled mechanic and to something wholly negligible for a plant superintendent. These arbitrary limits evidently operate to pull down the ratio of compensation cost to payroll in a period of advancing wages and to increase the ratio in a period of falling wages. If, then, there has been a marked change in wage level between the period for which pure premium experience is available and the period for which rates are to be projected, the pure premiums derived from such experience will no longer reflect the current cost of compensation.

The Classification Committee of the Pennsylvania Bureau, in projecting rates for 1919, was confronted by precisely this situation. Between 1916, the year predominantly represented by the available experience, and 1918, the year of rate revision, the purchasing power of money had declined by at least one third, and average weekly earnings of wage workers had increased in about the same ratio. The consequent alteration in the ratio of compensation cost to payroll is exhibited in Table VII. It will be seen that for all industries other than coal mining, taken as an aggregate, the effective ratio of compensation to wages declined from .474 in 1916 to .438 in the first half of 1918. On this showing the pure premiums of 1916 should be multiplied by a factor of .92 to approximate the conditions of 1918.[29] This ratio will vary, of course, as between high and low wage industries, as also between industries directly and those more remotely affected by wartime inflation. The data in hand, however, were insufficient to establish dependable

[29] The actual reduction in pure premiums was probably greater than the foregoing calculation would indicate. When jobs are scarce and wages low compensation necessarily becomes, in some degree, unemployment insurance; conversely, when employment is plentiful and compensation falls to one third of earnings, men return to work, often at full wages, while still in a partly disabled condition. It is probable that the consequent falling off in number of accidents compensated, and in the average duration of compensation, will much more than offset any tendency to higher accident rates. If this view is correct, the "industrial activity factor," injected in the rate revision of 1917, should have been *less*, not *more*, than unity. It will be interesting to study 1918 experience with this thought in view.

factors for particular industries. Still less was it possible to forecast the trend of wages or of industrial activity. At most the broad assumption—thus far borne out by events—seemed justified, that wage rates would not during 1919 recede from the level attained in the first half of 1918.[31] The average wage level factor of .92 was, accordingly adopted for all classifications except coal mining, for which the specific indication of .85 was followed. For rate pro-

FIGURE 1.

WEEKLY WAGES RELATED TO THOSE OF 1890.[32]

jection, the "wage level" factor was combined with the "age of act" factor of 1.14, computed in the usual manner, giving a total multiplier of 1.05 for the conversion of 1916 to 1919 pure premiums.

A "wage level" factor, is should be remarked, is important only in face of a very exceptional advance (or decrease) in wage rates,

[31] The upward trend continued, as is well known, through the latter half of 1918. But for the end of the war, which at the time of the Pennsylvania rate revision no one foresaw, the present year would doubtless have established a new high level of prices and wages.

[32] Compiled from Rubinow's, "The Recent Trend of Real Wages," *American Economic Review*, 1914; Statistical Abstract of the United States, 1917; Hatch, The Labor Market Bulletin, February, 1919.

and then only for such jurisdictions as have fixed a low maximum of weekly compensation. In ordinary times, wage fluctuations from year to year are inconsiderable and the effect thereof upon pure premiums practically negligible. (See Fig. 1.) Between 1910 and 1915, *e.g.*, the increase in wage rates was about 16 per cent. The great bulk of wage earners in 1915 were still within the low maximum ($20 per week) fixed by the Pennsylvania statute, so that compensation cost would have increased almost *pari passu* with wages. The wage increase during the three years 1916–1918 was greater than the total for the preceding twenty-five years and carried a large proportion of wage workers, for the first time, beyond the Pennsylvania compensation maximum. Hence the propriety of a wage factor for converting pre-war to the post-war level.

VI.

The grounds for preferring a "graded" to a "flat" expense loading have been elsewhere expounded.[33] It only remains to set forth the practical application of the principle to Pennsylvania Compensation Insurance Rates.

Management expenses for stock companies were taken at 42.5 per cent. of gross premiums, distributed as follows:

TABLE VIII.

1.	Total. 2.	Proportionate to		
		Gross Rate. 3.	Pure Premium. 4.	Payroll. 5.
ALL EXPENSES	42.5	25.0	11.0	6.5
Acquisition.....	17.5	17.5	—	—
Taxes	5.0	5.0	—	—
Claim adjustment...	6.5	—	5.0	1.5
Inspection	3.5	—	2.0	1.5
Audits.....	2.0	—	—	2.0
Home office	6.5	1.0	4.0	1.5
Profits.....	1.5	1.5	—	—

From this distribution are obtained the values of A, E and K in the formula:

$$(1) \qquad R = \frac{\pi(1+E)+K}{1-A},$$

[33] Woodward, "Provision for Expenses in Workmen's Compensation Premiums," *Proceedings*, III, 140–148, and discussion, IV, 135–147; Downey, "The Making of Rates for Workmen's Compensation Insurance," *Journal of Political Economy*, XXV, 974–981.

wherein R is gross rate, π is pure premium, and E, A and K are the fractional expense ratios proportionate, respectively, to pure premium, gross rate and payroll. Since the total average expense loading is 42.5 per cent., E, which is 11 per cent. of gross rate (Column 4) is 19 per cent. of pure premium. Since, moreover, the average gross rate is known to be \$1.00, K (Column 5), is \$.065 per \$100 of payroll or, with the addition of the catastrophe pure premium, \$.075. Applying these values to formula (1) we have:

$$(2) \qquad R = \frac{1.19\pi + \$.075}{.75},$$

which reduces to $1.58\pi + \$.10$. But pure premiums were obtained at the 1916 level, whereas rates were to be projected for 1919. The conversion factor, as already explained, was taken at 1.05. With this modification the rate projection formula becomes:

$$(3) \qquad R = 1.67p. + \$.10,$$

where p = 1916 pure premium.

The resultant gradation of expense loading is illustrated by the accompanying graph. It will be observed that the grading is very steep at the lower and practically nil at the upper end of the scale. Low rates, accordingly, are sharply increased; high rates are moderately reduced. A flat loading of the same average amount would give a rate of \$.17 with a \$.10 pure premium, of \$3.49 with a \$2.00 pure premium, and of \$5.22 with a \$3.00 pure premium. The corresponding graded rates are \$.26, \$3.28 and \$4.87.

VII.

The classification experience was presented upon a form which showed for each state the payroll, the losses distributed into death, permanent total, permanent partial, temporary, and medical benefits, the number of compensatable accidents classified by severity of injury, and the partial and total pure premiums for the combined experience reduced to the Pennsylvania 1916 level. There was likewise a form for each industry group which gave the combined payrolls and partial pure premiums for each classification and for the group total, and separately, the group total of Pennsylvania payrolls and partial pure premiums. A complete set of classification and group sheets, typewritten and bound in con-

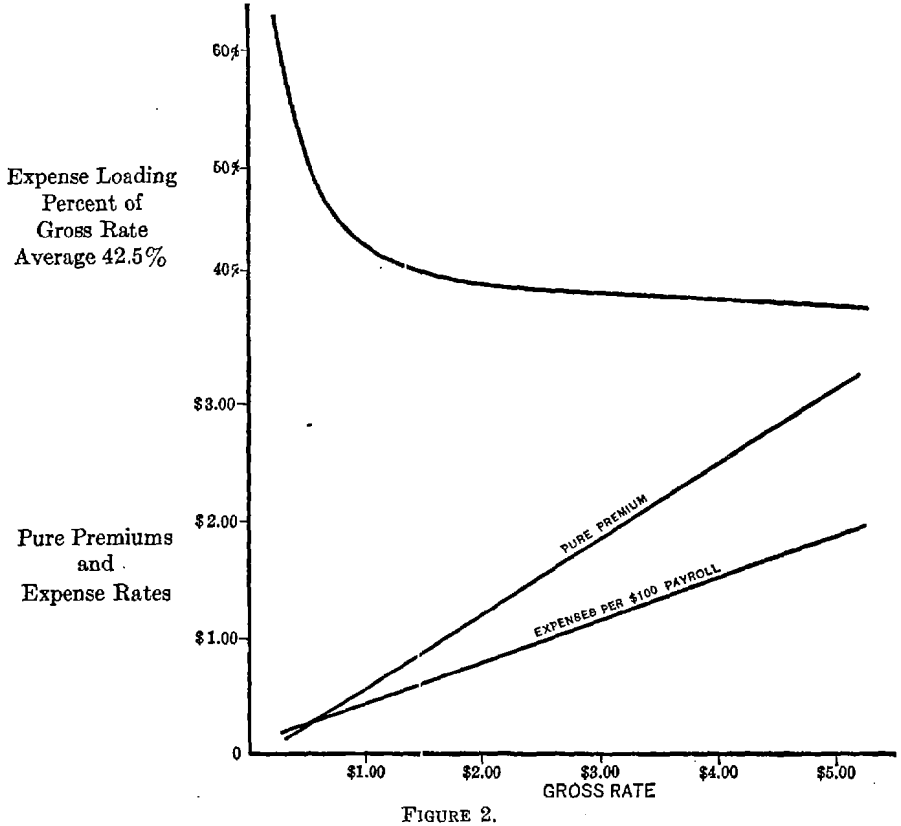

FIGURE 2.

EFFECT OF GRADED EXPENSE LOADING.

venient form, was furnished tc each member of the Classification Committee. The resultant saving of committee time very much more than covered the cost of this somewhat elaborate tabulation.

VIII.

Compensation insurance manuals have been printed in many forms—as an alphabetical list of classifications, from "abdominal truss manufacturing" to "zinc smelting," alphabetically within industry schedules,[34] and by industry groups with alphabetical index. The last-mentioned arrangement was probably suggested

[34] A familiar arrangement in employers' liability manuals, wherein the "state differentials" often varied from schedule to schedule.

to American manual makers by the Manual of the Swiss Accident Insurance Institute;[35] its use has been urged upon the National Reference Committee by Messrs. Woodward, Magoun and others, and it was unanimously adopted by the Classification Committee of the Pennsylvania Bureau.

The principal advantage of the group, as against an alphabetical manual, are:

1. The bringing together of related classifications upon the same page, which admits of ready rate comparisons and facilitates the detection of errors and inconsistencies in the assignment of rates by bringing to bear thereon the criticism of agents, employers and home office underwriters.

2. The elimination, as independent classifications, of cross-references and petty subdivisions of the same industry or occupation.[36] Some six hundred classifications were, in this way, stricken from the Pennsylvania Manual.

3. The expression of classification limitations in the group head note which—apart from the notable saving of space—assures that any given qualification shall be applied to all closely related classifications. Good examples are the exclusion of founding, forging and woodworking from the machine shop classifications, the exclusion of hot and cold rolling from the wire products classifications, and the inclusion of drivers and chauffeurs in the several classifications for fuel and material dealers. In the past, qualifications expressed for certain classifications have inadvertently been omitted from others covering similar industries or from cross references.

4. The affording of a cue to the intent of a classification by means of the group title. Thus the group title "wood turning" qualifies "woodenware manufacturing, N.O.C." in such a way as to indicate the exclusion therefrom of a risk whose output is a miscellaneous line of wood products in the manufacture whereof wood turning does not form a substantial element.[37]

[35] Woodward, "Premiums and Reserves of the Swiss Accident Insurance Institute," *Proceedings*, IV, 53.

[36] Such, *e.g.*, as "silo erection—metal," "cornice and skylight erection," "tank erection, metal—within buildings," "corrugated iron buildings, erection," "coppersmithing—away from shop," "tinsmithing—away from shop" and "roofing—sheet metal."

[37] One risk formerly so classified manufacturers of children's sleds, baby fences, porch swings and "other wood novelties."

With respect to convenience for agents' use, it is probable that the group manual is more convenient to one who is conversant therewith than any alphabetical list. An alphabetical list, in fact, suffers from the two-fold limitation, that the same key-word will not occur to every user—few will remember to look under "circular looms" for "flexible piping" or under "insulators" for "slate pencils"—and that the indefinite multiplication of key-words (*i. e.*, cross references) leads to an indefinite extension of space. A good index should, of course, accompany the group manual; but this index should consist of key-words and references only, without the verbiage necessary to delimit manual classifications.

Compensation manuals have heretofore been burdened with a mass of matter pertaining to public liability insurance. It is probable that the compilation of a separate public liability manual would be to the advantage of all concerned. Risk classifications for compensation insurance are in great part irrelevant to public liability—there being, in general, no discoverable relationship between the hazard to employees and the hazard of passersby. In many cases, indeed, the basis of rates is totally distinct—area and frontage, number of seats, number of vehicles or number of floors. There results from the use of compensation classifications for public liability insurance a complicated system of rate symbols, symbol values, notes and references, difficult to interpret and laborious to use. The number of public liability rates is small and the list of relevant classifications would presumably be brief. The rates, moreover, are not dependent upon compensation benefits, so that a public liability manual might well be substantially uniform throughout the country. Such a manual, complete within itself, might readily be issued in a form convenient for binding in the same cover with the compensation manual. This suggestion is respectfully submitted to the bureau having jurisdiction thereover.

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The methods and results of the Pennsylvania Manual revision, 1918, have yet to approve themselves by the test of time. The actuarial procedure, however,—here the matter of chief interest—has already been adopted, in its leading features, by the National Actuarial Committee. It seems not inappropriate, therefore, to suggest that this procedure, so far as it undertakes to convert realized experience to the supposed current level, might well be simplified. Compensation insurance rate makers have come to depend,

in an unfortunate degree, upon theoretical modifiers of pure premium experience. "Age of act," "industrial activity," "wage level," "underestimate," and "merit reduction" factors[38] have been so piled one upon the other that rates have ceased to bear a close and consistent relationship to experienced pure premiums.[39] In good part, this over-extension of hypothetical multipliers has been a natural, if not inevitable, result of immature experience. So long as recorded exposures were limited, reserves of doubtful adequacy, benefits unstable, and the trend of compensation cost obscure, insurers were justified in adding an appreciable safety factor to the bare pure premiums. So long, moreover, as such need exists, actuarial computations, however fallible in themselves, are a safer, because a more systematic guide, than underwriting judgment alone. In part, also, pure premium modifiers have been made necessary by frequent changes in compensation benefits, and this condition is with us still. Yet, when all allowances are made, it may be questioned whether theoretical factors have not been too freely introduced in the vain and illusory attempt to keep rates abreast of current cost.

The attempt to reflect current cost in current rates is futile just because current cost can never be ascertained. Time is required to mature losses and to audit payrolls. The experience relied upon for current rate making is necessarily past experience and the features of the current situation which will serve to modify that experience have already changed before their effect can be determined. No sooner is an industrial activity factor injected into rates than a radical advance in wages alters the whole relationship of compensation cost to payrolls. By the time a corrective wage level factor has been established, wage levels have taken a downward trend.[40] In this game of hide and seek, accordingly, rates never do reflect current cost; it cannot even be said that the approximation is closer than would be obtained by reliance upon unmodified pure premiums, while the fluctuations from year to year are far more ex-

[38] In the Pennsylvania rate revision, 1918, only two modifiers—age of act and wage level—were used, and these nearly cancel each other ($1.4 \times .92 = 1.05$).

[39] Compare Downey, "The Making of Rates for Workmen's Compensation Insurance," *Journal of Political Economy*, XXV, 971–974.

[40] To judge from past experience with credit inflation, wages and commodity prices will maintain a permanently higher level than in the pre-war period, though how much higher it were bootless to conjecture.

treme. If the whole attempt to approximate current cost were frankly abandoned and rates based directly opon pure premium experience for, say the five years next preceding each annual revision, modified only for differences in compensation benefits[41]—it is almost certain that rates would be more stable and the long term results more satisfactory to all concerned.

[41] Mr. E. J. Bond cogently urged some such procedure at a recent meeting of the National Reference Committee.