

material in egg and sperm. So far as those characteristics are concerned which appear late in development, it is highly probable that there is equality of inheritance from both parents, but in the early and main features of development, hereditary traits, as well as material substance, are derived chiefly from the mother.

Finally I may call attention briefly to the bearing of these conclusions on the mechanism of evolution. I have elsewhere (*SCIENCE*, No. 536) discussed the proposition that the evolution of organisms must take place through the evolution of their germ cells, and that relatively slight modifications in the localization of the formative substances of the egg may produce profound modifications in the adult.

One of the principal difficulties in explaining, on evolutionary grounds, the origin of different phyla has been the dissimilar locations of corresponding organs or parts. These difficulties are well illustrated by the theories which attempt to derive the vertebrates from the annelids or from any other invertebrate type. If evolution takes place through the transformation of the egg cell rather than of the adult, it is no more difficult to explain the different locations of corresponding parts in these phyla than their different qualities. Changes in the relative positions of parts which would be absolutely impossible in the adult may be readily accomplished in the unsegmented egg, as is shown by cases of inverse symmetry.

In the light of the conclusion that only the later and more detailed differentiations are influenced by the sperm, it follows that experimental work which aims to modify the fundamental features of an organism must be directed to the ovarian egg rather than to the sperm, or to the developing embryo.

EDWIN G. CONKLIN

UNIVERSITY OF PENNSYLVANIA

*THE INFLUENCE OF FRICTION IN ECONOMICS*¹

THERE has always prevailed, since the foundation of systematic political economy,

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a conflict between men of theory and men of action. Men engaged in practical business affairs and even in great financial operations have refused again and again to accept the abstract conclusions drawn from so-called economic laws, and have insisted that the rule of practical common sense, if based upon a careful observation of facts, was a safer guide than economic theory. In the field of tariff legislation this divergence of opinion has perhaps been more marked than in the field of finance. This difference, so far as it exists, tends to support the view which is here laid down—that the economist has erred in a measure in seeking to apply abstract principles too rigidly to actual conditions by failing to take account of friction in the application of these principles.

The economist, working out the theory of the conduct of the economic man according to the principles of enlightened self-interest, finds in them a harmony and a rule of law which in his mind give them something of the beauty and precision of the movement of the spheres. He is impatient of qualifications which detract from the simple and direct operation of the principles derived from these theories. The principles of the flow of capital to the market where the price paid for its use is the highest, of changes in prices according to changes in the quantity of money, of the evolution of production and manufactures in such a manner that each community and each individual shall find his most profitable work under the regime of free competition, are principles so simple to his mind that he can not understand how they can be disputed.

Nor could such principles be long disputed, if the current of trade flowed as freely as the waters of the ocean into a vacuum wherever scarcity indicated a given demand, and if money and capital

moved without restraint to the market where they found the most profitable use. If every one bought in the cheapest and sold in the dearest market, then universal free trade might prevail among the nations, imperialism would fold its flag and sheathe its sword, and every community would be producing either the agricultural products or manufactured goods which experience had taught that it could produce with the greatest efficiency and in exchange for which it could obtain the greatest sum of the desirable products of other communities.

But we know that this is not the case. No peace conference and no appeal to the universal brotherhood of man can prevent wars based upon the intensity of industrial competition. The world of to-day is organized upon the system of competing nationalities. Many generations distant is the dream of universal peace among the nations, such as Rome by her power enforced for four centuries throughout nearly the entire civilized world from the time of Augustus to that of the third Valentinian. The origin of modern wars, as was doubtless the case in reality with many ancient and medieval wars, is the struggle for existence. Few nations have yet been willing to stand forth, as does Great Britain in the field of trade, seeking no shelter behind artificial barriers against the competition of other peoples. The cause of free trade, which it was believed in Cobden's time had only to be presented to civilized men, like the teachings of the gospel, in their simple beauty, to make converts of all the world, has made little visible progress in recent years. On the contrary, a great wave of protectionism swept over Europe in the eighties and the barriers have been erected higher in most cases rather than lower within our generation. Converts to the principles of Adam Smith and John Stuart Mill and Cobden

have undoubtedly been made among thinking men, but even those men, when exalted to official place, have usually found that they had to deal with a *status quo* which was too enormously complicated to permit the cutting of the Gordian knot of special privilege and interdependent industries during the time in which they were likely to continue as public servants.

More significant still of the general belief of responsible governments, that universal free trade and the unfettered movement of capital are still far in the future, has been the policy of imperialism which has followed on the heels of protection and been deemed sufficiently important to justify the sacrifice of thousands of lives and millions of treasure, even by that champion of economic freedom, the empire of Great Britain. Experience has shown that "trade follows the flag" to a large extent, not perhaps because competition in a free field would not make the flag a negligible factor, but because by skilful regulations and legislation can be created discriminations and favors of many sorts which give potent advantages to those under the flag over alien rivals. Even the policy of "the open door" in the East, which did honor to the memory of Secretary Hay as much as it did violence to the professed economic views of some of his predecessors, was not potent enough to insure that equality of opportunity for non-Russians in Manchuria which it was designed to secure and did not prevent the greatest death-struggle of our generation between Russia and Japan as to who should in future attend to the execution of this avowed policy of equality.

If the professor of political economy, therefore, desires to exercise a greater influence than he exercises to-day in molding the policy of this nation or any other, he may well give greater weight than heretofore to the influence of friction in econ-

omies instead of reposing upon the comfortable assumption that economic forces operate in a vacuum. Experience demonstrates that even the movement of capital is not without friction. If friction did not exist, the interest rate for loans upon equally secure collateral would be the same in New York as in London, in St. Petersburg as in Paris, in Arkansas as in Chicago. Wherever good opportunities for loans arose, money would flow like water into the vacuum of demand. The merchant of Little Rock, other things being equal, would obtain his borrowed capital at the same rate as the mercer of London or the jeweler of the Rue de la Paix. But the merest tyro in finance knows that this is not the case. Not only has the creation of physical means of communication been necessary to bring markets together, but the creation of the means of exchange has also been necessary. And so far as markets have been brought together, it is largely by state-created, but not state-operated, institutions. How could the market of Paris draw to itself the savings of France for investment in the securities of the world and maintain the lowest and most uniform discount rate of any great market but for the giant mechanism which Napoleon created, under the guidance of Mollien, under the name of the Bank of France? How could Canada enjoy comparative uniformity of interest rates in all her provinces but for the Canadian banking law, which confers upon institutions of limited liability the privilege of issuing circulating notes and establishing branches in every part of the Dominion? As Bagehot truthfully declared of the conditions under which capital is transferred, "You can not have it unless you have a strong government, which will keep peace in the delicate line on which people are moving." And again he sets forth, as indicating the narrow limits within which

the law of the transfer of capital operates even in modern society:

But though the loan fund begins so early in civilization, and is prized so soon, it grows very slowly; the full development—modern banking such as we are familiar with in England—stops where the English language ceases to be spoken.

And if there are fetters upon the free movement of capital, how much greater are those upon the free movement of labor! It is a favorite argument, and a sound one, of even the most orthodox of economists, that the effect of a depreciating currency is felt in the rise of prices before it results in the rise of wages. The friction which attends the lifting of the wage scale is forged into a powerful argument in favor of giving steadiness to the unit of value. Why then is not the effect of this friction worthy of consideration when it affects rates of customs duties and other national economic policies? I do not say that this argument is not often abused, but I do say that the classical economist is not justified in appealing to its finality in the one case and treating it as beneath contempt in the other.

The abstract principle of wages is that, other things being equal, similar service should command the same equivalent in every part of the world. But one finds skilful carpenters in Manila working for about fifty cents a day in gold, and in America at two dollars and fifty cents. In Hong Kong in 1901 I was told that good Chinese brick-layers were working for forty cents a day in silver or about twenty cents in gold. Why did they not strike for the same wages as their fellow-workmen in London or New York, or San Francisco? Because, behind them, in the interior of China, were millions upon millions of their fellow-countrymen, as ready to take their places in the ranks of cheap workers as the loyal Japanese soldiers and

sailors who were ready to climb over the bodies of their dead comrades to victory before the walls of Vladivostock or on the smoking decks of their battleships in the China Sea. Would it be of any use to preach to the Chinese mechanic in Hong Kong the doctrine of the eventual equalization of wages by the movement of masses of laborers from poorly-paid markets to those well paid until wages in Hong Kong rose to the level of those in London? Would he not reply that an equalization which could not be accomplished in perhaps three generations was too remote to justify his hazarding his job?

The operation of the quantity theory of money is another field in which economists themselves have been compelled by the exigencies of their own arguments to admit the influence of friction upon the working out of theory. Whatever may be thought of the principles laid down when the use of money was not so extensively supplemented as at present by instruments of credit, it is now obvious that those principles rarely operate in a vacuum. Other influences, so important that they often outweigh changes in the quantity of the metallic monetary stock, come constantly into operation. The argument of a few extremists in the silver campaign, that "money of ultimate redemption," or "basic money," alone influences prices, would hardly be defended to-day even by the followers of Mill. Those, on the other hand, who depart farthest, either from his theories or from their practical application, contend that prices are influenced by the volume of banking credits, by the rate of discount, and preeminently by the demand and supply for particular articles which interacts in one case upon demand and supply for other articles, so that there is never reached a static point at which a proportionate increase in the quantity of money is accompanied by a like and uni-

form increase along the entire line of manufactured and exported goods.

The friction which takes place in the introduction of a new stock of gold from the mines into general circulation has been made the subject of elaborate studies by Cairnes, Chevalier and many others. Their arguments are often quoted in support of the contention that out of this friction emerges ultimately a definite relation between prices and the quantity of money. But if this friction occurs in this first flow of the new metal from the mines, then it almost inevitably follows that it occurs also in its later movements between communities and even in its relation to different articles. The supply of any article may be so uniform that it is inadequate under certain conditions of demand and excessive under new conditions of demand. Hence come about relations of supply to demand which affect such articles differently from those whose supply can be promptly curtailed or promptly expanded according to the conditions of the market. Friction operating with different degrees of intensity in the case of different articles thus makes it practically impossible that at any given moment such friction shall have been overcome in equal degree for all commodities and that they shall show a uniform increase or decrease in price based upon a corresponding change in the quantity of money. Of this friction intelligent economists now generally take note, even where they adhere to the theory that in the end prices become adjusted to an increase or decrease in the stock of the standard metal.

If the influence of friction, then, can be admitted in respect to the movement of capital, the tendency of wages, and changes in the quantity of money, is it not illogical to insist too strongly that it should not be recognized in systems of taxation and especially in rates of customs duties? The

contention that "the foreigner pays the tax," made by the extreme protectionists in framing the McKinley and Dingley laws, may find verification in specific instances, where the foreigner would prefer to hold a market already acquired, even at a lower rate of profit, rather than to sacrifice a plant built entirely or chiefly for supplying that market. Cases of this kind do not, of course, justify the attempt by political legerdemain to impose upon other nations the fiscal charges of the state. Indeed, to the enlightened cosmopolitan they appear a rather undignified and pitiful device to rob somebody else to obtain one's daily bread. But the fact can hardly be disputed that the operation of those simple economic harmonies which were the dream of Mill and Bastiat and Cobden is essentially hampered by the inability of capital and labor to move instantly from one place to another or from one employment to another.

A nation which has built up even an artificial system can not perhaps afford to throw down the structure at a blow. It may be demonstrable that the sooner it is destroyed the more fully will come into operation the principle that labor finds its most efficient employment under the system of free competition. But if the existing capital of the nation is invested, as in the case of the United States, in manufacturing establishments to the extent of thousands of millions of dollars, too great a sacrifice may be involved in abandoning enterprises suddenly, even where the capital invested in them was misapplied. Hence practical statesmen, whatever their theoretical views, have in but few cases proposed the sweeping abolition of protective tariff laws. Changes which will afford free raw materials to manufacturers, and will reduce excessive profits and unnecessary exactions upon the customer, can undoubtedly be made with

wisdom in this and most other protective countries. The appeal to throw down the structure, however, must almost inevitably be treated by practical statesmen, like the quantity theory of money and the theory of the free movement of capital, as representing what might be desirable if economic forces operated in a vacuum, but what is rarely, if ever, attainable in the world of practical affairs.

The science of political economy can afford to recognize these limitations upon its application to practical affairs, without yielding that devotion to abstract truth which gives charm to the work of its greatest exemplars. If there have been conflicts in the past between men of theory and men of action, they have been largely due to this failure to recognize the restrictions imposed by actual conditions, the disposition to insist that a fundamental truth once demonstrated should be accepted by all men, without regard to limitations of time and space, just as the great teachers of Christianity have sometimes urged that the existing social order should be forsaken and that Christ's mandate should be put in immediate force, to sell all that one hath and give to the poor. The practical theologian knows as well—perhaps better—than the political economist, that these principles are not of immediate application in their extreme form and that if the world can be guided steadily towards those heights where truth lies, it will make more rapid progress than by preaching the impracticable in a world of practical men and practical affairs. It is the duty of the political economist to continue to preach these fundamental truths which have been worked out by the masters of the science within the past two centuries, but this need not lead him to reject and spit upon the practical considerations which the statesman has to face in applying abstract principles to mundane conditions.

It should not be forgotten that economic science differs in essential respects from the physical sciences. In those sciences we find forces which work according to fixed laws. Even in them we find the effect of those laws mitigated or offset by friction and opposing forces. In the world of economic science we do not deal with conditions so unvarying. The so-called laws of economic science are simply the interpretation of what is likely to be the action of men under the stimulus of self-interest in the field of free competition for the acquisition of goods and the accumulation of capital. But while two streams of water act in exactly the same way under similar physical laws, no two men act in precisely the same way under the operation of mental laws. At least, if laws exist which compel such uniformity of mental action, they are too abstruse to have yet been discovered and formulated.

From the standpoint of existing conditions, therefore the psychological element is an important factor in mitigating the operation of so-called economic law. To acquire commodities and save capital is not man's sole impulse. On the contrary, in the midst of the most highly developed civilized society to-day, a large percentage of men are influenced by other motives than the desire to achieve the greatest result by the utmost exertion of their labor. Some prefer idleness to labor; others prefer spending to saving; others pursue ambitions which have their roots only remotely in the acquisition of money. And if this is so in civilized communities, how much more is it so in those where commerce is feebly developed, where the church or the state, or immemorial custom prescribe the routine of each man's life, and where competition in our modern American sense is almost a thing unborn.

Economic law does not operate in a vacuum or in anything approaching a

vacuum even in the most advanced modern society. It gropes blindly in a mist of disturbing forces, and with many digressions from its true objective, even where its operation is most nearly unhampered. The political economist, therefore, can afford to admit that the man of practical affairs sees in some respects as clearly as himself regarding existing requirements, even though his eyes are fastened upon the ground while his own are uplifted to the stars.

CHARLES A. CONANT

SCIENTIFIC BOOKS

Ice Formation, with Special Reference to Anchor-Ice and Frazil. By HOWARD T. BARNES, M.A., D.Sc., F.R.S.C. New York, John Wiley and Sons. 1906. Pp. 260.

To persons living in moderate climates, the statement of Dr. Barnes, in his introduction, is very striking that where surface ice is prevented from being formed "as in a rapidly flowing river we meet with the worst effects from the presence of ice"; notwithstanding the fact that the temperature of the water never varies more than a few thousandths of a degree from its freezing point, even when the air is 30° or 40° lower. The account which Mr. Barnes gives of the difficulties which the ice causes in the St. Lawrence River at Montreal entirely substantiates the statement. There are three kinds of ice which are met with; the surface ice, the anchor-ice, which is formed in the bed of the river and the frazil, which is formed as small individual crystals at the surface of the swiftly flowing water. The frazil is formed in the rapids and is carried under the surface ice in the quiet water below and adheres to its under surface. Thus the ice becomes thick enough to choke up the channel of the river and cause a serious flood. Frazil also interferes with the water power used at Montreal by choking up the machinery, and a commission has existed for some time for the purpose of studying the condition leading to the formation of frazil and the best methods of preventing the damage done by it. This commission had made many determinations of the temperature of the