Chapter 18

Iron and Steel Products

THE iron and steel products group consists of industries which manufacture crude iron and steel, and those which use iron and steel as principal materials in the fabrication of other products. It does not include the important machinery and transportation equipment industries, which are classified separately.

One of the most important of the manufacturing groups, iron and steel products stood among the first three, ranked according to value added, both in 1899 and in 1937.

TRENDS IN THE PHYSICAL OUTPUT OF THE IRON AND STEEL PRODUCTS INDUSTRIES

Indexes of physical output of the two basic iron and steel industries, blast-furnace and steel-mill products, are available for the entire period 1899–1937; of two specialist industries, wire and wrought pipe, for 1909–37 and 1925–37, respectively; and of four other industries for varying periods, none longer than 1914–37 (Table 53 and Chart 20).

Blast-Furnace Products. This industrial category includes establishments engaged in the first stage of iron and steel processing: the manufacture from ore and scrap of pig iron and ferro-alloys. (Ferro-alloys made in electric furnaces are classified as products of the chemical industry.) The output of blast-furnace products rose 171 percent from 1899 to 1937. The sharpest increase came in the first ten years, when output went up by 79 percent; in the next decade production rose

TABLE 53

IRON AND STEEL PRODUCTS[a]

Physical Output: Indexes and Percentage Changes[b]

	Blast-Furnace Products	*Steel-Mill Products*	*Wire, n.e.m.*[c]	*Wrought Pipe, n.e.m.*[c]	*Cast-Iron Pipe*	*Files*	*Firearms*	*Tin Cans and Tinware, n.e.c.*[d]	*Total*	
									Unadjusted	Adjusted
YEAR	INDEX OF PHYSICAL OUTPUT (1929: 100)									
1899	32	24	..	..	..	..	..	..	25	21
1904	38	29	..	..	..	..	..	..	30	29
1909	58	43	66	..	..	..	..	..	46	44
1914	53	44	64	..	62	..	..	..	46	48
1919	70	63	69	..	44	..	..	..	64	59
1921	39	38	51	..	48	..	52	..	39	46
1923	93	81	97	..	93	..	77	..	83	84
1925	84	82	92	77	113	..	70	..	83	87
1927	84	81	98	68	114	..	93	87	83	87
1929	100	100	100	100	100	100	100	100	100	100
1931	44	47	50	63	69	63	56	92	50	54
1933	32	43	46	31	31	65	56	94	45	45
1935	51	64	67	56	46	72	72	119	65	61
1937	88	97	90	91	68	106	107	160	98	89
PERIOD	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT									
1899–1937	+171	+313	..	..	..	..	..	..	+294	+327
1899–1909	+79	+84	..	..	..	..	..	..	+83	+110
1909–1919	+20	+46	+4	..	..	..	..	..	+40	+34
1919–1929	+43	+58	+45	..	+129	..	..	..	+57	+70
1929–1937	−12	−3	−10	−9	−32	+6	+7	+60	−2	−11

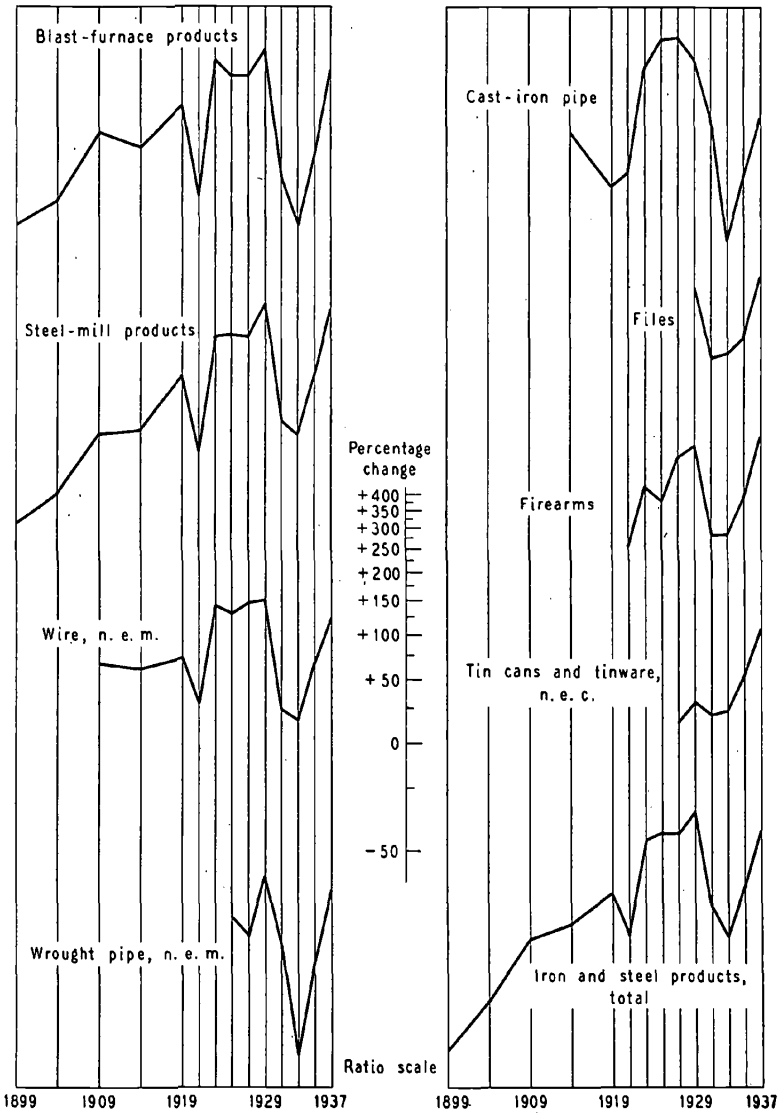
[a] Industries for which there are no adequate quantity data for any period listed above are: bolts and nuts, not elsewhere made; forgings, not elsewhere made; galvanizing, not elsewhere done; nails and spikes, not elsewhere made; springs, steel, not elsewhere made; structural metal work, not elsewhere made; wirework, not elsewhere classified; doors, metal; heating apparatus; stoves and ranges; plumbers' supplies, not elsewhere classified; screw-machine products; cutlery, not elsewhere classified; saws; tools, other; hardware, not elsewhere [illegible]. These industries are covered in Chapter 2 and in detail in Appendix A. Appendix B presents these data, together with the indexes derived from them. The indexes cited here for individual industries have been adjusted to take account of changes in the coverage of the respective samples, except when such adjustment was impossible.

The percentage changes are not always entirely consistent with the indexes given above because the changes were computed from the indexes in Appendix B, which are carried to one decimal place.

Chart 20

IRON AND STEEL PRODUCTS

Indexes of Physical Output



only 20 percent; in the third it increased 43 percent; but in the last period it declined 12 percent.

Of the two principal products, ordinary pig iron and ferro-alloys, the latter appears to have increased in importance. Between 1925 and 1937 the output of ferro-alloys rose from 430 thousand long tons to 629 thousand; pig iron output was 36 million long tons in both years. A much more profound change in the character of the industry's output resulted from a shift to new methods of delivery. In 1909 about half the pig iron was delivered in molten form to adjoining steel works, and the other half was cast into pigs and transported cold. By 1937 the fraction of iron delivered molten had risen to 70 percent.

Steel-Mill Products. This industry, one of the most important in the field of manufactures, utilizes most of the pig iron made in blast-furnaces as a principal material in the manufacture of steel. The steel is prepared in the form of steel ingots, castings, and rolled products. Some establishments in the industry carry fabrication beyond the rolling stage into such processes as tin dipping, wire drawing, and pipe and tube manufacturing, and for this reason the industry overlaps a number of others in the group.

The output of steel-mill products quadrupled between 1899 and 1937.[1] As in the blast-furnace products industry, output rose most rapidly in the first and third periods. Between 1899 and 1909 the increase was 84 percent; in the next decade 46 percent, and in the third 58 percent. From 1929 to 1937 there was a decline of 3 percent.

It is noteworthy that in every period the output of the steel industry rose in relation to the output of the blast-furnace products industry. An important reason for the more rapid growth of steel was the relative rise in the open-hearth process and the decline in the Bessemer process:

[1] Owing to a decline in the degree of duplication in the industry's products, the rise is somewhat understated; see Appendix B. The duplication arises from intra-industry sales of unrolled steel and semifinished products.

Process	*Production of Steel Ingots and Castings* (million long tons)					*Percentage Distribution*				
	1899	1909	1919	1929	1937	1899	1909	1919	1929	1937
Open-hearth	3.0	14.2	26.7	48.2	47.0	28	60	79	86	91
Bessemer	7.5	9.2	6.9	7.1	3.5	71	39	20	13	7
Other	0.1	0.1	0.3	0.8	1.1	1	1	1	1	2
TOTAL	10.7	23.5	34.0	56.2	51.6	100	100	100	100	100

The open-hearth process, although it is slower and requires more expensive equipment than the Bessemer process, yields a product of better quality, permits the use of high phosphorus ore, and—most important in the present connection—utilizes scrap iron and steel.[2] The increase in the proportion of steel made in open-hearth furnaces, from 28 percent in 1899 to 60 percent in 1909 and 91 percent in 1937, was accompanied by a rise in the ratio of scrap to pig iron charged to steel furnaces. In 1909 (the first year for which Census data become available) 10 million tons of scrap and 19 million tons of pig iron were consumed in steel works. In 1937 the amount of scrap used was 27 million tons, and the amount of pig iron (including ferro-alloys) 30 million.

Technological developments in the steel industry led also to savings in materials. The economies are indicated by the following figures, given for all the years for which they are available:

	1909	*1914*	*1919*	*1929*	*1935*	*1937*
1. Materials consumed: pig iron (including ferro-alloys) and scrap (million long tons)	29.0	28.1	40.8	64.8	38.5	57.5
2. Products: ingots and castings (million long tons)	23.5	23.4	34.0	56.2	34.4	51.6
3. Ratio, 2 ÷ 1	.81	.83	.83	.87	.89	.90

In 1937 about 10 percent less ferrous materials were used in the production of a ton of steel than were required in 1909.[3]

[2] E. D. McCallum, *The Iron and Steel Industry in the United States* (P. S. King, 1931), pp. 77–78.

[3] Some iron ore is used also, but it is not quantitatively important.

Improved furnace design and increased knowledge of the equilibrium relationship between slag and metal helped to reduce the amount of metal lost in the slag. Again, improved tapping and teeming practice cut down pit losses and skull losses in ladles.[4] As a result of these technological advances, the net output of the steel industry rose in relation to its gross output.[5]

Steel-mill products are so numerous that we can list only the more important ones in attempting to show the changing composition of the industry's output. Continuous data are available only beginning with 1909:

Product	*Quantity* (million long tons)				*Percentage Change*[a]
	1909	1919	1929	1937	1909 to 1937
Unrolled steel					
Ingots	.14	.71	.66	.64	+350
Direct steel castings	.45	.68	1.21	1.04	+132
Semifinished rolled products					
Blooms, billets and slabs	4.97	6.23	7.63	7.65	+54
Sheet and tinplate bars	1.65	2.86	5.06	2.64	+60
Muck and scrap bar	.17	.17	.07	.022	−87
Finished rolled products					
Rails	2.84	2.08	2.67	1.41	−50
Rail joints and fastenings, tie plates, etc.	.39	.46	.87	.46	+17
Structural steel, light and heavy	2.10	2.45	4.47	3.11	+49
Concrete reinforcing bars	.19	.30	.97	.81	+325
Merchant bars, mill shafting, wire rods, etc.	4.13	5.34	7.70	5.52	+34
Plates, no. 12 and thicker, not coated	2.87	5.47	5.21	3.34	+183
Sheets, no. 13 and thinner, not coated					
Plain automobile body			3.90	4.79	
Black for tinning	.63	.56	.14	.78	+23

[4] We are indebted to Walter S. Tower, of the American Iron and Steel Institute, for this information.

[5] It may be estimated, roughly, that as a result of the savings in materials, net output rose about 25 percent more than gross output from 1909 to 1937.

Product	Quantity (million long tons)				Percentage Change
	1909	1919	1929	1937	1909 to 1937
Strips, bands, flats, scroll and hoops, narrower than 24 inches	.34	.74	2.01	2.29	+589
Cotton ties, for sale		.043	.038	.062	
Skelp	.68	.92	1.27	1.14	+68
Axles, rolled and forged	.094	.098	.150	.13	+35
Armor plate and ordnance, for sale	.027	.10	.01	.020	−26
Scrap iron and steel	1.24	2.11	2.83	2.94	+138
Rerolled or renewed rails	.11	.10	.057	.032	−70

[a] The percentage changes are not always entirely consistent with the quantities given above because the changes were computed from the data in Appendix B, which are carried to more decimal places.

All the quantities listed are those sold or transferred; commodities produced and consumed in the same plant are not included. It is noteworthy that only a small fraction of the total volume of ingots produced was sold. Of 50 million tons produced in 1937, 49 million were consumed in the same works in the manufacture of rolled and finished products, 0.5 million were transferred to other plants of the same company, and only 0.2 million tons were sold.

Between 1909 and 1937 the aggregate output of the industry almost doubled. Individual products which rose much more rapidly than the aggregate were ingots for sale, concrete reinforcing bars, thick and auto plates, and narrow strips and bands. In the same period there were declines in the output of muck and scrap bar, rails (new and renewed), and armor plate and ordnance.

Marked improvements in the quality of steel and steel products have been noted in testimony by the United States Steel Corporation before the Temporary National Economic Committee.[6] During the last 15 years steel sheets used in making automobile bodies have had their "deep drawing

[6] "Improved Quality of Steel as a Price Reduction," a pamphlet published by the United States Steel Corporation (November 1939).

qualities" increased by 30 to 40 percent; this means that sharply rounded shapes may be stamped deeper. Again, sheets are now made wider. As a result of these improvements, a front fender can be stamped out of one sheet, whereas formerly a fender was made of two sheets separately formed and then joined together. Moreover, because of the fine grain and dense polished surface of modern sheet steel, the time required to apply paint to automobile body parts has been reduced from a minimum of 48 hours to 6.

Tin plates also have been improved remarkably. Higher corrosion resistance now makes possible the canning of certain types of acid fruits and the storing of cans of such fruits for longer periods. Other advances are noted in the following quotation: [7]

> The purchaser of modern tin plate has less waste in trimming the sheets to the size and shape required for his purposes since modern tin plate is made more accurate in its dimensions than was the tin plate of fifteen years ago. Increased uniformity of thickness has contributed to the economical use of high speed machines with automatic feeders in the can-making industry, by eliminating the necessity of frequent adjustment in the machines, and has also resulted in a reduction in sheet damage. It is estimated that, due to the improved quality of modern tin plate, the average weight of tin plate used for any given purpose has decreased about 10 percent. . . . Formerly, a relatively high number of sheets of the tin plate were damaged in transit to the purchaser's plant due to twisted and bent edges. The modern, much more compact and better protected packages, made possible by the almost perfect uniformity of the sheets, have greatly reduced these losses.

Improved quality of output in the steel industry has contributed on many counts to greater productivity in the steel-consuming industries.

Wire. This industry manufactures wire and wire products

[7] *Ibid.*, pp. 4–5.

from purchased rods. These products are made also to a large extent in the steel-mill products and nonferrous-metal products, n.e.c. industries, from rods manufactured in the same plant: in 1929 the wire industry turned out only 34.8 percent of all wire and wire products.

The output of the specialist wire industry, which we are considering here, rose only 4 percent from 1909 to 1919. Between 1919 and 1923 it increased over 40 percent, reaching a level which it maintained until 1929. From 1929 to 1937 output fell 10 percent. The net increase between 1909 and 1937 was 35 percent. Detailed statistics concerning the products of the industry are available in continuous form from 1909 to 1929. Between these two years there were declines in coated iron and steel wire, nails and spikes, and barbed wire.

Wrought Pipe. This industry, too, specializes in products made to a large extent also in the steel-mill products industry. Only 27 percent of all the wrought pipe produced in 1929 was made in the specialist industry, whose output rose 30 percent from 1925 to 1929, and fell 9 percent from 1929 to 1937.

Cast-Iron Pipe output fell almost 30 percent from 1914 to 1919, a decline reminiscent of those occurring in this period in the other industries devoted largely to construction materials. From 1919 to 1929 there was a rise of 129 percent (with a peak in 1927) and from 1929 to 1937 a decline of 32 percent. The net increase between 1914 and 1937 was only 11 percent. Between these two years bell and spigot pipe, flanged pipe, and culvert pipe declined. Gas and water-pipe fittings made an especially large gain, from 42 thousand tons to 163 thousand.

Tin Cans and Other Tinware, not elsewhere classified, the last industry in the list for which we have quantity data, attained a particularly large increase in output. From 1927 to 1929, the product of this industry rose 15 percent, and from 1929 to 1937, 60 percent, a net increase of 84 percent in ten

years. All the individual products of the industry for which we have data increased, particularly packers' cans. As was noted above, savings of materials were effected in the tin can industry through reductions both of the wastage involved in the trimming of tin plates to prescribed sizes and shapes, and of the weight of tin plate required for any given purpose.

Summary. Among the individual industries, blast-furnace products lagged behind total manufacturing, except in the period 1899–1909. This was true also of wire in the three periods for which we have data.

In all the industries the increase in output was more rapid than the rise in population, except in 1929–37, when only two industries outstripped population growth, and in 1909–19, when wire rose only 4 percent.

The output of the iron and steel group as a whole followed fairly closely the trend of the important steel-mill products industry. The net gain between 1899 and 1937 was 294 percent according to the unadjusted index, and 327 percent according to the adjusted index. In the last period, 1929–37, output fell 2 percent according to the unadjusted index and 11 percent according to the adjusted index. The group index rose about as rapidly between 1899 and 1937 as the index for all manufacturing combined. In the first and third periods the group index rose faster, in the second and fourth periods more slowly.

CHANGES IN THE INDUSTRIAL PATTERN OF IRON AND STEEL PRODUCTS MANUFACTURE

We have noted that the output of blast-furnace products rose less rapidly than that of steel-mill products; and that the average output of these two industries rose less rapidly than the group total. The effect of these varying trends upon the composition of the group's output is brought out in Table 54. The relative contribution of blast-furnace products fell

TABLE 54

IRON AND STEEL PRODUCTS

Relative Contributions of Component Industries to the Physical Output of the Entire Group[a]

Industry	*Percentage Distribution, Comparable Pairs of Years*									
	1899	1937	1899	1909	1909	1919	1919	1929	1929	1937
Blast-furnace products	10.5	6.8	13.7	11.7	8.5	7.6	6.7	5.7	4.7	4.6
Steel-mill products	48.8	48.1	45.9	40.2	42.7	46.6	47.8	44.5	45.8	49.7
Wire, n.e.m.[b]					3.1	2.4	2.8	2.3	2.7	2.7
Cast-iron pipe							1.0	1.4	1.5	1.1
Wrought pipe, n.e.m.[b]									1.6	1.6
Files									0.3	0.3
Firearms	40.7	45.1	40.4	48.1	45.7	43.4	41.7	46.1	0.5	0.6
Tin cans and tinware, n.e.c.[c]									2.6	4.7
All other products									40.3	34.5
TOTAL[d]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Derived from Table 53. For an explanation of the derivation of the measurements see footnote 10, Chapter 4.

[b] N.e.m. denotes not elsewhere made.

[c] N.e.c. denotes not elsewhere classified.

[d] The columns do not add up to 100.0 in every instance because they contain rounded percentages.

from 10 percent in 1899 to 7 percent in 1937, and there were declines in each of the four subperiods distinguished in the table. The contribution of steel-mill products to the group's output was practically the same in 1937 as it had been in 1899, although it fluctuated from one period to another. Our data are most detailed for the last period, 1929–37, when there were substantial rises in steel-mill products, in tin cans and in tinware not elsewhere classified; appreciable declines in cast-iron pipe and in the total of "all other" industries; and minute changes in the few remaining industries in the group for which we have figures.

TABLE 55

IRON AND STEEL PRODUCTS

Relative Contributions of Component Industries to the Value Added by the Entire Group[a]

Industry	*Percentage Distribution*						
	1899	1909		1919		1929	1937
		Comparable with 1899	Comparable with 1919	Comparable with 1909	later years		
Blast-furnace products	17.6	10.1	9.1	7.4	7.5	5.0	4.3
Steel-mill products	48.2	46.6	42.2	46.8	47.6	44.9	50.9
Bolts and nuts, n.e.m.[b]	1.4	1.7	1.5	1.8	1.9	1.8	1.8
Forgings, n.e.m.[b]	1.3	1.5	1.4	3.8	3.9	2.6	2.0
Galvanizing, n.e.d.[c]	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Nails and spikes, n.e.m.[b]	1.4	0.6	0.5	0.4	0.4	0.2	0.2
Springs, steel, n.e.m.[b]	0.6	0.6	0.6	1.0	1.0	0.6	0.5
Structural metal work, n.e.m.[b]	6.8	8.0	7.3	5.1	5.2	7.1	4.3
Wire, n.e.m.[b]	0.6	3.4	3.1	2.4	2.5	2.7	2.8
Wirework, n.e.c.[d]	2.1	2.5	2.2	1.6	1.6	2.4	3.0
Wrought pipe, n.e.m.[b]	1.4	1.1	1.0	1.2	1.3	1.7	1.5
Cast-iron pipe		[e]	1.3	1.0	1.0	1.4	1.2
Doors, metal	0.1	0.2	0.2	0.3	0.3	1.3	1.0
Heating apparatus	2.8	4.5	4.0	3.6	3.7	4.8	8.9
Stoves and ranges	0.5	0.7	6.4	5.0	5.1	5.2	
Plumbers' supplies, n.e.c.[d]	1.8	3.2	2.9	1.3	1.3	2.5	2.2
Screw-machine products	0.7	0.8	0.8	1.4	1.4	2.0	2.1
Cutlery, n.e.c.[d]	2.3	2.2	2.0	1.9	2.0	2.0	1.7
Files	0.5	0.6	0.5	0.6	0.6	0.3	0.4
Saws	0.9	0.9	0.8	0.8	0.8	0.5	0.4
Tools, other	2.0	2.7	2.5	4.0	2.4	2.1	1.7
Firearms	1.0	0.9	0.8	0.9	0.9	0.6	0.6
Hardware, n.e.c.[d]	5.5	6.1	5.5	4.3	4.4	4.7	4.5
Safes and vaults	0.5	0.7	0.6	0.4	0.4	0.4	0.1
Tin cans and tinware, n.e.c.[d]		[f]	2.5	2.8	2.8	3.1	3.9
TOTAL[g]	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Basic data are given in Appendix C.
[b] N.e.m. denotes not elsewhere made.
[c] N.e.d. denotes not elsewhere done.
[d] N.e.c. denotes not elsewhere classified.
[e] Included in foundry and machine-shop products prior to 1909.
[f] In 1899, included in sheet metal work, not elsewhere classified.
[g] The columns do not add up to 100.0 in every instance because they contain rounded percentages.

The contributions of the component industries to the value added by the iron and steel products group as a whole are summarized in Table 55. From this tabulation, it appears that the relative contribution of the blast-furnace industry to the value added by the group declined between 1899 and 1937 much more than its relative contribution to the physical output of the group. The only other outstanding decline between 1899 and 1937 was in the relative contributions (to value added) of nails and spikes and structural metal work. Wire, metal doors, heating apparatus, stoves and ranges, and screw-machine products rose rather sharply.

The most interesting change in the group's composition is the decline of the blast-furnace products industry in relation to the steel-mill products industry. This relative decline persisted not only throughout the period 1899–1937 considered as a whole, but also in each of the subperiods. We have already remarked upon the displacement of pig iron by scrap and upon the savings effected in the quantity of all ferrous materials consumed in the production of steel. Another factor that made for divergence was the increased share obtained by the steel-mill products industry of the pig iron produced by blast furnaces:

	1899	*1909*	*1919*	*1929*	*1937*
1. Pig iron and ferro-alloy production, blast-furnace products industry (millon long tons)	14.4	25.7	30.9	42.5	36.8
2. Pig iron and ferro-alloy consumption, steel-mill products industry (million long tons)	10.4	19.1	24.4	35.4	30.2
3. Ratio, (2) ÷ (1)	.72	.74	.79	.83	.82

The share of steel-mills increased from 72 to 82 percent between 1899 and 1937, and the share of the other industries declined correspondingly.[8]

[8] Of the 36.8 million long tons of pig iron produced in 1937, 29.5 million were used in the steel-mill products industry, 1.9 million in the foundry and machine-shop products industry, 0.6 million in the cast-iron pipe industry, and 4.8 million in other industries.