Stanley Fischer: Reflections on macroeconomics then and now

Speech by Mr Stanley Fischer, Vice Chair of the Board of Governors of the Federal Reserve System, at the "Policy Challenges in an Interconnected World" 32nd Annual National Association for Business Economics Economic Policy Conference, Washington DC, 7 March 2016.

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The chart can be found at the Board of Governors of Federal Reserve System's website

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I am grateful to the National Association for Business Economics (NABE) for conferring the fourth annual NABE Paul A. Volcker Lifetime Achievement Award for Economic Policy on me, thereby allowing me the honor of following in the footsteps of Paul Volcker, Jean-Claude Trichet, and Alice Rivlin. The honor of receiving the award is enhanced by its bearing the name of Paul Volcker, a model citizen and public servant, and a giant in every sense among central bankers.

One thinks of many things on an occasion such as this one. My mind goes back first to growing up in a very small town in Zambia, then Northern Rhodesia, and to the surprise and delight my parents would have felt at seeing me standing where I am now. They would have been even more delighted that my girlfriend, Rhoda, whom I met when my parents moved to a bigger town in Zimbabwe, and I have been happily married for 50 years. But that is not the story I will tell today. Rather, I want to talk about our field, macroeconomics, and some of the lessons we have learned in the course of the last 55 years – and I say 55 years, because in 1961, at the end of my school years, on the advice of a friend, I read Keynes's *General Theory* for the first time.

Did I understand it? Certainly not. Was I captivated by it? Certainly, though "captured" is a more appropriate word than "captivated." Does it remain relevant? Certainly. Just a week ago I took it off the bookshelf to read parts of chapter 23, "Notes on Mercantilism, the Usury Laws, Stamped Money and Theories of Under-Consumption." Today that chapter would be headed "Protectionism, the Zero Lower Bound, and Secular Stagnation," with the importance of usury laws having diminished since 1936.

There is an old joke about our field – not the one about the one-handed economist, nor the one about "assume you have a can opener," nor the one that ends, "If I were you, I wouldn't start from here." Rather it's the one about the Ph.D. economist who returns to his university for his class's 50th reunion. He asks if he can see the most recent Ph.D. generals exam. After a while it is brought to him. He reads it carefully, looking perplexed, and then says, "But this is exactly the same as the exam I wrote over 50 years ago." "Ah yes," says the professor. "It is the same, but all the answers are different."

Is that really the case? Not really, though it is true to some extent in the realm of policy. To discuss the question of whether the answers to the questions of how to deal with macroeconomic policy problems have changed markedly over the past half-century or so, I will start by briefly sketching the structure of a basic macro model. The building blocks of this model are similar to those used in many macro models, including FRB/US, the Fed staff's large-scale model, and a variety of DSGE (dynamic stochastic general equilibrium) models used at the Fed and other central banks and by academic researchers.

The structure of the model starts with the standard textbook equation for aggregate demand for domestically produced goods, namely:[1]

1. $AD = C + I + G + NX$;
2. Next is the wage-price block, which is based on a wage or price Phillips curve. Okun's law is included to make the transition between output and employment;
3. Monetary policy is described by a money supply or interest rate rule;
4. The credit markets and financial intermediation are built off links between the policy interest rate and the rates of return on, and/or demand and supply functions for, other assets;
5. The balance of payments and the exchange rate enter through the balance of payments identity, namely that the current account surplus must be equal to the capital account deficit, corrected for official intervention;
6. Dynamics of stocks: There are dynamic equations for the capital stock, the stock of government debt, and the external debt.

When I was an undergraduate at the London School of Economics (LSE) between 1962 and 1965, we learned the IS-LM model, which combined the aggregate demand equation (1) with the money market equilibrium condition set out in (3). That was the basic understanding of the Keynesian model as crystallized by John Hicks, Franco Modigliani, and others, in which it was easy to add detail to the demand functions for private-sector consumption, C; for investment, I; for government spending, G; and for net exports. The Keynesian emphasis on aggregate demand and its determinants is one of the basic innovations of the Keynesian revolution, and one that makes it far easier to understand and explain what factors are determining output and employment.

Continuing down the list, on price and wage dynamics, the Phillips curve has flattened somewhat since the 1950s and 1960s.[2] Further, the role of expectations of inflation in the Phillips curve has been developed far beyond what was understood when A.W. Phillips – who was a New Zealander, an LSE faculty member, and a statistician and former engineer – discovered what later became the Phillips curve. The difference between the short- and long-run Phillips curves, which is now a staple of textbooks, was developed by Milton Friedman and Edmund Phelps, and the effect of making expectations rational or model consistent was emphasized by Robert Lucas, whose islands model provided an imperfect information reason for a nonvertical short-run Phillips curve. In Okun's law, the Okun coefficient – the coefficient specifying how much a change in the unemployment rate affects output – appears to have declined over time. So has the trend rate of productivity growth, which is a critical determinant of future levels of per capita income.

In (3), the monetary equilibrium condition, the monetary policy decision was typically represented by the money stock at the LSE and perhaps also at the Massachusetts Institute of Technology (MIT) after the Keynesian revolution (after all, "L" represents the liquidity preference function and "M" the supply of money); now the money supply rule is replaced by an interest-rate setting rule, for instance a reaction function of some form, or by a calculated "optimal" policy based on a loss function.

The development of the flexible inflation-targeting approach to monetary policy is one of the major achievements of modern macroeconomics. Flexible inflation targeting allows for flexibility in the speed with which the monetary authority plans on returning to the target inflation rate, and is thereby close to the dual mandate that the law assigns to the Fed.

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[1] A fuller description of the equations is contained in the appendix.

[2] See Blanchard (2016).

A great deal of progress has been made in developing the credit and financial intermediation block. As early as the 1960s, each of James Tobin, Milton Friedman, and Karl Brunner and Alan Meltzer wrote out models with more fully explicated financial sectors, based on demand functions for assets other than money. Later the demand functions were often replaced by pricing equations derived from the capital asset pricing model. Researchers at the Fed have been bold enough to add estimated term and risk premiums to the determination of the returns on some assets.[3] They have concluded, inter alia, that the arguments we used to make about how easy it would be to measure expected inflation if the government would introduce inflation-indexed bonds failed to take into account that returns on bonds are affected by liquidity and risk premiums. This means that one of the major benefits that were expected from the introduction of inflation-indexed bonds (Treasury Inflation-Protected Securities, generally called TIPS), namely that they would provide a quick and reliable measure of inflation expectations, has not been borne out, and that we still have to struggle to get reasonable estimates of expected inflation.

As students, we included NX, net exports, in the aggregate demand equation, but we did not generally solve for the exchange rate, possibly because the exchange rate was typically fixed. Later, in 1976, Rudi Dornbusch inaugurated modern international macroeconomics – and here I'm quoting from a speech by Ken Rogoff – in his famous overshooting model.[4] As globalization of both goods and asset markets intensified over the next 40 years, the international aspects of trade in goods and assets occupied an increasingly important role in the economies of virtually all countries, not least the United States, and in macroeconomics.

At the LSE, we took a course on the British economy from Frank Paish, whose lectures consisted of a series of charts, accompanied by narrative from the professor. He made a strong impression on me in a lecture in 1963, in which he said, "You see, it (the balance of payments deficit) goes up and it goes down, and it is clear that we are moving toward a balance of payments crisis in 1964." I waited and I watched, and the crisis appeared on schedule, as predicted. But Paish also warned us that forecasting was difficult, and gave us the advice "Never look back at your forecasts – you may lose your nerve." I pass that wisdom on to those of you who need it.

I remember also my excitement at being told by a friend in a more senior class about the existence of econometric models of the entire economy. It was a wonderful moment. I understood that economic policy would from then on be easy: All that was necessary was to feed the data into the model and work out at what level to set the policy parameters. Unfortunately, it hasn't worked out that way. On the use of econometric models, I think often of something Paul Samuelson once said: "I'd rather have Bob Solow's views than the predictions of a model. But I'd rather have Solow with a model than without one."

We learned a lot at the LSE. But wonderful as it was to be in London, and to meet people from all over the world for the first time, and to be able to travel to Europe and even to the Soviet Union with a student group, and to ski for the first time in my life in Austria, it gradually became clear to me that the center of the academic economics profession was not in London or Oxford or Cambridge, but in the United States.

There was then the delicate business of applying to graduate school. There was a strong Chicago tendency among many of the lecturers at the LSE, but I wanted to go to MIT. When asked why, I gave a simple answer: "Samuelson and Solow." Fortunately, I got into MIT and had the opportunity of getting to know Samuelson and Solow and other great professors. And I also met the many outstanding students who were there at the time, among them Robert Merton. I took courses from Samuelson and Solow and other MIT stars, and I wrote my thesis

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[3] See D'Amico, Kim, and Wei (2014).

[4] See Dornbusch (1976) and Rogoff (2001).

under the guidance of Paul Samuelson and Frank Fisher. From there, my first job was at the University of Chicago – and I understood that I was very lucky to have been able to learn from the great economists at both MIT and Chicago. Among the many things I learned at Chicago was a Milton Friedman saying: "Man may not be rational, but he's a great rationalizer," which is a quote that often comes to mind when listening to stock market analysts.

After four years at Chicago, I returned to the MIT Department of Economics, and thought that I would never leave – even more so when MIT succeeded in persuading Rudi Dornbusch, whom I had met when he was a student at Chicago, to move to MIT – thus giving him too the benefit of having learned his economics at both Chicago and MIT, and giving MIT the pleasure and benefit of having added a superb economist and human being to the collection of such people already present.

MIT was still heavily involved in developing growth theory at the time I was a Ph.D. student there, from 1966 to 1969. We students were made aware of Kaldor's stylized facts about the process of growth, presented in his 1957 article "A Model of Economic Growth." They were:

1. The shares of national income received by labor and capital are roughly constant over long periods of time.
2. The rate of growth of the capital stock per worker is roughly constant over long periods of time.
3. The rate of growth of output per worker is roughly constant over long periods of time.
4. The capital/output ratio is roughly constant over long periods of time.
5. The rate of return on investment is roughly constant over long periods of time.
6. The real wage grows over time.

Well, that was then, and many of the problems we face in our economy now relate to the changes in the stylized facts about the behavior of the economy: Every one of Kaldor's stylized facts is no longer true, and unfortunately the changes are mostly in a direction that complicates the formulation of economic policy.[5]

While the basic approach outlined so far remains valid, and can be used to address many macroeconomic policy issues, I would like briefly to take up several topics in more detail. Some of them are issues that have remained central to the macroeconomic agenda over the past 50 years, some have to my regret fallen off the agenda, and others are new to the agenda.

1. **Inflation and unemployment**: Estimated Phillips curves appear to be flatter than they were estimated to be many years ago – in terms of the textbooks, Phillips curves appear to be closer to what used to be called the Keynesian case (flat Phillips curve) than to the classical case (vertical Phillips curve). Since the U.S. economy is now below our 2 percent inflation target, and since unemployment is in the vicinity of full employment, it is sometimes argued that the link between unemployment and inflation must have been broken. I don't believe that. Rather the link has never been very strong, but it exists, and we may well at present be seeing the first stirrings of an increase in the inflation rate – something that we would like to happen.
2. **Productivity and growth**: The rate of productivity growth in the United States and in much of the world has fallen dramatically in the past 20 years. The table shows calculated rates of annual productivity growth for the United States over three periods: 1952 to 1973; 1974 to 2007; and the most recent period, 2008 to 2015. After having been 3 percent and 2.1 percent in the first two periods, the annual rate of productivity

[5] See Jones and Romer (2010).

growth has fallen to 1.2 percent in the period since the start of the global financial crisis.

The right guide to thinking in this case is given by a famous Herbert Stein line: "The difference between a growth rate of 1 percent and 2 percent is 100 percent." Why? Productivity growth is a major determinant of long-term growth. At a 1 percent growth rate, it takes income 70 years to double. At a 2 percent growth rate, it takes 35 years to double. That is to say, that with a growth rate of 1 percent per capita, it takes two generations for per capita income to double; at a 2 percent per capita growth rate, it takes one generation for per capita income to double. That is a massive difference, one that would very likely have severe consequences for the national mood, and possibly for economic policy. That is to say, there are few issues more important for the future of our economy, and those of every other country, than the rate of productivity growth.

At this stage, we simply do not know what will happen to productivity growth. Robert Gordon of Northwestern University has just published an extremely interesting and pessimistic book that argues we will have to accept the fact that productivity will not grow in future at anything like the rates of the period before 1973. Others look around and see impressive changes in technology and cannot believe that productivity growth will not move back closer to the higher levels of yesteryear.[6] A great deal of work is taking place to evaluate the data, but so far there is little evidence that data difficulties account for a significant part of the decline in productivity growth as calculated by the Bureau of Labor Statistics.[7]

3. **The ZLB and the effectiveness of monetary policy**: From December 2008 to December 2015, the federal funds rate target set by the Fed was a range of 0 to ¼ percent, a range of rates that was described as the ZLB (zero lower bound).[8] Between December 2008 and December 2014, the Fed engaged in QE – quantitative easing – through a variety of programs. Empirical work done at the Fed and elsewhere suggests that QE worked in the sense that it reduced interest rates other than the federal funds rate, and particularly seems to have succeeded in driving down longer-term rates, which are the rates most relevant to spending decisions.

   Critics have argued that QE has gradually become less effective over the years, and should no longer be used. It is extremely difficult to appraise the effectiveness of a program all of whose parameters have been announced at the beginning of the program. But I regard it as significant with respect to the effectiveness of QE that the taper tantrum in 2013, apparently caused by a belief that the Fed was going to wind down its purchases sooner than expected, had a major effect on interest rates.

   More recently, critics have argued that QE, together with negative interest rates, is no longer effective in either Japan or in the euro zone. That case has not yet been empirically established, and I believe that central banks still have the capacity through QE and other measures to run expansionary monetary policies, even at the zero lower bound.

4. **The monetary-fiscal policy mix**: There was once a great deal of work on the optimal monetary-fiscal policy mix. The topic was interesting and the analysis persuasive. Nonetheless the subject seems to be disappearing from the public dialogue; perhaps in ascendance is the notion that – except *in extremis,* as in 2009 – activist fiscal policy

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6 See, for instance, Mokyr, Vickers, and Ziebarth (2015).

7 See Byrne, Fernald, and Reinsdorf (forthcoming).

8 Inside the Fed, the range of 0 to 1/4 percent is generally called the ELB, the effective lower bound.

should not be used at all. Certainly, it is easier for a central bank to change its policies than for a Treasury or Finance Ministry to do so, but it remains a pity that the fiscal lever seems to have been disabled.

5. **The financial sector**: Carmen Reinhart and Ken Rogoff's book, *This Time Is Different*, must have been written largely before the start of the great financial crisis. I find their evidence that a recession accompanied by a financial crisis is likely to be much more serious than an ordinary recession persuasive, but the point remains contentious. Even in the case of the Great Recession, it is possible that the U.S. recession got a second wind when the euro-zone crisis worsened in 2011. But no one should forget the immensity of the financial crisis that the U.S. economy and the world went through following the bankruptcy of Lehman Brothers – and no one should forget that such things could happen again.

   The subsequent tightening of the financial regulatory system under the Dodd-Frank Act was essential, and the complaints about excessive regulation and excessive demands for banks to hold capital betray at best a very short memory. We, the official sector and particularly the regulatory authorities, do have an obligation to try to minimize the regulatory and other burdens placed on the private sector by the official sector – but we have a no less important obligation to try to prevent another financial crisis. And we should also remember that the shadow banking system played an important role in the propagation of the financial crisis, and endeavor to reduce the riskiness of that system.

6. **The economy and the price of oil**: For some time, at least since the United States became an oil importer, it has been believed that a low price of oil is good for the economy. So when the price of oil began its descent below $100 a barrel, we kept looking for an oil-price-cut dividend. But that dividend has been hard to discern in the macroeconomic data. Part of the reason is that as a result of the rapid expansion of the production of oil from shale, total U.S. oil production had risen rapidly, and so a larger part of the economy was adversely affected by the decline in the price of oil. Another part is that investment in the equipment and structures needed for shale oil production had become an important component of aggregate U.S. investment, and that component began a rapid decline. For these reasons, although the United States has remained an oil importer, the decrease in the world price of oil had a mixed effect on U.S. gross domestic product. There is reason to believe that when the price of oil stabilizes, and U.S. shale oil production reaches its new equilibrium, the overall effect of the decline in the price of oil will be seen to have had a positive effect on aggregate demand in the United States, since lower energy prices are providing a noticeable boost to the real incomes of households.

7. **Secular stagnation**: During World War II in the United States, many economists feared that at the end of the war, the economy would return to high pre-war levels of unemployment – because with the end of the war, demobilization, and the massive reduction that would take place in the defense budget, there would not be enough demand to maintain full employment.

   Thus was born or renewed the concept of secular stagnation – the view that the economy could find itself permanently in a situation of low demand, less than full employment, and low growth.[9] That is not what happened after World War II, and the

[9] I am distinguishing in this section between secular stagnation as being caused by a deficiency of aggregate demand and another view, that output growth will be very slow in future because productivity growth will be very low. The view that future productivity growth will be very low has already been discussed, with the conclusion that we do not have a good basis for predictions of its future level, and that we simply do not know whether future productivity growth will be extremely low or higher than it has been recently. There is no shortage of views

thought of secular stagnation was correspondingly laid aside, in part because of the growing confidence that intelligent economic policies – fiscal and monetary – could be relied on to help keep the economy at full employment with a reasonable growth rate.

Recently, Larry Summers has forcefully restated the secular stagnation hypothesis, and argued that it accounts for the current slowness of economic growth in the United States and the rest of the industrialized world. The theoretical case for secular stagnation in the sense of a shortage of demand is tied to the question of the level of the interest rate that would be needed to generate a situation of full employment. If the equilibrium interest rate is negative, or very small, the economy is likely to find itself growing slowly, and frequently encountering the zero lower bound on the interest rate.

Research has shown a declining trend in estimates of the equilibrium interest rate. That finding has become more firmly established since the start of the Great Recession and the global financial crisis.[10] Moreover, the level of the equilibrium interest rate seems likely to rise only gradually to a longer-run level that would still be quite low by historical standards.

What factors determine the equilibrium interest rate? Fundamentally, the balance of saving and investment demands. Several trends have been cited as possible factors contributing to a decline in the long-run equilibrium real rate. One likely factor is persistent weakness in aggregate demand. Among the many reasons for that, as Larry Summers has noted, is that the amount of physical capital that the revolutionary information technology firms with high stock market valuations have needed is remarkably small. The slowdown of productivity growth, which as already mentioned has been a prominent and deeply concerning feature of the past six years, is another important factor.[11] Others have pointed to demographic trends resulting in there being a larger share of the population in age cohorts with high saving rates.[12] Some have also pointed to high saving rates in many emerging market countries, coupled with a lack of suitable domestic investment opportunities in those countries, as putting downward pressure on rates in advanced economies – the global savings glut hypothesis advanced by Ben Bernanke and others at the Fed about a decade ago.[13]

Whatever the cause, other things being equal, a lower level of the long-run equilibrium real rate suggests that the frequency and duration of future episodes in which monetary policy is constrained by the ZLB will be higher than in the past. Prior to the crisis, some research suggested that such episodes were likely to be relatively infrequent and generally short lived.[14] The past several years certainly require us to

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on this issue among economists, but the views to some extent appear to depend on whether the economist making the prediction is an optimist or a pessimist.

[10] This research includes recent work by Johannsen and Mertens (2015) and Kiley (2015) that uses extensions of the original Laubach and Williams (2003) framework. An international perspective on medium-to-long-run real interest rates is provided by U.S. Executive Office of the President (2015). Reinhart and Rogoff (2009) and Hall (2014) discuss the long-lived effects of financial crises on economic performance. See also Hamilton and others (2015). I have, in addition, drawn on Fischer (forthcoming).

[11] It is also a major factor explaining the phenomenon of the economy's impressive performance on the jobs front during a period of historically slow growth.

[12] See, for instance, Gordon (2014, 2016).

[13] See Bernanke (2005). See also the recent work by Caballero, Farhi, and Gourinchas (2008); and Mendoza, Quadrini, and Rios-Rull (2009).

[14] See, for instance, Reifschneider and Williams (2000), Blanchard and Simon (2001), and Stock and Watson (2003).

reconsider that basic assumption. Moreover, recent experience in the United States and other countries has taught us that conducting monetary policy at the effective lower bound is challenging.[15] And while unconventional policy tools such as forward guidance and asset purchases have been extremely helpful and effective, all central banks would prefer a situation with positive interest rates, restoring their ability to use the more traditional interest rate tool of monetary policy.[16]

The answer to the question "Will the equilibrium interest rate remain at today's low levels permanently?" is also that we do not know. Many of the factors that determine the equilibrium interest rate, particularly productivity growth, are extremely difficult to forecast. At present, it looks likely that the equilibrium interest rate will remain low for the policy-relevant future, but there have in the past been both long swings and short-term changes in what can be thought of as equilibrium real rates.

Eventually, history will give us the answer. But it is critical to emphasize that history's answer will depend also on future policies, monetary and other, notably including fiscal policy.

Concluding remarks

Well, are the answers all different than they were 50 years ago? No. The basic framework we learned a half-century ago remains extremely useful. But also yes: Some of the answers are different because they were not on previous exams because the problems they deal with were not evident fifty years ago. So the advice to potential policymakers is simple: Learn as much as you can, for most of it will come in useful at some stage of your career; but never forget that identifying what is happening in the economy is essential to your ability to do your job, and for that you need to keep your eyes, your ears, and your mind open, and with regard to your mouth – to use it with caution.

Many thanks again for this award and this opportunity to speak with you.

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[15] For a discussion of various issues reviewed by the Federal Open Market Committee in late 2008 and 2009 regarding the complications of unconventional monetary policy at the ZLB, see the set of staff memos on the Board's

[16] See Williams (2013).

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Appendix

The following model includes a number of elements that play a central role in the analysis of economic fluctuations and in larger policy models as I have encountered them at the Federal Reserve and other institutions.

An *aggregate demand* relationship, in the form of the investment-saving (or IS) curve, characterizes the negative dependence of economic activity on the real borrowing rate, $i_B - \pi^e$, and the positive dependence on expected output, y^e; government spending, G; and net exports, NX, as a function of the exchange rate, e, and foreign output, y^f:

$$y = A(i_B - \pi^e, y^e, G, NX), with NX = f\left(\frac{eP^f}{P}, y^f\right). \quad (1)$$

The *Phillips curve* describes a relationship between inflation and labor market slack. Inflation responds negatively to the level of the unemployment gap, u^{gap}, and to changes in aggregate productivity, z (including shocks to commodity prices). Current inflation also responds positively to expected future inflation, π^e, and to the level of the borrowing rate and of the exchange rate, $\phi(i_B, e)$ (cost - push shocks):

$$\pi = f(u^{gap}) - z + \pi^e + \phi(i_B, e). \text{ (Phillips curve)} \quad (2)$$

Current issues regarding the role of expectations, the size of the slope, and the pass-through from exchange rate movements to domestic prices and wages can be addressed in this context. Recent discussions can be found in Blanchard's (2016) reference to the back-to-the-1960s thinking about the Phillips curve and in Blanchard, Cerutti, and Summers's (2015) thoughts on hysteresis mechanisms underlying the inflation and unemployment dynamic.

To connect cyclical fluctuations in the level of aggregate activity with changes in employment, *Okun's law* has been proved useful as an empirical description of the relationship between the output gap and the unemployment gap, $u^{gap} = u - u^*$ (see Knotek (2007); and Daly, Fernald, Jordà, and Nechio (2013, 2014)):

$$y^{gap} = -\gamma u^{gap}. \text{ (Okun's law)} \quad (3)$$

To characterize *monetary policy*, it is nowadays useful to consider how the central bank affects the level of interest rates by setting the federal funds rate, i, in response to deviations of expected inflation from its target, $\pi^{gap} = \pi^e - \pi^*$ (inflation gap), and percent deviations of output from its potential level, $y^{gap} = y - y^*$ (output gap):

$$i = f(\pi^e - \pi^*, y^{gap}). \quad (4)$$

To capture the role of credit and financial intermediation in the economy, consider a *loan market equation*, where the demand on the left-hand side depends negatively on the borrowing rate, i_B, and the level of economic activity (higher income implies lower financing needs). The supply of loans depends negatively on the level of interest rates, i, and positively on the level of intermediation spreads, ω, and income, y (to the extent that higher aggregate income increases deposits and banks' capitalization and hence the supplies of intermediated funds). This equation pins down the equilibrium level of the intermediation spread, ω:

$$L_d(i_B, y) = L_s(i, \omega, y). \quad (5)$$

The borrowing rate, i_B, is then equal to the sum of the risk-free rate set by the central bank, i, and the spread, ω:

$$i_B = i + \omega. \quad (6)$$

This analysis is in the spirit of James Tobin's approach to monetary economics as was recently described by Solow (2004) and extended by Woodford (2010) to describe the role for financial intermediation shocks. It also captures the work by B. Friedman, B. Bernanke, and A. Blinder

in thinking about the role of credit and credit spreads in the transmission of monetary policy impulses.

Open economy aspects are captured by the following equations: The *balance of payment* is in equilibrium when net exports are compensated by capital flows of opposite sign. Capital flows depend on the difference between the domestic interest rate and the foreign rate adjusted for depreciation:

$$NX\left(_{eP\,f\,P}\,,y_{\,f}\right)+CF\left(i\_i\,f\,\__{dee}\right)=0\ . \quad (7)$$

Furthermore, the *uncovered interest rate parity* equates the rate of return on domestic assets, i , to the rate of return on foreign assets, $i\,f$, plus future expected changes in the exchange rate, $_{dee}$, and a residual risk premium component, RP :

$$i=i\,f\,+_{dee}+RP\ . \quad (8)$$

For a detailed description of these relationships, see Dornbusch, Fischer, and Startz (2014); and Obstfeld and Rogoff (1996).