CUMULATIVE PROCESS MODELS FROM THORNTON TO WICKSELL

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The celebrated Wicksellian theory of the cumulative process is a landmark in the history of monetary thought. It gave economists a dynamic, three-market (money, credit, goods) macromodel capable of showing what happens when banks, commercial or central, hold interest rates too low or too high. With it one could trace the sequence of events through which money, interest rates, borrowing, spending, and prices interact and evolve during inflations or deflations. The prototype of modern interest-pegging models of inflation, it influences thinking even today. It also confirms the adage, well known to historians of science, that no scientific discovery is named for its original discoverer [19, p. 147]. For, as documented below, it was not Knut Wicksell but rather two British economists writing long before him in the first third of the nineteenth century who first presented the theory.

The cumulative process analysis itself attributes monetary and price level changes to discrepancies between two interest rates. One, the market or money rate, is the rate that banks charge on loans. The other is the natural or equilibrium rate that equates real saving with investment at full employment and that also corresponds to the marginal productivity of capital. When the loan rate falls below the natural rate, investors demand more funds from the banking system than are deposited there by savers. Assuming banks accommodate these extra loan demands by issuing more notes and creating more demand deposits, a monetary expansion occurs. This expansion, by underwriting the excess demand for goods generated by the gap between investment and saving, leads to a persistent and cumulative rise in prices for as long as the interest differential lasts. As stressed by Wicksell, the differential vanishes once banks raise their loan rates to protect their gold reserves from depletion by cash drains into hand-to-hand circulation. Given the volume of real transactions paid in gold coin, these drains arise from the price increases that necessitate additional coin for such payments. The differential also vanishes when a loan rate set *above* the natural rate produces falling prices and a reversal of the cash drain. In this case, the resulting excess reserves induce banks to lower their rates toward equilibrium in an effort to stimulate borrowing. These adjustments, however, may occur too late to prevent substantial changes in prices.

From this analysis it follows that the monetary authority must strive to keep the money rate in line with the natural rate if it wishes to maintain price stability. To do this, it must raise or lower its own lending rate as soon as prices show the slightest tendency to rise or fall and maintain that rate steady when prices exhibit no tendency to move in either direction. By following this rule, it eradicates the two-rate disparity that generates inflation or deflation.

The foregoing model and its policy implications are well known. Not so well known, however, is that the model was already more than 70 years old when Wicksell presented it in his *Interest and Prices* in 1898. Long before then, Henry Thornton (1802, 1811) and Thomas Joplin (1823, 1828, 1832) had already constructed versions of the model and had employed it in their policy analysis. The model's two-rate, saving-investment, loanable-funds framework was as much their invention as Wicksell's. The same is true of their demonstration that inflation stems from usury ceilings and bankers' attempts to peg loan rates at levels other than those that clear the market for real capital investment. Even the model's famous equilibrium conditions-two-rate equality, saving-investment equality, loan-saving equality, aggregate demand-supply equality, monetary and price stability-were recognized by them. All they lacked was an automatic stabilizing mechanism that brings the cumulative process to a halt by the convergence of the loan rate on the natural rate.

And this was provided by Wicksell in the form of the feedback effect of price changes on the loan rate. In an attempt to correct some misconceptions about the theory's origins and to give these pioneers their due, the paragraphs below outline the model and its components to show what the three contributors had to say about each.

The Model and Its Components

To identify the specific contributions of Wicksell and his predecessors, it is useful to have some idea of the model they helped create. As presented here, that full-employment model consists of seven equations linking the variables investment I, saving S (both planned or ex ante magnitudes), loan rate i, natural rate r, excess aggregate demand E, money-stock change dM/dt, and price-level change dP/dt.[1] Of these, saving and investment are taken to be increasing and decreasing linear functions of the loan rate, the presumption being that higher rates encourage thrift but discourage capital formation.

The first equation states that investment I exceeds saving S when the loan rate of interest i falls below its natural equilibrium level r (the level that equilibrates saving and investment),

$$(1)\ I - S = a(r - i),$$

where a is a coefficient relating the investment-saving gap to the rate differential that creates it. The second equation states that the excess of investment over saving equals the extra money dM/dt created to finance it,

$$(2)\ I - S = dM/dt.$$

That is, assuming banks create money by way of loan, monetary expansion occurs when they lend more to investors than they receive in deposit from savers, To see this, denote the (investment) demand for loans L_D as $L_D = I(i)$, where I(i) is the schedule relating desired investment spending to the loan rate. Similarly, denote loan supply Ls as the sum of saving S(i)-all of which is assumed to be deposited with banks-plus new money dM/dt created by banks in accommodating loan demands ; in short, Ls = S(i) + dM/dt. Equating loan demand and supply (L_D = Ls) yields equation (2) above.

[1] For similar models, see Eagly [2] and Laidler [10, pp. 104-5, 117].

The model's third equation says that an excess of investment over saving at full employment generates an equivalent excess demand E for goods,

$$(3)\ I - S = E,$$

as aggregate real expenditure outruns real supply. The fourth equation says that this excess demand bids up prices, which rise by an amount dP/dt proportionate to the excess demand,

$$(4)\ dP/dt = kE.$$

Substituting equations (1) and (3) into (4), and equation (1) into (2), yields

$$(5)\ dP/dt = ka(r - i) \text{ and}$$

$$(6)\ dM/dt = a(r - i),$$

which together state that price inflation and the money growth that underlies it both stem from the discrepancy between the natural and loan rates of interest. This, of course, is the model's most famous prediction.

Finally, the seventh equation closes the model by linking loan rate changes di/dt to price changes dP/dt. It states that bankers adjust their rates upward in proportion to the price rises so as to protect their gold reserves from being exhausted by inflation-induced cash drains into hand-to-hand circulation. That is, assuming the public makes a certain proportion of its real payments in the form of coin, rising prices increase the quantity of coin required for that purpose. To arrest the resulting drain of coin reserves into hand-to-hand circulation, bankers raise their loan rates by an amount di/dt proportionate to price changes dP/dt,

$$(7)\ di/dt = b\ dP/dt.$$

This equation ensures that the loan rate eventually converges to its natural equilibrium level, as can be seen by substituting equation (5) into equation (7) and solving the resulting differential equation for the time-path of the loan rate.[2] At this point, saving

[2] Solving the differential equation di/dt = bka(r-i) obtained by substituting equation (5) into equation (7) yields the expression for the time-path of the loan rate i,

$$i(t) = (i_0 - r)\, e^{-bkat} + r$$

where t is time, e is the base of the natural logarithm system, i_0 is the initial disequilibrium level of the loan rate, and r is the (constant) natural rate. This expression states that the loan rate will converge on the natural rate with the passage of time if the coefficients b, k, and a are each positive, as is assumed in the model in the text.

equals investment, excess demand vanishes, money and prices are stable, and bank lending equals saving -these results obtaining when one sets the two rates equal to each other in the model. These of course are the famous Wicksellian conditions of monetary equilibrium. Given the model and its components, one can identify what Wicksell and his precursors contributed to it.

Henry Thornton

The origins of the cumulative process model are to be found in Chapter 10 of Henry Thornton's classic *An Enquiry into the Nature and Effects of the Paper Credit of Great Britain* (1802) and in the first of his two parliamentary speeches of 1811 on the Bullion Report. In those works he contributed four ideas that together constitute the central analytical core of the model. He also demonstrated the model's power as a tool of policy analysis.[3]

First, he noted that the quantity of loans demanded depends upon a comparison of the loan rate of interest with the expected rate of profit on the use of the borrowed funds. He says, "In order to ascertain how far the desire of obtaining loans at the bank may be expected at any time to be carried, we must enquire into the subject of the quantum of profit likely to be derived from borrowing there under the existing circumstances. This is to be judged of by considering two points: the amount, first of interest to be paid on the sum borrowed; and, secondly, of the mercantile or other gain to be obtained by the employment of the borrowed capital. . . . We may, therefore, consider this question as turning principally on a comparison of the rate of interest taken at the bank with the current rate of mercantile profit" [20, pp. 253-4]. He continues : "The borrowers, in consequence of that artificial state of things which is produced by the law against usury, obtain their loans too cheap. That which they obtain too cheap they demand in too great quantity" [20, p. 255]. Thus a loan rate equal to the profit rate limits loan demands to noninflationary levels. But a loan rate below the profit rate induces additional-and inflationary-loan demands.

Second, he explained how the rate differential, through its effect on loan demands, translates into money and price level changes. As noted above, the rate differential induces an expansion of loan demands. Assuming that bankers accommodate these loan demands by increasing their note issue-an assumption that implies a willingness to let reserve to note and deposit ratios fall-the money stock expands. The resulting money-induced rise in aggregate expenditure puts upward pressure on prices. It also, because of an assumed sluggish adjustment of wages and other costs to rising prices, stimulates output and employment. Given that the economy normally operates close to its full-capacity ceiling, however, the price effect predominates. It follows that price inflation as well as the money growth that underlies it stems from the differential between the loan and profit rates as indicated by the expressions $dP/dt = ka(r-i)$ and $dM/dt = a(r-i)$. Here is the first model to show that inflation occurs when bank rates are pegged at inappropriate levels.

Third, he stressed that the rate differential, if maintained indefinitely, produces cumulative (continuing) rather than one-time changes in money and prices. This is so, he said, because as long as the loan rate remains below the equilibrium rate, borrowing will continue to be profitable ("the temptation to borrow will be the same as before") even at successively higher price levels. The result will be more borrowing, more lending, more monetary expansion, still higher prices and so on without limit in a cumulative inflationary spiral. Under these conditions, "even the most liberal extension of bank loans" will fail to have the slightest "tendency to produce a permanent diminution of the applications to the bank for discount" [20, p. 256]. On the contrary, loan demands will be insatiable while the rate differential lasts.

Fourth, from the foregoing considerations Thornton derived his fundamental equilibrium theorem, namely that monetary and price level stability obtain when the loan rate equals the profit rate. Such two-rate equality, he said, would allow the banking system to "sufficiently limit its paper" to noninflationary levels "by means of the price [i.e., rate] at which it lends" [20, p. 254]. For with the two rates equal, their differential would vanish and with it the inducement to borrow and lend that produces inflationary money growth. Money and prices would stop rising and stabilize at a constant level. Having described the two-rate equilibrium, however, he did not explain what forces would drive banks to attain it. His model lacked the automatic equilibrating mechanism through which inflation induces banks to raise their loan rates to equilibrium in order to protect their reserves from cash drains into hand-to-hand circulation.

[3] On Thornton, see Hayek [4, pp. 12-14; 20, pp. 49-50] and Schumpeter [18, pp. 720-4].

Thornton's Policy Conclusions

Thornton's fifth contribution was his demonstration of the model's usefulness as a tool of policy analysis. He used his model to determine the cause of the paper pound's depreciation on the foreign exchanges during the Napoleonic wars when Britain had suspended the convertibility of her currency into gold at a fixed price upon demand. He attributed the depreciation to note overissue caused by the Bank of England's discount rate being too low. Usury ceilings, he noted, constrained the Bank's rate to a 5 percent maximum at a time when, owing to the boom conditions of the war, the expected rate of profit was well in excess of 5 percent. The result of this differential was a loss of Bank control over the volume of its loans and its note issue, both of which had expanded to produce inflation. To give the Bank a firm grip on the money supply, he urged removing the usury ceiling and requiring the Bank to set its discount rate equal to the profit rate. As a second-best alternative, he endorsed the Bank's policy of rationing loans. Apart from such direct credit rationing, however, he saw no end to inflation as long as the differential persisted. In this connection, he noted that no amount of monetary expansion could lower the profit rate to the level of the discount rate. The profit rate, he said, is a real variable determined by the demand for and supply of real capital. As such, it is invariant with respect to changes in nominal variables like the money stock. Somewhat inconsistently, he admitted that money growth could stimulate capital formation through *forced saving*-the inflation-induced redistribution of purchasing power from fixed-income receivers to capitalist investors. But he thought such effects to be quantitatively unimportant. For that reason, he made no mention of the resulting capital accumulation's impact on the profit rate.

He also employed his model to refute the real bills doctrine according to which inflationary overissue is impossible as long as banks lend only on sound commercial paper arising out of real transactions in goods and services. He contended that the real bills test provided no check to overissue when the loan rate is below the profit rate. For the resulting price rise emanating from the differential would, by raising the nominal value of real transactions, in&ease the nominal volume of eligible bills coming forward for discount. Since these bills would pass the real bills test (i.e., they are backed by an equivalent value of goods) they would be discounted and the money stock would expand. This monetary expansion would validate a further rise in prices thereby resulting in more bills being presented for discount leading to further monetary expansion and still higher prices and so on ad infinitum in a never-ending inflationary spiral. These examples show that for Thornton the cumulative process model was not a theoretical toy but a key component of his policy analysis.

Thornton's Contemporaries

Thornton's two-rate analysis was accepted by at least four of his contemporaries. Thus J. R. McCulloch, in his refutation of the real bills doctrine, argued that loan demands depend primarily on "the rate of interest for which those sums can be obtained, compared with the ordinary rate of profit that may be made by their employment" [13, p. 235]. Similarly, Lord King warned that such loan demands "may be carried to any assignable extent" if the rate differential persists [9, p. 22]. John Foster put the point even more forcefully. He said that if the directors of the Bank of England were to expand the note issue in an effort to accommodate all loan demands arising at the disequilibrium rate, they "might at length reduce the value of their notes to that of the paper on which they are engraved" [3, p. 113]. But perhaps the clearest and most succinct statement came from David Ricardo who wrote that "The applications to the Bank for money, then, depend on the comparison between the rate of profits that may be made by the employment of it, and the rate at which they are willing to lend it. If they charge less than the market [i.e., natural] rate of interest, there is no amount of money which they might not lend,-if they charge more than that rate, none but spendthrifts and prodigals would be found to borrow of them. We accordingly find, that when the market rate of interest exceeds the rate of 5 per cent at which the Bank uniformly lend, the discount office is besieged with applicants for money; and, on the contrary, when the market rate is even temporarily under 5 per cent, the clerks of that office have no employment" [17, p. 364].

Missing from the analysis of Thornton and his contemporaries was any mention of the model's real saving and investment schedules. These components were largely overlooked before the appearance of Thomas Joplin's *Outlines of a System of Political Economy* (1823), Views on the Currency (1828), and *An Analysis and History of the Currency Question* (1832).

Thomas Joplin

Joplin incorporated saving and investment schedules into Thornton's model and defined the natural rate as the rate that equilibrates the two.[4] He then argued that an increase in the demand for capital, by raising the natural rate above the loan rate, will open a saving-investment gap and a corresponding excess demand for goods that bids up prices progressively as long as the rate differential lasts. He likewise noted that money growth would accompany and validate the price increases as bankers (who have no way of knowing what the natural rate is and so charge their customary rate) honor all credit demands at the going loan rate. These considerations led him to conclude with Thornton that monetary and price level changes stem from disparities between the two rates. He also concluded that monetary equilibrium and its attendant balance conditions-saving-investment equality, loan-saving equality, aggregate demand-supply equality, monetary and price level stability-obtain only when the two rates are equal.

Joplin's observations are so Wicksellian that they must be read to be believed. On the relation $I-S=dM/dt$ between the investment-saving gap and the monetary change that finances it, he wrote, "When the supply of capital exceeds the demand, it has the effect of compressing it [the circulation]; when the demand is greater than the supply, it has the effect of expanding it again" [8, p. 101]. On the expression $dM/dt=a(r-i)$ connecting money-stock changes with the natural rate-loan rate disparity, he remarked that since bankers "never can know what the true [natural] rate of interest is" they "charge a fixed [loan] rate," with the consequence that the currency "expands and contracts, instead of the interest of money rising and falling" [8, pp. 109, 111].

Likewise, on the mechanism through which deviations of the loan rate from the natural rate produce inflation, he observed, "Money comes into the market . . . from the banks . . . in consequence not of a demand for currency, but of a demand for capital, determined by the interest which the banks charge proportioned to the market [i.e., natural] rate. And in all cases the influx of money into the market . . . is not the effect, but the cause of high prices" [6, pp. 258-9]. Here is an explicit recognition of (1) the two-rate disparity, (2) the investment demand for loans, (3) a loan-determined money stock, and (4) the money-price relationship-all key ingredients of Wicksell's analysis. Finally, on pegging the loan rate above the natural rate so that saving exceeds investment and loans, money, and prices all fall, he said, "If it [fall of prices] proceeded from the interest charged by the banks, being too high, the economy [i.e., saving] of the country, instead of reducing the interest . . . would find vent in discharging the debts due to the banks, at the high rate of interest they imposed; and the value of money and profits of trade would thus be kept up to that level which rendered the general economy [saving] greater than the general expenditure [investment]" [6, pp. 209-10]. Here is perhaps the first application of the cumulative process model to the deflationary case in which a loan rate above the natural rate spells an excess of saving over investment, a deficiency of aggregate demand, a contraction of borrowing and the money stock, and a consequent fall of prices. In other words, Joplin recognized that interest-rate pegging can lead to deflation as well as inflation.

Like Thornton, he saw forced saving as one effect of the price inflation produced by banks' willingness to lend more than the savings voluntarily deposited with them. "If the issues of the bank are not increased by any loan it makes at interest, an equal amount of money must have been previously saved out of income, and paid into the bank, in which case, the party borrows the income previously saved ; but if not, and the issues of the bank are increased by the loan, prices rise, and the party who has borrowed the money obtains value for it by depriving the holders of the money in previous circulation, of a proportionate power of purchasing commodities. An economy is thus created, though a forced economy, but it answers all the purpose of a volutary one" [7, p. 146]. He opposed forced saving on the grounds that it involved a fraud and an injustice on the preexisting money holders.

From his analysis he concluded that interest-rate pegging is an important cause of price-level fluctuations. "One effect, no doubt, would be produced by the bank regulating its issues by the demand for [loans] at a particular rate of interest, namely, that the rate of interest would be kept steady. Instead of the savings of income rising above four per cent [following, say, an upward shift in the loan demand schedule], the enlargement of issues would create an additional quantity sufficient to supply, at four per

[4] On Joplin, see Corry [1, pp. 54-6, 60-1, 110], Hayek [4, pp. 15-7], Link [12, pp. 73-102], Schumpeter [18, p. 723], Viner [22, pp. 190-2], and Warburton [23, pp. 125, 290].

cent, the increased demand. On the other hand, when the savings of income were not in such request, and the demand at four per cent fell off, the notes of the bank would be withdrawn, and the supply of such savings, to a corresponding extent, would be cancelled, by which the rate of interest would be kept up [above its natural level]. The alteration in the [loan] demand for capital would not affect its value. The supply of it by means of the enlargement and contraction of the currency, would be created and cancelled as it was required. Prices would fluctuate instead of the interest of money" [7, pp. 152-3].

He contended that these price fluctuations occur because banks possess the power of creating and destroying paper money at will by varying their reserve ratios. Take away this power, he said, and banks would become pure intermediaries, lending only the savings entrusted to them. In this case, saving would equal investment, loan rates would equal the natural rate, excess demand would be zero, and price stability would prevail. To make these equilibrium conditions a reality he proposed a policy of 100 percent required gold reserves behind note issues.

To summarize, Joplin gave the model its most complete formulation up to Knut Wicksell. His inclusion of saving and investment schedules allowed him to show how gaps between the two produced by deviations from the natural rate translate into money-stock changes and excess demand that bids up prices. In short, he recognized all the model's components except the price-induced interest-adjustment mechanism that ensures the stability of monetary equilibrium.

Knut Wicksell

When Wicksell presented his cumulative process model in 1898, he thought he was the first to do so.[5] At that time he was totally unaware of the earlier work of Thornton and Joplin. Not until 1916 did he discover from his colleague David Davidson that Thornton had foreshadowed him by almost 100 years. But he apparently never learned about Joplin, whose saving-investment version of the model was virtually identical to his.

One finds in his model all the elements developed by Thornton and Joplin. The two-rate disparity is there, as are the saving-investment gap, the excess demand for goods that bids up prices cumulatively, and the accompanying money growth resulting from banks' willingness to accommodate all credit demands at the going loan rate. His conclusion-that monetary and price-level changes stem from the two-rate disparity-is the same as theirs. So too is his list of monetary equilibrium conditions, including two-rate equality, saving-investment equality, loan-saving equality, aggregate demand-supply equality, and monetary and price-level stability. True, he differed from Joplin on how these conditions should be achieved. He preferred a policy of promptly moving the discount rate in the same direction as prices are changing, stopping only when price movements cease. By contrast, Joplin preferred a policy of 100 percent required gold reserves. But both believed that there existed a workable policy rule to keep money rates in line with the natural rate. Like his predecessors, he even used his model as a tool to explain British price movements in the nineteenth century, although he focused on secular rather than cyclical changes.

He differed from Thornton and Joplin chiefly in his inclusion of the stabilizing feedback effect of price-level changes on the loan rate. By adding this element to the model he was able to show that the cumulative process is self-limiting provided banks maintain some desired level of gold reserves and provided the public transacts a certain proportion of its real payments in gold coin. Since inflation increases and deflation decreases the need for coin in circulation to effectuate these given real payments, banks, he argued, will find their reserves being depleted in the former case and augmented in the latter. To arrest these price-induced reserve drains or accumulations they will adjust their rates upward or downward. In this way those price changes bring their own cessation as the loan rate converges on the natural rate.

He also demonstrated that the cumulative process is *not* self correcting in hypothetical "cashless" or pure credit economies using no metallic money, all payments being made by bookkeeping entries, Since specie drains are not a threat in such economies, banks need hold no reserves and are free to maintain indefinitely any money rate they choose. As a result, there exists no reserve constraint in the cashless society to limit the cumulative process. Thus any spontaneous disturbance that upsets the initial equality between the two rates will set in motion an inflation or deflation that can continue indefinitely. He further argued that the same may be true even in pure cash societies if technological innovations,

[5] On Wicksell, see Jonung [5], Laidler [10], Leijonhufvud [11, pp. 151-61], Patinkin [15, pp. 587-97; 16] and Uhr [21, pp. 198-254].

wars, and other real shocks cause the natural rate to change before the loan rate can ever catch up with it. In this case, the loan rate's lag behind the moving natural rate spells incomplete adjustment, persistent disequilibrium, and ceaseless price changes.

This last insight, which combined the notions of an active or leading natural rate and a passive or trailing loan rate, enabled him to resolve what Keynes was later to call the Gibson paradox. This paradox, which neither Thornton nor Joplin addressed, holds that prices and interest rates historically move together in the' same direction when, according to standard monetary theory, they should move inversely as excess issues of money temporarily depress interest rates while raising prices. In resolving the paradox, Wicksell agreed that prices and loan rates would move inversely if those rates fell below a given natural rate. For example, if loan rates fell to 4 percent when the natural rate was 5 percent, prices would rise. On the other hand, prices and loan rates would tend to move together if the natural rate itself moves and the loan rate lags behind (i.e., adjusts incompletely to the changing natural rate). In this case, loan rates, though rising or falling, would still be too low or too high relative to the natural rate to prevent a cumulative rise or fall in prices. Indeed, this was precisely Wicksell's explanation of long-term price changes in nineteenth century Britain. These changes he saw as emanating from movements of the active natural rate about the lagging loan rate. Except for these applications, Wicksell's use of the model was the same as Thornton's and Joplin's.

Concluding Comments

That Wicksell at best only rediscovered or reinvented the model now universally associated with his name is hardly surprising. It merely confirms the validity of Stigler's Law of Eponymy according to which no scientific discovery is named for its original discoverer. Still this finding, though completely unexceptional, is nevertheless at odds with some recent interpretations of the model's history. Certainly it is not true, as suggested in Axel Leijonhufvud's recent essay on the "Wicksell Connection," that the model derives solely from Wicksell. Nor is it true, as Leijonhufvud contends, that Wicksell originated the saving-investment approach to macroeconomics [11, pp. 132-3]. For, as documented above, the cumulative process model together with its implied conditions of monetary equilibrium originated not with Wicksell but rather with Thornton and Joplin. Of these two pioneers, Joplin deserves at least some credit for initiating the saving-investment approach since it was he who first introduced saving and investment schedules into the model.

These findings also cast doubt on Robert Nobay's and Harry Johnson's recent attempt to distinguish between classical and Wicksellian phases in the evolution of monetary thought [14, pp. 471-3]. The classicals, according to this distinction, concentrated on establishing the proposition of the long-run neutrality of money. Wicksellians, by contrast, focused on the dynamic implications of monetary responses and disturbances as well as on the conditions of monetary equilibrium. What is overlooked is that at least two classical monetary theorists, namely Thornton and Joplin, were Wicksellians as far as their monetary analysis was concerned. True, they accepted the neutrality proposition. But their main concern was investigating the dynamics of money's response to deviations of the loan rate from the natural rate. They also sought to eliminate those deviations so that prices could be stabilized. To that end they spelled out the conditions of monetary equilibrium and prescribed policies to achieve them. In these ways they strongly resembled Wicksell.

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