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Does Monetarism Retain Relevance?

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The quantity theory and its monetarist variant attribute significant recessions to monetary shocks. The literature in this tradition documents the association of monetary and real disorder.[1] By associating the occurrence of monetary disorder with central bank behavior that undercuts the working of the price system, quantity theorists argue for a direction of causation running from monetary disorder to real disorder.[2] These correlations are robust in that they hold under a variety of different monetary arrangements and historical circumstances.

Nevertheless, correlations, no matter how robust, do not substitute for a model. As Lucas (2001) said, "Economic theory is mathematics. Everything else is just pictures and talk." While quantity theorists have emphasized the importance of testable implications, they have yet to place their arguments within the standard workhorse framework of macroeconomics—the dynamic, stochastic, general equilibrium model. This article asks whether the quantity theory tradition, which is long on empirical observation but short on deep theoretical foundations, retains relevance for current debates.

Another problem for the quantity theory tradition is the implicit rejection by central banks of its principles. Quantity theorists argue that the central bank is responsible for the control of inflation. It is true that at its January 2012 meeting, the Federal Open Market Committee (FOMC) adopted an inflation target. However, the FOMC did not accompany its announcement with

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[1] Two examples of discussion of monetarist ideas are Laidler (1981) and Mayer (1999).

[2] For example, Milton and Rose Friedman (1980) wrote: "In one respect the [Federal Reserve] System has remained completely consistent throughout. It blames all problems on external influences beyond its control and takes credit for any and all favorable circumstances. It thereby continues to promote the myth that the private economy is unstable, while its behavior continues to document the reality that government is today the major source of instability."

quantity-theoretic language. Quantity theorists argue that the reason central banks are responsible for inflation is their power over money creation, not any influence over conditions in financial markets (intermediation between savers and investors). Power over money creation comes from the Fed's monopoly over creation of the monetary base (reserves of commercial banks held as deposits with the Fed and currency held by the nonbank public), which serves as the medium for exercising finality of settlement in payments.

This article summarizes the quantity theory tradition without attempting to exposit a quantity-theoretic model. Section 1 sharpens the issues at stake by briefly summarizing some "red flags" for monetarists concerning the behavior of the monetary aggregates over the past few years. The remaining sections provide an overview of the monetarist tradition, which derives from the longer-run quantity theory tradition.

1. MONETARIST RED FLAGS

In Europe, the behavior of the monetary aggregates engenders monetarist criticisms. In the United Kingdom, the growth rate of money (broad money or M4) started declining in late 2007 from a level of around 13 percent and became negative in 2011. In the Eurozone, the growth rate of money (broad money or M3) started declining in late 2007 from a level of around 12 percent, ceased growing in late 2009 and early 2010, and then steadied at around 3 percent in 2011.[3] Because monetary velocity (the ratio of nominal gross domestic product [GDP] to money) exhibits a downward trend in both the United Kingdom and the Eurozone, the increased money demand reinforces the monetary contraction.

Does this pattern of "high" followed by "low" money growth constitute evidence of go-stop monetary policy? Despite low rates of interest, do the recent low rates of money growth indicate contractionary monetary policy? Does the sustained decline in nominal GDP growth provide evidence of contractionary monetary policy? As elucidated in Section 4, the issue is stark. One possibility is that in the monetarist tradition the decline in money growth, nominal GDP growth, and real GDP growth reflects a negative monetary shock and causation going from money to output. Alternatively, the precipitating shock could have been real with causation going from real output to money.

[3] Figures from Federal Reserve Bank of St. Louis, *International Economic Trends*.

2. THE SPIRIT OF THE QUANTITY THEORY TRADITION

David Hume ([1752] 1955) expressed the kind of empirical correlations used by quantity theorists to support the hypothesis of the short-run nonneutrality of money and longer-run neutrality.

> Lowness of interest is generally ascribed to plenty of money. But... augmentation [in the quantity of money] has no other effect than to heighten the price of labour and commodities.... In the progress toward these changes, the augmentation may have some influence, by exciting industry, but after the prices are settled... it has no manner of influence.
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> [T]hough the high price of commodities be a necessary consequence of the increase of the gold and silver, yet it follows not immediately upon that increase; but some time is required before the money circulates through the whole state.... In my opinion, it is only in this interval of intermediate situation, between the acquisition of money and rise of prices, that the increasing quantity of gold and silver is favourable to industry.... [W]e may conclude that it is of no manner of consequence, with regard to the domestic happiness of a state, whether money be in greater or less quantity. The good policy of the magistrate consists only in keeping it, if possible, still increasing...

Knut Wicksell ([1935] 1978, 6) referred to episodes of economic disruption in a paper money standard:

> By means of money (for example by State paper money) it is possible—and indeed this has frequently happened—to destroy large amounts of real capital and to bring the whole economic life of society into hopeless confusion.

Hume was generalizing about the expansionary impact of gold inflows from the New World.[4] Wicksell referred to the inflationary issuance of paper money to finance government deficits. An example often cited in the 19th century was the assignat experience in revolutionary France before Napoleon restored the gold standard (White [1876] 1933). The Hume and Wicksell references make evident the exogenous origin of money creation. The Bullionist (quantity theorists)/Antibullionist (real bills) debate following the depreciation of the pound when Britain abandoned the gold standard during the Napoleonic Wars originated the quantity-theoretic criterion for money creation as an independent force (shock) in the more typical case of a central bank employing an interest rate target. The quantity theory imputes causality to monetary disturbances based on central bank behavior that flouts the need to provide a nominal anchor and to allow the price system to work. The Bullionists argued that as

[4] For references to episodes of deflation, see Humphrey (2004).

a consequence of setting its bank rate below the "natural" rate of interest, the Bank of England created money, which forced an increase in prices.[5]

Wicksell ([1898] 1962, 120, 148, and 189) repeated the Bullionist criticism that inflation (deflation) results if the central bank sets a bank rate that ignores the determination of the real rate of interest by market forces:[6]

> [T]here is a certain level of the average rate of interest which is such that the general level of prices has no tendency to move either upwards or downwards.... Its magnitude is determined by the current level of the natural capital rate and rises and falls with it. If...the average rate of interest is set and maintained *below* this normal level...prices will rise and go on rising.
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> [O]nce the entrepreneurs begin to rely upon this process continuing—as soon, that is to say, as they start reckoning on a future rise in prices—the actual rise will become more and more rapid. In the extreme case in which the expected rise in prices is each time fully discounted, the annual rise in prices will be indefinitely great. [Italics in original.]
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> If prices rise, the rate of interest is to be raised; and if prices fall, the rate of interest is to be lowered.

As evident from the above quotations, quantity theorists contend that the uniqueness of the central bank derives from its control over money creation. That contention contrasts with the view of a central bank as a financial intermediary that exercises its control through influence over conditions in credit markets. In an exchange with Senator Prescott Bush (R-CT), Milton Friedman [U.S. Congress 1959, 623–4] expressed the quantity theory view:

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[5] Thornton ([1802] 1939, 255–6) wrote: "[C]apital...cannot be suddenly and materially encreased by any emission of paper. That the rate of mercantile profits depends on the quantity of this bona fide capital and not on the amount of the nominal value which an encreased emission of paper may give to it, is a circumstance which it will now be easy to point out.... It seems clear that when the augmented quantity of paper...shall have produced its full effect in raising the price of goods, the temptation to borrow at five percent. will be exactly the same as before; for the existing paper will then bear only the same proportion to the existing quantity of goods, when sold at the existing prices, which the former paper bore to the former quantity of goods, when sold at the former prices; the power of purchasing will, therefore, be the same; the terms of lending and borrowing must be presumed to be the same; the amount of circulating medium alone will have altered, and it will have simply caused the same goods to pass for a larger quantity of paper.... [T]here can be no reason to believe that even the most liberal extension of bank loans will have the smallest tendency to produce a permanent diminution of the applications to the Bank for discount."

Thomas Joplin ([1823] 1970, 258–9) employed the terminology of the "natural" rate of interest. When the loan rate diverges from the natural rate, the money supply changes to the extent that this divergence produces a difference in the saving and investment planned by the public.

For a discussion of the history of the distinction between real and nominal interest rates, see Humphrey (1983). For a discussion of the Bullionist-Antibullionist debate, see Hetzel (1987).

[6] Wicksell's analysis did not incorporate the distinction between the nominal and real interest rate developed by Fisher (1896). Friedman ([1968] 1969) first combined this distinction with the Wicksell analysis.

> Senator Bush: What should the Federal Reserve Board do with demands for credit increasing? Prior to the most recent recession, we had tremendous increases in the use of installment credit. In fact, there are some pretty reliable opinions that it was overuse of credit by consumers, particularly installment credit that brought about this recession in business because it stimulated the purchase of goods beyond the year in which they should be buying them. . . .
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> Mr. Friedman: Congress and its agencies have a definite responsibility about money. So far as credit is concerned, free enterprise is just as good for credit as it is for shoes, hats, and anything else. The objective of our policy ought to be to allow credit to adjust itself in a free market, provided we maintain a stable monetary background.

3. QUANTITY THEORY HYPOTHESES

The quantity theory starts from two premises. The first premise is that the central bank is the institution that controls money creation. It does so through its control over its liabilities—the monetary base. Because individual welfare depends only on real variables (physical quantities and relative prices), the central bank must endow money, a nominal (dollar) variable, with a well-defined (determinate) value. Phrased alternatively, the intrinsic worthlessness of money requires the central bank to choose a nominal anchor that determines the money price of goods (the price level).

The second premise is that changes in the price level play a role in the working of the price system in a way that depends on how the central bank chooses the nominal anchor. The three basic choices that exist for the central bank define alternative monetary regimes. First, with a gold (commodity) standard, the central bank sets the parity price of gold (the paper dollar price of gold). The price level then adjusts to give the paper dollar the same real purchasing power as a gold dollar. Second, with a fixed exchange rate and for a small open economy, the central bank sets the foreign exchange value of the currency. The price level then adjusts to provide the real terms of trade that equilibrates the balance of payments. With each regime, an explicit rule underpins the belief that the central bank will maintain the nominal anchor (the dollar peg to gold or the foreign exchange value of the currency) in the future.

With the third choice of monetary regime, the concern of the central bank is for stability of the domestic price level. This regime necessitates a floating exchange rate (Keynes [1923] 1972, ch. 4). The price level adjusts to endow the nominal quantity of money with the purchasing power desired by the public. A central bank desirous of achieving price stability must close down this adjustment by making nominal money grow in line with the public's demand for real money. How the central bank does so depends on a choice

of one of two possible nominal anchors determined by a choice of one of two possible instruments.

With a reserve aggregate as the instrument, the central bank follows a "Pigovian" rule in which a reserves-money multiplier relationship controls money creation (Pigou 1917). With an interest rate as the instrument, the central bank follows a "Wicksellian" rule in which maintenance of equality between the "bank rate" and the "natural rate" controls money creation (Wicksell 1898 [1962]).[7] With either instrument, the central bank must follow a rule that disciplines the way in which the public forms its expectation of the future price level. The reason is that money possesses value in exchange today only because of the expectation that it will possess value in exchange tomorrow, and the rule conditions that expectation.[8]

With a reserve-aggregate targeting regime, the central bank controls the nominal quantity of money through its control over a reserve aggregate. Given a well-defined demand for real money (the purchasing power of money), sustained changes in the nominal quantity of money that do not correspond to prior changes in the real demand for money work through a real balance effect to change growth in the nominal expenditure of the public relative to trend growth in real output.[9] Trend inflation emerges as the difference. Inflation maintains equality between the real purchasing power desired by money holders and the real purchasing power of the nominal quantity of money (Pigou 1917; Keynes [1923] 1972).

In a reserve-aggregate targeting regime, a real balance effect provides the nominal anchor by giving the price level a well-defined value. As explained by Patinkin (1965), arbitrary changes in the price level produce changes in real money balances (outside money) and consequent changes in the expenditure of the public that counteract the price level changes. Woodford generalizes

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[7] For a review of the quantity theory literature, see Humphrey (1974, 1990).

[8] Woodford (2005) states the general argument for a rule based on the idea that individuals make efficient use of information (take account of the forecastable behavior of central banks) in forecasting the future: "Because the key decision-makers in an economy are forward-looking, central banks affect the economy as much through their influence on *expectations* as through any direct, mechanical effects of central bank trading in the market for overnight cash. As a consequence, there is good reason for a central bank to commit itself to a systematic approach to policy that not only provides an explicit framework for decision-making within the bank, but that is also used to explain the bank's decisions to the public." (Italics in original.)

[9] Friedman ([1961] 1969, 255) wrote of the real balance effect consequent upon an open-market purchase by the central bank: "[T]he new balance sheet is out of equilibrium, with cash being temporarily high relative to other assets. Holders of cash will seek to purchase assets to achieve a desired structure.... [T]his process...tends to raise the prices of sources of both producer and consumer services relative to the prices of the services themselves; for example, to raise the price of houses relative to the rents of dwelling units, or the cost of purchasing a car relative to the cost of renting one. It therefore encourages the production of such sources...and, at the same time, the direct acquisition of services rather than of the source...."

Patinkin's analysis by adding to contemporaneous money the public's expectation of future money.[10]

Since the Treasury-Fed Accord of 1951 and before December 2008, the Fed has possessed an evolving reaction function broadly characterized as "lean-against-the-wind" (LAW).[11] The instrument has been a short-term interest rate (the funds rate since 1970). In order to provide for nominal and real stability, the central bank must implement LAW in a way that allows the price system to work and that conditions the public's expectation of the future value of money (McCallum 1986; Goodfriend 1987; Hetzel 1995).[12] With an interest rate instrument, a real balance effect does not provide a nominal anchor. The nominal anchor comes from credibility for a rule with which the central bank will initiate a contractionary monetary policy action if the public's expectation for inflation exceeds the bank's target (Goodfriend 1993; Hetzel 2008a, ch. 21), and conversely for a shortfall of expected inflation from the target.[13]

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[10] As formulated by Woodford (2003, 108), equation (1) expresses the price level (P) given the central bank's target for money (M^s):

$$\log P_t = \sum_{j-0}^{\infty} \varphi_j E_t \left[\log M^s_{t+j} - \eta_i \log \left(1 + i^m_t\right) - u_{t+j} \right] - \log \bar{m}.$$

In (1), φ_j depends on the interest elasticity of money demand, η_i; i^m is the interest paid on money; u captures exogenous changes in real output, the natural rate of interest, money demand, and the interest paid on money; $\bar{m}$ is the steady-state demand for real money.

[11] LAW marked the departure from the real bills pre-World War II focus on financial market instability construed as speculative behavior in asset markets or macroprudential regulation in today's terminology (on real bills, see Humphrey [1982] and Hetzel [1985]). With LAW, the FOMC focused directly on the economy as opposed to asset prices. Hetzel (2008a, 2008b) contrasts the two broad variants of LAW. The first variant emerged gradually with FOMC chairman William McChesney Martin (until derailed by the populist policies of Lyndon Johnson) and reemerged after the Volcker disinflation. It focused on moving short-term interest rates in a way that countered sustained changes in the rate of resource utilization in the economy (*changes* in the output gap) and on maintaining low, stable inflation premia in long-term government bond yields. The second characterized the "fine tuning" period from the mid-1960s through the end of the 1970s. It focused on moving short-term interest rates in response to the *level* of the output gap and on responding directly to actual inflation. Hetzel (2012) argues that this latter variant reappeared in 2008 through the practice of responding directly to actual inflation. LAW procedures provide a necessary condition for allowing market forces to determine the real interest rate. The fine-tuning variant under which the FOMC periodically attempts to increase the magnitude of a negative output gap to lower inflation contravenes this latter principle.

[12] If the central bank possesses a credible rule that stabilizes the expectation of the future price level, it need only respond to the real behavior of economy. The LAW procedures with which the Fed moves the funds rate away from its prevailing value in response to sustained changes in the economy's rate of resource utilization cause the real funds rate to track the natural rate of interest (Hetzel 2008b). In effect, the central bank delegates to the price system determination of the real interest rate and, by extension, other real variables. In principle, realized inflation can offer information on the real economy and a central bank reaction function could include as arguments both real output and inflation, but that fact in no way implies central bank manipulation of a Phillips curve relationship between inflation and output.

[13] With an interest rate instrument, money demand controls money creation. The central bank then limits money creation indirectly through its control of the public's expectation of the future price level. That expectation disciplines nominal money demand. The discipline comes from the

With an interest-rate instrument and a LAW reaction function, growth in nominal expenditure emerges as the sum of two components: growth in real expenditure and in inflation. Because of the assumption that the central bank cannot exercise systematic control over real variables, to avoid becoming a source of instability, the central bank needs to implement LAW in a way that allows the price system to determine the first component—real expenditure (output). The rule determines the long-run behavior of the second component—trend inflation—through the way in which it conditions the inflationary expectations of firms that set prices for multiple periods.[14] Trend nominal expenditure then arises from the sum of the two components: potential output growth and trend inflation. Because of the central bank's interest rate peg, the nominal money stock follows the public's demand for nominal money. However, the rule constrains that demand in a way consistent with the inflation target.

To reiterate, the central bank is unique because of its monopoly over the creation of the monetary base and, as a consequence, over broader money creation. With a floating exchange rate, the price level adjusts to endow the nominal quantity of money with the purchasing power desired by the public. This monetary character of the price level endows the central bank with control over inflation through its control over trend growth in nominal expenditure. Central to the way in which quantity theorists endow this framework with empirical content is the assumption that the price system works well in the absence of monetary shocks that cause the price level to evolve in an unpredictable way (Humphrey 2004). Violation of the discipline placed on central banks by a rule that allows the price system to determine real variables produces monetary emissions (absorptions) that force changes in nominal expenditure (output) and the associated booms and recessions.

The assumption that markets work well in the absence of monetary disorder subsumes more fundamental assumptions about markets. Competitive

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belief by the public that the central bank will vary its interest rate target if, in the future, the price level deviates from target. As formulated by Woodford (2003, 83), equation (2) expresses the contemporaneous price level (P) given the central bank's target for the price level (P^*):

$$\log P_t = \sum_{j-0}^{\infty} \varphi_j E_t \left[\log P^*_{t+j} + \phi_p^{-1} \left(\hat{r}_{t+j} - v_{t+j} \right) \right].$$

In (2), ϕ_p measures how the central bank changes its interest rate instrument in response to deviations of the price level from target and φ_j is a function of ϕ_p; v_t captures exogenous changes to the interest rate rule; $\hat{r}$ is the natural rate of interest.

[14] In the base case of price stability maintained by a credible rule, firms setting prices for multiple periods only change their dollar prices in order to change the relative price of their product. For a general discussion, see Wolman (2001, 30–1) and Goodfriend (2004b, 28). The central bank moves its interest rate instrument in a way that tracks the natural interest rate. Allowing the price system to work causes firms to maintain the optimal markup of product price over marginal cost. The environment of nominal expectational stability conditions the price-setting behavior of firms and maintains price stability apart from random, transitory changes in prices.

markets determine market-clearing prices and those prices aggregate information from dispersed markets efficiently. As a result, the central bank can avoid major recessions by following a rule that allows market forces to determine real variables (the real rate of interest, real output, and employment) and relative prices. Moreover, the efficient use of information by market participants implies that the central bank cannot systematically control real variables (exploit the inflation/unemployment correlations of empirical Phillips curves).[15]

Monetary nonneutrality arises from behavior by the central bank that causes the price level to evolve in an unpredictable way.[16] In the absence of a widely understood, credible rule underpinning an inflation target, changes in the price level have to occur in a way that is uncoordinated by a common set of expectations among price setters. That unpredictability presents price-setting firms with a coordination problem that they cannot solve. To counter monetary instability, collectively, firms would have to move dollar prices together to search for the price level that endows nominal money with the real purchasing power desired by money holders while also maintaining dollar prices individually to achieve the relative prices that clear markets. The price system fails to provide the requisite coordination.

4. THE KEYNESIAN-MONETARIST DEBATE

No central bank characterizes the role it plays in the economy as emanating from its control over money creation. Instead, central banks characterize their influence over prices and the economy in terms of how they affect conditions in financial markets and the resulting impact on financial intermediation. Moreover, the use of the language of discretion when combined with the legislative injunction to maintain "maximum employment" implies ongoing discretionary intervention into the working of the price system rather than implementation of a rule that delegates the determination of

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[15] The best known statement of the hypothesis that the central bank cannot control real variables in a predictable fashion is in Friedman ([1968] 1969). In response to an attempt by the central bank to control real variables in a systematic fashion, expectations adjust in a way that cause prices to change to eliminate the ability of the central bank to manipulate the real quantity of money: The long-run neutrality of money telescopes into the short run. In an attempt to systematize this hypothesis, Lucas ([1972] 1981) provided the first systematic exposition of quantity theory ideas. See also Humphrey (1999).

Friedman ([1958] 1969, 182–3) wrote: "[O]nce it becomes widely recognized that prices are rising, the advantages…[adduced to support the view that 'slowly rising prices stimulate economic output'] will disappear.… If the advantages are to be obtained, the rate of price rise will have to be accelerated and there is no stopping place short of runaway inflation. From this point of view, there may clearly be a major difference between the effects of a superficially similar price rise, according as it is an undesigned and largely unforeseen effect of such impersonal events as the discovery of gold, or a designed result of deliberative policy action by a public body."

[16] This hypothesis is in the spirit of the model in Lucas ([1972] 1981) in which only unpredictable policy actions have real effects. In New Keynesian sticky price models, the central bank can exert a predictable control over real variables.

employment to market forces. Implicitly, the message is that the central bank counters economic instability that arises in the private economy. Although not articulated as such, it follows from such an "activist" policy of intervening to influence employment that the control of inflation entails trading off between inflation and unemployment based on a Phillips curve relating the two variables.

As a way of assessing the tacit rejection of quantity theory ideas by central banks, this section reviews the Keynesian-monetarist debate. As in the real bills tradition, Keynesians often assume that recessions follow as the consequence of prior unsustainable speculative increases in asset prices and credit-driven overconsumption. Herd behavior among investors reflects "animal spirits." Both traditions reject the relevance of money as a factor determining either prices or cyclical fluctuations. With the central bank as a financial intermediary, the liabilities of the central bank (the monetary base and, by extension, the money stock) are determined by market (real) forces. In the real bills tradition, purposeful monetary expansion by the central bank leads to asset bubbles. In the Keynesian tradition, purposeful monetary expansion by the central bank leads to offsetting changes in monetary velocity that render monetary policy inefficacious. Both traditions attribute nominal and real instability to real shocks.

Figures 1 through 7 organize the discussion. Figures 1 and 2 show annual rates of consumer price index (CPI) inflation, respectively, for the intervals starting after the Civil War to World War II and subsequent to World War II to the present. For the post-World War I period to World War II, Figures 3–5 present graphs of growth rates of nominal and real output (GNP), M1 velocity and the interest rate, and growth rates of M1 and nominal output (gross national product [GNP]). For the post-Korean War period until the start of the Volcker disinflation, Figures 6 and 7, respectively, present graphs of growth rates of nominal and real output (GDP) and growth rates of M1 and nominal output (GDP).[17] In Figures 3 and 6, which display the rate of growth of nominal and real output for the years 1919–1940 and 1953–1981, inflation (deflation) measured by the implicit output deflator appears as the rate of growth of nominal output (dashed line) minus the rate of growth of real output (solid line). Inflation appears as the cross-hatched lines sloping upward

[17] The second set of graphs excludes the graph of the interest rate and M1 velocity because of the small interest sensitivity in the latter period of real M1 demand (the inverse of velocity). The graphs end in the early 1980s when the deregulation of interest rates made real M1 demand sensitive to interest rates. As a result, the visual relation between M1 and nominal GDP disappears. In particular, when the economy weakens and the interest rate falls, funds flow out of the money market into NOW accounts (interest-bearing checkable deposits included in M1). Heightened M1 growth then corresponds to weakness in nominal output growth. Even with a stable M1 demand function, the relationship between growth rates of money and nominal output is obscured by a decline in velocity (Hetzel and Mehra 1989). The pre-1981 period is an extraordinary laboratory for testing quantity theory ideas because of the usefulness of M1 growth as a measure of the impact of monetary policy on nominal expenditure and nominal output.

(dashed line above the solid line), while deflation appears as the cross-hatched lines sloping downward (solid line above the dashed line).

Keynesian economists have pointed to real shocks to explain the behavior of inflation shown in Figures 1 and 2. At the time of the Samuelson-Solow ([1960] 1966) formulation of the Phillips curve relating inflation to the unemployment rate, Keynesian economists divided inflation into three major categories: demand pull, cost push, and wage-price spiral.[18] By assumption, the real interest rate is ineffectual in keeping real output close to potential output. Persistent positive output gaps created by positive real shocks such as increased defense expenditures or an investment boom fueled by excessive optimism create demand-pull inflation. The exercise of market power by large corporations and unions creates cost-push inflation. Inflationary expectations, which are by assumption undisciplined by the systematic behavior of the central bank, can create a self-perpetuating spiral of wage and price increases. Because Keynesians believe that real phenomena like government deficit spending and the monopoly power of unions and corporations cause inflation, they argue that the control of inflation requires manipulation of a countervailing real force—the output gap. Specifically, to counter inflationary forces, the central bank must increase the amount of idle resources in the economy (unemployed workers).[19]

Figures 3–5 and 6–7 are useful in discussing the opposite assumptions made about causality by Keynesians and quantity theorists. Heuristically, in discussing causality, these two schools place the graphs in a different order. Keynesians place the graph showing real output first and money last while quantity theorists reverse the order. That is, Keynesians and quantity theorists are divided over whether the shocks that drive the fluctuations in the real output series are real or nominal and over the causes of the common movements of real and nominal variables (whether Phillips curve correlations are structural).[20]

Keynesians believe that real shocks drive the fluctuations in real output. Fluctuations in nominal output, monetary velocity, and money are derivative to the fluctuations in real output. Such real shocks typically appear as

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[18] See, for example, Ackley (1961, ch. 16).

[19] In the 1970s, the United States and other industrial countries used incomes policies and actual wage and price controls to control perceived cost-push inflation (Hetzel 2008a) and, it was assumed, to lessen the need for excess unemployment to control inflation. As a result of the failure of aggregate-demand policy to control unemployment combined with intervention by government into private price setting to control inflation, governments turned the control of inflation over to central banks. However, that assignment of responsibility left unaddressed the Keynesian presumption that the control of inflation requires manipulation of an output gap subject to Phillips curve constraints.

[20] This discussion omits the real business cycle (RBC) viewpoint. Early Keynesianism (see Samuelson 1967) and the RBC view share a common assumption about the irrelevance of monetary shocks for the business cycle. Quantity theory arguments for the primacy of monetary shocks as precipitating serious recessions are antithetical to both the Keynesian and RBC views, which maintain the irrelevance of monetary phenomena for the behavior of real phenomena.

irrational swings in investor sentiment between excessive optimism and excessive pessimism (animal spirits). Sticky prices transmit the shock to nominal output. Pessimism about the future causes monetary velocity (the demand for money) to decline as households hoard money. However, the decline in output produces an even larger decline in the demand for money and the central bank accommodates that decline by contracting the money stock. If the central bank were to increase the money stock, a pessimistic public would simply hoard the additional money (a liquidity trap).

In recession, the central bank can lower the real interest rate by lowering its interest rate target. The real interest rate is the price of current resources in terms of future resources foregone. A "low" real interest rate should transfer demand for consumption and investment from the future to the present and thereby mitigate negative shocks to real aggregate demand. However, Keynesians believe that the real interest rate in particular and the price system in general are inefficacious. The price system fails to serve its role as an equilibrating mechanism. Pessimism about the future overwhelms the self-equilibrating properties of the price system.

The Keynesian policy prescription for recession is deficit spending by the government. Ex ante, given an increase in pessimism about the future, private saving exceeds investment. With reductions in the real interest rate ineffective in redistributing aggregate demand from the future to the present, only a decline in output reduces saving to restore ex post equality between saving and a lower level of investment. (The Keynesian multiplier derives from the fact that saving declines only as a fraction of the decline in output.) The counterpart to irrational pessimism on the part of households is a short time horizon that does not account for the recovery of economic activity in the future. In contrast, government can take a longer-run perspective. By running a deficit, it can dissave sufficiently to offset the excessive saving of the public.

Real shocks interact with a poorly working price system characterized by sticky nominal prices and by relative prices that fail to clear markets. Keynesians want central banks to target a real variable—the output gap—and to determine the behavior of inflation as an optimal tradeoff between the output gap and (changes in) inflation based on a presumed hard-wired real-nominal (unemployment-inflation) relationship captured by Phillips curve correlations. Price stickiness constitutes a friction that causes real shocks to impact real output and employment. At the same time, it is the lever by which a central bank can exercise control over real variables through its control over nominal variables (the nominal interest rate and nominal expenditure).

In contrast to Keynesian assumptions, quantity theorists attribute sustained changes in prices (inflation and deflation) to behavior by the central bank that produces sustained departures of money growth from the growth in real money demand consistent with the growth in potential output. Intuitively, as illustrated in Figures 3 and 6, inflation makes the real purchasing power

of the money growth consistent with growth in nominal GDP (dashed line) consistent with the real purchasing power demanded as a result of growth in real GDP (solid line). In attributing causation to the correlations among the series displayed in Figures 3–5 and 6–7, quantity theorists assume an initial monetary shock manifested in the fluctuations in money. Given an assumption of stability in the functional form for monetary velocity, they consider the fluctuations in nominal and real output as derivative.

Because money is endogenously determined when the central bank employs an interest rate peg, fluctuations in money need not reflect monetary shocks. The endogeneity of money implies that neither sustained high (low) money growth nor sharp fluctuations in money growth necessarily produce inflation (deflation) or cyclical fluctuations in economic activity. The relevant criterion for money to become a source of nominal and real instability is behavior by the central bank that flouts the discipline imposed by the requirements of creating a stable nominal anchor and of allowing the price system to work. Flouting that discipline creates monetary shocks through forcing changes in money that require an unpredictable evolution of the price level.

5. MONETARIST METHODOLOGY FOR TESTING "MONEY MATTERS"

Much of the monetarist literature concentrates on event studies designed to distinguish between real and monetary causes of inflation and of the business cycle. Friedman and Schwartz (1963) are synonymous with this methodology. As examples, Friedman and Schwartz ([1963] 1969, 216–7) attributed the deflation that began after 1873 to "political pressure for resumption [establishment of gold convertibility of the paper greenbacks issued in the Civil War that] led to a decline in high-powered money. . . ." In arguing for monetary shocks as the cause of recessions, that is, for monetary contraction arising from events unrelated to the determination of nominal income, they argued:

> [C]hanges in the stock of money can generally be attributed to specific historical circumstances that are not in turn attributable to contemporary changes in money income and prices.. . . [In 1892–94] agitation for [monetizing] silver and destabilizing movements in Treasury cash produced fears of imminent abandonment of the gold standard by the United States and thereby an outflow of capital which trenched on gold stocks. Those effects were intensified by the banking panic of 1893, which produced a sharp decline, first in the deposit-currency ratio and then in the deposit-reserve ratio.

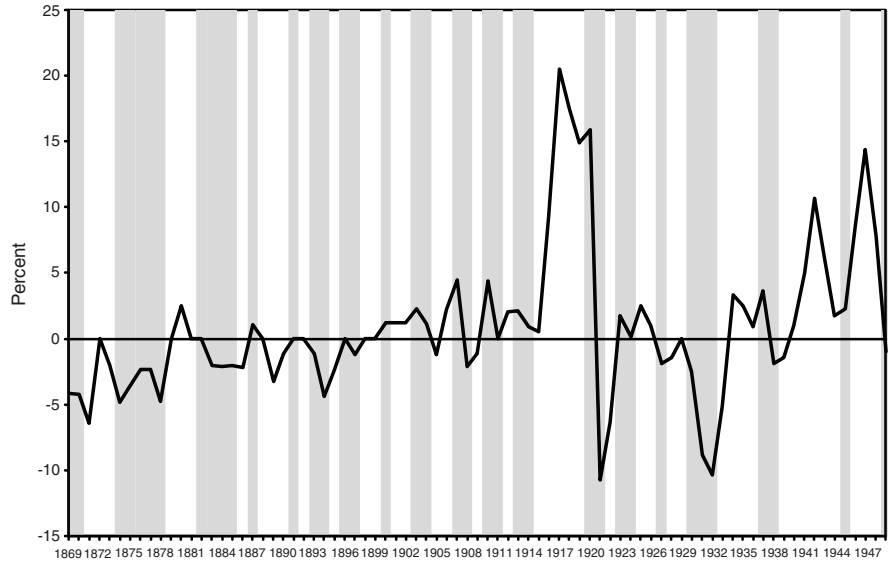
With the establishment of a central bank (the Fed), this strategy for identification of monetary shocks becomes harder. The desired information, namely, the economy's response to the Fed's behavior, is confounded in macroeconomic correlations with the Fed's response to the economy's behavior. As

a result, quantity theorists rely on an identification strategy based on the assumption that nominal and real stability require consistent implementation of a rule that provides a stable nominal anchor and that allows the price system to determine real variables.

An implication of the assumption that the price system works well to maintain economic stability unless disrupted by monetary disturbances is that monetary policy procedures that provide for economic stability require continual adjustment of the central bank's interest rate target in response to the ongoing fluctuations in strength and weakness in economic activity. It becomes natural to look for isolated episodes in which the Fed has pursued some objective unrelated to smoothing the fluctuations in the growth rate of real economic activity that produce corresponding changes in the economy's rate of resource utilization. That is, the intent is to isolate departures from moving the real interest rate implicit in the interest rate target in a way that redistributes aggregate demand over time to counter unsustainable strength and weakness in the economy. With such departures, the Fed moves short-term interest rates up or down in a sustained way and then either imparts significant inertia or holds fixed its interest rate target despite increasing weakness or strength in the economy. One then looks for monetary deceleration or acceleration. The quantity theory hypothesis is that this criterion provides a necessary and sufficient condition for booms and recessions (Hetzel 2012, chs. 6 and 7).

Obvious examples are the interest rate pegs of World War I and World War II. The example highlighted by Friedman and Schwartz (1963) and Meltzer (2003) was the intermittent real bills focus of policy prior to World War II. With real bills, the Fed concentrated on preventing speculative bubbles in asset prices rather than on allowing the real interest rate to vary continually to stabilize real economic activity. Another example, highlighted by the same authors, was the decade-and-a-half effort to manage aggregate demand in a way intended to stabilize the unemployment rate at its full-employment level started after the Kennedy tax cut in 1964. In conjunction with pursuit of the objective of full employment, policymakers attempted to maintain a moderate level of demand-pull inflation while using incomes policies to mitigate cost-push inflation (Hetzel 2008a; forthcoming). Hetzel (2012) argues that the employment by central banks since 2008 of reaction functions that entail a direct response of the interest rate setting to realized inflation constitutes another example. As argued by Friedman (1960), such a rule imparts inertia to reductions in short-term interest rates in the face of persistent declines in economic activity (Hetzel 2012).

Figure 1 Inflation: 1869–1949



Notes: Annual percentage change in the CPI. Data from Officer and Williamson (2012). Shaded areas represent National Bureau of Economic Research (NBER) recessions.

Disentangling Causation: Money and Prices

The following sketches briefly the kind of historical narrative quantity theorists have used to disentangle causation between money and prices. Figure 1 shows annual inflation rates from 1869–1949. Quantity theorists argue that the monetary arrangements of the United States explain the broad patterns shown in the graph.[21]

From 1869 through 1897, deflation predominated. After the Civil War, the United States stopped issuing Greenbacks while the economy grew. The

[21] Friedman (1966, 17) stated the quantity theory position phrased in terms of the events he used to disentangle causation from correlation. That is, he argued that historical experience demonstrated that intervention by the government into the price setting in private markets was inevitably futile as a way of controlling inflation. Only moderation in money growth was effective.

"Since the time of Diocletian,... the sovereign has repeatedly responded to generally rising prices in precisely the same way: by berating the 'profiteers,' calling on private persons to show social responsibility by holding down the prices at which they sell their products or their services, and trying, through legal prohibitions or other devices, to prevent individual prices from rising. The result of such measures has always been the same: complete failure. Inflation has been stopped when the quantity of money has been kept from rising too fast, and that cure has been effective whether or not the other measures were taken."

resulting deflation allowed a return in 1873 to the gold standard at the pre-war parity. The deflation also reflected increases in the real price of gold due to limited worldwide supplies of gold combined with increased demand as the world economy grew and the demand for monetary gold stocks increased as countries joined the international gold standard as part of the Latin Monetary Union. Starting in the mid-1890s, the world stock of gold began to grow because of gold discoveries in Alaska and South Africa and because invention of the cyanide process rendered the extraction of gold more efficient.[22]

The monetization of government debt in World War I created a large spike in inflation. When released from the task of financing the war effort, in 1920 and 1921, the Fed initiated a contractionary monetary policy with sharp increases in the discount rate to end inflation and to arrest gold outflows. The severe deflation associated with the Great Depression, which began in August 1929, was derived from the Fed's desire to maintain a high cost to banks of obtaining funds first to stop and then to prevent reemergence of a presumed speculative bubble in the price of equities and real estate.[23] The inflation after 1934 occurred because of the monetization of the gold inflows accompanying the increase in the dollar price of gold and political instability in Europe. The Fed's immobilization of bank reserves in 1936 and 1937 through phased increases in required reserve ratios temporarily replaced monetary expansion and inflation with monetary contraction and deflation. World War II again created inflation through a rate peg that forced the Fed to monetize government deficits.

Figure 2 shows annual inflation rates from 1949–2011. The surge in inflation in late 1951 was an inflation shock. It arose during the Korean War when the crossing of the Yalu River by the Chinese in November 1951 created the expectation of World War III with the return of price controls and inflation (Hetzel and Leach 2001a). However, contrary to the Keynesian presumption of hard-wired (intrinsic) inflation persistence, the shock did not propagate. In 1957, inflation increased to 3 percent. Arthur Burns, who was chairman of the Council of Economic Advisors from 1953 to 1956, and William McChesney Martin attributed the increase to the slowness of policy to tighten after the 1954 trough in the business cycle (Hetzel 2008a, 52).

The most striking part of Figure 2 is the irregular increase in inflation from 1 percent in 1964 to 13 percent in 1981 followed by disinflation and quiescent

[22] Various monetary histories exist for the United States (Friedman and Schwartz 1963; Friedman 1992; Timberlake 1993; Meltzer 2003, 2009; and Hetzel 2008a, 2012).

[23] Like Friedman and Schwartz (1963), Hetzel (2012, ch. 4) attributes the Depression to contractionary monetary policy. Friedman and Schwartz place primary emphasis on bank runs. In contrast to Friedman and Schwartz, Hetzel emphasizes the robustness of the banking system. He argues that, given unit banking, the decline in the money stock required by contractionary monetary policy took place in part through closing the weaker banks by bank runs. The bank runs were a byproduct, not a cause of, contractionary monetary policy.

Figure 2 Inflation: 1949–2011

Notes: Annual percentage change in the CPI. Data from Officer and Williamson (2012). Shaded areas represent NBER recessions.

inflation until the drop in 2009. Hetzel (2008a, chs. 6–12 and 22–25; 2012, ch. 8; forthcoming) attributed the increase in inflation to a monetary policy oriented toward achievement of full employment, almost universally considered as represented by a 4 percent unemployment rate, combined with the widespread understanding of inflation as a cost-push phenomenon. Given the presumed high social costs of an unemployment rate in excess of 4 percent and the belief in the nonmonetary character of inflation, the working assumption of monetary policy was that "incomes policies," represented in the extreme case by wage and price controls, were the desirable method of restraining inflation. The prevailing assumption was that using restrictive monetary policy (low rates of money growth) to deal with an inflation caused by cost-push pressures and by inflation shocks would create "high" interest rates that would hurt housing disproportionately and would create a socially intolerable level of unemployment. With a few exceptions, Federal Open Market Committee (FOMC) members attributed high rates of growth of money to the need to accommodate cost-push inflation in order to avoid high unemployment.

Disentangling Causation: Money and Output in the Depression

The following provides a flavor of the kind of monetary narrative that quantity theorists provide to disentangle causation from the correlations shown in Figures 3–7. For quantity theorists, the iconic example of Fed interference with the price system is its high interest rate policy (started in 1928) of countering the presumed speculative excess in financial markets associated with high price/earnings ratios for stocks on the New York Stock Exchange. In his testimony at the Strong hearings [U.S. Congress 1927, 381], Cassel provided an early statement of this criticism:

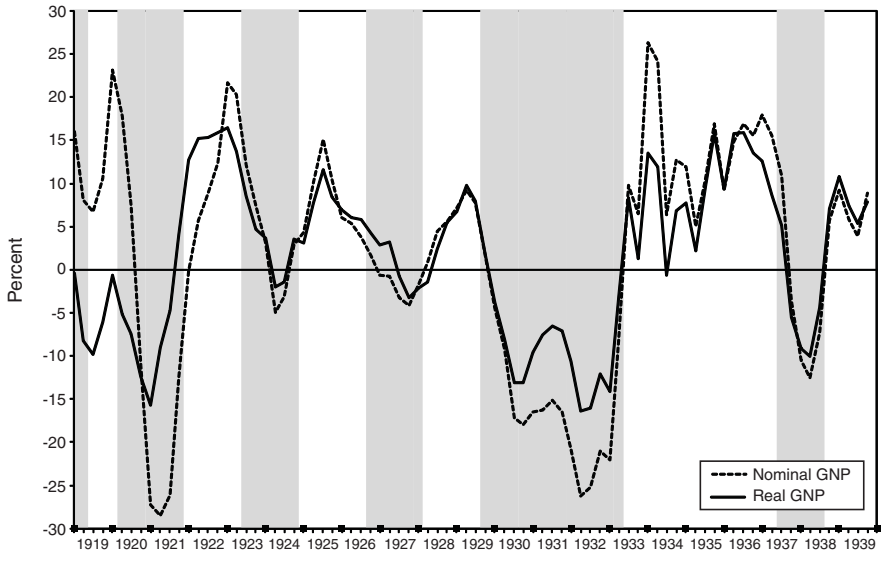
> Cassel: [Increases in Federal reserve bank rates to limit speculation] may have an effect on the general level of prices that will result in a depression in production in the country, followed by a decrease in employment, all only for the purpose of combating some speculators in New York. I think that is absurd.... [T]he Federal reserve system has no other function than to give the country a stable money. The business of checking stock-exchange speculation is disturbing this function....
>
> Mr. Wingo: I say that monetary causes are not the only causes that affect the general price level. There are other things besides monetary causes.
>
> Cassel: No; the general level of prices is exclusively a monetary question.

In 1930, Cassel (1930) provided a more complete account of how the Fed's focus on preventing asset bubbles required interference with the working of the price system. That interference created monetary contraction and deflation.[24]

> This limitation [of money supplies]...has of late been far too strict. The reason is the attempt to regulate the bank rate in such a way that it would have a supreme influence on the Stock Exchange, limiting the speculative inflation of share prices.... The Federal Reserve system...since last summer has adhered to rates which were far too high, with the result of a collapse in prices which seriously endangered the whole political economy.... The collapse in prices is bound to drag with it the whole rest of the world.... The whole matter is a blatant example of what happens if we yield to the modern tendency of permitting Government to meddle unnecessarily with economics. The Government assumes a task which is not in its province; in consequence of this it is driven to mismanage one of its most pertinent tasks, i.e., the supervision of money resources. This causes a depression, which the same government seeks to remedy by measures which are again outside the sphere of its true activity and which can only make the whole position worse.

[24] Lars Christensen, *The Market Monetarist*, June 9, 2012, reproduces the quotation.

Figure 3 Real and Nominal GNP Growth Rates: 1919–1939



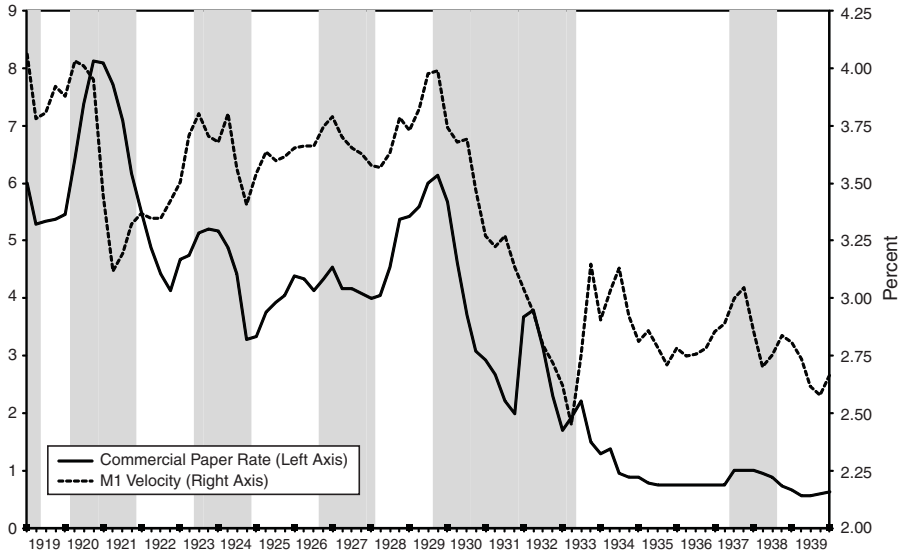
Notes: Quarterly observations of four-quarter percentage changes in real and nominal GNP growth. Rising cross-hatching indicates inflation and falling cross-hatching indicates deflation. Data from Balke and Gordon (1986, Appendix B). Shaded areas represent NBER recessions. Heavy tick marks indicate fourth quarter.

In congressional testimony in April 1932, Gov. Harrison explained why the Fed was unwilling to pursue an expansionary monetary policy. The House Committee on Banking and Currency held these hearings to promote a bill to require the Fed to restore the price level to its pre-deflation value. Repeatedly, Harrison challenged that goal on the grounds that it would require the Fed to increase bank reserves while the price level was falling even if it believed that banks would use the additional funds for speculative purposes. Harrison (U.S. Congress 1932, 485) said:

> [S]uppose. . . the price level is going down, and the Federal reserve system begins to buy government securities, hoping to check the decline, and that inspires a measure of confidence, and a speculation is revived in securities, which may in turn consume so much credit as to require our sales of Governments. There was that difficulty in 1928 and 1929.

Hetzel (2008a, 2012) argues that the Fed fell into a deflation trap. The high nominal interest rates presumed necessary to restrain speculation required monetary contraction. Monetary contraction created deflation, which

Figure 4 M1 Velocity and Commercial Paper Rate



Notes: Quarterly observations of M1 velocity: GNP divided by M1. Data for GNP are from Balke and Gordon (1986, Appendix B); M1 is from Friedman and Schwartz (1970); commercial paper rate is from Board of Governors of the Federal Reserve System (1943). Shaded areas represent NBER recessions. Heavy tick marks indicate fourth quarter.

engendered expected deflation. Expected deflation raised real interest rates. Higher real interest rates exacerbated monetary contraction, and so on. Starting in March 1933, the monetary standard changed (Hetzel 2012). The new Roosevelt administration undertook to end the Depression. Based on the widespread public association of economic decline with deflation, the administration undertook measures to raise "prices." However, consonant with the common understanding at the time, it thought in terms of raising relative prices. The desire to raise the prices of agricultural products entailed manipulating the dollar price of gold.

In March 1933, Roosevelt embargoed gold exports and floated the dollar. For the remainder of 1933, the government pursued what amounted to a commodity stabilization scheme to raise the dollar price of gold. In January 1934, the United States raised the dollar price of gold from $20.67 per ounce to $35.00 per ounce. At the same time, the Fed removed itself from the active conduct of monetary policy in favor of the Treasury by freezing the size of the holdings of Treasury securities in its portfolio and by keeping the discount rate at a level that eliminated most borrowing by banks from the discount

window. Along with political instability in Europe, the dollar depreciation in 1934 from $20.67 an ounce to $35 an ounce produced gold inflows, which the Fed monetized.

Prior to March 1933, the Fed's instrument was the marginal cost of funds to banks determined by the sum of the discount rate and the nonpecuniary ("administrative guidance") surcharge imposed on banks' use of the discount window (Hetzel 2008a, ch. 3; Hetzel 2012, ch. 4). These procedures made the monetary base endogenous. After March 1933, the monetary base became exogenous. Despite the exogenous increases in money produced by gold inflows, M1 velocity remained a stable function of interest rates (Figure 4). That fact contradicts the Keynesian liquidity trap assumption that purposeful money creation would simply be neutered by an offsetting change in velocity.

Friedman and Schwartz (1982, 626) generalized:

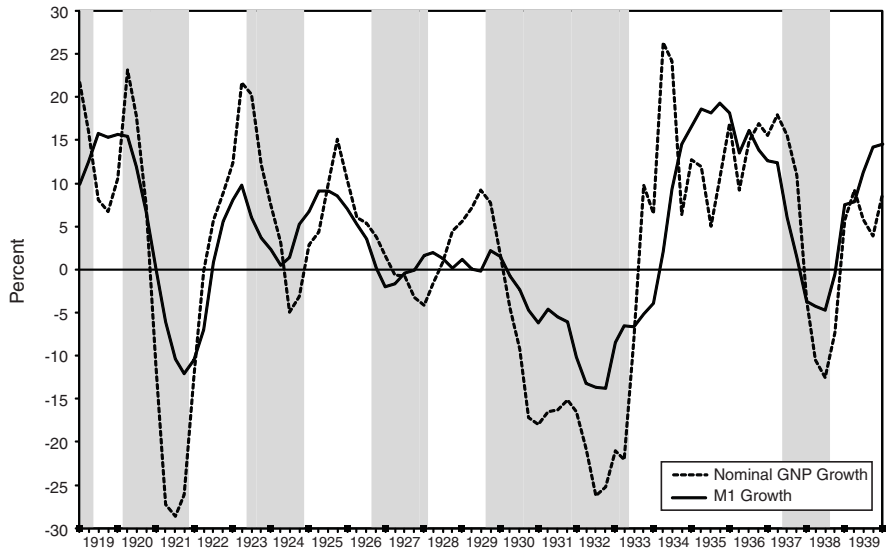
> A stable demand function for real money balances means that an autonomous change in either nominal money or nominal income will have to be accompanied by a corresponding change in the other variable, or in variables entering into the demand function for money, in order to equate the desired quantity of money balances with the quantity available to be held.... Given stability of money demand, *variability in conditions of money supply*, and similar parallelism for the period as a whole, it is appropriate to regard the observed fluctuations in the two nominal magnitudes as reflecting primarily an influence running from money to income. (Italics supplied.)

Disentangling Causation: Money and Output in the Stop-Go Period

After the Treasury-Fed Accord of 1951, in an evolutionary process, FOMC chairman William McChesney Martin and his adviser Winfield B. Riefler developed procedures termed "lean-against-the-wind" (LAW) by Martin (Hetzel and Leach 2001a, 2001b; Hetzel 2008a, ch. 5). In the changed intellectual environment of the time in which government accepted a role in economic stabilization, LAW involved moving short-term interest rates in a way that counteracted above-trend and below-trend growth in real output. Under Martin, concern for increases in long-term government bond yields furnishing evidence of increases in expected inflation replaced the real bills concern with speculative increases in asset prices (Hetzel 2008a, ch. 5).

The extent of the discipline placed on LAW derives from the importance the FOMC assigns to price stability or stabilization of inflation at a low level. However, different chairmen have imposed such discipline in two very different ways. They have imposed it either by behaving in a way that stabilized expected inflation or by responding to the actual emergence of inflation. Hetzel (2008a) terms the former variant "lean-against-the-wind with credibility."

Figure 5 M1 and Nominal GNP Growth: 1919–1939



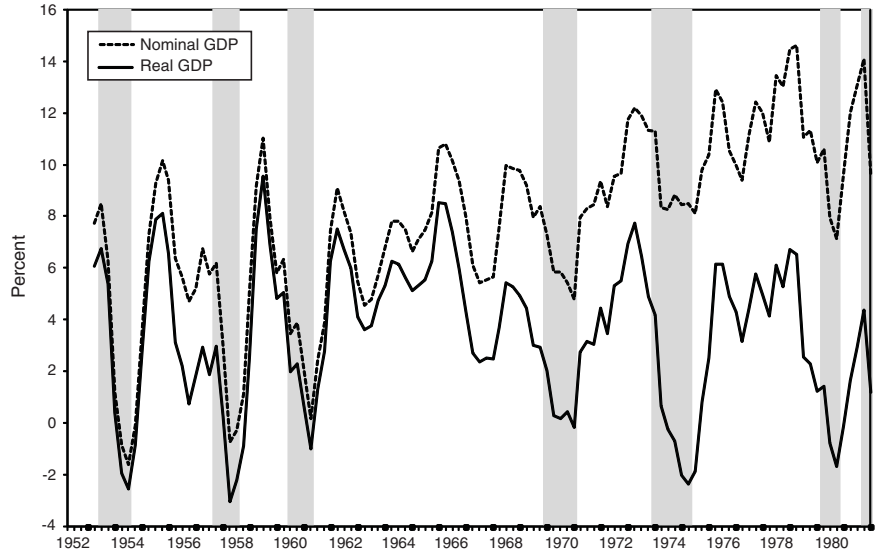
Notes: Quarterly observations of four-quarter percentage changes in nominal GNP and M1 growth. Data for GNP are from Balke and Gordon (1986, Appendix B). M1 is from Friedman and Schwartz (1970). Shaded areas represent NBER recessions. Heavy tick marks indicate fourth quarter.

Martin departed from LAW with credibility after 1964 in an ultimately futile attempt to avoid a politically divisive increase in interest rates with his own FOMC house divided. He attempted to eliminate the need for an increase in interest rates through a tax hike that would eliminate the deficit. The effort failed (Bremner 2004; Hetzel 2008a, ch. 7). Despite the passage of an income tax surcharge in June 1968, which transformed the deficit into a surplus, high money growth trumped restrictive fiscal policy, and the economy expanded while inflation rose.

Arthur Burns, Martin's successor, desired to control inflation and inflationary expectations but through the use of incomes policies to control the wage setting of corporations and unions with presumed market power. In this way, Burns viewed monetary policy through the lens of the businessman (Hetzel 1998). Burns' successor, G. William Miller, buttressed by a Keynesian Board of Governors, followed a similar strategy.

Under Burns and Miller, monetary policy earned the appellation of stop-go or, more aptly, go-stop. Given the political and policymaking consensus holding 4 percent as a desirable target for the unemployment rate, the FOMC

Figure 6 Real and Nominal GDP Growth Rates: 1952–1981



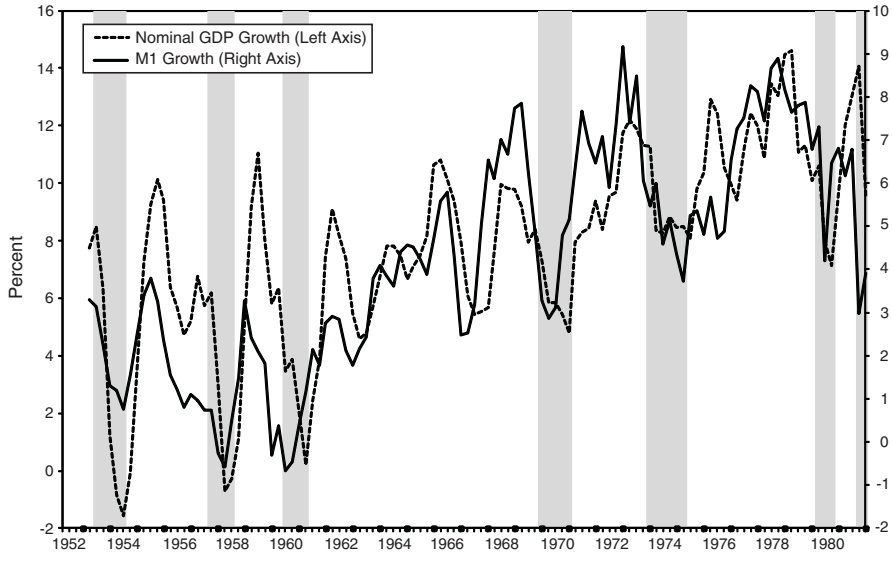
Notes: Quarterly observations of four-quarter percentage changes in real and nominal GDP. Shaded areas represent NBER recessions. Data from Haver. Heavy tick marks indicate fourth quarter.

operated with consensus about the magnitude of the output gap. The output gap was the difference between actual output and output consistent with a 4 percent unemployment rate. In go phases, the FOMC pursued an expansionary monetary policy by limiting increases in the funds rate even after the emergence of economic recovery. In doing so, it intended to engineer a high enough rate of growth in aggregate output in order to lower the magnitude of the assumed negative output gap.

In response to stimulative monetary policy, with a lag of almost two years, the inflation rate rose (Hetzel 2008a, Figure 23.3).[25] The FOMC responded directly to the increase in realized inflation by raising the funds rate and then maintaining that rate while a negative output gap developed (see discussion explaining Figures 8.1–8.5, Hetzel 2012). The resulting cyclical inertia in

[25] Friedman (1989, 31) wrote: "[A] change in the rate of monetary growth produces a change in the rate of growth of nominal income about six to nine months later.... The changed rate of growth of nominal income typically shows up first in output and hardly at all in prices.... The effect on prices...comes some 12 to 18 months later, so that the total delay between a change in monetary growth and a change in the rate of inflation averages something like two years."

Figure 7 M1 and Nominal GDP Growth: 1952–1981



Notes: Quarterly observations of four-quarter nominal GDP and M1 growth. Data for GDP are from Haver. M1 is from Friedman and Schwartz (1970) and from the Board of Governors via Haver. M1 in 1981 is "shift-adjusted" (Bennett 1982). Shaded areas represent NBER recessions. Heavy tick marks indicate fourth quarter.

interest rates created procyclical money growth. In the stop phases, the FOMC never intended to engineer recession. The intent of the FOMC was always to maintain a negative output gap of moderate magnitude to lower inflation in a controlled way—the so-called easy landing.

The stop-go period is the closest one comes in historical experience to the policy guideline represented by conventional Taylor rules. That is, the FOMC acted on the basis of an assumed knowledge of the output gap and responded directly to realized inflation. The FOMC also acted with a sense of the normal or benchmark interest rate such that a "high" interest rate indicated contractionary monetary policy and a "low" interest rate indicated expansionary monetary policy. This sort of policy rule turned out to be destabilizing as predicted by Friedman (1960).

Under chairmen Volcker and Greenspan, the FOMC returned to the procedures that had evolved in the pre-1965 era. The FOMC followed a LAW procedure but with a rule designed to stabilize expected inflation. The discipline imposed by the desire to return to low, stable inflationary expectations removed much of the cyclical inertia in funds rate movements. Specifically,

the FOMC moved the funds rate in a sustained, persistent fashion in response to changes in the rate of resource utilization in the economy.

In doing so, the FOMC moved the funds rate in response to sustained changes in the output gap, but without any presumption about the magnitude of the gap. Moreover, it abandoned any assumption of knowledge of a normal or benchmark real interest rate and allowed changes in the funds rate to cumulate without fear of overly high or low interest rates. The discipline on changes in the funds rate made in response to sustained changes in the economy's rate of resource utilization came from a superimposed reaction to sharp increases in bond rates interpreted as increases in expected inflation. That is, the FOMC followed its LAW procedures subject to the constraint that financial markets believed that funds rate changes would cumulate to whatever degree necessary to prevent deviations of trend inflation from a low, stable value. The rule stabilized the expectation of inflation and thus conditioned the price-setting behavior of firms setting prices for multiple periods. Phrased alternatively, the Fed's reaction function abandoned the direct response to realized inflation that had characterized the earlier stop-go period (Hetzel 2008a).

Several authors have characterized the monetary policy that followed the Volcker disinflation (Goodfriend 1993, 2004b; Mehra 2001; Goodfriend and King 2005; Hetzel 2008a, chs. 13–15; Hetzel 2012, ch. 8; Hendrickson 2012). The common strand in these accounts is the importance that FOMC chairmen Volcker and Greenspan assigned to stability in inflationary expectations measured by moderate long-term bond rates and by the absence of discrete jumps in bond rates. Stability of expected inflation meant not only a low inflation premium in bond rates but also the decoupling of increases in the inflation premium from the above-trend growth in output that had developed in the stop-go era. The focus on expected inflation moved the FOMC away from the direct response to inflation that had characterized the stop phases of the preceding stop-go monetary policy.

The considerable stability in growth of potential output in the 1980s that persisted through most of the 1990s meant that to achieve low, stable inflation the FOMC had to engineer low, stable growth in nominal expenditure (GDP). However, the FOMC lacked a nominal GDP target.[26] Given the FOMC's concern for inflationary expectations, the sensitivity of "bond-market vigilantes" to a reemergence of the inflation that followed above trend growth in the prior stop-go era meant that the FOMC had to raise the funds rate promptly in response to strong real growth. That behavior largely removed the cyclical inertia in interest rates that had characterized the stop-go era.

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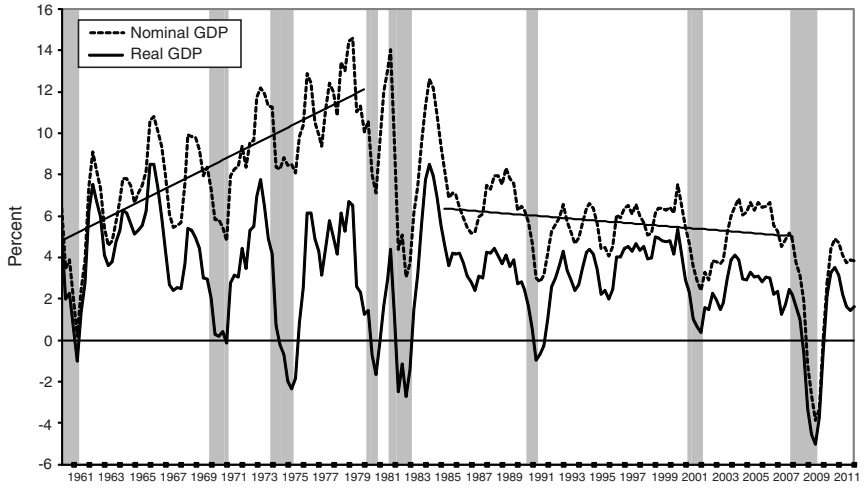
[26] The procedures are described in Section 3 in the paragraph that begins "With an interest rate instrument and a LAW reaction function. . . ." The objective was stable trend inflation; however, the intermediate target was stability in expected trend inflation. Only with stable growth in potential output due to steady growth in productivity and labor are these LAW-with-credibility procedures equivalent to nominal GDP targeting.

Figure 8 Growth Rates of Nominal and Real GDP



Notes: Quarterly observations of four-quarter percentage changes of real and nominal GDP. Trend lines fit to observations from 1960:Q1–1979:Q4 and 1985:Q1–2007:Q4. Shaded areas represent NBER recessions. Data from Haver. Heavy tick marks indicate fourth quarters.

Figure 8 shows the upward trend in nominal GDP growth that preceded the Volcker disinflation and the moderate downward trend after the Volcker disinflation. After this disinflation and prior to 2008, the main cyclical fluctuations in nominal GDP growth occurred in the last part of the 1980s and in the last part of the 1990s. Each episode arose as an echo of the prior go-stop monetary policy with the go phases initiated by FOMC concern for unwanted strength in the foreign exchange value of the dollar and an associated reluctance to raise the funds rate despite unsustainable growth rates in the real economy (Hetzel 2008a, chs. 14 and 16).

6. CONCLUDING COMMENT

This article has summarized quantity theory views and has provided a sampling of the sort of historical narrative its proponents have used to buttress their position that inflation is a monetary phenomenon and that cyclical fluctuations derive from monetary shocks.

APPENDIX: POST-2008 QUANTITATIVE PROCEDURES

Since December 2008, when the FOMC lowered the funds rate basically to zero, the relevant monetary regime has been reserve-aggregate targeting (quantitative operating procedures). The determining factor is that the FOMC's reaction function has set the size of its asset portfolio and, as a consequence, the size of the monetary base. Given the public's demand for currency, bank reserves are exogenously given to the banking system. Since spring 2009, through purchases known in the market as quantitative easing but within the Fed as large scale asset purchases (LSAP), the FOMC has twice increased the size of its asset portfolio.[27] (In late 2011, reserves also increased when foreign central banks drew on the Fed's swap lines.)

For the given level of bank reserves, the banking system's desire to decrease (increase) excess reserves determines the aggregate acquisition (sale) of its assets and, as a result, the expansion (contraction) of bank liabilities. Growth in bank deposits and in money follows. Given a well-defined demand for real money, growth in money determines growth in nominal expenditure. Given the high level of demand by banks for excess reserves that arose in response to the uncertainty created subsequent to the failure of Lehman Brothers in September 2008 and the near-zero funds rate, since January 2009, the monetary aggregate M2 (adjusted for flight-to-safety inflows) has grown on average at a 4 percent annual rate. That rate of money growth has been consistent roughly with 4 percent growth in nominal GDP. (For details, see Hetzel [2012, postscript].)[28]

The following analysis assumes that the shock that created the 2008–2009 recession was monetary, not real (see Hetzel 2012, ch. 12). It follows that the productive capacity of the economy did not contract and that the 8 percent unemployment rate that existed in 2012 revealed a negative output gap. At the same time, the Fed's credibility for its inflation target of 2 percent has set the expectational environment in which firms set dollar prices for multiple periods. As a result, core inflation has been steadied at 2 percent.[29] With

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[27] Although the LSAP purchases occurred in response to an unemployment rate in excess of 8 percent and core personal consumption expenditures (PCE) inflation of less than 2 percent, it is unclear what the policy rule is.

[28] In the period since fall 2008, to determine the resulting growth rate for nominal expenditure (output or GDP), one must remove the inflow of funds from the money market into the too-big-to-fail banks precipitated by stress in financial markets. Such deposits are unrelated to the transactions demand for money and nominal expenditure. Those inflows occurred discretely in September 2008, in June and July 2011, and to a lesser extent at year-end 2011.

[29] Inflation shocks due chiefly to increases in energy prices boosted inflation, especially starting in late 2010. The resulting transitory increase in inflation temporarily depressed output.

baseline inflation of 2 percent, nominal GDP growth of 4 percent allows for 2 percent growth in real GDP.

Assuming that the growth rate of potential output is 2 percent, real GDP growth of 2 percent during the later stage of the economic recovery leaves the negative output gap intact. The uncertainty created by a weak labor market makes the public pessimistic about the future. That pessimism has engendered low long-term real rates of interest.[30] Moreover, it has made the natural rate of interest (the short-term real interest rate consistent with full employment) negative. A funds rate near zero combined with expected inflation of 2 percent creates a negative real interest rate of about 2 percent. The natural real interest rate must lie somewhat below this value in order to maintain a rate of real GDP growth insufficient to eliminate the negative output gap.

If the natural rate of interest lay significantly below the actual short-term real interest rate, monetary contraction would ensue. The reason is that individual banks would sell assets in an attempt to place the reserves they gained in the higher-yielding deposits offered by the Fed at an interest rate of .25 percent. Monetary contraction would depress nominal output growth and, with inflation of 2 percent real growth, would decline further below normal for an economic recovery. With expected inflation remaining at 2 percent and actual inflation steadied around 2 percent as a result, higher nominal GDP growth would produce higher real GDP growth through a real balance effect that stimulates nominal expenditure. Higher real growth would ultimately raise the natural interest rate.

Since December 2008, the Fed has paid to banks interest on reserves (IOR) at 25 basis points. That innovation renders more complicated the classification of the Fed's operating procedures as reserve-aggregate targeting or interest rate targeting. Whether allowing banks to lend to the central bank (IOR) is consistent with reserve-aggregate targeting or with interest rate targeting depends on the FOMC's reaction function. Prior to December 2008, the FOMC implemented an interest rate targeting regime (Hetzel 2012, ch. 14).

In a regime of interest rate targeting, the FOMC possesses a reaction function that uses the interest rate as the policy instrument. The FOMC could then use the level of IOR as the mechanism for setting the desired interest rate target. In this case, given the interest rate target set equal to the value of the IOR, the FOMC could expand the size of its asset portfolio without depressing short-term interest rates below its rate target (Goodfriend 2000). For example, the FOMC might want to purchase Treasury securities in order to expand the size of its asset portfolio and, as a byproduct, increase bank excess reserves as a way of providing banks a cushion against short-term funding problems. Such an initiative would be consistent with limiting the extent of the financial

[30] The assumption that the origin of this pessimism lies in a negative monetary shock differentiates this view from an animal spirit view.

safety net in which banks experiencing a run have unlimited access to the discount window. Alternatively, if the FOMC wanted to use credit allocation as an instrument, it could purchase mortgage-backed securities to lower the yield difference between mortgages and Treasury securities. (That initiative would not be a free lunch in that it would require a somewhat higher target for the interest rate to maintain inflation at target.)

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The Performance of Non-Owner-Occupied Mortgages During the Housing Crisis

Breck L. Robinson

The past decade has seen a dramatic rise and fall in home values within the United States, causing policymakers to contemplate their cause and solution. Much of the attention and blame for the rise in mortgage delinquencies and foreclosures has been attributed to mortgages that were originated to subprime homeowners. These homeowners have high loan-to-value ratios, high debt-to-income ratios, low credit scores, and little or no documentation of income.[1] In addition to rising risk, other factors contributed to the housing crisis. For example, changes in economic conditions like higher unemployment rates led to a lower capacity for homeowners to meet their mortgage obligations.[2]

In an attempt to limit the impact of the housing crisis and to help stimulate a housing recovery, policymakers have proposed a number of foreclosure mitigation programs to help homeowners that are owner occupants. Unfortunately, none of the programs initiated to help slow down the housing crisis

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[1] Doms and Krainer (2007) find an increase in riskiness in the pool of potential homeowners around the expansion of the subprime market. Bhardwaj and Sengupta (2008) find that underwriting standards did not universally decline prior to the housing crisis, especially in the subprime market.

[2] Campbell and Dietrich (1983) and Deng, Quigley, and van Order (2000) find a positive relationship between unemployment rate and mortgage default.

were able to achieve the goals stated by policymakers.[3] One possible reason why these programs have not been successful is that there are multiple causes of the housing crisis. The lack of success of these programs suggests that a public policy approach to combat mortgage delinquencies and foreclosures needs to be flexible and multidimensional in order to be effective.

One segment of the housing market that has received little attention from policymakers and the press is the plight of homeowners who do not reside in their home. This group of homeowners is typically identified as non-owner occupants, which includes investors in residential properties and owners of vacation homes. The 2003 American Housing Survey produced by the Harvard Center for Housing Studies found that 35 percent of American renters lived in single-unit housing and another 21 percent live in two- to four-unit structures. In other words, non-owner occupants provided about half of the single-family housing for renters in the United States in 2003. However, it is not known how mortgages to non-owner occupants performed during the housing crisis.

In this article, I investigate the size and importance of the non-owner occupant housing market prior to the housing crisis. Using two nationally representative data sets for mortgage originations, I show that prior to the housing crisis, the size of the mortgage market for non-owner occupants grew at a faster pace when compared to owner occupants.

In order to explore the impact of the housing crisis on non-owner occupants, I use two measures of mortgage performance. The first is foreclosure rates. Using aggregate data on owner and non-owner occupant mortgages, the results show that foreclosures rates for the two groups are similar. One possible explanation for this result is that non-owner occupants are held to a higher underwriting standard, which may help mitigate perceived differences in default.

The second measure of mortgage performance is a prevalence and performance index. Using state-level data, a number of states received high impact measures during the housing crisis, but the source of their impact varies by region of the country. For example, the driving factor for a high impact ratio for states in the Midwest is poor mortgage performance. This result is very different for states in the South and West where high impact ratios are driven mostly by a high concentration of non-owner occupant mortgages. In other words, the impact of the housing crisis on non-owner occupied mortgages is widespread, but the source of their impact varies by region. Not surprising, the states identified in this study are the same states that are identified in the press as being the hardest hit during the housing crisis.

[3] Programs that have been initiated during the housing crisis include the Federal Deposit Insurance Corporation's "Mod in a Box," Hope for Homeowners, and the Home Affordable Mortgage Program, among others.

The remainder of this article is organized as follows: Section 1 presents a discussion on the motivation behind foreclosure, and Section 2 provides a discussion of the data. Section 3 provides evidence of the impact of foreclosures in the housing market from non-owner occupants, and the results are summarized Section 4.

1. MOTIVATION BEHIND FORECLOSURE: THEORY

Policymakers have wondered if mortgage holders who use their homes as investment properties played a role in contributing to the current housing crisis. "Investors" are defined as those individuals who do not use their home as their primary residence, but to generate revenue. Answering this question is difficult—the main hurdle facing researchers is that data limitations make it difficult to measure home purchase activity for this particular group of homeowners. However, data is available if I broaden my focus to include both investors and owners of second homes. I define a second homeowner as an individual who purchases a non-primary residence for recreational use as an occasional or seasonal residence. This broader group of investors and second homeowners is defined as non-owner occupants.[4]

The post-origination performance of mortgages has been the subject of academic research, but almost all of it, both empirical and theoretical, has focused on the performance of homeowners in their primary residence.[5] A few studies of owner occupants indirectly provide insight into the behavior of non-owner occupants. For example, studies like Cowan and Cowan (2004) and Immergluck and Smith (2004) find that foreclosure rates are higher among non-owner occupants even after controlling for credit scores and other risk factors.

They contend that the decision of the mortgage holder to become delinquent or enter foreclose depends on the homeowner's ability and willingness to repay his/her mortgage. Other studies, including Bajari, Chu, and Park (2008) and Haughwout, Peach, and Tracy (2008), find that non-owner occupants are more likely to exercise their option to default even after controlling for other factors. In addition, Gerardi, Shapiro, and Willen (2008) find a similar result when using condominiums and multifamily dwellings as proxies for loans to non-owner occupants.

There are two theories that have been proposed to help explain why homeowners enter foreclosure: "trigger-event" theory and "options" theory.[6] Trigger-event theory states that an individual may experience a life-changing

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[4] A single-family home is defined as a detached structure with one to four residents, a townhouse, or a condominium contained in a larger building but available for sale separately.

[5] Quercia and Stegman (1992) and Vandell (1995) provide a nice review of the literature.

[6] See Avery, Brevoort, and Canner (2008).

event that negatively impacts the homeowner's ability to meet his/her financial obligations. Typically, trigger events lead to disruptions in income or an expansion in expenses due to a loss of employment, change in marital status, or a health-related event.[7] In other words, when a financial hardship occurs, the homeowner is less likely to remain current on his/her mortgage and other financial obligations.

While trigger-event theory helps explain mortgage foreclosures that are driven by factors outside the homeowner's direct control, it does not explain those situations where the homeowner is making a conscious decision to allow foreclosure to occur, even when the homeowner's current financial situation may not have changed. Under option theory, the homeowner has an incentive to walk away from his/her home when the value of the home is less than the amount owed on the mortgage.[8] Option theory does not suggest that homeowners will always walk away from their home or will do so immediately after finding themselves in a negative equity position. Homeowners may delay exercising their option to pay their mortgage if they believe that housing values are not likely to increase in the near future.[9] In addition, homeowners may not exercise their foreclosure option even if they believe housing values may not appreciate to the full cost of the home given that foreclosure is not without costs. Owner occupants face sizeable transaction costs associated with foreclosure that directly impact the homeowners' credit reports and will reduce their access to credit and increase borrowing costs in the future.

Gerardi, Shapiro, and Willen (2008) use a theoretical model for foreclosure where homeowners enjoy a stream of monetary and non-monetary benefits from homeownership. I contend that ownership status is a factor in determining how quickly a homeowner will initiate foreclosure under option theory. The reason for a difference in the value of the foreclosure option associated with ownership status is that different owners place different values on the financial and non-financial benefits associated with homeownership. For example, given that owner occupants reside in the home full time where they are likely to develop an emotional attachment to their home, they are likely to place a higher value on the non-monetary benefits associated with homeownership. As a result, owner occupants are less likely to exercise their foreclosure option even when there is a decline in the potential monetary benefits of homeownership.

On the other extreme, non-owner occupants are more likely to initiate foreclosure, for they are more likely to place a higher value on the potential

[7] See Vandell (1995); Elmer and Seelig (1999); and Deng, Quigley, and Van Order (2000).

[8] Bajari, Chu, and Park (2008); Foote, Gerardi, and Willen (2008); Haughwout, Peach, and Tracy (2008); and Bhutta, Dokko, and Shan (2010) find that negative equity is highly correlated with higher default rates.

[9] See Hendershott and Van Order (1987); Kau, Keenan, and Kim (1994); and Kau and Keenan (1995).

monetary benefits of homeownership. Since non-owner occupants do not reside in the home full time, they consume less of the non-monetary benefits of homeownership.[10] As a result, non-owner occupants will place a higher value on rental income and capital gains generated from homeownership, net of holding costs.[11] Among the groups of non-owner occupants, second homeowners represent a hybrid group, for they are likely to fall in between investors and owner occupants regarding their willingness to exercise their foreclosure option. They place a higher value on their foreclosure option when compared to owner occupants, but a lower value relative to investors. One reason why second homeowners are different is that they occupy their second homes more frequently than investors, causing them to place a higher value on the non-financial benefits of homeownership. However, second homeowners are more likely to place a higher value on the monetary benefits of their second home when compared to the primary residence inhabited by owner occupants. Specifically, second homeowners are more likely to use their second home to generate rental income and are more likely to dispose of their second home if a financial opportunity arises.

2. DATA

The data used in this article come from LPS Applied Analytics, Inc. I collect loan origination data for the time period 2004–2007. Individual loans originated for my sample are followed starting at their origination date and ending when the loan is foreclosed or refinanced. If the loan remains active for the whole time period, then the last observation date of record is June 2011. LPS provides loan-level data compiled from the largest loan servicers and covers around 67 percent of the U.S. mortgage market for the period analyzed in this study.[12] One of the benefits of the LPS data is that loan-level information is available at the time of origination, including the risk characteristics of the borrower. Specific variables such as loan amount, appraisal value, and borrower income can be found in the data. In addition, LPS provides information that can be used as a proxy for the riskiness of the borrower. Such information includes the borrower's credit rating (FICO score), loan-to-value, and debt-to-income ratios at the time of origination.

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[10] "Ruthlessness" is an extreme variant of "option" theory. In this case, the borrower is assumed to have no emotional attachment to his/her home, creating an incentive for the borrower to view the homeownership decision strictly as a financial transaction.

[11] Gerardi, Shapiro, and Willen (2008) note that non-owner occupants face a number of disadvantages, such as public assistance to delinquent borrowers usually targets owner-occupants. In addition, since non-owner occupants must either forgo rental income or seek tenants, the search for tenants involves administrative costs and risks, like property damage from renting or lost income when tenants fail to remain current on their rent.

[12] Cordell, Watson, and Thomson (2008) provide additional detail and insight into the LPS data.

In addition to applicant information that is reported at the time the loan is originated, LPS provides loan-level performance data for each month the loan remains active with the reporting loan servicer. For example, the borrower's payment status is provided (payment, prepayment, or default), including whether the borrower's loan is current (30-, 60-, or 90-days delinquent). For the purposes of this study, I will focus my attention on loan defaults that are caused by foreclosure.

Additional data used in this study are provided by the Home Mortgage Disclosure Act (HMDA) for the time period 1996–2006. The HMDA data provides loan-level information for borrowers at the time of origination. One of the primary differences between the LPS and HMDA data sets is that HMDA provides loan-level information by lender and includes information on the race and sex of the borrower.

As a supplement to the HMDA data, data obtained from the National Association of Realtors (NAR) are used to acquire home sales data for the time period 2003–2007. One of the benefits of using the NAR data is that home sales to non-owner occupants can be disaggregated into either second homeowners or investors. The HMDA data distinguishes between owner and non-owner occupants at the time of origination, but within the non-owner occupant group, HMDA does not provide the same level of detail.

3. EVIDENCE OF SIGNIFICANCE AND IMPACT ON FORECLOSURES TO NON-OWNER OCCUPANTS

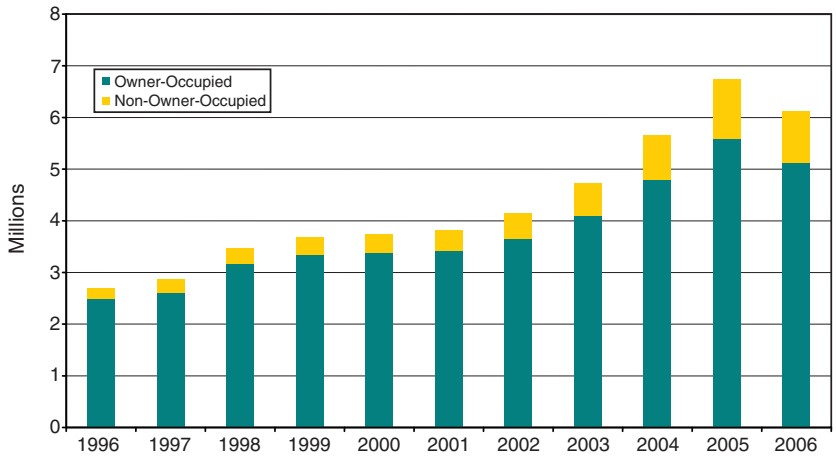
Growth in Mortgage Market

Before I start to explore the role that non-owner occupants played in the housing crisis by analyzing measures like foreclosure rates, I need to identify the size of the housing market controlled by non-owner occupants.[13] Using data from HMDA, Figure 1 provides a breakdown of the number of mortgages originated by ownership type. In 2000, the role non-owner occupants played in the home purchase market was fairly small, constituting about 8 percent of the first lien mortgages originated. However, the share of first lien mortgages originated to non-owner occupants increased over time, reaching a peak of almost 16 percent in 2005.

Data on home sales is provided by NAR in Figure 2. In 2003, home sales for primary residents were slightly more than 4.5 million units, while home sales to non-owner occupants were almost 2.25 million units. Similar to the pattern observed in the HMDA data, home sales to non-owner occupants were largest in 2005, where they reached almost 3.5 million units.

[13] Avery, Brevoort, and Canner (2008) find a positive relationship between the share of mortgages originated to non-owner occupants and delinquency rates.

Figure 1 Mortgage Originations for Home Purchase by Occupancy Type

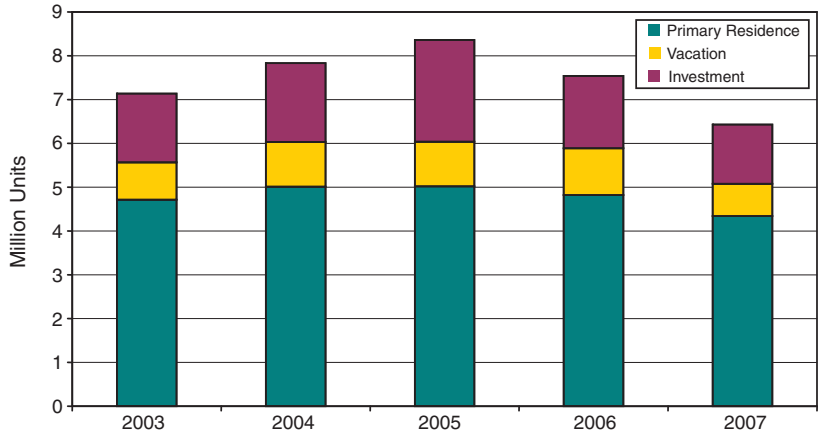


When using growth rates as a measure of the significance of the housing market controlled by non-owner occupants, the data presented in Figure 2 show a similar story. Data from the NAR for the time period prior to the housing crisis show that home buying activity by non-owner occupants grew faster than activity by owner occupants. For example, during the time period 2003–2005, home purchases by investors increased almost 50 percent, while home purchases to owner occupants rose just 6.4 percent. A similar result exists when using HMDA data. For example, home purchase mortgage originations to non-owner occupants rose 84 percent between 2003 and 2005. Over the same time period, originations to owner occupants rose by 36 percent.

The data from both HMDA and NAR show that non-owner occupants played a sizeable and increasing role in the housing market prior to the housing crisis.[14] However, while the size of the market for non-owner occupants provides added justification for studying them separately as an ownership

[14] The results presented using HMDA and NAR data show that non-owner occupants played an increasing role in the housing market prior to the housing crisis. However, the relative size of mortgages originated to non-owner occupants is quite different between the two data sources. There are several explanations why HMDA and NAR provide different numbers. For example, the data provided in NAR come from a survey, whereas HMDA captures actual home purchases using mortgages. However, HMDA data may not provide a complete picture of originations in the mortgage market. For example, HMDA only provides data on homes that are purchased using a mortgage (no cash purchases). In addition, reporting requirements cause HMDA to underrepresent mortgages originated by small lenders and lenders in rural markets. Also, for those homeowners who use both a first and second mortgage to purchase a home, both mortgages show up in the data as if two separate homes were being purchased. Avery, Brevoort, and Canner (2008) show that

Figure 2 Home Sales for Owner Occupants, Second Homeowners, and Investors



group, their size and growth leading up to the housing crisis does not mean that they played a significant role.[15]

Housing Prices

I argue above that non-owner occupants are more likely to view homeownership as a profit opportunity. This suggests that non-owner occupants may be attracted to areas of the country where housing values are rising more rapidly. It is also possible that this causation will flow in the opposite direction. For example, non-owner occupants may expect housing values to increase in the future, causing them to buy housing in anticipation of future price appreciation.

While the direction of the relationship between home prices and non-owner occupant buying activity will not be determined in this study, I can identify the strength of this relationship prior to the housing crisis. Figure 3 uses state data to compute cross-sectional correlations between the lagged

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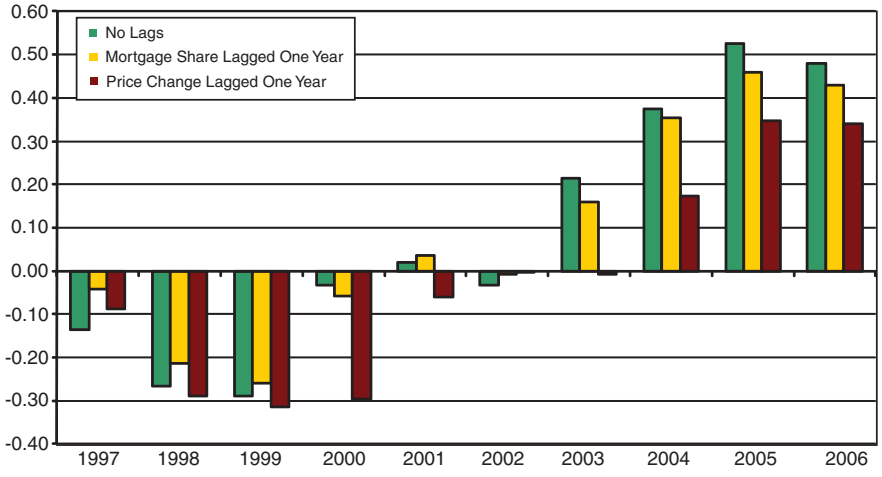
first and second mortgages for single home purchases increased substantially prior to the housing crisis (2004–2006).

[15] HMDA and LPS data may underreport the number of mortgages held by non-owner occupants. Both HMDA and LPS depend on homeowners to self-report the occupancy status of the home, and LPS also relies on self-reporting to distinguish second homes from investment properties. Differences in underwriting standards based on the occupancy and usage of the home creates an incentive to misreport homeowners' true intentions.

Figure 3 Cross-State Correlations Between Non-Occupants' Share of Home-Purchase Mortgage Originations and Annual Percentage Changes in Housing Prices, 1997–2006



one-year percentage change in home prices and the share of mortgage originations to non-owner occupants (red bar). Because the direction of the causation is unknown, a correlation is also calculated between the lagged one-year share of mortgages originated to non-owner occupants and the percent change in home values (yellow bar). Lastly, the green bar shows the correlation between both variables using no lags. Coming into the 21st century, the two variables in Figure 3 show a strong negative correlation. In other words, the relationship between mortgage origination activity by non-owner occupants and home prices is negative. However, contrary to the earlier results, all three correlation measures experience a strong positive relationship prior to the housing crisis. These results show that the share of originations to non-occupant owners either mirrored appreciation in home prices or were a contributing factor. In other words, the results indicate that, just prior to the

housing crisis, non-owner occupants played a positive role in contributing to a run up in housing prices.[16,17]

Risk Characteristics

As stated previously, theory suggests that non-owner occupants are expected to have a higher mortgage foreclosure rate. If theory parallels reality, I would expect higher underwriting standards for non-owner occupants in order to help mitigate the higher perceived risk associated with their foreclosure option.[18] Higher underwriting standards for non-owner occupants would take the form of higher income and FICO scores, while having lower loan-to-income, debt-to-income, and mortgage amount.

Figures 4, 5, 6, and 7 use data from HMDA and LPS at the time of origination to compare borrower risk profiles for owner occupants and non-owner occupants. Using HMDA data, Figure 4 reports borrower income by state for first lien originations disaggregated by occupancy type. The data show that owner occupants have a lower median income when compared to non-owner occupants. This result is even more striking given that only in the case of owner occupants that purchased homes in California does the average income meet or exceed the median income level for non-owner occupants. In a typical state, the median income for owner occupants ranges from $60,000 in 2004 to $65,000 in 2007. For the same time period, the median income for non-owner occupants is considerably higher, ranging from $100,000 to $125,000 for the same period.

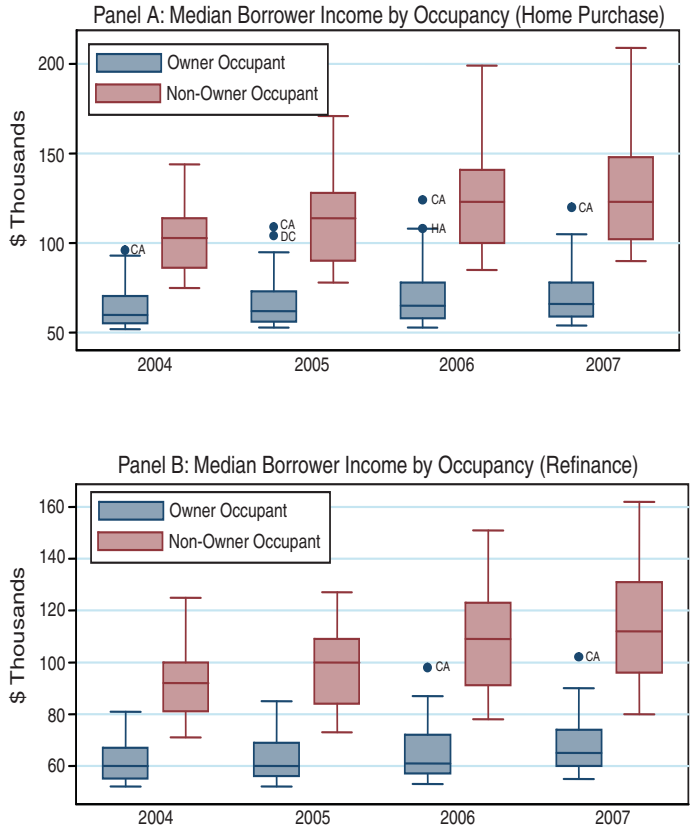
In order to observe differences in credit quality without using income by ownership type, it is necessary to use LPS data. As mentioned earlier, the LPS data has the ability to identify those homeowners who classify themselves as either investors or second homeowners. Based on the discussion above, non-owner occupants are more likely to exercise their foreclosure option when compared to owner occupants. Among the group of non-owner occupants, second homeowners are expected to be less likely to exercise their foreclosure option when compared to investors because second homeowners place more value on the non-monetary benefits associated with homeownership. Figure 5 presents FICO scores for occupant owners, second homeowners,

[16] For the years just prior to the housing crisis, the highest correlations in Figure 3 are for the contemporaneous results and the lowest correlations are when the housing price appreciation variable is lagged. It is also important to note that there is a slight asymmetry between the two correlations using lagged variables, but this result is similar to Wheaton and Lee's (2008) findings on lead-lag relationships between sales and prices for total home purchases.

[17] Wheaton and Nechayev (2008) find that the share of non-owner occupant mortgage activity is positively correlated with errors in forecasting housing prices.

[18] See Vandell (1995) for a survey of the empirical literature on mortgage default and a discussion of individual variables in the default decision.

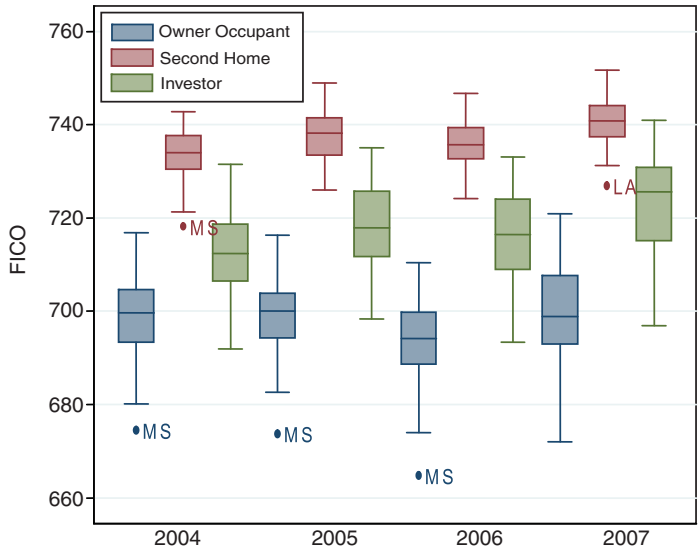
Figure 4 Distributions Across States for the Median Income of Owner Occupant and Non-Owner Occupant Mortgage Borrowers, by Loan Purpose and Year of Origination (HMDA)



Notes: The data are median applicant income for each state and the District of Columbia, segregated by occupancy. The line in each box represents the median incomes across the 50 states and the District of Columbia. Each box covers the interquartile range for income (25th percentile and 75th percentile) of the distribution. The "whiskers" extend beyond the box either to the end of the distribution or to a length of 1.5 times the interquartile range, whichever comes first. The dots beyond the whiskers are classified as extreme outliers and these dots are identified by their state code.

and investors. The data from Figure 5 show that at the time of origination, occupant owners consistently have a lower median FICO score when compared to non-owner occupants. Among the two groups of non-owner occupants, second homeowners consistently have a higher median FICO score. This result seems surprising given that it was hypothesized that second

Figure 5 Distribution Across States for the Mean FICO Score of Owner Occupant and Non-Owner Occupant Mortgage Borrowers, by Year of Origination (LPS)

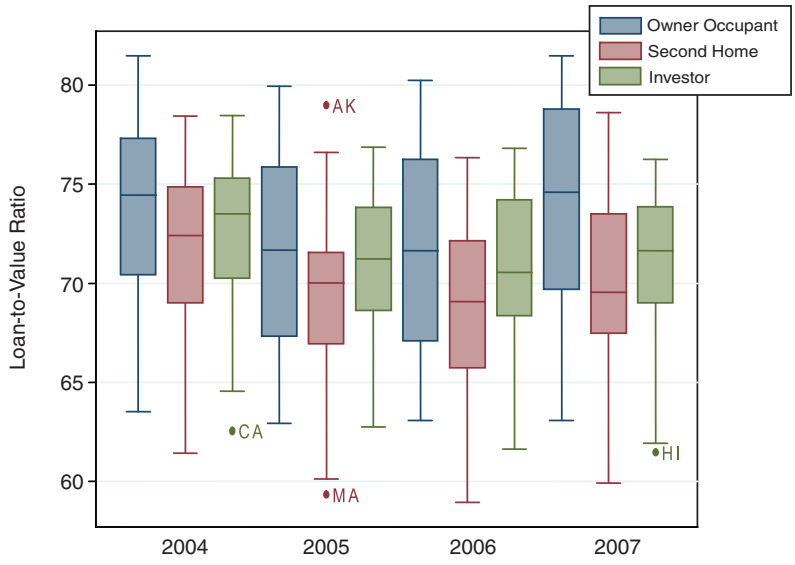


Notes: The data represent the mean FICO score for each state and the District of Columbia, segregated by occupancy. Loans that have a loan-to-value ratio that exceeds 400 are dropped from the sample.

homeowners would be less likely to exercise their default option when compared to investors. One possible explanation for this result is that investors may be less likely to initiate default when a "trigger event" occurs, like a loss of employment, because investors could use the investment property as a source of income to help cover expenses. A similar trigger event may lead to foreclosure for second homeowners given that they already have a primary residence and the non-monetary benefits from owning the second home may become less important under financial hardship. Another possible explanation for higher FICO scores for second homeowners is that it takes more financial resources to purchase an additional home primarily for enjoyment purposes. As a result, a stronger financial position would translate into a higher FICO score.

With respect to the loan-to-value ratio and debt-to-income ratio, homeowners, regardless of ownership status, will place a higher value on the foreclosure option if they hold less equity in their home or hold more overall

Figure 6 Distribution Across States for Loan-to-Value Ratios for Owner Occupant and Non-Owner Occupant Mortgage Borrowers, by Year of Origination (LPS)



Notes: Loan-to-value ratios here are computed as the original principal of the mortgage divided by the appraised value of the property. Loans that have a loan-to-value ratio that exceeds 400 are dropped from the sample.

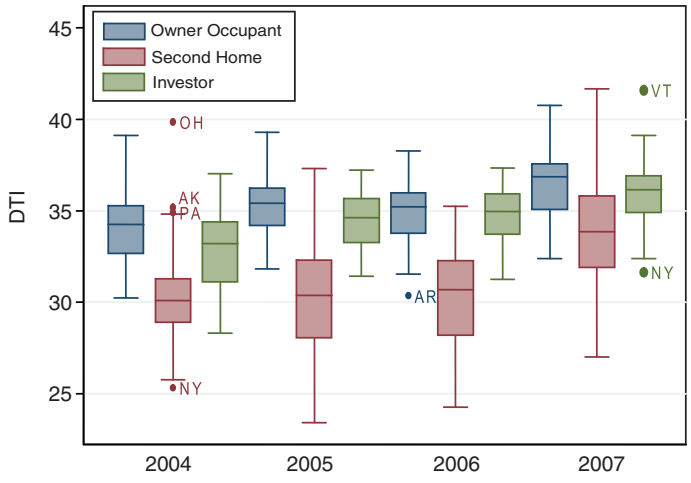
debt.[19,20] Figures 6 and 7 show that occupant owners on average have higher loan-to-value and debt-to-income ratios when compared to non-owner occupants. However, based on median score, the loan-to-value ratios do not exhibit that homeowners associated with any group were reaching in order to purchase a home.[21] Within the non-owner occupant group, investors consistently have

[19] Data for loan-to-value are derived at the time the loan is originated, but this value may have changed if the servicer has performed a post-origination appraisal on the property. As a result, an unknown percentage of the mortgages in the sample may have post-origination loan-to-value numbers.

[20] Von Furstenberg (1969) and Campbell and Dietrich (1983) find evidence that initial loan-to-value ratios alone are significant predictors of default.

[21] It is important to note that it is not possible to make a definitive statement about the financial capacity of borrowers without knowing additional financial information. For example, a homeowner could have a mortgage that includes a relatively high interest rate, yet still have a relatively low debt-to-income or loan-to-value ratio. In other words, the interest expense on outstanding debts could be an important factor in assessing financial capacity, but this information is not part of the calculation used to determine these numbers.

Figure 7 Distribution Across States for Debt-to-Income Ratios of Owner Occupant and Non-Owner Occupant Mortgage Borrowers, by Year of Origination (LPS)

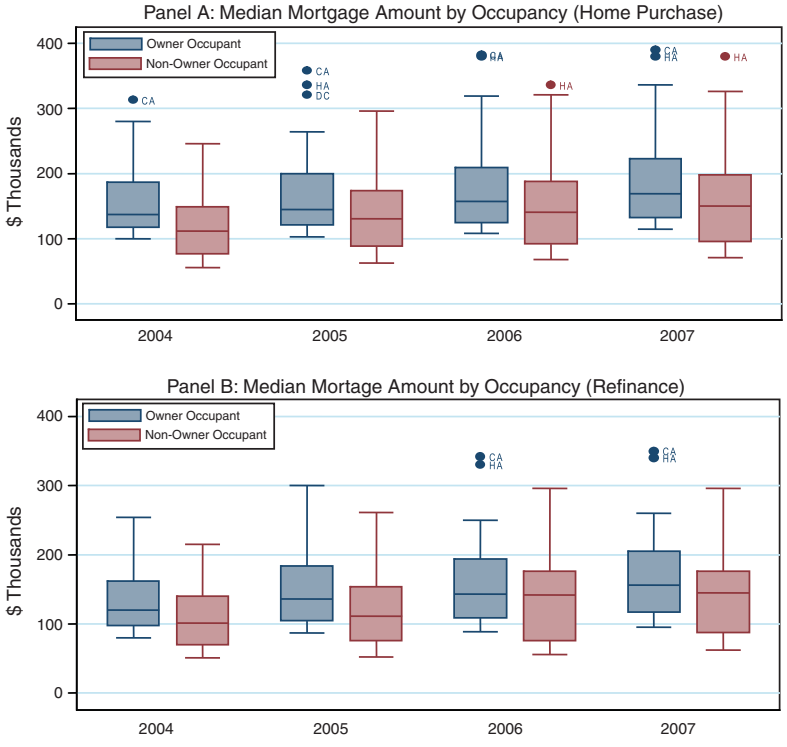


Notes: Loans that have a loan-to-value ratio that exceeds 400 are dropped from the sample.

a higher risk profile when compared to second homeowners. This result is surprising given that investors have higher risk characteristics and lower FICO scores when compared to second homeowners. As stated earlier, it is possible that underwriters view the potential income from an investment property as a mitigating risk factor in the underwriting decision.

In summary, the data for Figures 4–7 show that non-owner occupants have higher median incomes, higher FICO scores, and lower debt-to-income and loan-to-value ratios when compared to owner occupants. These measures are all consistent with non-owner occupants being held to a higher underwriting standard. Given the lower risk profile, it is possible that non-owner occupants would be able to access larger amounts of mortgage credit. However, lenders may restrict the size of loans that non-owner occupants can receive in an attempt to reduce their exposure to default. In Figure 8, I use HMDA data to compare the mortgage amount at the time of origination between owner and non-owner occupants. The data show that the median mortgage amount for non-owner occupants is smaller. In short, this result is consistent with our earlier findings that lenders use higher underwriting standards for non-owner occupants to help mitigate the increased probability of default associated with the higher value of the default option. It is interesting to note that just prior

Figure 8 Distribution Across States for the Median Loan Amount for Owner Occupants and Non-Owner Occupants, by Loan Purpose and Year of Origination (HMDA)



Notes: The data are median mortgage amounts for each state and the District of Columbia, segregated by occupancy. Each box covers the 25th to 75th percentile; the line in the box is the median.

to the housing crisis, a number of the risk measures mentioned above were remaining steady or declining.

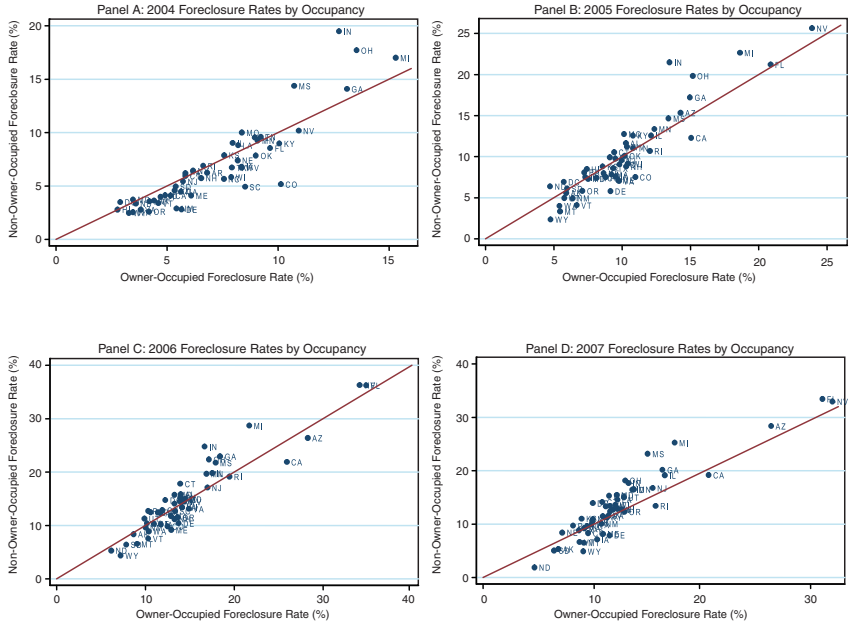
Foreclosures

As discussed above, I believe that non-owner occupants have a stronger financial incentive to exercise their foreclosure option when compared to owner occupants. However, it is difficult to predict if the foreclosure rate for non-owner occupants will be higher given that this group has stronger financial characteristics. It is possible to observe differences in foreclosure patterns

between owner and non-owner occupants using LPS data. In this study, a mortgage is considered in foreclosure if the mortgage defaults following origination. For example, mortgages originated in 2004 to non-owner occupants experience a foreclosure rate of 6.9 percent, which is slightly lower than the 7.5 percent foreclosure rate for owner occupants for the same origination year. As discussed earlier in the article, it would be expected that foreclosure rates for non-owner occupants would rise faster than for owner occupants as economic conditions deteriorate, causing the potential financial benefit from homeownership to decline. As expected, as the housing crisis started to unfold, foreclosure rates for both groups started to rise, but foreclosure rates grew faster for non-owner occupants. For example, in 2005, foreclosure rates for non-owner occupants exceeded those of owner occupants and remained higher throughout the sample period. For the years 2005–2007, foreclosure rates for non-owner occupants were 12.8 percent, 20.0 percent, and 17.4 percent, respectively. During the same years, the foreclosure rates for owner occupants were 12.3 percent, 18.7 percent, and 15.1 percent, respectively.

While the data show that foreclosure rates for non-owner occupants grew faster during the housing crisis, there has been little discussion regarding differences in housing market performance and ownership status at the state level. In an attempt to explore this relationship, Figure 9 plots the relative foreclosure rates for owner occupied and non-owner occupied mortgages generated by year of origination by state. The 45-degree line represents equality, where foreclosure rates for both owner occupants and non-owner occupants are the same. Consistent with the results presented above for the United States as a whole, most states lie near the 45-degree line, but there is a movement above the 45-degree line over time. In other words, for loans originated in 2004, more states experience higher foreclosure rates among mortgages originated to owner occupants. However, this relationship starts to change in 2005 as more states experience higher foreclosure rates among non-owner occupants. A few states that have not received much attention in the press experience relatively high foreclosure rates for non-owner occupants. Specifically, the symbols for Michigan, Indiana, and Ohio are well above the 45-degree line, which means that in these states non-owner occupants are distinctly more likely to be in foreclosure. The symbols for some of the Sunbelt states like California, Florida, and Nevada, which have been identified in the press for having high foreclosure rates, are shown to be near or below the 45-degree line in most years. In other words, foreclosure rates among owner and non-owner occupants are relatively the same in these states. Given that Florida and Nevada are destination states for vacation homeowners, it was somewhat surprising that the relative foreclosure rates for non-owner occupants were not higher.

Figure 9 A Cross-State Comparison of Foreclosure Rates on Non-Owner-Occupied and Owner-Occupied Mortgages, by Year or Origination



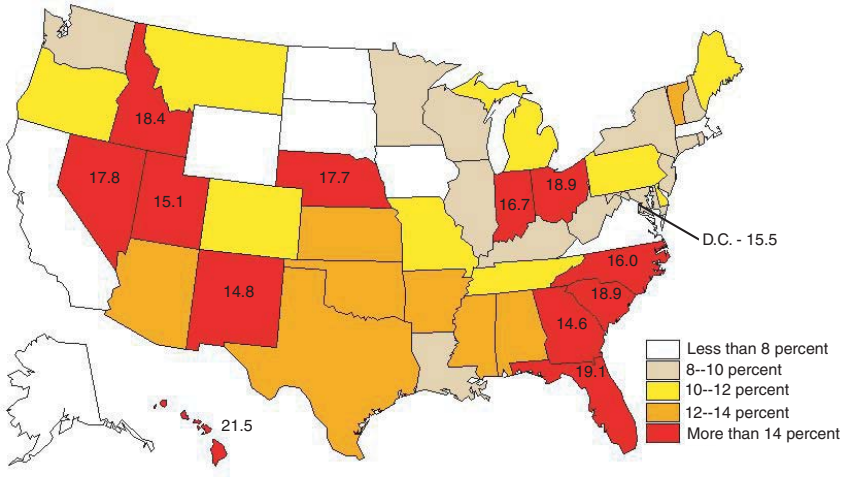
Notes: Home purchase and refinance originations from LPS.

The Spatial Pattern of Foreclosures

As noted earlier, foreclosure rates were trending higher for non-owner occupants nationally and at the state level prior to the housing crisis. However, the role non-owner occupants played in the housing crisis cannot be observed by simply studying foreclosure rates, for doing so would imply that the share of loans originated to owner occupants and non-owner occupants were the same. As a result, it is necessary to recognize that the share of mortgages originated to non-owner occupants varies across states and that this variation may play a role in determining the impact non-owner occupants had in the housing crisis.[22]

[22] Doms, Furlong, and Krainer (2007) find a strong relationship between the share of mortgages originated to investors and delinquency rates among subprime borrowers.

Figure 10 Share of Foreclosure that Involves Non-Owner-Occupied Properties (LPS Data for Mortgages Originated in 2006)



Cartographer: Michael Grover and Eli Popuch, February 2010.

Source: Breck Robinson, FRB Richmond, ESRI.

Figure 10 uses LPS data for mortgages originated in 2006 to show that the share of foreclosures varies significantly across states. For example, the share of foreclosures attributed to non-owner occupants in California is 7 percent. However, the share of foreclosures in Florida is 19 percent.

While the share of foreclosures among non-owner occupants is greater than the national average for a number of states, it would be inaccurate to characterize the role non-owner occupants played in the housing crisis in these states as problematic. For example, in states with relatively few foreclosures overall, the incidence of foreclosures on non-owner-occupied properties could be low in an absolute sense and yet account for a high share of the state's few foreclosures. Conversely, in states with many foreclosures, non-owner-occupied properties could account for a relatively low share of overall foreclosures and yet be much more common when compared to a state that has few foreclosures. This is not just a hypothetical issue. For example, in Figure

10 the share of foreclosures among non-owner occupants was roughly equal in Alabama and Arizona at 12 percent. However, foreclosure rates on mortgages originated in 2006 to owner occupants were about two-and-a-half times higher in Arizona as in Alabama. As a result, using the share of foreclosures among non-owner occupants to measure impact will understate the role non-owner occupants played in the housing crisis in Arizona and overstate their role in Alabama.

In response to the shortcomings discussed above when using a measure like the share of foreclosures to observe impact, a more comprehensive measure is needed that incorporates both the prevalence and performance of non-owner occupant mortgages. In order to observe the impact of foreclosures by non-owner occupants, impact is broken down into two components: prevalence and performance. I define the prevalence measure as the number of non-owner occupant mortgages divided by the total number of housing units by year of origination.[23] I could have used an alternative measure of prevalence, where the denominator is the total number of first lien home purchases plus refinanced mortgages in the same calendar year. Results in this "per mortgage" measure of prevalence for non-owner occupant mortgages are qualitatively similar to the "per housing unit" results. In the analysis, I use the "per housing unit" measure because it is not sensitive to year-to-year fluctuations associated with mortgage lending activity, as noted by Mayer and Pence (2008). The other component to the impact measure is performance. I define performance as the number of foreclosures on non-owner occupant mortgages divided by the total number of non-owner occupant mortgages by year of origination. The product of these two measures represents the number of foreclosures by non-owner occupant mortgages divided by the total number of housing units:

$$Impact = Prevalence \times Performance.$$

Using LPS data for home purchases and refinances, Table 1 provides information on prevalence and performance for mortgages originated for each year between 2004–2007. In 2004, for example, there are 472 mortgages originated to non-owner occupants for every 100,000 housing units in the United States. Of the mortgages originated to non-owner occupants in 2004, 6.9 percent were foreclosed or in foreclosure by July 2011. Taken together, the impact from non-owner occupant mortgages originated in 2004 implies that there were about 33 foreclosures on mortgages originated to non-owner occupants for every 100,000 housing units.

[23] Total housing units is defined as first liens on home purchase loans, including refinancings on single-family homes, excluding home improvement loans. The data on state housing units come from the American Community Surveys for the time period 2004–2007.

Table 1 Prevalence, Performance, and Foreclosure Impact of Non-Owner Occupant Mortgages in our LPS Data, 2004–2007

Year of Mortgage Origination	Performance	Prevalence	Impact
2004	6.9	472	32.6
2005	12.8	616	78.8
2006	20.0	558	94.2
2007	17.4	437	76.0
2004–2007	14.3	521	74.5

Notes: "Performance" refers to the percent of non-owner occupant mortgages foreclosed; "prevalence" refers to the number of non-owner occupant mortgages per 100,000 housing units; "impact" refers to the number of non-owner occupant mortgage foreclosures per 100,000 housing units.

Compared with 2004, the impact of foreclosures on non-owner occupants increased for loans originated in 2005 and 2006. This is partly due to the increased prevalence of non-owner-occupied mortgages (616 and 558 per 100,000 housing units, respectively) during this time period. In addition, the performance of mortgages to non-owner occupants declined sharply from 2004 to 2005 and 2005 to 2006. For example, the foreclosure rate increased roughly by 14 percentage points between 2004 and 2007. As a result, our overall measure of impact (non-owner occupant foreclosures per 100,000 housing units) rose to 78.8 in 2005 and then to 94.2 in 2006. The average number of foreclosures for the time period 2004–2007 is 74.5 foreclosures per 100,000 housing units.[24] The impact measure for non-owner occupant mortgages originated in 2007 is 76.0 per 100,000 housing units, which is slightly above the 2004–2007 national average. The lower number in 2007 is partly due to the start of the housing crisis, which reduced the prevalence of non-owner-occupied mortgages from 558 to 437 per 100,000 housing units.[25] Table 1 provides an overview of the impact of non-owner occupant foreclosures in 2004–2007.

Figure 11 shows how the prevalence, performance, and impact of non-occupant foreclosures varied across the United States for the years 2004–2007. In this figure, prevalence, performance, and impact are measured relative to national norms. This means that the point 1.0 on the horizontal axis stands for a level of prevalence equal to the 2004–2007 U.S. average for prevalence. Similarly, the point 1.0 on the vertical axis stands for a performance level equal to the 2004–2007 U.S. average for performance. The highest point on

[24] The full impact of non-owner-occupied mortgages may be higher than the numbers reported in this study, because the LPS data do not cover the entire mortgage market and may underestimate the share of mortgages originated to non-owner occupants.

[25] Another factor is that loans originated in 2007 had less time to enter foreclosure when compared to loans originated in earlier years.

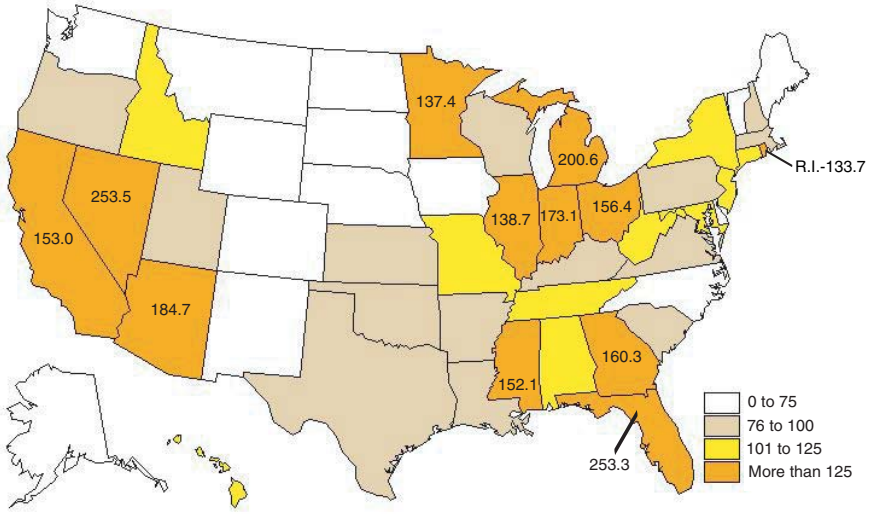
Figure 11 The Relative Impact (per Housing Unit) of Non-Owner Occupant Foreclosures for Mortgages Originated, by State

Notes: The middle line represents an impact factor that is equal to the LPS data 2004–2007 national average of 37.6 non-owner occupant foreclosures per 100,000 housing units. The lower and upper lines represent impact factors of half and three times the national average.

the vertical axis in Figure 11, Panel A is labeled IN for Indiana, and it has an x-axis value of about 0.64. This means that Indiana's prevalence measure in 2004 is about 0.64 times the corresponding prevalence measure for non-owner occupant mortgages for the United States over the period 2004–2007. On the y axis, the value for Indiana is about 1.4. This means that Indiana has a foreclosure rate for non-owner-occupied mortgages that is almost 1.4 times higher than the corresponding 2004–2007 U.S. average. The product of these two factors for Indiana is about .90. In other words, the degree of relative impact from foreclosures on non-occupants in Indiana was 10 percent lower than the corresponding national average.

Figure 11, Panel A also tells us something about why foreclosures on non-occupant mortgages originated in 2004 are relatively important in each state. Note that Indiana experienced an above-average impact from foreclosures on non-owner occupants because of performance issues. On the other extreme, Nevada experienced a relatively low foreclosure rate on mortgages to

Figure 12 Non-Owner-Occupied Mortgage Prevalence per Housing Unit, Relative to 2004–2007 U.S. National Average (LPS Data for Mortgages Originated in 2006)



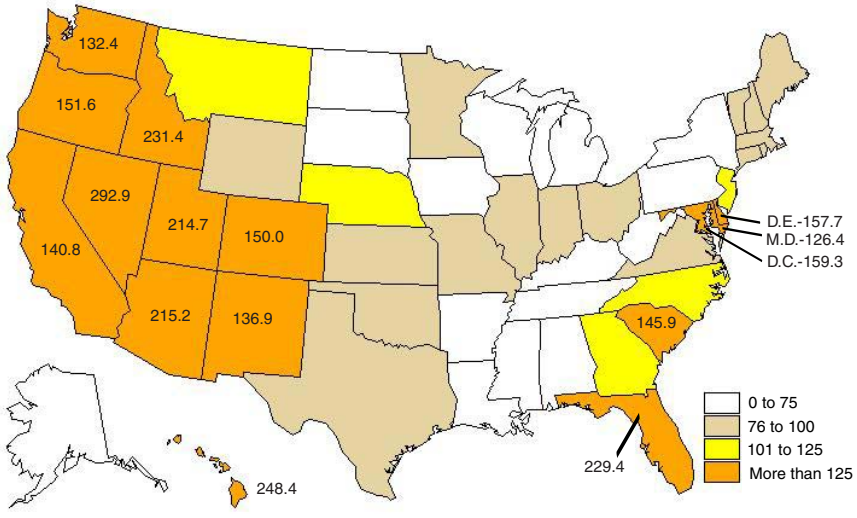
Cartographer: Michael Grover and Eli Popuch, February 2010.

Source: Breck Robinson, FRB Richmond, ESRI.

non-owner occupants, but had an above-average impact because mortgages to non-owner occupants were prevalent.

Figure 11, Panels B, C, and D present the same analysis but for mortgages originated to non-owner occupants for the years 2005, 2006, and 2007, respectively. From 2004–2005, the distribution of impact measures shift toward the Northeast, as the prevalence of non-owner occupant mortgages increases. At the same time, the average performance of mortgages in the sample started to deteriorate. In three states—Nevada, Florida, and Arizona—the impact of foreclosures to non-owner occupants reached or exceeded three times the 2004–2007 national average in 2005. This was driven by high prevalence in Arizona and a combination of high prevalence and poor performance in Nevada and Florida. For a cluster of Midwestern states (Indiana, Michigan, and Ohio),

Figure 13 Non-Owner-Occupied Mortgage Foreclosure Rate Relative to the 2004–2007 U.S. National Average (LPS Data for Mortgages in 2006)



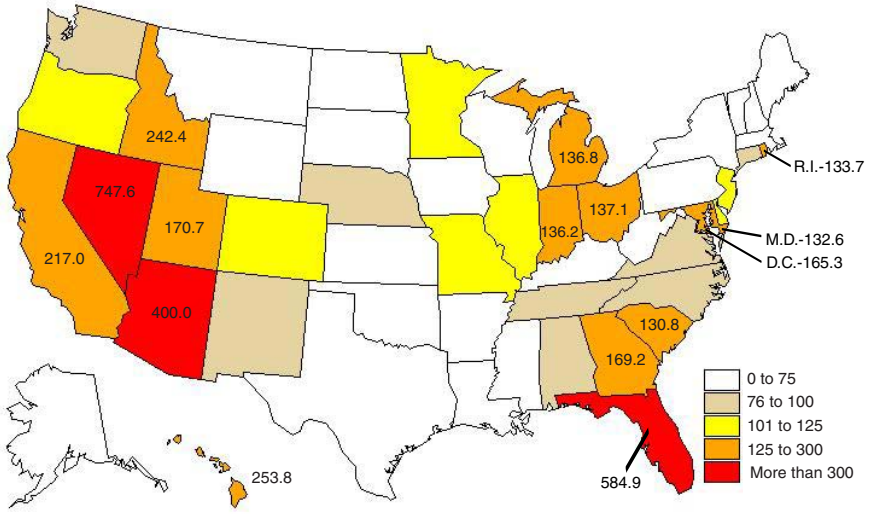
Cartographer: Michael Grover and Eli Popuch, February 2010.

Source: Breck Robinson, FRB Richmond, ESRI.

the foreclosure impact for 2005 reached or exceeded the 2004–2007 national average, even though mortgages to non-owner occupants were not especially prevalent. However, these states had above-average impact measures due to below-average performance of mortgages to non-owner occupants.

In 2006, both performance and prevalence of mortgages to non-owner occupants declined. Visually, this result is observable as a shift toward the Northwest in the distribution of impact measures. Several Midwestern states continued to experience very poor performance combined with relatively low prevalence. Deteriorating performance combined with high prevalence kept the impact numbers very high in Nevada, Florida, and Arizona. In the case of Hawaii, Idaho, Delaware, and Utah, high impact outcomes were driven by

Figure 14 Non-Owner-Occupied Mortgage Foreclosure Impact per Housing Unit, Relative to 2004–2007 U.S. National Average (LPS Data for Mortgages Originated in 2006)



Cartographer: Michael Grover and Eli Popuch, February 2010.

Source: Breck Robinson, FRB Richmond, ESRI.

high prevalence, while poor performance was a problem in states like Indiana, Michigan, and Ohio.

In most states, a combination of lower prevalence and better performance reduced the impact measures for mortgages originated in 2007. The reduction in impact measures is observable as a shift toward the Southwest in the distribution of impact ratios in Figure 11, Panel D. However, the impact measures for Arizona, Florida, and Nevada are still quite high when compared to the national average for the time period 2004–2007.

To provide a clearer view of the geographic patterns in foreclosure to non-owner occupants and its underlying factors, Figures 12, 13, and 14 use maps to show the prevalence, performance, and impact for mortgages originated in 2006 for all 50 states and the District of Columbia. Figure 13 shows that in

2006, non-owner occupant mortgages were relatively prevalent in the West (including Hawaii) and along the mid- to lower-East Coast states from Florida to New Jersey. Among the states that were identified as having a high prevalence of non-owner-occupied mortgages, only Arizona, California, Florida, Georgia, Maryland, Nevada, and New Jersey also experienced poor performance. In addition to these states, a number of states in the Midwest and parts of the Northeast experienced high foreclosure rates. In Figure 14, the impact ratios for Arizona, Florida, and Nevada are 400 percent, 585 percent, and 748 percent, respectively, above the national average. There are a number of states that have been highlighted in the press for having high foreclosure rates in general, like California, Georgia, Maryland, and parts of the Midwest. It is interesting to note that these same states were experiencing high impact ratios for non-owner occupant mortgages in 2006. Our map also shows that Idaho, South Carolina, and Utah were experiencing an above-average impact from foreclosures on mortgages to non-owner occupants. This result is surprising given that the press has not labeled any of these states as foreclosure hotspots.

4. CONCLUSION

During the housing crisis, it was unknown if mortgages to non-owner occupants helped exacerbate the housing crisis. It has been discussed that non-owner occupants are sensitive to changes in home prices because they are more likely to view homeownership as a financial asset, causing non-owner occupants to increase their demand for housing in areas where housing prices have increased or are expected to increase. As a result, non-owner occupants are more likely to exercise their option to default when compared to owner occupants. Subsequently, it would be expected that lenders would hold non-owner occupants to a higher underwriting standard in order to reduce their probability of default. The results show that non-owner occupants have higher incomes, higher credit scores, smaller loans, and generally a lower overall risk profile. If markets are operating correctly, higher underwriting standards for non-owner occupants should result in similar foreclosure rates relative to owner occupants, but differences in foreclosure rates should widen during an economic downturn when the financial benefits from homeownership decline. I observe this pattern in foreclosure rates when using national data.

In an attempt to observe the impact of foreclosures at the state level, an impact measure is decomposed to show the prevalence and performance of non-occupant mortgages. States that experienced the highest impact from foreclosures on properties owned by non-owner occupants (Arizona, Florida, and Nevada) exhibit both relatively poor performance and relatively high prevalence. However, a couple of states experienced an impact ratio that exceeded the national average mainly due to poor performance (i.e., Indiana, Michigan, and Ohio, and some other Midwestern and Northeastern states). By

contrast, Idaho and some other Western states had a high prevalence for mortgages originated to non-owner occupants, leading to a relatively high impact measure.

The housing crisis and the subsequent hardships faced by homeowners have been well chronicled in the press. All across the United States, homeowners have experienced declining home prices and high rates of foreclosure. This has led policymakers to initiate programs to stabilize home values by reducing foreclosures. However, policymakers have given little attention to the plight of non-owner occupants, even though the prevalence and performance of mortgages originated to this group has helped exacerbate high foreclosure rates in many states. The inability of previous programs to address the needs of all homeowners may have been a contributing factor regarding the size of the decline and the length of the housing crisis.

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On the Benefits of GDP-Indexed Government Debt: Lessons from a Model of Sovereign Defaults

Juan Carlos Hatchondo and Leonardo Martinez

Whether governments should issue GDP-indexed sovereign debt—that promise payments that are a function of the gross domestic product (GDP)—continues to be the subject of policy debates. On the one hand, several studies highlight possible benefits from tying sovereign debt obligations to domestic GDP.[1] One benefit from GDP-indexation is that issuing debt that promises lower payments when GDP takes low values may facilitate the financing of automatic stabilizers (such as an increase in unemployment benefits during economic downturns) and countercyclical fiscal policy. Another benefit is that GDP indexation could diminish the likelihood of fiscal crises for governments that face a countercyclical borrowing cost (in part because of a countercyclical default risk). Kamstra and Shiller (2010) argue that GDP indexation would help investors who want exposure to income growth (for instance, to protect relative standards of living in retirement) and protection against inflation.

On the other hand, there are several difficulties in the implementation of the basic idea described in the previous paragraph. First, GDP-indexed bonds may introduce moral hazard problems by weakening the government's incentives to implement growth-promoting policies (see, for instance, Krugman [1988]). Second, GDP may not be easily verifiable. This is in part because the

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[1] See, for instance, Shiller (1993), Borensztein and Mauro (2004), Borensztein et al. (2004), Griffith-Jones and Sharma (2005), and the references therein.

government could manipulate the GDP calculation (however, reporting lower GDP figures may imply a political cost). Moreover, even without manipulation, final GDP data are available with a significant lag.[2] This could force a government to make a high payment during a low GDP period because the previous year GDP was high (problems created by lags in GDP statistics could be mitigated by provisions on the government's accounts; see United Nations [2006]).[3] Third, gains from indexing sovereign debt to GDP may be limited because domestic GDP is not the only determinant of default risk and the government's borrowing cost (think, for instance, about contagion, shocks to the investors' risk aversion, political shocks, etc.; see Tomz and Wright [2007]). Perhaps because of the implementation difficulties described above, the majority of sovereign debt is not GDP indexed. However, past experiences show that issuing GDP-indexed debt is feasible. For instance, Argentina issued GDP warrants in 2005, during a period of renewed interest in these contracts (see United Nations [2006]). The 2012 debt restructuring in Greece also included the issuance of bonds carrying detachable GDP warrants.[4]

This article contributes to the debate on GDP-indexed sovereign debt by discussing the effects of using this debt contract. We study a model in which the government faces a countercyclical borrowing cost because of a countercyclical default risk. We use this model to discuss the effects of introducing GDP-indexed bonds.

We introduce income-indexed sovereign bonds into the equilibrium default model studied by Aguiar and Gopinath (2006) and Arellano (2008), who extend the framework proposed by Eaton and Gersovitz (1981) to analyze its quantitative performance. We study a small open economy that receives a stochastic endowment stream of a single tradable good. The government's objective is to maximize the expected utility of a representative private agent. Each period, the government makes two decisions. First, it decides whether to default on previously issued debt. Second, it decides how much to borrow or save. The cost of defaulting is given by an endowment loss and temporary exclusion from capital markets. We study two versions of this model. First, we assume that the government issues one-period bonds that promise a non-contingent payment. Second, we assume the government can issue a one-period income-indexed bond that promises a payment function of next-period

[2] For instance, payments for the GDP warrants issued by Argentina during its 2005 debt restructuring are made effective with a one-year lag.

[3] These problems could be addressed by indexing debt contracts to variables that are correlated to GDP and that the government cannot control (such as commodity prices or trading partners' growth rates; see Caballero [2002]).

[4] Other experiences with GDP indexation include various "Value Recovery Rights" indexed to GDP issued by Bosnia and Herzegovina, Bulgaria, Costa Rica, Nigeria, and Venezuela in the early 1990s as part of the Brady bonds restructuring (Sandleris, Sapriza, and Taddei 2011). For instance, Bulgaria issued, in 1994, bonds with a potential premium if Bulgaria's GDP exceeded 125 percent of its 1993 level.

income. In both cases, bonds are priced in a competitive market inhabited by risk-neutral investors.

We solve the model using the calibration in Arellano (2008), which is based on an economy facing significant default risk: Argentina before its 2001 default. The ex-ante welfare gain from the introduction of income-indexed bonds when there is no initial debt is equivalent to an increase of 0.5 percent of consumption. Introducing income-indexed bonds results in welfare gains because it allows the government to:

1. *Eliminate defaults.* In the model, debt and income are the only determinants of default. With income-indexed bonds, the government makes a different payment promise for each level of next-period income, which means that there is no uncertainty about whether a government promise will be paid. Then, lenders would never pay for a payment promise on which they know the government would default and a bond making such a promise is not traded. In contrast, with non-contingent bonds, when the government borrows it promises the same payment for all next-period income levels. The government defaults in the next period at income levels that are sufficiently low.

2. *Increase its indebtedness from 4 percent to 18 percent of mean income.* The government is assumed to be eager to borrow (it discounts future consumption at a rate higher than the risk-free interest rate). With indexed bonds, the government can bring forward resources from future high-income states without increasing the default probability in low-income states (the cost of defaulting is assumed to be lower in low-income states). In contrast, with non-contingent bonds, the future resources the government can bring forward are limited by default risk. If the government issued a non-contingent bond equivalent to 18 percent of mean income, for most current income levels the revenue it would collect from that debt issuance would be even smaller than the revenue it would collect from issuing debt equivalent to 4 percent of mean income. The reason is that lenders would internalize that, at a debt of 18 percent of mean income, there is a significant mass of income realization states at which the government would default, and lenders would thus offer to buy those bonds at a significant discount.

3. *Reduce the ratio of standard deviations of consumption relative to income from 1.07 to 0.79.* With income-indexed bonds, the government chooses to smooth consumption by buying claims that pay in states with lower income and borrowing against states with higher income. Furthermore, the borrowing cost is constant because the government does not pay a default premium. Thus, the government chooses to borrow more when income is lower. In contrast, with non-contingent bonds, the borrowing cost is countercyclical. In bad times, the cost

of defaulting is assumed to be lower and, therefore, the probability of default and the cost of borrowing are higher. Consequently, optimal borrowing becomes procyclical: In bad times, since the cost of borrowing is higher, the government chooses to finance more of its debt service obligations by lowering consumption instead of borrowing.[5]

It should be noted that our analysis does not consider the implementation difficulties of GDP-indexed bonds that we mentioned above: We assume that the government cannot affect GDP growth, that bond payments can be determined using current income, and that income is the only determinant of sovereign defaults. Thus, the gains from introducing GDP-indexed bonds measured in this article should be seen as an upper bound. Relaxing the simplifying assumptions that limit our analysis increases the dimensionality of the model's state space and thus augments the computation time required to solve the model. Relaxing these simplifying assumptions is the subject of our ongoing research but is beyond the scope of this article.

In spite of the interest in GDP-indexed bonds among policymakers, there are few formal studies of the effects of introducing these bonds. Athanasoulis and Shiller (2001) and Durdu (2009) also study the effects of GDP-indexed debt but in frameworks without endogenous borrowing constraints determined by default risk.

Chamon and Mauro (2006) study the effects of introducing GDP-indexed bonds using a debt sustainability framework, commonly used in policy institutions. Because of the low computation cost of solving this framework, Chamon and Mauro (2006) can study a set of debt instruments richer than the one we study in this article. However, a disadvantage of the sustainability framework is that the government's borrowing (the primary balance) is estimated using past data and is not the result of an optimization problem. Thus, the analysis assumes that the government's borrowing does not change when indexed bonds are introduced (in contrast with our findings). Furthermore, their debt sustainability framework does not allow default risk to affect the borrowing cost. The framework is also not suitable for the derivation of the optimal indexation. As we do, Chamon and Mauro (2006) find that indexation could reduce default risk.

Faria (2011); Sandleris, Sapriza, and Taddei (2011); and Hatchondo, Martinez, and Sosa Padilla (2012) study the effects of introducing GDP-indexed sovereign debt in an environment with equilibrium default risk. Comparing quantitative predictions of these studies is difficult because of differences in the parameterizations and the reported statistics. Faria (2011) and Sandleris, Sapriza, and Taddei (2011) present the effects of introducing

[5] This is consistent with evidence of procyclical fiscal policy in emerging economies (that pay a high and volatile interest rate), as documented by Gavin and Perotti (1997); Kaminsky, Reinhart, and Vegh (2004); Talvi and Vegh (2005); Ilzetzki and Vegh (2008); and Vegh and Vuletin (2011).

an income-indexation that is not chosen by the government and is constant over time. As in this article, Hatchondo, Martinez, and Sosa Padilla (2012) allow the government to choose how to index its debt to future income in each period. Hatchondo, Martinez, and Sosa Padilla (2012) compare the effects of introducing income indexation with the ones of introducing interest-rate indexation. The latter form of indexation is the main focus of that article.

The rest of the article proceeds as follows. Section 1 introduces the model. Section 2 discusses the parameterization. Section 3 presents the results. Section 4 concludes.

1. THE MODEL

There is a single tradable good. The economy receives a stochastic endowment stream of this good y_t, with

$$\log(y_t) = \log(A) + \rho \log(y_{t-1}) + \varepsilon_t,$$

with $|\rho| < 1$, and $\varepsilon_t \sim N\left(0, \sigma_\epsilon^2\right)$.

The government's objective is to maximize the present expected discounted value of future utility flows of the representative agent in the economy, namely

$$\mathbb{E}_t \left[\sum_{j=t}^{\infty} \beta^{j-t} u\left(c_j\right) \right], \tag{1}$$

where $\mathbb{E}$ denotes the expectation operator, β denotes the subjective discount factor, and the utility function is assumed to display a constant coefficient of relative risk aversion denoted by γ. That is,

$$u\left(c\right) = \begin{cases} \frac{c^{(1-\gamma)}-1}{1-\gamma} & \text{if } \gamma \neq 1, \\ log(c) & \text{if } \gamma = 1. \end{cases} \tag{2}$$

Each period, the government makes two decisions. First, it decides whether to default. Second, it chooses the number of bonds that it purchases or issues in the current period.[6]

There are two costs of defaulting (Hatchondo, Martinez, and Sapriza [2007a] discuss the costs of sovereign defaults). First, a defaulting sovereign is excluded from capital markets. In each period after the default period, the country regains access to capital markets with probability $\psi \in [0, 1]$.[7] Second, if a country has defaulted on its debt, it faces an income loss of $\phi\left(y\right)$

[6] Bianchi, Hatchondo, and Martinez (2012) study a sovereign default framework where the government can issue debt and accumulate assets simultaneously.

[7] Hatchondo, Martinez, and Sapriza (2007b) solve a baseline model of sovereign default with and without the exclusion cost and show that eliminating this cost affects significantly only the

units in every period in which it is excluded from capital markets. Following Arellano (2008), we assume that

$$\phi(y) = \begin{cases} y - \lambda & \text{if } y > \lambda \\ 0 & \text{if } y \leq \lambda. \end{cases} \tag{3}$$

With this income loss function, the default cost rises more than proportionately with income. This property of the income loss triggered by defaults helps the equilibrium default model to match the high sovereign spreads—defined as the difference between the sovereign bond yield and a risk-free interest rate—observed in the data (see, for instance, the discussion of the effects of the income loss function in Chatterjee and Eyigungor [forthcoming]). This is also a property of the income loss triggered by default in Mendoza and Yue (2012).[8]

We focus on Markov perfect equilibrium. That is, we assume that in each period, the government's equilibrium default and borrowing strategies depend only on payoff-relevant state variables. As discussed by Krusell and Smith (2003), there may be multiple Markov perfect equilibria in infinite-horizon economies. In order to avoid this problem, we solve for the equilibrium of the finite-horizon version of our economy, and we increase the number of periods of the finite-horizon economy until value functions for the first and second periods of this economy are sufficiently close. We then use the first-period equilibrium functions as the infinite-horizon-economy equilibrium functions.

Government bonds are priced in a competitive market. Lenders can borrow or lend at the risk-free rate r, are risk neutral, and have perfect information regarding the economy's income.

We study two versions of this model. First, we assume the government can issue non-contingent bonds. Each bond is a promise to deliver one unit of the good in the next period. Second, we assume the government can issue an indexed bond that promises a next-period payment that is a function of next-period income.

Recursive Formulation with Non-Contingent Bonds

Let b denote the government's current bond position, and b' denote its bond position at the beginning of the next period. A negative value of b implies that the government was a net issuer of bonds in the previous period. Let d denote

debt level generated by the model. Hatchondo, Martinez, and Sapriza (2009) argue that lower borrowing levels after a default could be explained by political turnover that triggered a default (see, also, Hatchondo and Martinez [2010] for a discussion of the interaction between political factors and default decisions).

[8] Mendoza and Yue (2012) introduce an endogenous channel through which defaults decrease output in the defaulting economy: They assume that when the government defaults, local firms lose access to foreign credit, which is necessary to finance the purchases of foreign inputs.

the current-period default decision. We assume that $d = 1$ if the government defaulted in the current period and $d = 0$ if it did not. Let V denote the government's value function at the beginning of a period, that is, before the default decision is made. Let V_0 denote the value function of a sovereign not in default. Let V_1 denote the value function of a sovereign in default. Let F denote the conditional cumulative distribution function of the next-period endowment y'. Let h and g denote the optimal default and borrowing rules followed by the government. The default rule h takes one of two values: 0 if the rule prescribes to pay back, and 1 if the rule prescribes to default.

The price of a bond equals the payment a lender expects to receive discounted at the risk-free rate. The bond price is given by the following functional equation:

$$q(b', y) = \frac{1}{1+r} \int \left[1 - h\left(b', y'\right)\right] F\left(dy' \mid y\right). \tag{4}$$

This bond price satisfies a lender's expected-zero-profit condition and is equal to the payment probability discounted by the risk-free interest rate. Recall a bond promises to pay one unit of the consumption good next period. Thus, the payment the holder of a bond will receive next period with the state $\left(b', y'\right)$ is given by $\left[1 - h\left(b', y'\right)\right]$.

For a given price function q, the government's value function V satisfies the following functional equation:

$$V(b, y) = \max_{d \in \{0,1\}} \{d V_1(y) + (1-d) V_0(b, y)\}, \tag{5}$$

where

$$V_1(y) = u(y - \phi(y)) + \beta \int \left[\psi V(0, y') + (1-\psi) V_1(y')\right] F\left(dy' \mid y\right), \tag{6}$$

$$V_0(b, y) = \max_{b'} \left\{u\left(y + b - q(b', y)b'\right) + \beta \int V(b', y') F\left(dy' \mid y\right)\right\}. \tag{7}$$

Definition 1 *A Markov perfect equilibrium is characterized by*

1. a set of value functions V, V_1, and V_0,
2. a default rule h and a borrowing rule g,
3. a bond price function q,

such that:

(a) given h and g, V, V_1, and V_0 satisfy functional equations (5), (6), and (7), when the government can trade bonds at the bond price function q;

(b) the bond price function q is given by equation (4); and

(c) the default rule h and borrowing rule g solve the dynamic programming problem defined by equations (5) and (7) when the price at which the government can trade bonds is given by the bond price function q.

Recursive Formulation with the Indexed Bond

With the income-indexed bond, the government can choose what to promise to pay next period for each realization of next-period income y' (payments can be negative). Let $\hat{b}'$ denote the payment function promised by the government. Let $\hat{g}$ and $\hat{h}$ denote the government's borrowing and default rules, respectively.

As in the previous subsection, a bond price is equal to the expected payment a lender will receive, discounted at the risk-free rate. For the indexed bond, this price is given by

$$\hat{q}(\hat{b}', y) = \frac{1}{1+r} \int \hat{b}'(y') \left[1 - \hat{h}(\hat{b}'(y'), y')\right] F\left(dy' \mid y\right). \tag{8}$$

Note that, with N possible income levels $\{y_1, y_2, ..., y_N\}$, we could think about the government choosing a portfolio of N defaultable Arrow-Debreu securities instead of the payments of an income-indexed bond. For all $i \in \{1, 2, ..., N\}$, security i promises to deliver one unit of the good in the next period if and only if $y' = y_i$. The price of each of these securities is equal to the expected payment the lender will receive. Let b_i denote the number of securities issued by the government promising to pay if and only if $y' = y_i$. Let $P_i(y)$ denote the probability of $y' = y_i$ given current income y. The price of a security promising to pay if and only if $y' = y_i$ is equal to the likelihood of $y' = y_i$ multiplied by the payment the lender would receive $\left(1 - \hat{h}(b_i, y_i)\right)$, and discounted at the risk-free rate:

$$\tilde{q}(b_i, y) = \frac{1}{1+r} \left[1 - \hat{h}(b_i, y_i)\right] P_i(y). \tag{9}$$

Without loss of generality, we assume that the government only promises payments $\hat{b}'(y')$ for which it would not choose to default. Since the government makes a different promise for each level of next-period income, and debt and income are the only determinants of default, there is no uncertainty about whether a government promise will be paid. Note that, for any payment $\hat{b}'(y')$ on which the government would choose to default ($\hat{h}(\hat{b}'(y'), y') = 1$), the contribution of $\hat{b}'(y')$ to the bond price in equation (8) is equal to zero. Then, the government cannot gain from promising a payment $\hat{b}'(y')$ on which it would

choose to default.[9] In contrast, without income indexation, the government may issue a bond promising a payment on which it will default next period in some states (y') but not in other states. Since the government may pay next period, lenders are willing to pay for a defaultable bond.

Let W_1 denote the value function of a government in default. Since a defaulting government does not pay its debt, W_1 is not a function of the debt level.

Let W_0 denote the value function of a government not in default. When the government pays it debt, its expected utility is a decreasing function of its debt level.[10]

Since W_0 is decreasing with respect to the government's debt level and W_1 is not a function of the government debt level, for any income level y, there exists a debt level $B(y)$ such that the government defaults if and only if its debt level is higher than $-B(y)$. This debt threshold satisfies $W_0(B(y), y) = W_1(y)$, where

$$W_0(b, y) = \max_{\hat{b}'} \left\{ u(c) + \beta \int W_0(\hat{b}'(y'), y') F\left(dy' \mid y\right) \right\} \tag{10}$$

$$s.t. \quad c = y + b - \frac{1}{1+r} \int \hat{b}'(y') F\left(dy' \mid y\right), \tag{11}$$

$$\hat{b}'(y') \geq B(y') \text{ for all } y', \tag{12}$$

and

$$W_1(y) = u(y - \phi(y)) + \beta \int \left[\psi W_0(0, y') + (1 - \psi) W_1(y')\right] F\left(dy' \mid y\right). \tag{13}$$

One way of thinking about the government's lack of commitment to its future default decisions is to suppose that, each period, decisions are made by a different government, and that the current government has no control over future governments' decisions. For instance, the borrowing constraint in equation (12) is exogenous to the current government because $B(y')$ is determined by the next-period government's default decision and the current government cannot control that decision.

The borrowing constraint in equation (12) is the only difference between the economy with indexed bonds and an Arrow-Debreu economy. A binding borrowing constraint would be the source of inefficiency in the indexed-debt economy.

Definition 2 *A Markov perfect equilibrium is characterized by*

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[9] Equivalently, with Arrow-Debreu securities, if the government chooses a b_i for which it would choose to default next period ($\hat{h}(b_i, y_i) = 1$), lenders would not pay for b_i ($\tilde{q}(b_i, y) = 0$).

[10] This is also a property of V_0. Chatterjee et al. (2007) provide a formal characterization of equilibrium functions in a default model.

1. a set of value functions W_0 and W_1,

2. a borrowing rule $\hat{g}$,

3. debt thresholds $B(y')$,

such that:

(a) given the borrowing rule $\hat{g}$ and debt thresholds $B(y')$, W_0 and W_1 satisfy functional equations (10) and (13);

(b) given debt thresholds $B(y')$, the borrowing rule $\hat{g}$ solves the dynamic programming problem defined by equation (10); and

(c) $B(y)$ satisfies $W_0(B(y), y) = W_1(y)$.

2. PARAMETERIZATION

We solve the model for the parameterization presented by Arellano (2008). This parameterization was chosen to mimic some moments of the Argentinean economy: properties of the GDP time series and the standard deviation of the trade balance from 1993–2001, an average debt service-to-GDP of 5.53 percent between 1980 and 2001, and a default frequency of 3 defaults per 100 years chosen after counting 3 defaults in the last 100 years for Argentina. Each period corresponds to a quarter. Table 1 presents the parameter values.

The parameterization studied by Arellano (2008) is a common reference for quantitative studies of sovereign defaults. However, some important limitations of this parameterization have been documented in the literature. A model with one-period bonds targeting the average debt service-to-GDP ratio results in debt levels that are too low compare to the data (Hatchondo and Martinez [2009]; Arellano and Ramanarayanan [2012]; Hatchondo, Martinez, and Roch [2012]; and Chatterjee and Eyigungor [forthcoming] study frameworks with long-term debt). Targeting a default frequency of 3 defaults per 100 years implies that the model generates sovereign spreads that are lower than the ones observed in Argentina before its 2001 default. This occurs in part because the model assumes risk-neutral lenders (Lizarazo [2006], Arellano [2008], and Borri and Verdelhan [2009] present models with risk-averse lenders).

We solve the models numerically using value function iteration. We find two value functions: one for a government not in default, and one for a government in default (i.e., V_0 and V_1, or W_0 and W_1). We discretize endowment levels and we use spline interpolation for asset positions. The stochastic process for the endowment is discretized using Tauchen (1986) on a uniformly distributed grid of endowment realizations. We center points around the mean

Table 1 Parameter Values

Sovereign's Risk Aversion	γ	2
Interest Rate	r	0.017
Income Autocorrelation Coefficient	ρ	0.945
Standard Deviation of Innovations	σ_ϵ	0.025
Income Scale	A	10
Exclusion Length	ψ	0.282
Discount Factor	β	0.953
Default Cost	λ	0.969 $E(y)$

and we use a width of three standard deviations. We use 200 endowment grid points.[11]

3. RESULTS

Table 2 reports moments in the simulations of the models with non-contingent and indexed bonds. Statistics correspond to the mean of the value of each moment in 500 simulation samples. Each sample consists of 32 periods before a default episode. The simulations in the economy with state-contingent claims are computed using the same 500 samples of 32 periods that were used to compute the simulations in the benchmark economy. The interest rate spread (r_s) is expressed in annual terms. The trade balance (income minus consumption) is expressed as a fraction of income ($tb = \frac{y-c}{y}$). The logarithm of income and consumption are denoted by $\tilde{y}$ and $\tilde{c}$, respectively. The standard deviation of x is denoted by $\sigma(x)$ and is reported in percentage terms. The coefficient of correlation between x and z is denoted by $\rho(x, z)$. Moments are computed using detrended series. Trends are computed using the Hodrick-Prescott filter with a smoothing parameter of 1,600.

Table 2 shows that the income-indexed bond allows the government to avoid defaults. With non-contingent bonds, the government, when it borrows, promises payments for which it would choose to default if next-period income is low. In contrast, with income-indexed bonds the government cannot gain from promising a payment for which it would choose to default.

Table 2 also shows that income-indexed bonds allow the government to increase its mean level of indebtedness from 4 percent to 18 percent of mean income. With non-contingent bonds, if the government were to promise to pay 18 percent of mean income, the probability of default would be very high and the government would have to pay a very high interest rate to compensate

[11] We do not find significant differences in the welfare gains from introducing indexed debt when we use 100 grid points instead (Hatchondo, Martinez, and Sapriza [2010] discuss the sensitivity of a default model's predictions to changes in the grid specification).

Table 2 Simulation Statistics

	Non-Contingent Bonds	Indexed Bonds
$\sigma(\tilde{y})$	5.58	5.58
Defaults per 100 Years	2.82	0.00
$E(r_s)$	3.24	0.00
$\sigma(r_s)$	2.92	0.00
Mean Debt (% of Mean Income)	3.94	17.89
$\sigma(\tilde{c})/\sigma(\tilde{y})$	1.07	0.79
$\sigma(tb)$	1.13	1.81
$\rho(tb, \tilde{y})$	−0.24	0.69
$\rho(r_s, \tilde{y})$	−0.36	0.00
$\rho(\tilde{c}, \tilde{y})$	0.98	0.96

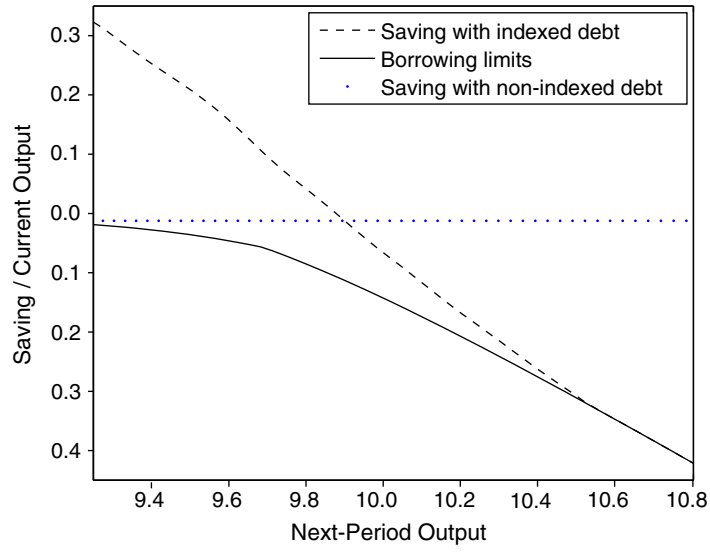
lenders for default risk. That interest rate would be high enough to deter the government from choosing such high debt levels. In contrast, with indexed bonds, the government can promise to pay more when next-period income is higher, which implies a higher cost of defaulting (see equation (3)). That is, with indexed bonds, the government can bring to the present resources from future high-income states without increasing the probability of default in low-income states. Figure 1 illustrates how this is in fact what the government chooses to do.[12] Recall that in the model the government is eager to borrow because it discounts future consumption at a rate higher than the risk-free interest rate.

In addition, Table 2 shows that income-indexed bonds allow the government to reduce the ratio of standard deviations of consumption relative to income from 1.07 to 0.79. A mirror result is that the trade balance is procyclical with income-indexed bonds and countercyclical with non-contingent bonds. To account for this result, note first that income-indexed bonds allow the government to smooth consumption by buying claims that pay in states with lower next-period income and borrowing against states with higher next-period income (see Figure 1).

Furthermore, as shown in Table 2, the spread is countercyclical in the economy with non-contingent bonds. In bad times, the cost of defaulting is lower (see equation (3)) and, therefore, the probability of default and the cost of borrowing are higher. Consequently, optimal borrowing becomes procyclical: In bad times, since the cost of borrowing is higher, the government chooses to finance more of its debt service obligations by lowering consumption instead of borrowing. In contrast, with indexed bonds, the cost of borrowing is constant and thus the government chooses to borrow more when income is lower.

[12] The figure also shows that the indexed-debt borrowing limit binds for sufficiently high next-period income. Furthermore, the figure shows that with non-contingent debt, the government only issues debt with a face value of 1.2 percent of current income.

Figure 1 Borrowing Decisions in a State with Zero Debt and Income Equal to its Unconditional Mean



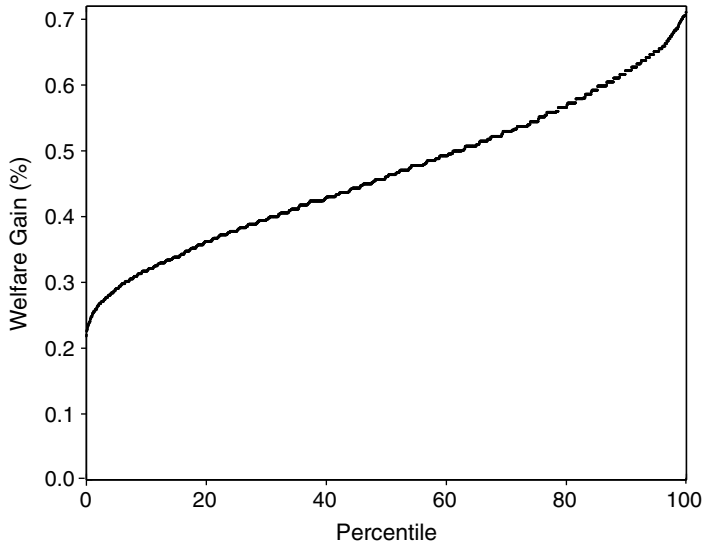
Notes: The dashed line represents the demand for claims contingent on next-period income chosen by the government. The solid line represents the thresholds at which the government will be indifferent between defaulting and not defaulting in the next period. The dotted line represents the saving decision in the economy with non-indexed debt.

Figure 2 presents the distribution of welfare gains from implementing indexed bonds. We compute this distribution using all combinations of income and debt levels in the simulations with non-contingent bonds, for periods with access to capital markets. For each combination of debt and income, we measure welfare gains as the constant proportional change in consumption that would leave a consumer indifferent between living in the economy with non-contingent debt and in the economy with income-indexed bonds. This consumption change is given by

$$\left(\frac{W_0(b, y)}{V_0(b, y)}\right)^{\left(\frac{1}{1-\gamma}\right)} - 1,$$

and can be easily derived from equations (1) and (2). A positive value means that agents prefer the economy with income-indexed bonds. For instance, the figure shows that for 50 percent of the combinations of income and debt levels we consider, welfare gains are higher than 0.45 percent.

Figure 2 Distribution of Consumption Compensation that Makes Domestic Agents Indifferent between Living in the Economy with Non-Contingent Debt and the Economy with Income-Indexed Bonds

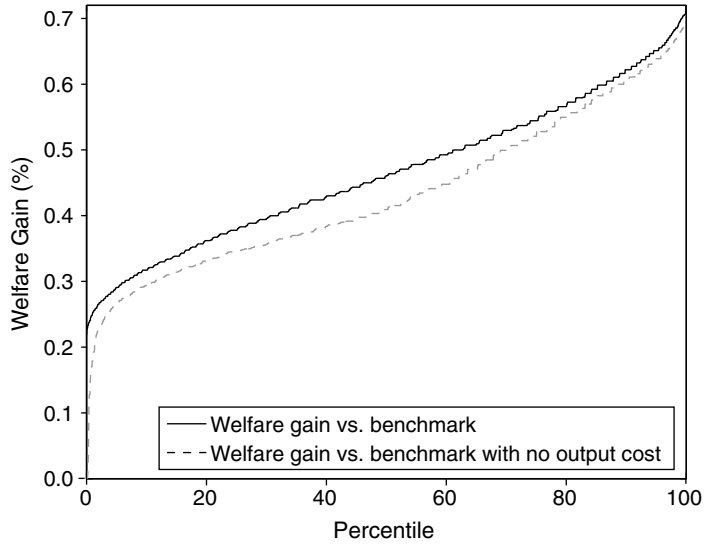


Notes: The distribution (in percentage terms) is computed using the distribution of income and debt levels observed in the economy with non-contingent bonds in periods with market access. For instance, the graph shows that, for half of the combinations of income and debt levels observed in the simulations, the welfare gain is no larger than 0.45 percent.

Figure 2 shows that, for all combination of income and debt levels we consider, the welfare gain from introducing indexed bonds is positive. On average, this gain is equivalent to an increase of 0.46 percent of consumption.

Figure 3 depicts the distribution of welfare gains computed comparing the economy with indexed debt with a hypothetical economy in which there are no income losses triggered by defaults but in which the government follows the saving and default rules of the benchmark economy with non-contingent debt. The figure indicates that income losses triggered by defaults play a relatively small role in accounting for the welfare gains from introducing indexed debt. Most welfare gains from intruding indexed debt come from the relaxation of the government's borrowing constraint: Indexed debt allows the government to borrow more and smooth consumption. The small role of income losses triggered by defaults is not surprising since defaults are infrequent and occur in periods where income losses are small (see equation (3)).

Figure 3 Distribution of Consumption Compensation that Makes Domestic Agents Indifferent between Living in Each of Two Economies with Non-Contingent Debt and the Economy with Income-Indexed Bonds



Notes: The first economy with non-contingent debt is our benchmark economy (welfare gains are represented with a dark line). The second economy with non-contingent debt is a hypothetical economy in which there are no income losses triggered by defaults, but the government follows the saving and default rules of the benchmark economy with non-contingent debt (welfare gains are represented with a gray line).

4. CONCLUSIONS

We introduced income-indexed bonds into a standard sovereign default model and illustrated how a government may benefit from using these bonds instead of non-contingent bonds. Income-indexed bonds allow the government to avoid costly default episodes, increase its level of indebtedness, and improve consumption smoothing.

There are difficulties from issuing income-indexed bonds that are not present in our setup. First, we do not consider difficulties that may arise in the verifiability of the state on which the debt contracts are written. Second, there may be other shocks that could affect the willingness to repay. Third, we circumvent moral hazard problems that could be created by the introduction of GDP-indexed bonds. Expanding our analysis would enhance the

understanding of the effects of introducing indexed sovereign bonds and is the subject of our ongoing research.

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