

Knut Wicksell and Gustav Cassel on the Cumulative Process and the Price-Stabilizing Policy Rule

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In economics as in anthropology, old artifacts spur continuing debates. A case in point is Knut Wicksell's celebrated 1898 analysis of the cumulative process of price inflation in pure credit, cashless economies. Some economists view Wicksell's model as a milestone in the evolution of quantity-theoretic monetary analysis inasmuch as it constitutes the seminal rigorous explanation of how loan-created stocks of bank money translate interest rate differentials into price level changes. Others, however, dispute this point and instead argue that money plays no role in determining price level changes in Wicksell's model.

Unfortunately, Wicksell's own writings do little to resolve the debate. Ambiguous in the extreme as to whether the cashless society version of the cumulative process has quantity-theoretic roots, his writings support quantity- and anti-quantity theory interpretations alike.

One person who could have resolved the debate was Wicksell's countryman and contemporary, the Swedish economist Gustav Cassel. In a 1928 journal article Cassel provided an extremely clear, compelling articulation of the quantity-theoretic foundations of the cumulative process. He then demonstrated the far-reaching significance of that articulation by extending it to more generalized considerations, including an analysis of the business cycle and

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alternative monetary policy rules. While Wicksell conducted monetary policy analysis using a model without money, Cassel showed that money plays a crucial, behind-the-scenes role even when excluded as a variable from the constituent equations of policy models and policy rules.

Cassel's demonstration should have made it clear that the quantity theory interpretation of the cumulative process and the operation of policy rules was correct and the anti-quantity theory interpretation was suspect. But that did not happen. Instead, Wicksell's Swedish followers largely overlooked Cassel's demonstration, perhaps because it was confined to a single published article in a foreign journal they did not ordinarily read. For whatever reason, Cassel's explanation exerted little influence and did nothing to prevent the flourishing of anti-quantity theoretic interpretations of Wicksell's work from the 1920s through the 1980s. The situation is different now. Cassel's rediscovered insights locate Wicksell's pure credit analysis of the cumulative process squarely in the quantity theory tradition. And, by stating that schema in its most precise, transparent form—not to mention extending its range of application—they spotlight the prescience, originality, and inventiveness of its creator, confirming Wicksell's place in the front rank of monetary theorists.

Wicksell's Three Contributions

Knut Wicksell's claim to fame as a monetary theorist rests on three contributions presented in his 1898 *Interest and Prices* and volume two of his 1906 *Lectures on Political Economy*. First is his concept of the hypothetical *pure credit economy*, or cashless society. In this regime all hard, or outside, money (gold coin and convertible paper currency) ceases to exist, the banking system consists of a single central bank that holds no reserves, and the medium of exchange is composed entirely of inside money, that is, checking deposits created by the central bank when it makes loans. With no reserve constraint to anchor nominal variables in the pure credit regime, deposit supply possesses potentially unlimited elasticity and the price level theoretically can rise (or fall) forever. It is the job of the central bank to prevent this outcome by means of its rate-setting policy. Such policy replaces the missing reserve constraint in imposing determinacy on an otherwise indeterminate money stock and price level.

Second is Wicksell's famous analysis of the *cumulative process* according to which price level movements stem from the differential between natural (equilibrium) and market (loan) rates of interest and continue as long as the differential persists. The rate differential is of key importance to Wicksell. It generates a gap between new capital investment and household saving, a gap that manifests itself in the form of an excess aggregate demand for goods that bids up prices cumulatively until the differential vanishes.

Wicksell's third contribution is his celebrated *feedback policy rule*, under which the central bank stabilizes the price level by adjusting its interest rate in response to price level deviations from target, stopping only when prices converge to target. A precursor of the modern Taylor rule, Wicksell's rule is the prototype of all feedback policy rules discussed in the monetary literature today.

Area of Disagreement

Wicksell scholars are in agreement on the originality, fecundity, and usefulness of these pioneering constructs. Agreement ends, however, on the role that Wicksell intended for changes in the quantity of deposit money to play in these constructs. Do bank money stock changes play an active, causal role in the transmission mechanism connecting rate differentials to price level changes? Or do they occur passively as a consequence of price level changes produced by nonmonetary means? In short, is bank money a price-determining or a price-determined variable in the workings of the cumulative process and the policy rule? Does causation run from deposits to prices as the quantity theory of money predicts? Or does it run from prices to deposit money, contrary to the quantity theory?

Active Money View

One group of scholars, including Arthur Marget (1938), Johan Myhrman (1991), Don Patinkin (1965), and Hans-Michael Trautwein (1996), contend that Wicksell saw endogenous (that is, responding to other variables in the model) changes in the stock of bank money as playing a crucial causal role. They argue that for him changes in the quantity of deposits constitute the necessary connecting link between the natural rate–market rate differential and the resulting rise in the price level. In their view, Wicksell understood that such money stock changes transform the interest differential and its associated investment-saving gap into the excess aggregate demand that bids up prices. They claim that without this monetary expansion to mediate and finance the excess demand, there would be no inflationary pressure and the rate differential would be abortive in influencing prices.

Patinkin explains how an excess of the natural over the market rate in Wicksell's pure credit economy engenders profit opportunities for investors and leads them to "increase their bank borrowings. The new demand deposits... placed at their disposal will enable them to increase their 'demand for goods and services as well as for raw materials already in the market for future production'" thereby raising prices (1965, 589–90). "By increasing the quantity of money in this way, the banks can bring about any specified price

level by maintaining a discrepancy between the market and real [natural] rates until the desired price level is reached, and then equalizing the rates at that point” (594). Rate differential determines deposit growth, which in turn determines price level change.

Marget repeatedly makes exactly the same point (1938, 179–86, especially 184–85), arguing, for example, that the level “of general prices depends upon the total amount of bank money issued,” which, “in turn, depends upon the relation of bank rate to natural rate” (263). He likewise voices the related point that Wicksell saw adjustments in the central bank’s loan rate of interest as working through money stock changes to stabilize prices in the feedback policy rule. Loan rate changes lead to corresponding changes in the demand for and supply of bank loans. More importantly, such rate changes lead to changes in the stock of deposit money created as a byproduct of the loans. This monetary change in turn moves prices. Here, then, we find the quantity theory proposition that although the interest rate differential determines changes in the stock of bank money, those money stock changes must precede and cause the resulting price level movements. Myhrman’s summary of the quantity theory interpretation is apt: Wicksell “explained the role of . . . inside money and the rate of interest in the transmission of monetary impulses to the price level [showing that] causation runs from the monetary system to the price level” (1991, 272).

Passive Money View

In contrast to Marget, Myhrman, Patinkin, and Trautwein, however, other prominent Wicksell scholars, notably Trygve Haavelmo (1978), Jürg Niehans (1990), and Axel Leijonhufvud (1981), deny that changes in the stock of bank money play a crucial, price-determining role in Wicksell’s cumulative process. In their interpretation, Wicksell held that interest rate differentials and the resulting excess aggregate demand drive up prices *directly* without the necessary intervention of bank money creation. Instead, bank money expansion comes at the end of each stage of the cumulative process and only then to accommodate, or validate, price increases already produced by nonmonetary forces. As Haavelmo puts it, rate-created “excess [aggregate] demand is the primary force, which inflates the value of PX [nominal output]” (1978, 214). Afterwards, the stock of loan-created bank money moves “along passively in order to cover the public’s [monetary] requirements, which in turn depend on PX ” (214).

In short, according to Haavelmo the behavior of bank money in Wicksell’s cumulative process is best described by the Banking Principle, according to which

the quantity of [bank] money plays a...passive role; it adjusts in accordance with the [monetary] requirements created by changes in the value of transactions when the price level is forced up or down by *other* factors. (1978, 210)

Niehans explicitly endorses Haavelmo's passive-money interpretation. He asserts that in "Wicksell's approach" the supply of bank money, far from playing an active, price-determining role, instead "adjusts passively to whatever households and firms demand" at given prices (1990, 275). Leijonhufvud agrees. He writes that "the excess demand for commodities" rather than "acceleration in the growth rate of 'money'" is what "drive[s] the price-level up" (1981, 159–60). It follows that "watching '*M*'... would not be of much help in forming rational expectations. In a world like Wicksell's, the money stock would be a lagging indicator. The growth rate of *M* is not driving the cumulative process" (159–60).

Leijonhufvud, Niehans, and Haavelmo are far from the first to claim that Wicksell's cumulative process consists of a transmission mechanism with links running unidirectionally from aggregate demand to prices and thence to money demand and supply. Earlier interpreters claimed to find this same mechanism in which bank money appears at the tail end of the causal queue. Thus William P. Yohe quotes a 1908 statement by one S. F. Altman alleging that Wicksell "believes that the [money] holding follows the price movement, which takes place through stronger purchase or sale of goods" (1959, 144, n. 67). Small wonder that Hugo Hegeland observed that "Knut Wicksell has provoked more discussion as to whether he was a opponent or adherent of the quantity theory than perhaps any other economist" (1951, 133).

Five Contentions

In an effort to resolve the controversy over the active money versus passive money interpretations of Wicksell, this article argues five points. First, proponents of the quantity theory interpretation may perhaps possess the correct analysis of the cumulative process and the operation of the feedback rule, namely that changes in the stock of bank money must precede and induce price level changes. Second, those proponents, their claims to the contrary notwithstanding, cannot consistently and unambiguously find that interpretation in Wicksell, who at times seems to side with the passive money view. That Wicksell's formulation could spawn two polar opposite views—one monetarist, the other antimonetarist—is not surprising given its ambiguities, inconsistencies, and peculiarities of phrasing and definition.

Third, for the quantity-theoretic version of the cumulative process and the policy rule, one must go not to Wicksell but rather to Cassel, his rival for the professorship at Lund, who presented that version in a remarkable but underrated article entitled "The Rate of Interest, the Bank Rate, and the Stabilization

of Prices” and published in the August 1928 issue of the *Quarterly Journal of Economics*. The article is especially noteworthy because it challenges the widespread view that Cassel adhered to a simple monetary model that excluded interest rates and had the path of the price level determined solely by the differential growth rates of the nominal supply of and real demand for monetary gold (see Jonung [1979]). True, Cassel used that simple model in much of his empirical work as reported in his famous textbook *The Theory of Social Economy*. But his *QJE* piece shows that, in at least one key theoretical essay, he employed a Wicksellian framework that incorporated natural and market rates of interest as well as an endogenous stock of inside, loan-created money to determine the price level.¹

The fourth contention of this article is that Cassel’s active-money exposition of the cumulative process contains innovations that advance it beyond Wicksell’s exposition. Cassel, like Wicksell, uses the cumulative process model to derive a stabilizing policy rule, but unlike Wicksell, he extends it to the analysis of the business cycle and alternative proposed monetary norms as well. With respect to the business cycle, he applies the cumulative process to show that monetary factors amplify real fluctuations. In other words, he broadens the scope of application of the cumulative process analysis beyond the confines imposed by Wicksell. In so doing, he demonstrates the versatility and explanatory power of the quantity theory.

Fifth, on one matter at least, namely the analysis of the operation of the price-stabilizing feedback policy rule, Cassel’s discussion lacks the precision of Wicksell’s. Wicksell not only specified the exact indicator to which the central bank responds but also described the behavior of the time path of the price level when it is constrained or influenced by the policy rule. Nevertheless, Cassel more than Wicksell saw that quantity-theoretic logic underlay their policy rules.

1. QUANTITY THEORY INTERPRETATION

Proponents of the quantity theory interpretation of Wicksell’s work generally attribute to him a version of the cumulative process model describable by five relationships shown below. These relationships are meant to depict the case of Wicksell’s pure credit economy in which (i) all saving S is deposited in banks,

¹ Cassel’s article is noteworthy also because it runs counter to Bo Gustafsson’s contention that Cassel’s “expositions are not seldom marred by contradictions and a vagueness in expression, only scantily veiled by his mastery of round and polished sentences” (1987, 375). Contrary to that verdict, Cassel’s exposition of the cumulative process in his *QJE* article is among the clearest and most succinct to be found in the literature on Wicksell. The mystery is why the Swedish successors of Wicksell and Cassel ignored this article. Had they read and cited it, the subsequent anti-quantity theory interpretation of the cumulative process might never have appeared, or at least would have been rendered more suspect than it was.

(ii) all investment I is bank-financed, (iii) the economy is closed such that all saving and investment are of domestic origin, (iv) banks lend solely to finance investment, (v) full employment prevails such that shifts in aggregate demand affect prices but not real output, which remains at its capacity level, and (vi) agents, always expecting current prices to prevail in the future, anticipate none of the price changes that occur.

Embodying the foregoing assumptions, the five relationships are capable of depicting steady state equilibrium as well as the dynamic disequilibrium adjustment process triggered by disturbances to equilibrium. The steady state solution obtains when the relationships are set equal to zero, resulting in the celebrated conditions of Wicksellian monetary equilibrium. These conditions are market rate of interest equals natural rate, saving equals investment, aggregate demand equals aggregate supply both in real and nominal terms, and the stock of bank money and the price level are stable and unchanging.

Now, a modern general equilibrium theorist, schooled in the notion that self-corrective forces operate with sufficient swiftness to maintain model economies in equilibrium, would solve the equations for their above-mentioned steady state values. He or she would further treat dynamics not as disequilibrium processes, but rather as equilibrium paths driven by moving state variables. Not so Wicksell. Believing that persistent departures from equilibrium were commonplace, he had more ambitious plans for his model. To him and many of his interpreters, the baseline conditions of monetary equilibrium merely set the stage for the cumulative disequilibrium process, which begins when the natural rate diverges from the market rate (see Trautwein [1996], 31–32). Wicksell attributed such divergences to a multitude of real shocks that disturb the natural rate while the inertial forces of habit, routine, and absence of base-money reserve constraints in the pure credit economy introduce sluggishness into bankers' adjustment of the market rate. In the pure credit economy, central bankers theoretically could hold the market rate—which in pure cash and mixed cash-credit economies tends to converge to the natural rate—below or above that latter rate forever.

Let the resulting natural-market rate divergence activate the cumulative process. Immediately the relationships shed their zero equilibrium steady state solutions to depict dynamic disequilibrium responses and adaptations. Shown below, the relationships in their dynamic setting treat causality as running unidirectionally from the independent variables on the right side of each equation to the dependent variables on the left. True, the modern theorist versed in formal equilibrium analysis may question this mode of reasoning. Accustomed to thinking in terms of a system of equations simultaneously satisfied by a set of variables, he or she would argue that it makes no sense to think of one variable adjusting first and thus causing another to adjust, and so on. Nevertheless, it is just this sort of chain of causation that lies at the heart of Wicksell's inflation mechanism and of the active versus passive money debate.

And it is just this sort of chain that the following relationships describe:

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

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

$$X = dM/dt, \quad (3)$$

$$E = X, \quad (4)$$

and

$$dP/dt = bE. \quad (5)$$

Equation (1) says that because lower market interest rates i encourage capital formation and discourage thrift, the planned investment expenditure I of business firms exceeds the planned voluntary saving S of households when the natural rate of interest r (the rate that equilibrates saving and investment) exceeds the lagging market rate i set by the banking system.² Here the coefficient a is the parameter that relates the investment-saving gap to the interest rate differential that generates it.

Equation (2) states that the gap, or excess of desired investment over desired saving, equals the additional money dM/dt newly created as a byproduct of the loans made to finance the gap. In other words, since the central bank (the only bank in the pure credit economy) creates new check-deposit money by way of loan, monetary expansion occurs when it lends more funds to business investors than it receives on deposit from savers (who Wicksell assumes lodge all their savings with the bank). Equation (2) admits of a simple derivation. Denote business demands for bank loans L_D as $L_D = I(i)$, where $I(i)$ is the schedule relating desired investment spending (assumed to be entirely financed by bank loans) with the loan rate of interest, or cost of borrowing, i . Similarly, denote bank loan supply L_S as the sum of household saving S deposited with banks plus new money dM/dt created by banks in accommodating loan demands. In short, $L_S = S(i) + dM/dt$. Equating loan supply and loan demand $L_S = L_D$ (where the causal arrow runs from right to left

² A lower market rate stimulates planned investment by raising the present discounted value of the stream of expected future returns to capital. The rise in this discounted revenue stream raises the price of capital goods above their replacement cost and makes it profitable to produce more of them. Furthermore, since the market rate is the intertemporal relative price of consumption today in terms of consumption sacrificed tomorrow, a fall in that price induces people to take more of consumption today. Consumption rises and saving falls, hence the shortfall of saving below investment at lower than natural interest rates.

since loan supply passively accommodates itself to loan demand) and solving for the gap between investment and saving yields equation (2).

Equation (3) is absolutely essential to the quantity theory interpretation. It recognizes that while the quantity of bank *loans* in an accommodative banking system is passively demand determined and can never be in excess supply, the same cannot be said for the stock of *money* created as a byproduct of the loans. On the contrary, such a loan-created money stock can, as long as nominal transactions and thus the public's demand for transaction balances remains momentarily unchanged, indeed be redundant, or overissued. Thus equation (3) says that because at prevailing prices P and real output Q the public's demand for money M_D as expressed by the equation $M_D = kPQ$ has not yet changed, the new money dM/dt created by loan constitutes an excess supply of money X .³ This undesired excess money supply is essential to the operation of the cumulative process because without it moneyholders would have no incentive to spend the additional money away. And with no incentive to spend it away, there would be no force to propel prices upward. Instead, the new money would be willingly held and absorbed into transaction balances and thus could never spur spending and prices.

Accordingly, equation (4) says that cashholders attempt to rid themselves of the excess money X by spending it on goods and services. The result is that the surplus money spills over into the commodity market to underwrite and mediate the excess aggregate demand for goods E implied by the gap between investment and saving. Indeed, the expenditure of the excess money is what transforms the excess *desired*, intended demand implicit in the investment-saving gap into excess *effective*, actual demand. In sum, equation (4) embodies Walras's Law according to which an excess demand for goods must be matched by a corresponding excess supply of something else, which quantity theorists take to be money.

According to equation (5), because Wicksell assumed that output is always at its full capacity level and so cannot expand, the excess effective demand E must exhaust its force in bidding up prices, which rise by an amount dP/dt proportional to the excess demand, with the coefficient b denoting the factor of proportionality. Substituting equations (1)–(4) into (5) and (1) into (2) yields the two equations

$$dP/dt = ab(r - i) \quad (6)$$

and

$$dM/dt = a(r - i), \quad (7)$$

³The money demand function $M_D = kPQ$ is the famous Marshall-Pigou (or Cambridge) *cash-balance* equation, in which the parameter k denotes the fraction of nominal income PQ that people desire to hold in the form of money balances M . Continental European quantity theorists already were beginning to employ this function, often in verbal rather than symbolic form, in Wicksell's time (see Ellis [1937, 154–75]).

which together state that price inflation and the money growth that underlies and permits it stem from discrepancies between the natural and market rates of interest. Further substitution of equation (7) into equation (6) yields the expression

$$dP/dt = b(dM/dt), \quad (8)$$

with causation running as always from right to left. Per this quantity theory interpretation, bank monetary expansion dM/dt is the necessary link that translates interest differentials into price level changes dP/dt in Wicksell's cumulative process.

2. ANTI-QUANTITY THEORY INTERPRETATION

By contrast, proponents of the passive-money interpretation who claim Wicksell as an adherent drop equations (2), (3), and (4) and have excess aggregate demand E itself (which they define as identical to the investment-saving gap) directly determine the price level change according to the three-equation system in which money is conspicuously absent:

$$I - S = a(r - i), \quad (9)$$

$$E = I - S, \quad (10)$$

and

$$dP/dt = bE. \quad (11)$$

In the passive-money interpretation, money stock changes, far from being the active intervening element that transforms interest differentials into price level changes, adapt passively to support the price changes already produced by excess aggregate demand. That is, assuming (i) that purchasers demand loans L_D from banks in order to be able to buy the same real quantity of goods Q at the raised prices dP/dt , (ii) that banks accommodate these borrowers by supplying new loans L_S in the form of bank money creation dM/dt , and (iii) that money circulates against goods with a given turnover velocity V , one obtains

$$L_D = (Q/V)dP/dt, \quad (12)$$

$$L_S = dM/dt, \quad (13)$$

and

$$L_S = L_D, \quad (14)$$

which upon substitution yields

$$dM/dt = (Q/V)dP/dt, \quad (15)$$

with causation running from price level changes dP/dt to money stock changes dM/dt .

In short, with the money stock adjusting passively to changes in the price level component of the money demand function, there can be no excess money supply. And without an excess supply of money, there is nothing to induce moneyholders to attempt to rid themselves of it by spending it away. No redundant money exists to spill over into the commodity market in the form of an excess demand for goods to bid up prices. On the contrary, far from over- or underissue forcing a change in prices, money supply conforms to money demand with neither excess nor deficiency and causality runs from prices to money in the passive money view. Here is an interpretation stemming from Wicksell's own analysis that is antithetical to what quantity theorists claim he sought to accomplish.

3. WICKSELL'S OWN VIEW

Quantity theorists may be right in contending that Wicksell, in Hans-Michael Trautwein's words, "wanted to demonstrate that the quantity theory of money is valid even in the extreme [pure credit economy] case of money supply endogeneity" (1996, 31). Still, it is difficult if not impossible to prove Trautwein's proposition conclusively from a representative sample of Wicksell's own writings. It is no wonder that quantity and anti-quantity theorists alike can claim Wicksell as an ally. In some passages, he indeed sides with the quantity theory, holding that bank money expansion is the crucial link connecting rate differentials to price level changes and transforming ex ante investment-saving gaps into ex post excess aggregate demand. In his 1898 article "Influence of the Rate of Interest on Commodity Prices," Wicksell speaks of prices adapting "themselves to the increase in the amount of money," implying that monetary expansion occurs before prices can change (80). Again, in volume two of his *Lectures on Political Economy* he implies money-to-price causality when he writes "of the influence of credit [demand deposits] on prices" (1906, 164).

Passive Money and Reverse Causality

In other passages, however, Wicksell unambiguously sides with the passive-money view. Asserting reverse causality, he writes in his 1925 piece "The Monetary Problem of the Scandinavian Countries" that monetary expansion may occur after rather than before prices have increased. Specifically, he argues that spenders themselves can directly raise nominal national income simply by bidding up all prices (accomplished through a temporary rise in

velocity) and subsequently borrowing from the banking system to cover the increased monetary requirement. Describing a pure credit economy in which “all payments were made on a cheque basis,” he says that whereas deposit checking accounts

would constantly increase in amount as prices rose, *at first . . . there would be no increase in the average amount or in the aggregate of these accounts*. In the course of time they would become inconveniently small in proportion to the increased volume of monetary payments [required to buy the national product valued at the higher prices]. *They would consequently need to be adjusted upwards*. In the final analysis this presupposes an increase in bank credit. [In this manner] as prices rose, bank deposits and bank loans would swell more or less automatically. (1925, 202, emphasis added)

The causal and temporal sequence here runs from prices P to loans L to money M with M adapting itself passively to prior changes in P .

Again, in still another passage asserting reverse causality, Wicksell writes that “a general rise in prices will cause banks of issue to increase their issue of notes” and that even if the “banks flatly refuse to expand their circulation” they cannot “prevent the rise [of prices] or force prices down”—those prices obeying nonmonetary imperatives (202). It is on the basis of these passages that Bertil Ohlin, in his introduction to the English translation of *Interest and Prices*, claims that Wicksell believed that “a general rise in prices may well come about because consumers increase their demand. . . for consumption goods. This. . . need not have anything to do with too large credits to producers. The conclusion to be drawn. . . is that. . . prices may rise or fall *ad libitum*” (1936, xx–xxi). In short, Wicksell provides ammunition for quantity and anti-quantity theory forces alike.

Application of Real Balance Mechanics to Outside Money

Wicksell’s inconsistency is most apparent in his contradictory treatment of an excess supply of outside versus inside money. In the case of outside money—gold coin and convertible currency—he recognized that such an excess money supply indeed could occur in pure cash and mixed cash-credit regimes and then spill over into the commodity market in the form of an excess demand for goods that drives up prices. In perhaps the best description of the operation of a real balance effect in the neoclassical monetary literature, he explained ([1898] 1965, 39–40) how a rise in M (or a random fall in P) would cause actual cash balances to become greater than desired. He then described how

cashholders, in an effort to work off these undesired balances, would spend the excess money on goods until prices rose sufficiently to render actual balances equal to desired ones.

Failure to Apply Real Balance Mechanics to Inside Money

When it came to inside, bank-created money, however, Wicksell abandoned the notion of an excess supply of money. The impossibility of a redundant stock of deposit money is already implicit in his tendency to define deposits and loans indiscriminately as *credit*. With this definition, he conflated a non-demand-determined variable (deposits) with a demand-determined one (loans). Treating both identically, he failed to see that deposits could be in excess supply even if loans—passively provided upon demand by a pliant, accommodative banking system—were not. As far as deposits were concerned, he argued that their quantity (like that of loans) is always demand determined. Further, he contended that deposit supply and demand are identical at all prices, such that both the price level and the nominal quantity of deposit money are indeterminate in the pure credit economy. In his words,

We have seen that in our ideal state [the pure credit economy] every payment, and consequently every loan, is accomplished by means of cheques or *giro* facilities. It is then no longer possible to refer to the supply of money as an independent magnitude, differing from the demand for money. No matter what amount of money may be demanded from the banks, that is the amount which they are in a position to lend. . . . The banks have merely to enter a figure in the borrower's account to represent a credit granted or a deposit created. When a cheque is then drawn and subsequently presented to the banks, they credit the account of the owner of the cheque with a deposit of the appropriate amount (or reduce his debit by that amount). *The "supply of money" is thus furnished by the demand itself.* (1898, 110, emphasis added)

If Wicksell's conclusion is correct, it follows that bank money can never be in excess supply. And if it can never be in excess supply, it cannot induce holders to attempt to rid themselves of it by spending it away. And if it is not spent away, it cannot be the force that generates an excess demand for goods and bids up the price level. One has to question, therefore, quantity theorists' wisdom in attributing equations (3) and (4) to Wicksell.

In short, with bank money completely demand determined, there can be no real balance effects of the kind that Wicksell applied to coin and currency in his treatment of pure cash and mixed cash-credit economies. Bank money, that is, cannot be the source of price level changes. It is hard to dispute David

Laidler's summary judgment: "There is no logical reason why Wicksell could not have" acknowledged that the public's demand for exchange media "would tend to give bank deposits the same role in the credit economy as currency in the cash economy: and then to note that deposits generated as a byproduct of credit creation would have, by way of cash balance mechanics, their own influence on the economy," that is, on the price level (1991, 148). "He did not take these steps, however" (148). His failure to do so would deprive his pure-credit-economy version of the cumulative process of quantity theory foundations and render it susceptible to anti-quantity theory interpretations.⁴

4. CASSEL'S QUANTITY-THEORETIC VERSION OF THE CUMULATIVE PROCESS

For a straightforward, consistent account of the quantity theory version of the cumulative process and feedback policy rule one must look not to Wicksell but rather to the work of his compatriot and sometime rival Gustav Cassel. In his 1928 *Quarterly Journal of Economics* article, Cassel, without once mentioning Wicksell's name,⁵ developed the cumulative process analysis for the case of a loan-created inconvertible banknote money administered by a central bank, which Cassel treats as the only bank in the economy.⁶ The monetary regime he

⁴ In contrast to the position taken above, a modern equilibrium theorist might find Wicksell's ambiguity commendable. He or she would argue as follows: First, one cannot rely on a full, or complete, general equilibrium analysis of Wicksell's model economy since the maintained assumption is that the bank rate is exogenously fixed for a time below its natural equilibrium level. Second, given this assumption, the proper method of analysis is to ask what the consistency conditions arising from market clearing and individual optimization imply about the remaining variables, money and prices in particular. These conditions imply that the stock of money and the price level both must rise. But nothing in the pure logic of Wicksell's abstract economy requires that the rising of one variable must be causally or temporally prior to the rising of the other. Therefore, Wicksell was right to leave the matter ambiguous. If so, then the whole active-versus-passive-money debate reduces to much ado about nothing. The fact remains, however, that the debate, pointless or not, has raged for almost one hundred years.

⁵ Despite Cassel's failure to cite Wicksell, he was clearly polishing and perfecting the latter's model.

⁶ Cassel's article exemplifies the tendency of scientific integrity to prevail over personal animosity in rigorous disciplines such as economics. It is no secret that Wicksell and Cassel disliked each other and frequently disagreed on issues other than the goal of price stability (Seligman 1962, 562; Blaug 1986, 43). Enmity between the two surfaced during their competition for the professorship at Lund when Wicksell advised Cassel to withdraw his application and disparaged his capital theory as the work of a rank amateur (Gardlund 1958, 321–22). Later, in correspondence, Wicksell complained of Cassel's arrogance, his overweening self-esteem, his pretensions to originality, and his notorious failure to cite predecessors and contemporaries whose ideas he used (Gardlund 1958, 322). Wicksell was, in his own words, put off by Cassel's habit of "incessantly singing his own praises, appointing himself generalissimus over the rest of us poor creatures" (322). Mutual antagonism intensified in 1919 when Wicksell published a devastating critique of Cassel's *Theory of Social Economy*, a critique that Cassel's favorite pupil, Gunnar Myrdal (1945, 10, quoted in Carlson 1994, 31, n. 4), called "bitter and uncomprehending" and that Cassel's secretary, Ingrid Giöbel-Lilja (1948, 231, quoted in Carlson 1994, 31, n. 4) described as revealing "a deep lack of understanding, almost bordering on hatred, of Cassel's whole personality." Following the publication of Wicksell's critique, Cassel ceased attending meetings of the Political Economy Club in

considers is therefore virtually the same as Wicksell's pure credit regime, the only difference being that inside money in the form of inconvertible banknotes replaces checking deposits as the sole medium of exchange.

Quantity Theory Components

Cassel provides a verbal account of all the components of the quantity theory version of the cumulative process. Of the equations $I - S = a(r - i)$ and $dM/dt = I - S$, he says, "there exists a definite equilibrium rate of interest [r]. If the bank rate [i] is lower than this equilibrium rate, people will go to the bank for covering their needs for capital [$I - S$], and the bank will have to issue notes [dM/dt] to meet such needs" (1928, 517).

He likewise makes it clear that the initial effect of the interest differential is to generate a loan-created monetary expansion that occurs prior to the rise in prices. "If the bank rate is kept too low [$r - i$]," he writes, "people will find it advantageous to borrow at the bank [$L_S = L_D$] and thus the supply of the means of payment [dM/dt] will swell" (516). In other words, a monetary overissue occurs as "the market borrows unduly much from the bank and becomes too abundantly supplied with means of payment" (517). The result is "an unnecessarily large issue of notes" (517) or "excessive supply of means of payment [X]" (527)—excessive, that is, in relation to the real demand for it, which, "without any more goods having been produced," (517) remains unchanged. Here is Cassel's recognition of the excess money supply condition $X = dM/dt$. Here, too, is his recognition of the corresponding excess aggregate demand and price-rise relationships $E = X$ and $dP/dt = bE$. These conditions hold, he says, when the excess money supply spills over into the commodity market in the form of an excess demand for goods that, in the fully employed economy, "is bound to force up prices" (517).

Application to Deflationary Case

Cassel applied the cumulative process analysis to the symmetrical case of price deflation. "If the bank rate [i] is raised above the equilibrium rate of interest [r], the demand for loans is affected" (1928, 525). Loan demand shrinks and with it loan supply and the nominal stock of money. The fall in the money stock means that "the nominal purchasing power of the market is reduced"

Stockholm, where Wicksell regularly aired his views. The antipathy culminated in Cassel's (1926; see Ohlin [1972, 107]) declining to write an obituary article on the recently deceased Wicksell on the grounds that "too much separated us" and that he could not in good faith give an unbiased appraisal of a man whose "extraordinarily dogmatic" character prevented him from appreciating Cassel's own work and that of others. Yet this antipathy did not prevent Cassel from inadvertently doing Wicksell—and monetary science—the supreme favor, two years after his death, of shearing Wicksell's cumulative process analysis of ambiguities and inconsistencies and securing it with solid quantity-theoretic foundations. Though delayed, the drive for scientific integrity triumphed after all.

below the unchanged real demand for it. In an effort to restore money balances to their desired level, people cut back their spending for goods “with the result that prices in general must fall” (525). Through the creation of an excess demand for money matched by an excess supply of goods, “the raising of the bank rate above the equilibrium rate. . . brings about a fall in the general level of prices,” just as “a reduction of the bank rate below the equilibrium rate,” by generating an excess money supply, is “bound to raise the general level of prices” (525–26).

To summarize, the foregoing constitute Cassel’s statements of the equations $X = dM/dt$, $E = X$, $dP/dt = bE$, and, via substitution, $dP/dt = b(dM/dt)$. This last equation encapsulates his acknowledgement of “the rise in prices that must follow upon the excessive supply of means of payment” just as the quantity theory’s postulate of money-to-price causality contends (527).

5. CASSEL ON THE CONDITIONS NECESSARY FOR PRICE STABILITY

Cassel’s credentials as a quantity-theory interpreter of the cumulative process manifest themselves most strongly in his discussion of the conditions required for price stability. Like Wicksell, Cassel stressed that “stability of prices is possible only when the bank rate is kept equal to the equilibrium rate of interest,” that is, when the rate differential is zero (1928, 517). Far more emphatically than Wicksell, however, he argued that not the two-rate equality per se but rather the resulting monetary limitation is the fundamental condition for price stability. Said he, “the purchasing power of the monetary unit is. . . determined by the scarcity that the central bank chooses to give to its note circulation” (516). Without such scarcity, “any price could be paid and prices would continue to rise indefinitely” (515). It therefore follows that an “indispensable condition of [price] stability is. . . that the supply of means of payment should be limited and thus that a certain scarcity in this supply should exist” (515). So when the central bank brings its bank rate to equality with the natural rate in order to “restrict its issue of notes,” it is the latter restriction itself and not the rate adjustment that stabilizes prices (516). The rate adjustment, because it limits loan demands and the quantity of bank money created as a byproduct of their accommodation, is merely the means by which the end of price-stabilizing monetary restriction is achieved.

6. CASSEL’S REJECTION OF INTEREST COST-PUSH THEORIES

The preceding has argued that Cassel, more so than Wicksell, established the quantity-theoretic foundations of the pure-credit-economy version of the

cumulative process. Further evidence confirming Cassel's strong adherence to the quantity theory comes from his critique of cost-push, or more precisely interest cost-push, theories of inflation.

Cost-push theories, of course, are the very antithesis of the quantity theory. They attribute price inflation not to excess money growth, but rather to underlying rises in factor-input prices (wages, rents, interest) that enter into unit costs of production. These costs are then passed on to consumers in the form of higher product prices. As a species of this genus, interest cost-push theories identify rises in the price of capital services as the inflationary culprit. As Cassel put it, they hold that "since the rate of interest is the price for a [capital] service" that "enters into the cost of production just as the price of any other service required in the process of production" (1928, 525), it therefore follows "that an increase in the rate of interest is bound to increase the cost of all products and therefore to enhance prices" (524). Cassel attributes this theory to the "practical business man" who, believing that rate hikes raise prices, "finds it very confusing when he hears a scientific economist or a representative of a central bank proclaim that the rate is increased in order to force prices down" (524–25).

Fallacies of the Interest Cost-Push View

Cassel rejected the interest cost-push view on two grounds. First, it confuses relative prices with the general (absolute) level of prices. Cost changes indeed influence the former set of prices, but money supply and demand determine the latter. It follows that if the central bank keeps the nominal supply of money equal to the real demand for it, relative prices will move with changes in the cost of production while aggregate prices remain unchanged. The structure and composition of relative prices will change, but not their general average.

Second, the theory erroneously assumes wages and rents do not fall when interest rates rise. In fact, economic logic strongly suggests that the opposite is true. Confronted with rising interest rates, cost-minimizing producers are likely to respond by cutting production and laying off labor and land. Owners of those factor inputs, in a successful effort to keep them fully employed, reduce their asking prices. Wages and rents fall. With capital inputs rising in price and labor and land inputs falling in price, the upshot is clear. The relative cost (and price) of capital-intensive goods—goods using capital relatively intensively in their production—rise when interest rates rise whereas the relative costs (and prices) of labor and land-intensive goods tend to fall.

Interest Cost-Push Affects Relative Prices, Not Absolute Prices

These considerations led Cassel to argue that, provided the central bank holds constant the stock of money per unit of real output by maintaining equality between market and natural rates, rises in interest rates can raise the relative prices of capital-intensive goods but not the aggregate of all prices. With the central bank limiting the money stock, “every rise in some prices must necessarily be counterbalanced by a fall in others” (Cassel 1928, 525). Why? Because the higher-cost and hence dearer-priced capital-intensive goods will require more money to be spent on their purchase leaving less for spending on labor- and land-intensive goods whose prices will accordingly fall. In the final analysis, upon a matched rise in the level of market and natural interest rates such that the money stock and aggregate spending remain unchanged, “only those goods will rise in price for the production of which a particularly large amount of disposal of capital has been required, whereas other prices must sink so low that the average level of all prices remains unaltered” (525).

Here is Cassel’s contention that the aggregate price level is a monetary phenomenon immune to matching (equilibrium) changes in the natural and market rates of interest. Here is his claim that such rate changes, being real phenomena, affect only relative real prices. Here too is his recognition that if the average of all prices is kept unchanged, it follows as a matter of arithmetic that a rise in some relative prices must be offset by a compensating fall in others.

7. EXTENSIONS OF THE CUMULATIVE PROCESS ANALYSIS

Wicksell applied the cumulative process analysis to explain price level movements alone. Cassel’s active-money view of the cumulative process, however, led him naturally to extend the analysis to examine cyclical fluctuations in real activity, something Wicksell was loath to do. Wicksell attributed business cycles to fluctuations in the natural rate and its underlying real determinants (technological progress, wars, and the like) rather than to discrepancies between that rate and the market rate. Hence, to him the cumulative process model with its two-rate differential was irrelevant to the analysis of the cycle.

Monetary Misbehavior Amplifies Real Cycles

Cassel disagreed. He held that rate differentials and the attendant surpluses and shortages of bank money magnify the amplitude and duration of cycles caused by real shocks. They “very much increase the strength of the cyclical movement of trade, with all its pernicious effects” (Cassel 1928, 528). In up-swings, when cyclical improvements in capital productivity raise the natural rate above the sluggishly adjusting market rate, the resulting rate differential

and the excess money it creates produce too much investment compared to the amount savers are willing to supply. The result is an unsustainable overinvestment boom that inevitably gives way to an underinvestment slump when cyclical falls in capital productivity lower the natural rate below the market rate. Clearly the monetary surpluses and shortages spawned by rate differentials accentuate real cycles. If they could be removed by central bank policy that keeps the market rate in continuous alignment with the natural rate, then, according to Cassel, “the whole cyclical movement of trade must become very much attenuated. For it [the cycle] will then be deprived of the great stimulus derived from the continual falsification of the capital market that is the consequence of an alternatively too abundant and too scarce supply of means of payment” (528).

Here was a key difference between Wicksell and Cassel. Both believed that cycles were essentially real phenomena generated by movements in the natural rate. But Cassel, wedded as he was to the active money view, further believed, as Wicksell did not, that monetary factors augmented real cycles and rendered them more damaging than they otherwise would be. Here then was Cassel’s justification for using the cumulative process analysis to study trade fluctuations: it revealed how money stock surpluses and shortages emanating from two-rate differentials exacerbated real cycles. In so doing, it revealed still another rationale for the active pursuit of monetary and price level stability: such stability could help constrain the business cycle and keep it within the limits dictated by real shocks and real propagation mechanisms alone.

Rejection of Non-Price-Stabilizing Policy Norms

It was on these grounds that Cassel (1928, 519–20) rejected alternative policy norms calling for (i) gently rising prices or creeping inflation, (ii) price deflation at a rate equal to the rate of productivity growth, and (iii) cyclically fluctuating prices. By departing from absolute monetary and price level stability, such norms implied corresponding deviations between market and natural rates of interest with all the cyclical dislocations attendant thereto.

Critique of the Gold Standard

It was also on these same grounds that Cassel (1928, 520–22) criticized the gold standard as a monetary regime. Under the gold standard, the nation’s price level was determined by the following relationship: dollar price of goods (the price level) equals fixed dollar price of gold times worldwide gold price of goods. By permitting movements in the worldwide gold price of goods—movements virtually guaranteed by dissimilar fluctuations in the respective growth rates of gold and goods—to pass through to corresponding movements in national general price levels, the gold standard institutionalized price

instability and the disruptions it would bring. Little wonder that Cassel, unconvinced as he was that foolproof ways could be found to prevent fluctuations in the world gold price of goods from affecting national price levels, recommended abolishing the gold standard for a rational paper standard administered by the central bank.

8. CASSEL AND WICKSELL ON THE FEEDBACK POLICY RULE

A rational money standard works only as well as the rule or norm the central bank employs in conducting policy. Both Wicksell and Cassel thought that the theoretically ideal policy rule was for the central bank to maintain its bank rate in continuous equality with the natural rate. But both also believed that such a rule was infeasible because it required knowledge of the natural rate, seen by them as an unobservable variable that is impossible to target.

Still, both men contended that the bank could target the price level even though it could never directly target the unobservable natural rate. It could determine from movements in the price level whether the bank rate was too low or too high relative to the natural rate and thus needed adjustment. As Cassel put it, since “it is impossible for the central bank to know exactly what this ‘natural rate’ is” (1928, 528), the “only practical way of ascertaining what is the correct bank rate is, therefore, by observing the results. If prices are seen to rise continuously, the bank may be sure that the rate is too low. Vice versa, when prices fall, the bank may conclude that the rate is too high” (518).

Cassel’s Statement of the Rule

From these considerations Cassel derived his version of the Wicksellian policy rule: “The bank has to adjust its rate so that no general tendency either to a rise or to a fall in prices arises. The practical rule is, therefore, that the bank rate should be so adjusted as to keep the general level of prices as constant as possible” (1928, 512).

Cassel’s rule, however, lacks the precision of Wicksell’s. In the latter rule, the bank rate adjusts in response to price deviations from target, and the response continues until prices roll back to their pre-inflation or pre-deflation levels. By contrast, Cassel’s rule is hardly that specific. It says only that the rate must be manipulated to hold prices constant. It fails to specify the indicator variable—namely price deviations from target $P - P_T$ —to which the central bank responds. And it fails to note that the response must be sustained until prices return to target.

Cassel’s imprecise formulation of the policy rule prevented him from seeing what Wicksell understood implicitly, namely that the rule can at best only stabilize prices on average over time. It cannot stabilize them at every

point in time. It can constrain their fluctuations within a narrow band about target, but it cannot continually keep them at target.

Dynamic Stability-of-Equilibrium Analysis Applied to Wicksell's Rule

Wicksell's conclusion—that a feedback policy rule linking bank rate adjustments to price level deviations from target can at best deliver price stability on average—emerges from a stability-of-equilibrium analysis performed on the model presented earlier in the article. Although there is no evidence that Wicksell himself performed this analysis, it is useful to do so here. First, reduce the rule-constrained cumulative process model to two differential equations. One, $dP/dt = a(r - i)$, states that prices adjust linearly to the natural rate–bank rate differential. The other, $di/dt = g(P - P_T)$, states that the central bank adjusts its rate di/dt in a fixed proportion g to price level deviations from target $P - P_T$. Here, of course, the natural rate r and price target P_T are treated as given, fixed constants, the natural rate having attained its predetermined level from a prior real shock.

Second, form the Jacobian matrix of the partial derivatives of the differential equations. This two-by-two matrix has as elements 0 and $-a$ in the first row and g and 0 in the second.

Third, observe that the matrix possesses a zero trace and a positive determinant ag . These two conditions, well known from stability analysis, indicate that the price level oscillates ceaselessly about target at an amplitude that depends upon the magnitudes of the adjustment parameters a and g .

Wicksell, of course, intuitively understood this result. He maintained that his feedback rule, if implemented, could deliver approximate stability in the sense of constraining price level fluctuations within a narrow band of plus and minus 3 percent about target (Uhr 1991, 94). Evidently such modest perpetual overshooting of the price level target bothered him not in the least. Had it bothered him, he might have modified his rule slightly to prevent such ceaseless overshooting and to ensure that prices eventually converge to target either monotonically or via damped oscillatory paths.

Wicksell's Rule Augmented

The modification in question calls for the central bank to adjust its interest rate in response both to price level deviations from target and to the rate of change (time derivative) of the price level according to the augmented rule $di/dt = g(P - P_T) + h(dP/dt)$. Adding this last term to the reduced-form model's rate-adjustment equation yields a Jacobian with a negative trace $-ha$ and a positive determinant ag . Both are required to ensure price convergence to target.

This modified rule seems eminently reasonable. Certainly central bankers, if charged with the duty of stabilizing prices, would respond to price level changes dP/dt as well as to price level gaps $P - P_T$. For just as a pilot landing a jumbo jet must heed his plane's vertical distance from the runway and its speed of approach lest it descend too rapidly and crash, so too must the central bank watch the gap between actual and target prices and the rate of price change lest it overshoot its target. Aside from this oversight, however, Wicksell's understanding of the feedback rule must be judged superior to Cassel's.

Bank Rate Affects Money Stock, Which Affects Price Level

Still, on one point at least Cassel outshone Wicksell. Cassel made it clear that the bank rate operates to stabilize prices not directly but indirectly, through the money stock. Bank rate adjustment affects the demand for and supply of loans and the quantity of money created as an offshoot of the loans. Changes in the money stock then restore prices to target. The rate is the central bank's instrument variable, the money stock its intermediate variable, and the price level its goal variable. In Cassel's own words, "the purchasing power of the monetary unit" is "determined by the scarcity the central bank chooses to give to its note circulation" (1928, 516). And "the ultimate and essential means" whereby "it is able to restrict its issue of notes" is "the bank rate" (516). Causation runs from bank rate to money supply to price level.

The significance of Cassel's contribution is this: it implies that money may be crucial to the workings of monetary policy even in models that exclude money from their equations. Wicksell, of course, had constructed just such a model. The cumulative process and policy rule equations of his model omit money and instead have interest rate adjustments alone moving prices. They give the impression that the behavior of the quantity of money is essentially a sideshow, irrelevant to the operation of the policy rule. Cassel's work implies that this impression is wrong. Although he failed to write down a formal, price-stabilizing policy rule, Cassel instinctively understood that the quantity theory underlies such a rule just as it does the cumulative process. If so, then money plays a role even in Wicksell's moneyless model. Money is crucial to the workings of the model because it translates rate changes and differentials into price level changes.

9. CONCLUSION

Anti-quantity and quantity theory interpretations vie in modern readings of Wicksell's cashless-economy model of the cumulative process. And for good reason: Wicksell wrote passages that support both interpretations. Some

passages allude to quantity-theoretic money-to-price causality, others to anti-quantity theoretic reverse, price-to-money causality. Moreover, he explicitly states the anti-quantity theory notion of a passive, demand-determined stock of inside money. Believing that such money can never be in excess supply, he fails to apply real balance mechanics to it to explain why people attempt to rid themselves of it by spending it away and so force a rise in prices. His pure credit economy case differs from his pure cash and mixed cash-credit economy cases in which the quantity theory always plays a dominant role.

His inconsistency is easily explained. As a pioneering monetary theorist, he was engaged in pathbreaking work of the highest order. Operating in new and unfamiliar territory, he was forging a complex analysis that combined elements of capital theory, price theory, production and distribution theory, and monetary theory. Involved as he was in this ambitious and far-reaching project, he could hardly be expected to state every nuance with the precision, clarity, and consistency that later scholars well acquainted with his analysis could give it. In any case, he failed to convey his intentions as clearly as one might have wished. In so doing, he left the door open for some of his successors to give his cumulative process analysis anti-quantity theory interpretations.

It remained for Gustav Cassel, writing 30 years after the publication of Wicksell's *Interest and Prices*, and fully cognizant of what Wicksell had sought to accomplish, to express matters clearly and to articulate the active money view. In so doing, he established for all time the quantity-theoretic foundations of the Wicksellian triumvirate: pure credit economy, cumulative process, and stabilizing policy rule. He showed that an endogenous, loan-created stock of bank money was essential to translate interest rate differentials into price level changes in the pure credit economy. Likewise, he established that bank rate adjustments work through money stock changes to stabilize prices in the operation of the feedback policy rule. In short, he completed the work Wicksell had started 30 years before.

Unfortunately, Cassel's contributions to cumulative process analysis and to the theory of stabilizing policy rules have gone largely unnoticed. Few cite his 1928 *QJE* article featuring those contributions. Citations instead are made to his *Theory of Social Economy* in which the contributions are missing. He is remembered today for (i) his purchasing power parity theory of exchange rates, (ii) his simplified version of the Walrasian system of general equilibrium, a version stripped of Walras, mathematics, marginal utility, and marginal productivity, (iii) his empirical claim that the differential growth rates of the gold stock and real output determine the path of the price level, and (iv) his theory that the limited life span (interest earning period) of savers sets a floor to interest rates. It is clear that he also deserves equal credit for establishing quantity theory foundations for policy rules and the cumulative process. Had Cassel's successors been more fully aware of his work in this area, subsequent interpretations of Wicksell's monetary constructs might have taken a different

turn. In any case, Cassel's rediscovered insights, highlighting as they do the originality and explanatory power of Wicksell's analytical model, confirm and underscore Wicksell's place in the pantheon of monetary theorists.

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