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Volume Author/Editor: Simon Kuznets

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Chapter Author: Simon Kuznets

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PART I

The Economic Problem of Seasonal Variations and their Statistical Measurement

CHAPTER I

THE ECONOMIC PROBLEM

1. The Causes of Seasonal Variations

Nature and human institutions conspire to produce seasonal variations in industrial and trade activity. Climatic seasons bring changes in the length of the day and night, in temperature and precipitation; and these in manifold ways affect conditions of production and demand for commodities. In the temperate zone the supply of all agricultural products and of some other raw materials varies strikingly from month to month in response to successive climatic changes. Climate determines the periods of growth and maturity of crops and livestock; consequently, economic activity connected with planting and harvesting, as well as most related processes, bear marked evidence of seasonal influence.[1] Limited seasons in outdoor pasturage time the breeding of livestock and tend to create definite periods in their maturity for slaughter or milk production. In the less important industry of trapping fur-bearing animals the influence of climate on breeding leads to closed seasons for game. Similarly, iron ore and other materials cannot be transported on the Great Lakes when winter closes them to navigation; tree-felling is possible only under certain conditions of moisture and temperature; clay cannot be obtained easily from frozen ground.

Demand for finished goods also is affected by climatic seasonal changes. The readiness of consumers to purchase textiles, shoes and automobiles varies with changes in temperature and precipitation. Warm weather reduces demand for some food products, such as meat, and increases that for others.

But all seasonal changes are not induced by climate. Conventions also exercise a pervasive and often a conspicuous in-

[1] Note that etymologically the word 'season' expresses the influence of climate upon one field of productive activity, agriculture. 'Season' is derived from the Latin 'sation-em' meaning the act of sowing, which in vulgar Latin came to mean 'time of sowing, seed-time.' See *The New English Dictionary*, Vol. VIII, Part II, p. 337.

fluence upon business and its periodical records. In monthly time series,[2] our most common quantitative measure of economic activity, the most pervasive of all seasonal variations is due primarily to the calendar, which makes February nearly 10 per cent shorter than January and April nearly 3 per cent shorter than March.[3] Appreciable in their influence upon many business processes are such conventional seasonal factors as religious observances, folk customs, fashions and business practices. Social life, like individual life, runs in grooves set by habits and customs, many of which spell recurrent modifications in the rate of economic activity.

Some economic pursuits escape the more conspicuous direct effects of climate and convention. Manufacturing activity, which involves the transformation of raw materials but is carried on indoors under controlled physical conditions, is affected by such conventional factors as holidays or vacations but obviously does not show seasonal swings as wide as those of agriculture or construction. Railroad transportation is little affected by changes in weather, or, since operation is continuous, by holidays and vacations. Trading on the security and produce exchanges is directly affected by holidays but is otherwise scarcely subject to the influence of seasonal factors.

2. The Economic Problem Defined

Thus, although seasonal changes affect most elements of economic life, they do so in differing degree. The direct influence of climatic and organic seasons upon the rate of flow of crops and livestock is clearly more conspicuous than upon the production of steel; the demand for clothing varies much more with changes in climate than does the demand for bread. Nor is it only the *magnitude* of the primary effects of seasons that differs for the various economic activities, producing seasonal swings of varying size or amplitude; the *timing* of these effects is also different, creating different patterns as the season begins in one month or another. The barley crop appears on the market during July and August, cotton during September and October; a large proportion of cattle and calves

[2] For a description of the time unit of measurement adopted in this study, see Chapter II, p. 23.

[3] For an interesting discussion of the influence of the calendar on the comparability of periodical statistics see *Statistical Errors and Calendar Reform* by Dr. H. Platzer (World Calendar Association, New York 1932).

are marketed in October, peak sales of hogs occur in January; and fruits and vegetables flood the markets from May to September. In winter occur both the seasonal low in agricultural crops and the peak in urban retail trade. Examples of such diversity in the timing of the direct effects of seasonal factors upon various branches of economic activity might easily be multiplied (see Chapter IX).

In the modern economic system, however, all phases of economic activity are interrelated. Wheat is grown by farmers and sold to grain houses and flour mills. Flour mills grind the grain into flour and sell it to flour wholesalers and to bakers. The latter, in their turn, convert flour into bread and bakery products which are sold to the ultimate consumers. Every branch of activity is thus a link in the long chain of buying-selling relationships that begins with the supply of the raw material and ends with the sale of the finished product. Perhaps we should not say 'ends,' for the final consumers themselves are usually active agents in economic life, each contributing to the total circular flow of commodities and services through the economic system.

Each branch of economic activity not only supplies commodities to some other branch, it also uses raw materials, labor and machinery to carry on its own processes. Thus, the production of cotton cloth is related on the one hand to the demand for textile mill goods and on the other to the supply of labor and machinery necessary to carry on the manufacturing process.

Other conditions being equal, the rate of output of any commodity ought to keep pace with the rate of its consumption, and the rate of productive activity and of the demand for labor and machinery with that of the supply of labor and machinery. Only under such an arrangement can the harmonious and efficient cooperation of the separate branches and factors in economic life, which is the implement and aim of the social division of labor, be achieved. But the direct effects of seasonal factors upon branches of activity whose economic interrelation implies the necessity and desirability of a similar rate of flow in each are frequently diverse. The problem then arises of how the cooperation can be effected; how the diverse consequences of seasonal influences, which disturb the harmonious and efficient coordination of the various elements in the economic system, can be adjusted.

3. The Scope of the Problem

Up to this point we have discussed the various elements in the economic system as if they were only cooperatively related. Such a description is valid if we are considering the sequence of a specific commodity from one stage of fabrication to the next or the cooperation of several productive factors in the output of a single commodity. But a consideration of the concomitant production of several economic goods makes it clear that in respect of the several uses to which a good belonging to any particular stage may be applied a competitive relationship exists. Thus, any raw material may be used in the production of several commodities; competition then arises among various branches of production for it, becoming especially extensive when it is a productive factor such as coal, iron, labor or credit. Even among final consumers the demand for clothing competes with that for automobiles, one article of food with another.

Obviously, competition among several elements, *a, b, c,* arises from the cooperative relation of each within the system to element *d.* Hence, in studying cooperatively related elements and the consequences of diversity in the seasonal influences acting upon them, we should define them as inclusively as possible, with all the competing branches of activity on both the supply and the demand side of the relationship considered together. Thus in studying the seasonal influences on the supply of labor and on the demand for it by agriculture we may confine ourselves to agriculture only upon the assumption that agricultural labor and other types of labor are non-competing. Otherwise, the seasonal influences on the total supply of labor should be compared with those on total demand.

Such an inclusive study of related elements presents certain difficulties. Seasonal influences can be clearly discerned only in their effect upon specific commodities, and their total impact upon several competing specific elements is not easy to ascertain. Nor is the distinction between competing and non-competing elements easily made. To what extent do agricultural and non-agricultural labor constitute non-competing groups? Or if they compete, is there perfect mobility, and therefore, perfect competition between them? In the measurement of seasonal influences on the totality of productive factors such as labor or credit questions of this kind arise frequently.

When two cooperative elements have been defined inclusively, the disturbance created by the differences between the primary seasonal influence upon each is measured by the disparity in respect of (a) *magnitude,* (b) *timing.* The greater the disparity in magnitude between the seasonal influences and the longer it is allowed to persist by the disparity in timing, the greater is the seasonal disturbance and the more formidable is the problem created.

The limits to the disparity measured under either of these two aspects are fixed by the definition of seasonal variations as those changes which recur monthly within an annual period.[4] Some branches of economic activity may be so affected by seasonal factors that we lose sight of them completely for some months and find them concentrated in a single month of the year. At the other extreme, an activity may be left entirely undisturbed by seasonal influences. But in respect of magnitude the disparity for any single month can be no greater than the volume of activity for eleven months (or, if a weekly unit is chosen, to the volume of activity for fifty-one weeks). In respect of timing the upper limit cannot exceed eleven months, if monthly units be adopted for measurement. Although the disparity possible between these limits may appear modest as compared with the degree of disparity involved in business cycles, disturbances even within them give rise to acute problems.

4. Solutions of the Seasonal Problem

When two specific activities in the economic system, cooperatively related, are directly affected by seasonal factors disparate either in timing or amplitude or in both, how can the necessary similarity in the rate of the two activities be attained, or what can be done in order to avoid at least the undesirable effects of dissimilarity in these rates? Several solutions are open:

(1) It is possible to reduce the disparity in primary seasonal influences upon any two specific elements by adding to either a competitive activity subject to other seasonal changes. Thus, the disparity in seasonal influences on the sale of one commodity (for example, ice) and on the supply of such selling

[4] See Chapter II, p. 25.

facilities as office and delivery equipment, sales and delivery force, goodwill, may be reduced by adding to the sales list another commodity (for example, coal), the seasonal demand for which is different from and complementary to that for the original merchandise. Similarly, the situation created by seasonality in the demand for agricultural labor may be relieved by calling on this labor supply to satisfy a demand for industrial as well as for agricultural activity.

This solution settles the problem and is, as will be seen presently, less burdensome than any other, but it assumes a mobility of factors which exists only within narrow limits. Productive equipment and intangible assets are adapted to the specific field in which any individual enterprise operates, for machinery, with the exception of power-producing units, has become more and more specialized with technical progress. A newspaper printing press cannot be used to produce cotton prints or a petroleum tank car to transport automobiles. Similarly, the knowledge of the market and the goodwill of an enterprise are usually confined to a single field of activity and cannot always be easily extended to include another. The more circumscribed the capital fund and entrepreneurial talent at the disposal of an enterprise the more difficult becomes expansion to another market, for a different field of operation can rarely be added without at least a partial investment of new funds and without straining the managerial ability of the concern.

Planning and regulated distribution of equipment might overcome some of the problems arising from the limitations of an individual concern. Also mobility of labor might be facilitated by helping workers to move in response to seasonal demand. The mobility of short-term capital has been increased through the establishment of central banks and the seasonal strain on money and credit thereby rendered much less acute. Nevertheless, in the existing system of private money economy, rather narrow limits are imposed upon the movement of capital once invested in specific equipment and upon the mobility of labor once made specialized by training and rooted to one spot by its adjustment to specific social conditions. Similar limitations apply to all large groups of productive factors.

Consequently, although this first solution of the seasonal problem promises to yield something of value if a conscious

social and technical policy is pursued, it can at present be applied only in a rather narrow field. In many progressive enterprises that deal in commodities subject to seasonal demand an effort is made to introduce by-products for the special purpose of reducing the seasonality in activity.[5] Extensive migration of labor to rural areas occurs during the harvesting season, and in some countries considerable movement of agricultural workers and of farmers during the dull winter months toward city pursuits. But this still leaves many activities, cooperatively related, for which the problem created by disparate primary seasonal influences must be solved in a different and much less satisfactory fashion.

(2) The rate of one activity may be changed so as to conform more closely to that of others. Such changes appear as a result of seasonal variations in prices on the market that connects the two branches of activity in question. These variations are the reaction of a competitive market to the disparity of seasonal influence on supply and demand, a manifestation of the tendency of the price mechanism to restore the balance. Thus, for example, the concentration of wheat output in one season of the year, while its industrial consumption is much less affected by climate, causes seasonally low levels in wheat prices in the months after the harvest and seasonally high levels in the months immediately preceding the new harvest. These *derived* or *induced* seasonal variations in the price of wheat provide an incentive to wheat consumers to buy and possibly even to consume more of the cheap grain during the months of seasonally high levels of wheat supply and less during the off-season months. Thus there appear in wheat purchasing *derived* or *induced* seasonal variations, and these bring its seasonality into closer conformity with that of wheat output.

It is by virtue of this solution of the seasonal problem that many branches of economic activity are characterized by changes that arise not from the direct effect of seasonal factors upon them but from seasonal influences upon some related branch. This fact, which will appear in the detailed exposition in Chapters III through VII, also accounts for the pervasive character of seasonal variations. In the numerous interrelations that bind the various elements in the economic system a

[5] For a discussion of some specific examples see Edwin S. Smith, *Reducing Seasonal Unemployment,* Chapters V and VI (New York 1931).

pronounced primary seasonal influence upon a few of these elements radiates throughout the system by imposing upon it derived variations.

From the activities directly affected by climatic or conventional seasons, acting separately or in unison, seasonal influences radiate to all other activities, probably without exception. In part these radiations are due to the conscious efforts already spoken of to counteract seasonal changes in demand or supply; in part they are unplanned consequences of these changes. For example, the fact that American crops are harvested largely in the autumn gives rise to a seasonal demand for currency in the farming districts, to seasonal changes in interest rates (and sometimes stock prices) in the financial centers, to seasonal changes in railway traffic, to seasonal changes in farmers' receipts, to seasonal changes in their payments to creditors, to seasonal changes in the business of country merchants, and to seasonal changes in wage disbursements. So, too, the expectation of heavy buying by consumers in the holiday season leads retailers to increase their stocks at earlier dates. In turn, the prospect of these large orders injects still earlier seasonal variations into manufacturing, into the demand for raw materials, into employment, and into wage payments, thus tending to produce secondary seasonal variations in retail buying itself.[6]

In the illustration above it is the seasonally less affected branch of activity (wheat purchasing and consumption) that, by becoming more seasonal, is brought into closer conformity with the branch seasonally more affected (wheat output). In a number of industries the adjustment may take an exactly opposite direction, the more affected branch of activity being rendered less seasonal. In the building industry, for example, the greater demand for construction materials and labor during the summer may and does result in higher summer prices for these factors of production; as a consequence the economic disadvantages of winter construction of buildings are reduced, more materials and labor tend to be purchased during the winter and the seasonality in the purchase of construction materials and labor is brought into closer conformity with the influence of seasonal factors on the production of construction materials and on the supply of building labor. Similar attempts to counteract primary seasonal influences and thereby to reduce disparities between related activities are prevalent among retailers in the form of price discounts during off-season periods.

[6] W. C. Mitchell, *Business Cycles* (National Bureau of Economic Research 1928) pp. 237-8.

Whether it is the less or the more seasonally affected branch of activity that is brought into closer conformity with the other through the appearance of seasonal variations in the prices on the market that connects the two, the reduction of seasonal disparity between the two may be made more effective by a controlled, seasonal scale of prices. If wheat producers could act in concerted agreement, they might, if they so desired, force into operation greater seasonal price differentials, making it still more advantageous for wheat purchasers to vary their buying and consumption with the seasons in wheat output. The producers of construction materials can reduce still further the disadvantages of winter building by setting up a clear-cut and rigid seasonal scale of prices. In their turn, house builders and owners may set up a sliding scale of rents to induce prospective tenants to lease their quarters during months other than those customary. A controlled scale of prices of that type, with the assurance to prospective purchasers of definite price advantages and disadvantages, may be much more effective in influencing purchasing policy than seasonal variations in free and competitive prices, which may be obscured by cyclical and random price changes.

Whether it be free or controlled seasonal variations in prices on the market connecting two related branches of activity, the seasonal disparity at these two branches may be reduced, if not completely eliminated, but at the expense of augmenting the disparity at the next link. An adjustment of the rate of wheat consumption by flour mills to conform with seasonal variations in the supply of wheat will increase the difficulties of harmonizing the rate of productive activity with the rate of the supply of productive factors other than wheat, such as machinery and labor, and also of adjusting the supply of wheat flour to the demand for it. A greater spread of winter construction of buildings will partly solve the problem created by the greater effect of weather on construction than on the production of building materials or on the supply of labor. But if, on the other hand, prospective tenants persist in renting new quarters on October 1, the disparity of seasonal influences on ' production ' and ' purchase ' of new quarters will only have been augmented by the spread of winter construction and the consequent increase in buildings completed by spring. Similarly, if by a seasonal scale of discounts, consumers are

induced to buy coal more heavily during the summer, the disparity in seasonal influence on production and purchase of coal is shifted to the next pair of related activities—purchase and consumption.

The effectiveness of this type of solution of the seasonal problem must, therefore, be measured in terms not only of the two given branches of activity but also of the related links. But even for each pair of related activities taken separately, the possibility of restoration of balance through seasonal variations in prices is limited. Where the attempt is to reduce seasonality in the seasonally more disturbed branch, the original seasonal disturbance in many instances is not sufficiently controllable to make feasible considerable elimination of it by any measure short of a technological revolution. In other cases, where technical conditions are more favorable, the effectiveness of economic incentives is limited by lack of response on the part of prospective purchasers, especially characteristic of ultimate consumers.[7] In addition, there is the difficulty of carrying through a systematic seasonal price policy in a competitive market with its manifold price changes, often more appreciable than the seasonal variations. But the main reason for the limited use of this solution of the seasonal problem is the possibility of an alternative solution, that of allowing the two related activities to proceed at disparate rates and of taking care of the disparity by accumulating seasonally variable stocks of the commodity in question. Seasonal price variations, on a free or controlled market, are obviously limited, since the loss to sellers arising from price discounts during months of seasonally heavy output cannot exceed the costs involved in retaining the surplus output in stock for sale during months of seasonally small output.

The same limitations restrict the effectiveness of seasonal price variations in instances where it is the less seasonally disturbed activity that is to be rendered more seasonal. In such instances there is the additional difficulty that the intensification of seasonality usually aggravates the seasonal problem at related links. To apply this type of solution throughout the chain from raw materials to the finished product becomes then particularly burdensome when manufacturing processes intervene between the seasonally affected supply of raw materials

[7] See again Edwin S. Smith, *Reducing Seasonal Unemployment*, Chapter III.

and the demand for finished goods. The variations in prices of seasonal raw materials may induce more seasonal purchasing by industrial consumers. But the further transference to manufacturing of seasonality in the purchase of raw materials is possible only if, during the seasonally heavy months, productive equipment and labor supply are increased to a level much above the average of the year. This means considerable instability in employment and in the utilization of machinery and the maintenance of idle labor and machinery during the seasonally low months. Furthermore, it may mean an increase in the disparity between the rate of supply of the finished product and the rate of demand for it.

The type of solution discussed will therefore be employed to reduce the seasonal disparity throughout the chain from raw materials to the finished product primarily when there is no possibility of stocking the commodity, that is, in the case of goods that are perishable in either the technical or the economic sense. Such physically perishable commodities as most fruits and vegetables, sugar-beets or milk must be converted or consumed immediately; no stocks may be kept to enable industrial or private consumption to proceed at a rate much different from that of the supply. Finished goods that are subject to fashion are economically perishable, for with a change in vogue, stocks decline in value as the nature of the demand is modified. In such instances, also, productive activity must follow closely the seasonally changing rates in the demand for the finished commodities.

(3) The third solution, the accumulation of stocks of the commodity in question, is economically feasible when the original seasonal disparity cannot be removed by dovetailing activities with diverse seasonal influences; when it cannot be eliminated through the incentives of a seasonal price scale whose costs to the sellers do not exceed that of stock accumulation; and when the commodity is by its physical and economic nature durable within the time range involved in seasonal variations and disparities. This solution is most commonly employed at points where the original seasonal disparity is greatest, that is, between the seasonal supply of raw materials and the comparatively unaffected manufacturing activity, and between industrial activity and the comparatively seasonal demand by final consumers.

Seasonal stocks of all raw materials that must be processed prior to consumption by ultimate buyers are kept so as to enable productive activity itself to proceed at the most even rate. Furthermore, the resultant manufactured products for which demand is highly seasonal are stocked to enable the industrial system to supply the demand during seasonally high months without unduly raising the rate of productive activity.

While stocking commodities seems preferable to maintaining idle equipment and labor, it is not without its burdens. From the social point of view, keeping stocks means diverting goods from active use into an idle state, a situation undesirable because of the limited amount of goods at the disposal of society. In addition, most commodities, if they are to be kept without physical deterioration, require protection, and this involves further outlay. While interest payments and cost of protection may be regarded as expenses expressive of the social cost of delay, the individual holder must add a further cost element as compensation for the risk of a decline in the price of the commodity held. Where the goal of the individual enterprise is that of profit, any delay in sale, other conditions being equal, is a burden that is to be avoided, if possible.[8]

5. Types of Seasonal Sequence in Industry and Trade

The present study deals primarily with seasonal changes in the flow of commodities in industry and trade, although it takes into account their radiation into the demand for labor and credit. Because of the necessity of limiting the field of inquiry, the seasonal aspects of economic activity, other than those affecting the flow of commodities, are discussed in general only (see Chapter VII).

Within the field delineated the most conspicuous type of seasonal problem is created by the fact that at both ends of the stream of commodities—at the appearance of the raw materials and at the point where the finished goods pass to ultimate consumers—primary seasonal factors exercise a conspicuous influence upon the rate of activity, and that on the intervening branches of manufacturing activity their influence is quite mild. In the following discussion seasonal changes are traced

[8] On the problem of manufacturing for stock see Edwin S. Smith, *Reducing Seasonal Unemployment,* Chapter XII.

from their origin in the supply of raw materials through the intervening stages to the production of finished goods and on to the flow of finished commodities through the hands of wholesalers and retailers into the possession of final consumers. Confining our study to those industries in which the seasonal influences are conspicuous at any one stage of this sequence we find the following four groups:

1. Industries in which the supply of raw materials is subject to large seasonal variations while the demand for the finished products is rather constant. Most food products fall into this category. The supply of such commodities as wheat, tobacco, sugar, milk and the dairy products and livestock is intermittent, resulting from organic processes that culminate only once, or at most twice a year. On the other hand, since they constitute the basic elements of our diet, the demand for most of them is rather constant.

2. Industries in which not only the supply of raw materials but also the demand for the finished product is subject to large seasonal variations. The most outstanding examples of this group are cotton and wool, both of which, in their raw form, are marketed once a year. Their finished products, cotton cloth and the various cotton products, wool clothing and wool sweaters, are also bought chiefly at definite seasons. Consequently the amplitude of the seasonal variations in final demand is almost as wide as that in the supply of the raw materials.

3. Industries that utilize raw materials whose supply is continuous, subject to rather mild seasonal variations, but whose final product is subject to a seasonally variable demand. Outstanding examples in this group are automobiles and gasoline. Rubber, steel, glass—the various raw materials that are utilized in the manufacture of automobiles—are produced at a relatively constant rate, their output being fairly independent of seasonal factors. On the other hand, the demand for cars, especially passenger cars, is highly variable, being concentrated in the spring. Similarly, crude petroleum is produced continuously throughout the year, but the demand for gasoline is

greatest during the summer when cars are used most extensively. Examples might be given of other durable consumers' goods, such as furniture.

4. In the construction industries neither the raw materials nor final demand but the productive process itself is subject to conspicuous primary seasonal influences. Most of the important construction materials are or can be produced steadily throughout the year. Disregarding the need for summer homes and the influence of moving dates, we have no reason to expect that the demand for dwellings is highly seasonal. But construction itself, being carried on out-of-doors, is subject to climatic influences. This is a highly interesting case, where, in contrast to all other manufacturing activities, the intermediate stage between the raw materials and the final product is subject to conspicuous seasonal influences of its own.

Examples of seasonal variations in each of the groups just outlined are discussed in detail in Part II. But first, the statistical methods of analysis must be presented. These tools for quantitative description of seasonal variations are discussed briefly in Chapter II.