

Special Commentary

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Does Disinflation Threaten the Global Economy?¹

Economies evolve over time, just as the nature of risks and challenges to economies changes. How can we estimate some early warning signals about an impending risk/crisis before it occurs? Recently, much of the discussion around monetary policy in a number of large developed economies, including the United States, Japan and the Eurozone, has focused on the risk of disinflation and how to avoid it. Here, our goal is to quantify the probability of deflationary pressures in these economies, and more broadly, for the global economy as a whole. This report provides an early warning system (EWS) to predict the near-term probability of inflationary/deflationary pressure for each of these regions. Specifically, we utilize an ordered probit approach to estimate the six-months-ahead probability of three distinct price scenarios: inflationary pressure, deflationary pressure or price stability.²

We build models for five regions to gauge each region's inflation outlook. Our first model assesses the inflation/disinflation outlook for the global economy, while the second model generates the likelihood of each inflation scenario for the advanced economies. Our final three models forecast the probability of inflation/disinflation for the U.S., Eurozone and Japan.

Our global model suggests deflationary pressure is more likely than the other two inflation scenarios, with the model forecasting a 0.97 probability of deflationary pressure in the next six months. The advanced economies model suggests the probability of deflationary pressure is 0.59. The probability of deflationary pressure is 0.63 for the United States, 0.84 for Japan and 0.52 for the Eurozone.

Since 2013, all five models have consistently suggested that deflationary pressure is the most likely of the three scenarios. Given the historical accuracy of these models, and by combining all these signals into one framework, we predict that the risk of deflationary pressure is much higher than the other two inflation scenarios for the global economy in the near term.

Why Use Five Different Models?

During the past eight years, a large number of economies, advanced economies in particular, experienced financial crises and subsequent recessions, and some fear that the lingering effects from these events may still be exerting downward pressure on the global inflation outlook.³ To

Our model aims to quantify the risk of disinflation in large advanced economies and the global economy as a whole.

The model predicts a 0.97 percent probability of deflationary pressure for the global economy in the next six months.

¹ The initial draft of this paper was presented at the 2015 Annual Meeting of American Economic Association, Boston. The full paper is available upon request.

² We define these scenarios as follows: "deflationary pressure", a term we use interchangeably with "disinflation", implies an inflation rate below a region's target range. "Stable prices" implies an inflation rate within the target range, and "inflationary pressure", which we use interchangeably with "inflation," is defined as an inflation rate above a region's target range. Please note that deflationary pressure does not necessarily imply outright deflation. See the next section for more detail about target ranges.

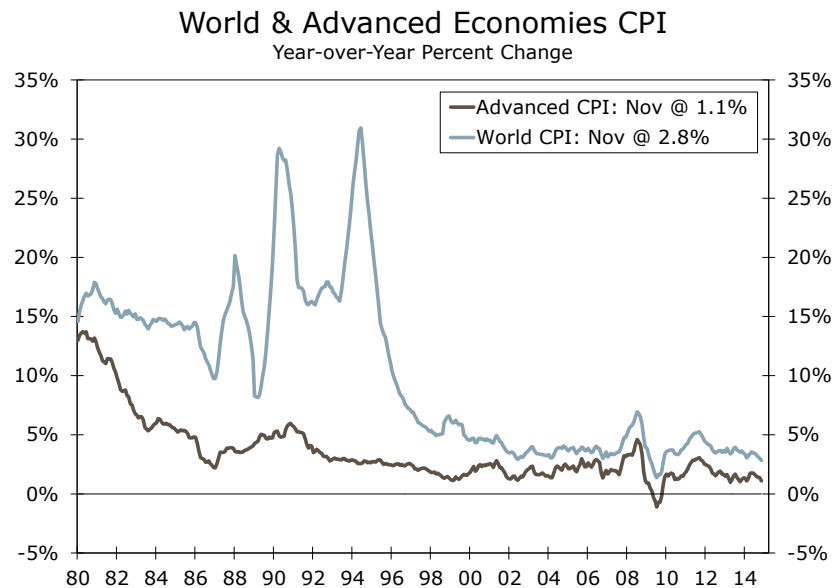
³ Major economies including the United States, Eurozone, Japan and United Kingdom experienced several notable events such as recessions, elevated unemployment rates, disinflation, large output gaps, budget gaps, etc.



determine if these fears are justified, we deploy a global ordered probit model using the IMF measure of global CPI, as shown in Figure 1.

The world economy is comprised of more than 180 economies, which can be divided into two broader groups: advanced and developing economies. In recent years, many advanced economies have faced lower inflation rates, while most developing countries are not worried about deflationary pressure as prices are growing at or above “normal” rates in these economies. For example, the IMF measure of CPI inflation for advanced economies has been less than 2 percent since January 2012, while average CPI inflation for emerging/developing economies over the same period was 5.8 percent. To estimate the risk of deflationary pressure for the advanced economies, we utilize an ordered probit model.⁴

Figure 1



Source: IMF, IHS Global Insight and Wells Fargo Securities, LLC

Inflation rates in large advanced economies play a large role in determining global inflation.

Some developed economies are large enough to affect other economies as well as the global economy, making it important to estimate the risk of disinflation for those economies individually. The U.S. economy is the largest economy in the world and some say the U.S. Great Recession (2007-09) may have been a key reason for the global economic downturn during that time period; the IMF reported global GDP growth rate for 2009 was -0.4 percent. Therefore, a higher risk of disinflation in the U.S. may boost the risk of global disinflation. By the same token, a higher risk of U.S. inflation either may reduce the risk of global disinflation (assuming U.S. inflationary pressure may offset other economies' deflationary pressure) or increase global inflation rates (in the case of rising inflation rates in the rest of the world). We utilize an ordered probit model to predict the probability of deflationary pressure for the U.S.

The Eurozone, as a single economic entity, is one of the largest economies in the world, but it has been struggling for the past several years, some say since the Great Recession began. Specifically, the unemployment rate in the Eurozone has been in the double digits since July 2011, and GDP growth rates have been less than 1 percent since June 2013 (the Eurozone was in recession between December 2011 and March 2013). Consequently, the country's CPI inflation rate has

⁴ Due to the data limitation problem, we are unable to build an ordered probit model for developing economies. In the future, if data become available (predictors of the model in particular) then we will seek to build a model to predict inflationary scenarios for developing economies.

been less than 1 percent since October 2013. Given the size and importance of the Eurozone economy to the world, we build a model to predict the probability of deflationary pressure in the Eurozone.

Japan is another major developed economy, and it has been in and out of actual deflationary territory roughly since 1994. The average CPI inflation rate in Japan for the 1990-2014 period was just 0.5 percent, and between 2000 and 2014, the average rate was -0.1 percent. To add to the pain, Japan reported negative GDP growth rates in Q2 and Q3 of 2014, sending the country into its third technical recession in the past five years.⁵ The last of our five probit models estimates probabilities of each price scenario for Japan's economy.

Econometrics of the Early Warning System

An EWS is a distinct approach compared to traditional forecasting methods, since traditional methods usually predict levels or growth rates of one or more variables of interest. In the case of the EWS method, an analyst is more interested in predicting specific states, which are structurally different from one another. For instance, in the present case, the objective is to predict probabilities of inflationary pressure, deflationary pressure and stable prices, and these three states for inflation are structurally different from each other.⁶

Global Model

Two threshold values for the world CPI inflation rate are utilized to determine periods of inflationary pressure, deflationary pressure and stable prices. Many central banks have an explicit inflation target rate, i.e., the central banks in the United States, Eurozone and Japan have an inflation target rate of or near 2 percent. However, there is no explicit inflation target for world prices, and 2 percent seems low since the world CPI consists of prices in developed and developing countries, and developing economies' inflation rates are much higher than the developed world, on average.

We define each inflationary scenario based on a "target" range for inflation.

A practical solution would be to use the long-run average rate as a benchmark. The average inflation rate for 1996-2014 is 4.4 percent, which we subsequently use as an "target" for world CPI inflation. Furthermore, we use a 0.5 percent spread from this 4.4 percent target (4.4 ± 0.5) to define three price scenarios. That is, if the world CPI growth rate is between 3.9 percent and 4.9 percent, then inflation is in the stable prices range and the dependent variable, Y_t , in the model is zero ($Y_t=0$). The value of the dependent variable is one ($Y_t=1$) if CPI inflation is running above 4.9 percent ($4.4 + 0.5$), which denotes inflationary pressure. By the same token, deflationary pressure is represented by CPI inflation below 3.9 percent ($4.4 - 0.5$) and $Y_t=-1$.

After creating the dependent variable for the global ordered probit model, we select predictors of the model. We include four predictors measuring major sectors of the global economy in the global model. The predictors are (1) the IMF G7 average 10-year government bond yield, (2) a world equity market index (the MSCI world index, year-over-year (YoY) growth rate), (3) the world unemployment rate and (4) the world index of leading indicators (YoY).

Advanced Economies Model

The second model uses a similar methodology but serves as an early warning signal for the advanced economies. The IMF characterizes a group of 36 countries as advanced economies and produces a measure of prices for that group, known as advanced economies CPI.⁷ We utilize the advanced economies CPI series to create the dependent variable of the ordered probit model. We set a 2 percent CPI inflation rate as the target rate for this group, since many central banks in

⁵ A technical recession is defined, sometimes, as two consecutive quarters of negative GDP growth rates.

⁶ The econometric methodology is explained in detail in the conference paper.

⁷ As of October 2014, there are 36 countries in the advanced economies group and a complete list of the countries can be found at the IMF website.

advanced economies have an inflation target of 2 percent (or near 2 percent), and we feel it is safe to assume the same inflation target for the whole group. Another reason for this assumption is that the average CPI growth rate over the past few decades in advanced economies was around 2 percent (1.97 percent for the 1995-2014 period). Therefore, we use 2 percent as an inflation target, and a spread of 0.5 percent (2 ± 0.5) to define inflationary pressure, deflationary pressure and stable prices for the advanced economies model. The advanced economies model also includes four predictors: the IMF G7 average 10-year government bond yield, the advanced economies unemployment rate, equity prices (the MSCI developed countries index, YoY) and LEI (OECD LEI, YoY).

Country-Level Models

Each model uses a region's unemployment rate, 10-year government bond yield, LEI and benchmark equity index.

For the United States, we utilized the PCE deflator as a measure of inflation because it is the preferred inflation measure of the FOMC. For the Eurozone and Japanese models, we use CPI inflation because this is the primary measure of prices in these economies. The FOMC, the European Central Bank and the Bank of Japan's target inflation rates are 2 percent or near 2 percent, so we use a 2 percent inflation target and a spread of 0.5 percent (2 ± 0.5) to create the dependent variables for these countries' ordered probit models.

The U.S. model includes the following four predictors; the unemployment rate, the S&P 500 index (YoY), the 10-year Treasury yield and the LEI (YoY). The four predictors of the Eurozone model are the Eurozone 10-year government bond yield, the unemployment rate, the LEI (YoY) and equity prices (the Euro Stoxx 50 index, YoY).⁸ The predictors of the Japanese model are the 10-year government bond yield, the unemployment rate, the LEI (YoY) and equity prices (Nikkei, YoY).

What Do the Models Tell Us?

For all five models, we generate simulated real-time out-of-sample probabilities of inflation scenarios. The major benefit of this exercise is that, as we have the actual inflation scenarios for an historical time period, we can evaluate each model's out-of-sample performance. For all five models, the complete sample period extends from Q1 1975 to Q3 2014. Using this sample data, we generate simulated real-time out-of-sample probabilities of each inflationary scenario for the period from Q1 1994 to Q3 2014. Our first forecasted value incorporates sample data from Q1 1975 through Q4 1993 and predicts probabilities for the next two quarters (Q1 1994-Q2 1994). The sample period for the next forecast (for Q2 1994-Q3 1994) is then expanded to include Q1 1994, such that the entire sample period now extends from Q1 1975-Q1 1994. We follow this recursive approach for the remainder of sample period, up until Q3 2014, the latest available data point.

The simulated real-time out-of-sample probabilities for the global model are plotted in Figure 2. The light brown bars (shaded area) above zero represent periods of inflationary pressure. That is, the bars (shaded area) above the zero-line indicate that the world CPI growth rate was greater than 4.9 percent during that time period. Similarly, the bars (shaded area) below the zero-line correspond to periods of deflationary pressure, i.e., when CPI inflation was below 3.9 percent. The blank area, between Q4 1999 and Q3 2001 for instance, shows prices were stable (CPI inflation between 3.9 percent and 4.9 percent).

⁸The Eurozone CPI series starts in 1997 and thereby dictates the start date of the Eurozone model.

Figure 2

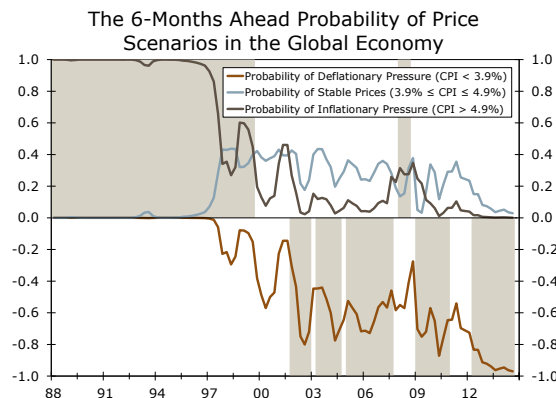
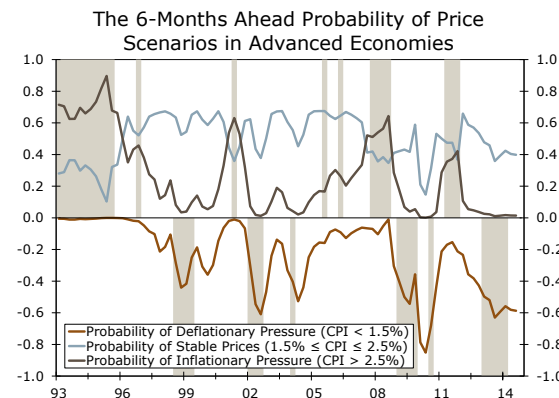


Figure 3



Source: IMF, IHS Global Insight and Wells Fargo Securities, LLC

In Figure 2, the brown line represents the two-quarters-out probability of inflationary pressure, the blue line represents the probability of stable prices and the red line corresponds to the probability of deflationary pressure. We converted the probability of deflationary prices into a negative series (multiplied values by negative one) such that a probability closer to -1 (minus one), indicates a higher risk of deflationary pressure within the next two quarters. Conversely, a probability closer to one for either of the other two scenarios suggests that this particular scenario is more likely.

The EWS for inflationary pressure has historically been consistent with actual periods of inflationary pressure. In our simulated out-of-sample period, Q1 1994-Q3 2014, for example, actual prices were in the inflationary range between Q1 1994 and Q3 1999 and the probabilities of inflationary pressure were above 0.5 for the Q1 1994-Q4 1997 and Q4 1998-Q2 1999 periods.⁹ The EWS for price stability signaled stable prices for the 2000-2001 period as the probability was above 0.35 between Q3 1999 and Q3 2001. Just as our model predicted, the global CPI inflation rate was in the 3.9 percent-4.9 percent range throughout this period.

The CPI inflation rate was in the deflationary pressure range during the Q4 2001-Q3 2007 period, except for the two quarters (Q1 2003 and Q4 2004) when prices were stable. Our global model suggested deflationary pressure throughout the entirety of this period. In addition, since 2009, most of the time global inflation rates have been in the disinflationary range, except for 2011, when inflation was in the stable range. The model persistently signaled disinflation and, since Q4 2012, probabilities were above 0.90. In sum, the global model successfully predicted all three inflation scenarios in our simulated out-of-sample period. Given the model's track record and the most recent probability reading of deflationary pressure at 0.97, we suggest there is a strong possibility of deflationary pressure in the near term for the global economy.

Figure 3 shows probabilities of the three inflation scenarios for advanced economies. We utilize the Q1 1994-Q3 2014 period for the out-of-sample simulation. Prices were in the inflationary pressure range between Q1 1994 and Q3 1995, a period during which the model consistently predicted a probability of 0.65 or higher of inflationary pressure. Between Q4 2007 and Q3 2008, the probability of inflationary pressure was above 0.5, and, in fact, CPI inflation was in the inflationary range during the same period. During the last three quarters of 2011, the model correctly signaled inflationary pressure, although the signal was not as strong as prior periods.

The EWS for inflationary pressure has historically been consistent with actual periods of inflationary pressure.

⁹There is another very brief period (first 3 quarters of 2008) of inflationary pressure in our simulated sample period. The model predicted elevated probabilities (above 0.2) of inflationary pressure for the Q3 2007-Q4 2008 period.

Figure 4

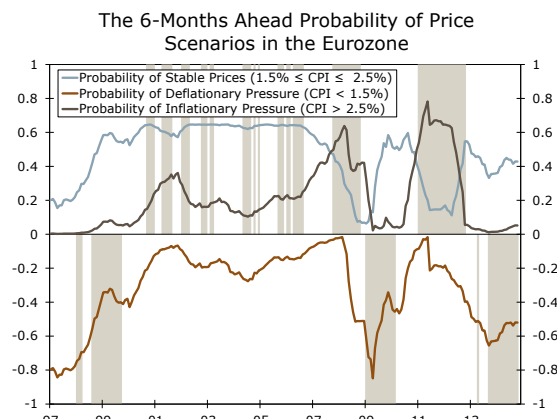
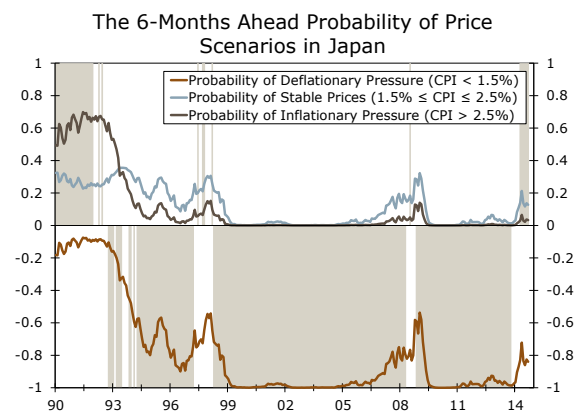


Figure 5

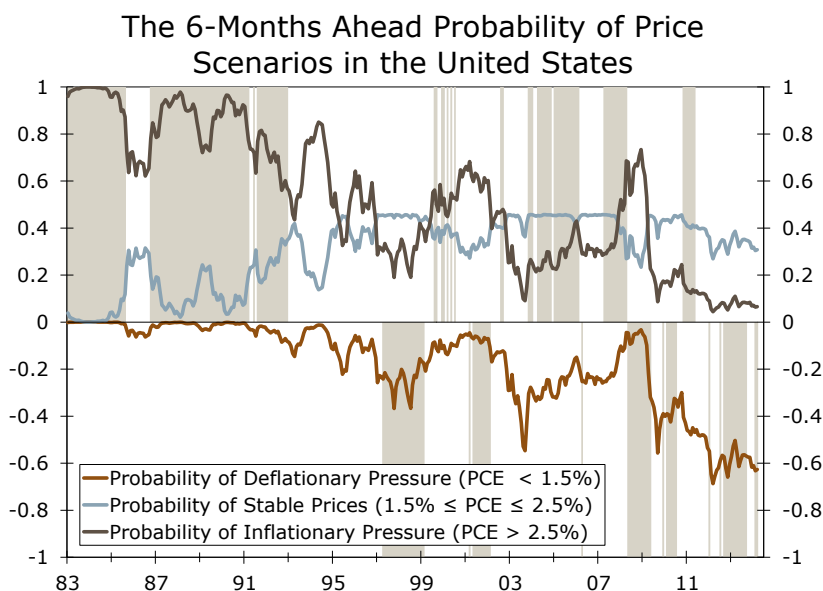


Source: IHS Global Insight, Bloomberg LP and Wells Fargo Securities, LLC

All five models indicate deflationary pressure is the most likely scenario in the next six months.

As can be seen in Figures 2-6, all five models have shown generally the same level of historical accuracy. That is, in periods where the model has predicted a certain inflation scenario, inflation has typically ended up in the same range during these periods. Looking to the most recent results, all five models have been consistently pointing to deflationary pressure as the most likely of the three scenarios. Notably, our Japan model has been predicting a probability above 0.5 of deflationary pressure since 1993. The likelihood of disinflation has been trending upward in all of these economies for the past few years, but has been particularly strong in recent quarters. Based on the most recent available data (Q3 2014), the probabilities of deflationary pressure in the next six months for the advanced economies, the United States, Japan and the Eurozone are 0.59, 0.63, 0.84 and 0.52, respectively. This coincides with the aforementioned increasing probability of global disinflation, as inflation in these regions plays an outsized role in determining global rates of inflation.

Figure 6



Source: U.S. Department of Commerce and Wells Fargo Securities, LLC

Concluding Remarks: Connecting Probabilities of the Five Models

One intriguing question arises: are the probabilities of these five models connected? Or, by integrating these probabilities, can we obtain a stronger signal for a particular inflationary situation for the global economy? The answer is yes, in our view. For instance, during 2008, inflation rates were in the inflationary pressure range for all five economies (even Japanese inflation was either in the inflationary pressure or stable prices region throughout mid-2008). During 2008, all five models estimated an uptick in inflationary pressure/stable prices probabilities along with declining deflationary pressure probabilities. By the same token, during 2009, all five models produced an increasing trend in deflationary pressure and actual inflation rates were in the deflationary zone in all five economies during the same time period. This suggests that if all models signal a particular inflation scenario, deflationary pressure for instance, then that can be viewed as a strong signal of that particular price scenario for the global economy in the near term.

In addition, since 2013, all models have been consistently signaling deflationary pressure. Given the historical accuracy of these models, and by combining all these signals into one framework, we suggest that the risk of deflationary pressure is much higher than the inflationary pressure or stable price scenarios for the global economy in the near term.

The risk of deflationary pressure is much higher than any other scenario for the global economy in the near term.

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