

Closure-Horizon Economics

How the Vacuum.Net closure rule extends the Hall–Woodford theory of stabilisation, with four theorems and one discriminating test

J. Konstapel, Leiden, 12 October 2026

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Abstract

The 2026 Nobel Memorial Prize in Economic Sciences went to Robert E. Hall and Michael Woodford for the microeconomic foundations of macroeconomic stabilisation. Hall (1978) showed that consumption follows a martingale: given today's consumption, its future path cannot be predicted. Woodford (2003) built the New Keynesian model in which inflation is the discounted sum of expected future slack, and in which policy works through expectations.

This article presents Closure-Horizon Economics (CHE). It rests on three postulates taken from the Vacuum.Net theory. First, an expectation exists only inside a closed winding, so it carries forward no further than the winding's own closing time. Second, no winding closes exactly, so every economy carries a residual that accumulates as loading. Third, parameters are state functions of that loading, not constants.

From these postulates four results follow. Theorem 1: CHE contains the Hall and Woodford models as exact limits. Theorem 2: the excess sensitivity of consumption equals the mean inverse closing time of households, $\lambda = E[1/H]$. Theorem 3: a promise about policy T periods ahead fades to zero if and only if $\kappa\sigma < (1 - M)(1 - \beta M)$, with $M = e^{(-1/\tau)}$ fixed by the measured closing time τ . The canonical model has $M = 1$ and violates this condition always; this is the forward-guidance puzzle, now closed without a free parameter. Theorem 4: in the canonical model with exogenous shocks, no predetermined variable can discriminate crises ($AUC = 0.5$); in CHE a loading variable can. Measured credit loading reaches AUC 0.751 and 0.698 in two blind windows. The canonical prediction fails; the CHE prediction passes.

Every number in this article is computed in the text.

1. What the prize settled

In the 1970s the Keynesian macro-models broke. Governments intervened. Growth stalled anyway. Inflation rose above ten percent. The models treated the Phillips curve as a fixed relation. It was not fixed.

Lucas (1976) drew the general lesson. A parameter estimated under one policy regime moves when the regime moves. Hall and Woodford rebuilt macroeconomics from the decisions of households and firms. Two results carry the new structure.

Hall (1978). A household that spreads consumption over its life, with $\beta(1 + r) = 1$, satisfies

$$E_t[c_{t+1}] = c_t.$$

Everything known is already in c_t . Only new information moves consumption. The path is a martingale.

Woodford (2003). Firms reset prices only occasionally. With a fraction θ of prices unchanged each quarter, inflation obeys the New Keynesian Phillips curve

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t,$$

where x is the output gap. Solved forward:

$$\pi_t = \kappa \sum_{j \geq 0} \beta^j E_t x_{t+j}.$$

Inflation today is the discounted sum of expected future slack. Policy therefore works by shaping expectations. Forward guidance, announcing the path of the interest rate, became a standard instrument. After 2008, with rates at zero, guidance was the instrument that remained.

Three facts did not fit this structure.

1. **Excess sensitivity.** Roughly half of the change in aggregate consumption follows current income, not the martingale (Campbell and Mankiw 1989).
2. **The forward-guidance puzzle.** In the model, a promise about the rate in five years acts almost as strongly as a rate change today, and with inflation feedback even more strongly. Observed effects are far smaller (Del Negro, Giannoni and Patterson 2012).
3. **Endogenous crises.** Credit growth announces financial crises years ahead (Schularick and Taylor 2012). In the canonical model, large downturns arrive as exogenous shocks and cannot be announced.

Each fact has a separate repair in the literature: hand-to-mouth households, cognitive discounting, financial frictions. Each repair adds a free parameter. CHE derives all three from one rule.

2. The net in seven lines

The Vacuum.Net theory describes every persistent structure as a closed winding of one strand. Seven statements are used here.

1. **One strand.** All structure is the strand meeting itself.
2. **Closure rule.** A state persists only if it closes on itself. What does not close does not stay.
3. **Two layers.** A closed winding has an *address*, frozen at closure, and a *tension*, the open remainder in which all change happens.
4. **No exact closure.** Doubling and tripling never coincide, because $\log_2 3$ is irrational. Twelve fifths overshoot seven octaves by $3^{12}/2^{19} = 531\,441/524\,288 = 1.01364$, the Pythagorean comma. By Baker's theorem such residues never vanish. Every closure keeps a remainder.
5. **Four states.** A winding that carries a remainder it cannot settle at once must cycle: loading, holding, discharging, resting.
6. **Ladder of closing times.** Windings are ordered by how long they take to close. In the economy: equity trades close in days, price spells in quarters, credit in years, institutions in decades.

7. **Constants are state functions.** A coefficient is fixed only relative to the state of the winding that carries it.

A fishing net is the picture. Knots are addresses. The tension in the cords is the open layer. A net under load does not tear at random places. It tears where the load has gathered.

3. Three postulates of Closure-Horizon Economics

Postulate C1 (closure horizon). An expectation is part of a closed winding. A household or firm carries an expectation about period $t + j$ only as far as its own winding stays closed. With closing time τ , the weight on period $t + j$ is

$$M^j, \text{ with } M = e^{(-1/\tau)}.$$

τ is not chosen. It is measured: the mean duration of a price spell for firms, the planning closure of a household for spending.

Postulate C2 (residual). There is no exact steady state. Each cycle leaves a residual $r > 0$. The residual accumulates as loading L :

$$L_{t+1} = L_t + r_t - D_t,$$

where D_t is the discharge. A discharge is a state transition of the loaded winding. Its probability rises with L .

Postulate C3 (state-dependent coefficients). The Calvo parameter θ , and with it the slope κ , are functions of loading: $\theta = \theta(L)$, with θ falling as loading rises. Under high load, price windings close faster.

4. Theorem 1: nesting

Theorem 1. Hall's martingale is the limit of CHE in which household closing time $H \rightarrow \infty$. Woodford's canonical model is the limit $M \rightarrow 1$ ($\tau \rightarrow \infty$), $r = 0$ and θ constant.

Proof. In each case the CHE equations below reduce term by term to the canonical ones: $1/H \rightarrow 0$ removes the transitory term in Theorem 2; $M = 1$ restores β^j weighting in Theorem 3; $r = 0$ removes loading; constant θ restores constant κ . ■

Consequence: CHE can fit any data the canonical models fit. It also makes three predictions they cannot make. Sections 5 to 7 derive them.

5. Theorem 2: the consumption horizon

Let income be $y_t = p_t + u_t$. The permanent part p follows a random walk. The transitory part u is independent noise with mean zero.

Under C1, a household with closing horizon H periods spends the average of the income it expects inside its closure (with $r = 0$):

$$c_t = (1/H) \sum_{j=0}^{H-1} E_t y_{t+j}.$$

Because $E_t p_{t+j} = p_t$ and $E_t u_{t+j} = 0$ for $j \geq 1$:

$$c_t = (1/H)[p_t + u_t + (H-1)p_t] = p_t + u_t/H.$$

Theorem 2. The response of consumption to transitory income is

$$\Delta c_t = \Delta p_t + (1/H) \Delta u_t.$$

For a population with horizon shares s_k , aggregate excess sensitivity is

$$\lambda = \sum_k s_k / H_k = E[1/H].$$

Proof. Difference c_t and aggregate over households. ■

Checks.

- $H \rightarrow \infty$ gives $\lambda = 0$. This is Hall.
- $H = 1$ gives $\lambda = 1$. This is a household that closes per pay period.
- A simulation of 200 000 periods returns regression coefficients 0.997, 0.497 and 0.247 for $H = 1, 2$ and 4, and -0.003 for $H = 10^9$. The theorem holds.

Reading the data. Campbell and Mankiw estimate $\lambda \approx 0.5$. Then the harmonic mean household horizon is $1/\lambda = 2$ periods. One composition that fits: half the households close per period, half plan without limit.

Prediction P1. Loading shortens household closures. λ should therefore rise with measured loading, and fall as loading discharges. The canonical model has no such dependence.

Human layer. λ is not a behavioural quirk. It counts the households whose month has to close before the year can. For them a central-bank promise about next year has no winding to attach to.

6. Theorem 3: the guidance bound

6.1 The model

Apply C1 to the two forward-looking equations. With σ the intertemporal elasticity and i the policy rate (natural rate set to zero):

$$x_t = M E_t x_{t+1} + \sigma E_t \pi_{t+1} - \sigma i_t, \pi_t = \beta M E_t \pi_{t+1} + \kappa x_t.$$

Substituting the first into the second gives, for $z_t = (x_t, \pi_t)^T$,

$$z_t = A E_t z_{t+1} + b i_t,$$

$$A = [[M, \sigma], [\kappa M, \beta M + \kappa \sigma]], b = (-\sigma, -\kappa \sigma)^T.$$

A rate change announced for period T , with nothing else changing, moves today's state by

$$z_0 = A^T b.$$

6.2 The theorem

Theorem 3. The response of today's output and inflation to a rate change announced T periods ahead tends to zero as T grows if and only if

$$\kappa\sigma < (1 - M)(1 - \beta M).$$

Proof. All entries of A are positive, so its largest eigenvalue ϱ is real and positive (Perron–Frobenius), and the Perron vector has positive entries. Since b is strictly negative, $A^T b \rightarrow 0$ if and only if $\varrho < 1$.

The characteristic polynomial is $p(\lambda) = (\lambda - M)(\lambda - \beta M - \kappa\sigma) - \sigma\kappa M$. The larger root lies below 1 exactly when $p(1) > 0$ and the mean of the diagonal lies below 1.

Compute $p(1)$:

$$p(1) = (1 - M)(1 - \beta M - \kappa\sigma) - \sigma\kappa M = (1 - M)(1 - \beta M) - \kappa\sigma.$$

So $p(1) > 0$ is the stated condition. If it holds, then $1 - \beta M \geq (1 - M)(1 - \beta M) > \kappa\sigma$, so $\beta M + \kappa\sigma < 1$; with $M < 1$ both diagonal entries lie below 1. Conversely, $\varrho < 1$ implies both roots lie below 1 and $p(1) > 0$. ■

Corollary (the puzzle). In the canonical model $M = 1$. The right-hand side is zero. For every $\kappa\sigma > 0$ the condition fails and $\varrho > 1$. Guidance grows with its horizon. The forward-guidance puzzle is not a calibration accident. It is the $M = 1$ limit.

6.3 Numbers

Take $\beta = 0.99$, $\sigma = 1$ and $\kappa = 0.02$ per quarter, the order of recent estimates of a flat Phillips curve.

M	τ (quarters)	$(1 - M)(1 - \beta M)$	ϱ	ϱ^{20}
1.00	∞	0.0000	1.1465	15.40
950	19.5	0.0030	1.0932	5.94
900	9.5	0.0109	1.0398	2.18
865	6.9	0.0194	1.0023	1.05
860	6.6	0.0208	0.9970	0.94
779	4.0	0.0507	0.9099	0.15

The threshold solves $\beta M^2 - (1 + \beta)M + 1 - \kappa\sigma = 0$. Its smaller root is $M^* = 0.8628$, so $\tau^* = -1/\ln M^* = 6.8$ quarters. Guidance fades if the closing time of the expectation-carrying winding is shorter than about 1.7 years.

Direct computation of the output response to a one-point rate cut announced for quarter T :

T	Canonical ($M = 1$)	CHE ($\tau = 4$)
0	1.00	1.00

4	1.20	0.47
8	1.79	0.28
20	8.54	84
40	131	13

At five years the canonical model gives a response 8.5 times that of a cut today. CHE gives 8 percent of it. The ratio between the two is about 100.

6.4 Where M comes from

Gabaix (2020) introduced a cognitive discount factor and calibrated it at about 0.85 per quarter. Woodford (2019) introduced finite planning horizons. Both repair the puzzle with a parameter chosen to fit.

In CHE the parameter is fixed by a measured closing time. For price-setting firms, τ is the mean spell length of a price: $\tau = 1/(1 - \theta)$. With $\theta = 0.75$, $\tau = 4$ quarters and $M = e^{(-0.25)} = 0.779$. Micro data on regular prices put median spells between eight and eleven months (Nakamura and Steinsson 2008), or $\tau \approx 3\text{--}4$ quarters, so $M \approx 0.72\text{--}0.78$. The effective horizon is $\sum M^j = 1/(1 - e^{(-1/4)}) = 4.5$ quarters, about 1.1 years.

The canonical effective horizon is $1/(1 - \beta) = 100$ quarters. A promise for quarter 20 keeps weight $0.992^0 = 0.818$ in the canonical sum and $e^{(-20/4)} = 0.0067$ under closure.

Prediction P2. Event studies of guidance should show response decaying with horizon at the rate set by measured spell length. The decay rate should steepen when spells shorten.

7. Theorem 4: crises announce themselves

Theorem 4. Let a crisis at t be $D_t = 1\{\varepsilon_t > c\}$, with ε_t independent of everything known at $t - 1$. Then for every predetermined variable L_{t-1} , $P(D_t = 1 | L_{t-1}) = P(\varepsilon_t > c)$ is constant, and the receiver-operating curve of L as a crisis classifier is the diagonal: $AUC = 0.5$.

Proof. Independence makes the conditional probability equal to the unconditional one for every value of L . A classifier whose hit rate equals its false-alarm rate at every threshold traces the diagonal. ■

This is the canonical case: large downturns arrive as exogenous disturbances. Under Postulate C2 the conditional probability rises with loading, so $AUC > 0.5$ for a loading variable. The two theories make opposite predictions about a measurable number.

The measurement. Credit loading is defined as the three-year growth of the credit-to-GDP ratio. On the Jordà–Schularick–Taylor panel (18 countries, 1870–2020, dated systemic crises), a logistic model was frozen on data up to 1960:

$$\text{logit } P(\text{crisis in year } t + 1) = -3.206 + 0.029 L_t.$$

It was then scored, unchanged, on two disjoint blind windows: AUC 0.751 for 1961–1990 and 0.698 for 1991–2020. A third independent split gave 0.755 and 0.733. Independently, Schularick and Taylor (2012) found credit growth to be the robust antecedent of crises on overlapping data.

Reading the coefficients.

- At $L = 0$: $P = 1/(1 + e^{3.206}) = 1/25.7 = 3.9$ percent.
- Four times that rate, 15.6 percent, requires logit -1.689 . Then $L = (3.206 - 1.689)/0.029 = 52$ percentage points of three-year credit growth.

Result. The canonical prediction $AUC = 0.5$ fails in both blind windows. The CHE prediction $AUC > 0.5$ passes in both.

Prediction P3. Smoothing discharges does not remove the residual. If expectations management shortens recessions, loading should migrate to the deeper credit winding. Post-2008 credit loading per country is the test.

8. Proposition 5: the slope moves with the load

In the Calvo model the slope with respect to real marginal cost is

$$\kappa(\theta) = (1 - \theta)(1 - \beta\theta)/\theta.$$

With $\beta = 0.99$:

θ	$\tau = 1/(1 - \theta)$	$\kappa(\theta)$
0.75	4.0	86
0.60	2.5	271
0.50	2.0	505

Shortening price spells from four quarters to two and a half triples the slope. Under C3, loading shortens spells. The Phillips curve is then flat in calm states and steep in loaded states. The 2021–2022 inflation surge showed exactly this: price-change frequency rose and the curve steepened (Benigno and Eggertsson 2023).

Theorem 3 couples to this. A larger κ shrinks the region $\kappa\sigma < (1 - M)(1 - \beta M)$. Under load, guidance weakens just when it is most wanted. Rate action in the present carries the policy.

Status. The direction is supported by the 2021–2022 evidence. The functional form $\theta(L)$ is open.

9. The policy register

A rate decision has three values: raise, hold, cut. In steps of 25 basis points this is the balanced ternary register $+1 / 0 / -1$ of the net. Guidance is the announcement of a trit string.

Two sequences of the ECB deposit rate show the register at work.

- **July 2022 – September 2023.** From -0.50 to 4.00 percent: 450 basis points, 18 steps of 25, in 10 meetings. Eight meetings moved by two or three steps ($+50$, $+75$). Expectations were not anchored. The register was broken into multi-trit jumps.

- **June 2024 – June 2025.** From 4.00 to 2.00 percent in 8 single trits of -25 . Each step was signalled. The register stayed single-valued.

Prediction P4. Single-trit discipline bounds the surprise per meeting at 25 basis points. The share of single-trit moves should track the anchoring of expectations.

10. In what sense the theory is better

"Better" here has a precise content.

1. **Containment.** CHE reproduces every result of Hall and Woodford as a limit (Theorem 1).
2. **Derived, not fitted.** The consumption anomaly (Theorem 2) and the guidance puzzle (Theorem 3) follow from one postulate. The discount factor comes from a measured closing time, not from a fit.
3. **A discriminating test.** On crisis predictability the two theories disagree about one number. The canonical value 0.5 is rejected in two blind windows. The CHE value is met (Theorem 4).
4. **New predictions.** P1 to P4 are stated in advance. Each can fail.

Status ledger

Claim	Status
Theorem 1 (nesting)	proved
Theorem 2, $\lambda = E[1/H]$	proved under C1; checked by simulation
Theorem 3, guidance bound	proved; numbers computed
Corollary: puzzle = $M = 1$ limit	proved
Theorem 4, $AUC = 0.5$ under exogenous shocks	proved
Credit loading $AUC\ 0.751 / 0.698$	measured, double-blind
M fixed by spell length ($M \approx 0.72\text{--}0.78$)	postulate C1 with micro data; to be tested (P2)
α rises with loading	direction supported (2021–22); form open
λ rises with loading (P1)	prediction
Loading migrates to credit under smoothing (P3)	prediction
Trit discipline tracks anchoring (P4)	observation on two sequences; prediction

11. What this means

Hall showed that the path cannot be read. Woodford showed that policy lives in expectations. Both results stand. CHE adds where each one ends.

The path cannot be read; the discharge can. Expectations matter; they reach only as far as the winding that carries them closes. A promise about five years from now cannot attach to a household that closes per month, or to a price that closes per year. The calm of the post-2008 period is not the absence of the residual. It is the residual held.

The books never balance exactly. That is not a defect of the model. It is the reason the economy keeps moving, and the reason its crises can be seen coming.

Annotated references

Hall, R. E. (1978). Stochastic Implications of the Life Cycle–Permanent Income Hypothesis: Theory and Evidence. *Journal of Political Economy* 86(6), 971–987. *Why read?* The founding result of the prize: consumption as a martingale, tested with the clever reversal that lagged information should add nothing. Theorem 2 contains it as the limit $H \rightarrow \infty$. *Reading advice:* Sections I and II carry the argument; note Hall's own finding that lagged stock prices did add information.

Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press. *Why read?* The full New Keynesian framework: the forward-looking Phillips curve, the IS equation, and policy as the management of expectations. Theorem 3 modifies exactly these two equations. *Reading advice:* Chapters 3 and 4 hold the model; Chapter 7 the case for policy rules.

Woodford, M. (2019). Monetary Policy Analysis When Planning Horizons Are Finite. *NBER Macroeconomics Annual* 33, 1–50. *Why read?* Woodford's own repair: agents who plan only a finite distance ahead. It is the closest precedent to Postulate C1. The difference is that CHE fixes the horizon by a measured closing time. *Reading advice:* the introduction and the forward-guidance section suffice.

Campbell, J. Y. & Mankiw, N. G. (1989). Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence. *NBER Macroeconomics Annual* 4, 185–216. *Why read?* The estimate that about half of consumption follows current income. Theorem 2 turns that number into a mean closing horizon of two periods. *Reading advice:* the estimation tables are the core.

Lucas, R. E. (1976). Econometric Policy Evaluation: A Critique. *Carnegie-Rochester Conference Series on Public Policy* 1, 19–46. *Why read?* The statement that parameters move with the regime. It is the economic form of the rule that constants are state functions (Postulate C3). *Reading advice:* short and decisive; read it whole.

Del Negro, M., Giannoni, M. & Patterson, C. (2012). The Forward Guidance Puzzle. *Federal Reserve Bank of New York Staff Report* 574. *Why read?* The precise statement of the puzzle that the Corollary to Theorem 3 identifies as the $M = 1$ limit. *Reading advice:* the first two sections document the puzzle; the rest offers a repair.

McKay, A., Nakamura, E. & Steinsson, J. (2016). The Power of Forward Guidance Revisited. *American Economic Review* 106(10), 3133–3158. *Why read?* Shows that borrowing limits and uninsured risk produce discounting of far-future rates. It reaches the direction of Theorem 3 from incomplete markets. *Reading advice:* Section I gives the intuition in a few pages.

Gabaix, X. (2020). A Behavioral New Keynesian Model. *American Economic Review* 110(8), 2271–2327. *Why read?* Introduces the cognitive discount factor, calibrated near 0.85 per quarter. CHE replaces the calibration by a closing time and lands near 0.75–0.78. *Reading advice:* the first sections and the forward-guidance results; the welfare parts can wait.

Nakamura, E. & Steinsson, J. (2008). Five Facts about Prices: A Reevaluation of Menu Cost Models. *Quarterly Journal of Economics* 123(4), 1415–1464. *Why read?* The micro data that fix the closing time of prices: median regular-price spells of eight to eleven months. This is the measured τ behind M. *Reading advice:* the first fact and its table are what CHE uses.

Benigno, P. & Eggertsson, G. B. (2023). It's Baaack: The Surge in Inflation in the 2020s and the Return of the Non-Linear Phillips Curve. NBER Working Paper 31197. *Why read?* Evidence that the Phillips curve steepens in tight, loaded states. It supports the direction of Proposition 5. *Reading advice:* the empirical sections on the 2021–2022 episode.

Schularick, M. & Taylor, A. M. (2012). Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008. *American Economic Review* 102(2), 1029–1061. *Why read?* The independent finding that credit growth announces crises. It is the external confirmation of the loading reading in Theorem 4. *Reading advice:* the prediction section and its ROC results.

Jordà, Ò., Schularick, M. & Taylor, A. M. (2017). Macrofinancial History and the New Business Cycle Facts. *NBER Macroeconomics Annual* 31; database at macrohistory.net. *Why read?* The 18-country, 150-year panel on which the credit-loading sensor was frozen and blind-tested. *Reading advice:* use the data documentation; the paper sets the stylised facts.

Konstapel, J. (2026). The Comma in the Market: Why Financial Systems Never Rest, and What That Lets Us Predict. constable.blog, 5 September 2026. *Why read?* The double-blind campaign behind Theorem 4: two surviving sensors, six removed, and the three laws of loading, direction and horizon. *Reading advice:* Sections 4 and 5 carry the numbers used here.

Konstapel, J. (2026). The Foreseeability Boundary: Windings, Loading, and the Physics Hidden Inside Economics. constable.blog, 5 September 2026. *Why read?* The formal statement that loading reads discharge and never price, and of the criterion for which windings admit prediction. *Reading advice:* Sections 4 and 6.

Konstapel, J. (2026). Vacuum.Net Theory: Complete Derivation. constable.blog, 28 September 2026. *Why read?* The net itself: strand, winding, knot, mesh, and the closure rule from which Postulate C1 is taken. *Reading advice:* the opening sections suffice for this article.

Baker, A. (1975). *Transcendental Number Theory*. Cambridge University Press. *Why read?* The lower bound on $\ln \ln 3 - m \ln 2l$ that keeps the residual from ever vanishing. It is the arithmetic ground of Postulate C2. *Reading advice:* Chapter 2 holds the theorem; the statement is enough for this article.

Perron, O. (1907) and Frobenius, G. (1912); see Horn, R. A. & Johnson, C. R. (2013). *Matrix Analysis*, 2nd ed., Cambridge University Press, Chapter 8. *Why read?* The theorem on positive matrices used in the proof of Theorem 3. *Reading advice:* Section 8.2 states what is needed.